Artifact: Journal of Design Practice
Volume 5 Number 2
 doi: 10.1386/art_00003_1

JENNY PINSKI
Loughborough University

FAITH KANE
Massey University

MARK EVANS
Loughborough University

Craft-based design for innovation: Potential in novelty, quality and sustainability through hands-on interaction

ABSTRACT

The industrial revolution created a rise in mass manufacture, increasing consumption to current unsustainable levels and marking a decline in hands-on craft practice. In contemporary practice, designers frequently employ digital ways of working and, whilst this may create opportunities and efficiencies, it can limit the working of materials by hand. In contrast, hands-on craft processes can develop in-depth knowledge and understanding to help solve complex and novel design problems. With increasing use of digital design methods, it is timely to reflect on the role and value of hands-on craft practices. The study explores the use of craft-based

KEYWORDS

design for sustainability
craft-based design
hands-on design
woven textiles
footwear
design process research

approaches to support design practice in relation to novelty and quality and considers its future potential to contribute towards design for sustainability. A design project that integrated hand weaving with sandal design was undertaken and qualitative data were collected. This was analysed through data reduction, coding, clustering and display and is presented as a case study. The findings indicate that a craft-based approach can contribute to a heightened control of materials, construction and awareness of wider design issues such as the development process, production methods and environmental impact. Difficulties were identified in inefficient use of time and a knowledge/skills gap between specialist design and craft disciplines.

1. INTRODUCTION

Creativity and developing novel design solutions is important for ongoing development within the design industry and consumers have become more open to innovation in footwear design (Huey and Kenny 2014: 8–9). Hands-on making can inform creative thought (Treadaway 2007: 35) and contribute towards the development of novel materials (Yair and Schwarz 2011: 312). However, it is rarely used in commercial footwear design.

The industrial revolution instigated a period of change for footwear design and manufacture as increasing levels of automation brought about the decline of the craftsperson (Walford 2007: 50–51). The current dominance of high-volume manufacturing has contributed towards environmental problems such as the generation of excessive waste. For example, in footwear production, around 25–35 per cent of leather and 20–25 per cent of textiles are discarded (Afirm Group 2010). In textiles manufacturing, machine-powered weaving technology became established (Buchanan 1995: 4) and the development of the power loom enabled manufacturers to quickly produce cloth of consistent quality without the need for skilled hand weavers (Benson and Warburton 1986: 10). As with footwear production, increases in the volume of textile manufacturing have had wide-reaching environmental and social impact.

The aim of this study was to assess the potential for craft-based approaches to support design practice and complex problem solving in relation to novelty, quality and design for sustainability. This resulted in the following three research questions:

1. What is the typical and state-of-the-art practice in footwear design, textile design and craft-based approaches to design?
2. Does a craft-based approach have the potential to positively impact on novelty, quality and design for sustainability – if so, how?
3. What key aspects of a craft-based approach may be transferable to other disciplines or design specialisms?

The methodology employed aligned with Frayling's notion of 'research into art and design' and 'research through art and design' (1993: 5). This employed a literature review to identify historical and theoretical concerns in the field, with empirical research involving practical experimentation supported by qualitative data collection and analysis. The resulting findings are presented

as a case study to support the development of novel theory through emergent processes and direct evidence (Eisenhardt 2002: 29).

The literature review identifies what is considered common practice within footwear and textile design. Through a review of approaches, including hands-on and digital, a basis and context for craft-based woven textile practice in sandal design is presented. This leads on to a discussion of previous studies and practice that involve the use of textile approaches and logic to enhance novelty, quality and design for sustainability. Methods are identified and their contributions to creative and sustainable agendas are discussed. Following the literature review, methods used in the empirical research are presented and the findings are discussed. 2D, 3D, digital, hands-on and hybrid approaches are analysed in terms of strengths and weaknesses. The article concludes by identifying key opportunities and considerations in the use of a craft-based woven textile approach to sandal design. Supported by the literature review, a future research opportunity is identified in testing the developed theory within other design specialisms and, more broadly, as an approach to complex problem solving.

2. LITERATURE REVIEW

2.1 Footwear design processes and approaches

In footwear design, ideas are typically generated through drawing in a 2D format and materials are then applied later in the process. At the early design stages, form is given primary consideration over material application (Schaffer and Saunders 2012). 3D digital processes are starting to be employed to increase efficiency in footwear design. It is used in aspects of the process such as the design of the shape around which the footwear is formed (known as a 'last') (Wang et al. 2011; Zhang et al. 2011) or the whole shoe design and sampling (Joneja and Kit 2013).

3D models can be used as an alternative to physical mock-ups in the early stages of the design process (Joneja and Kit 2013: 256) and computer-aided design (CAD) may feed directly into computer-aided manufacture (CAM). While there are benefits associated with an integrated CAD/CAM approach, there are also a number of difficulties and considerations. Joneja and Kit (2013) discuss this in relation to whole shoe design and sampling in which they identified limitations in the ability to accurately simulate and predict the stretching that occurs in the upper material during manufacture. Issues associated with levels of control in manipulating 3D digital models and software have been identified by Joneja and Kit (2013: 250), who discovered that complex outsoles (the part of the sole that touches the ground) were beyond the scope of footwear-specific CAD software. Although such studies have identified limitations associated with CAD/CAM, they are highly process focused and fail to acknowledge the wider implications of the removal of hand processes and direct interaction with material. More consideration needs to be given to this omission from a designer's perspective, particularly in relation to creative processes and the quality of outcomes. It is also possible that the automation of processes, such as creating templates for the footwear upper parts, called pattern cutting, may lead to an eventual gap in knowledge and limit designers' understanding of the construction. In the context of an increase in the use of CAD/CAM for footwear design, it is therefore necessary to consider the implications of removing the opportunities afforded from the use of hands-on processes.

2.2 Woven textile design processes and approaches

Woven textile design often consists of sampling at the early stages of the process using a loom that holds the threads to enable weaving to take place. Designers experiment with different colours, structures and yarns before moving on to larger development samples (Wilson 2001: 14–15). During the weaving process designers work with the constraints associated with the equipment using creativity, intuition and judgement to make real-time decisions and generate new ideas (Hemmings 2012: 7).

CAD can be used to create paper versions of woven textiles although this is not common practice due to the importance of the feel of fabrics (Wilson 2001: 15). In the case of digital woven Jacquard designs that have decorative patterns woven into the fabric, the process is different and artwork for a design is created digitally or hand-produced work is translated to a digital file. Digital sampling is then used to refine the artwork into a technically viable design. Following this, data are transmitted to the loom on which the fabric is made and a woven sample is produced (Holyoke 2013: 69). Once a final design has been refined, the designer records the technical details so that it can be directly reproduced (Wilson 2001: 15, 116–17). This demonstrates a benefit of working with a hands-on woven textile approach as, by generating physical samples and engaging in the related planning/specification processes, designers have full control over the outcomes that develop through a number of subjective and technical decisions. It is therefore possible to communicate the final design details using a specification with supporting samples for translation into a manufactured product.

2.3 Hands-on making in the design process

Hands-on making can inform creative thought (Treadaway 2007: 35) and the hands have been described as a 'form of knowledge' by McCullough (1998: 2). Hands-on methods can provide designers with new information about materials (Sennett 2009: 159) and provide a detailed understanding of the problem at hand. It can also contribute towards the development of novel materials (Yair and Schwarz 2011: 312). Working directly with materials provides inspiration and can lead to unexpected results (Albers 1961: 6), meaning that it is a viable approach to innovation.

A potential issue with integrating hands-on making in design activity relates to the availability and cost of equipment and materials (Leader 2010: 407–08). Within the context of this study, the availability of weaving equipment, which is generally bulky and noisy, would be a key concern. Another challenge is that designers must have adequate training and the ability to use such equipment. Weaving is a specialism requiring distinctive skills, as is footwear design. Careful consideration must therefore be given to how a craft-based method of sandal design could be implemented. Collaboration is a possible approach, with Lawson and Loke (1997: 182) stating that, where a number of people work together on a problem, creative thought can be stimulated more effectively to create greater potential for innovation. In addition, digital processes have been found to aid accuracy (Lawson 2002: 328; Sennett 2009: 81) and such strengths associated with digital methods can also be valuable within design practice. Therefore, it is also important to consider how such methods can support hands-on making.

2.4 Craft-based approaches to textile design and design for sustainability

Design for sustainability involves complex processes and multifaceted strategies are required to improve the environmental, social, economic and cultural issues. Kadish and Dulic (2015: 75–76) discuss the similarities between this complexity and that which is experienced in design. Designers embrace ambiguity and solve 'ill-defined' problems with a focus on the solution using 'constructive' modes of thinking (Cross 1982: 226). This means that designers explore the problem and solution in parallel (Cross 2004: 432; Lawson and Loke 1997: 176). Pye (1968: 4) describes the way in which this uncertainty is used to inform craft practice whereby practitioners determine solutions during the making process. Referred to as a 'workmanship of risk', Pye (1968: 4) describes the way in which the outcome is in constant jeopardy and argues that this leads to 'diversity' (1968: 73) and novelty. Hands-on craft-based methods can enable designers to manage complexity and consider a problem or a situation from different perspectives through the generation of embodied, tactile knowledge (Pallasmaa 2009: 109–10).

In a woven textile approach, designers experience the textile (or textile product) construction process first-hand. This leads to an awareness and intimate understanding of the product through physical engagement. This understanding may prompt designers to consider the wider context and implications of products. Walker (2014: 3) suggests that such consideration, for example in relation to production and disposal, is important when designing for sustainability.

2.4.1 Materials

To employ a craft-based approach, it is not always necessary to engage with actual materials. For example, in the field of architecture, Oxman (2012) reports on increasing interest in the role of materials in design and presents a theory of 'informed tectonics' where there is an informed relationship between design, material and structure. This method of design is likened by Oxman (2012) to crafts such as weaving and the logic of such crafts can be extended to be used within design disciplines. By considering design, fabrication, production and manufacturing in parallel, craft-based principles can be employed within digital processes (Oxman 2012: 450). Similarly, Spuybroek (2011) presents examples of architectural design using textile structures and principles to generate novel design concepts. In these examples, the flexibility of textile-based structures is exploited to engineer areas of different structural properties in a theory of 'textile tectonics' (2011: 7). In the creation of architectural forms using textile techniques, material and structural properties can inform the overall form and aesthetic leading to novel outcomes.

The concept of an informed relationship between materials and form is reflected in Bezooyen's (2014) theory of 'materials-driven design' in which materials are introduced at the early explorative stages of the design process. This approach was found to lead to heightened consideration of material qualities and their appropriateness for a design proposal. The resulting theory identified that the approach optimized aesthetic quality, usability and appropriateness for manufacture (Bezooyen 2014: 279). The approach reflects the principles of woven textile design where feel and the way a fabric hangs are integral and designers often construct samples by hand. Similarly, Karana et al. (2015) have developed a model of material-driven design that incorporates

heightened consideration for the experiential aspects of materials and the relationship of material properties and experiences with the end user. This was deemed to be important for commercial success through increased user satisfaction.

2.4.2 Construction

Hemmings (2012: 65) identifies the work of McMullen, who creates 3D structures using woven textiles and describes the potential for use in engineering and architecture. Textile design is also being used in the manufacture of footwear but, due to the secretive nature of the industry, the information available is largely limited to patent applications and marketing material. An example of this is the Nike Flyknit running shoe with a knitted upper. The brand claims that this construction enhances performance, reduces weight and has environmental benefits through reduced waste (Nike 2012). Although not academically corroborated, this serves as a corporate claim of in-depth exploration of materials and construction aiding innovation and providing multiple benefits, including the reduction of production waste. Similar approaches are used in the fashion industry in the design of fully fashioned knitwear, where garment panels are knitted to shape, resulting in little or no waste (Wilson 2001: 103).

Rissanen and McQuillan (2016) present a pattern-cutting approach that consists of the creation of garments fashioned from a whole piece of fabric with no waste generated through offcuts. Similarly, Niinimäki (2013) discusses zero waste fashion design where the textile process informs the garment. Aspects such as the width of the fabric and its properties are considered and it is concluded that, where the designer creates their own fabrics, the potential for novel outcomes is increased. Piper and Townsend build on this theory and present the development of a 'Composite Garment Weaving system' (2016: 4) in which items of clothing are designed using woven textile approaches and methods, allowing for single piece construction. This integration of woven textile and fashion design demonstrates an approach similar to that explored in this study, albeit with applications in a different discipline. Piper and Townsend discovered that, by designing the material and product in parallel, there may be associated environmental benefits by engineering garments to minimize waste in production (2016: 7). In addition, it means that it is possible to construct the form and material in one step, which may result in a reduction in energy and resource consumption.

The application of craft-based logic in the creation of an informed and holistic design process is a key area of investigation for this study. Examples discussed incorporate digital methods in craft-based approaches and the integration of CAD/CAM to aid its application in a commercial design and manufacturing context where a number of constraints must be considered.

2.5 Summary

Two overarching themes have emerged from the literature survey of craft-based textile approaches to design. The first was the use of craft-based logics to enable more informed design decisions. This can be executed using hands-on or digital processes but there may be additional benefits when engaging with materials early on in the design process. The second is related to the first but is more specific in terms of designing a product and material in parallel or using the form of a material to ensure that there is little or no waste in production. This provides an example of how a more materials-focused approach can

lead to environmental benefits including the development and commercialization of low-impact materials and a reduction in waste and energy/resource consumption. This research provides an example of such potential.

3. MAIN STUDY

3.1 Methodological approach

This article reports on a design project that incorporated craft-based woven textile practice into the design of sandal uppers. This is presented as a case study of practice that incorporates non-digital, digital, 2D, 3D and hybrid approaches. The role and effectiveness of each approach are evaluated. Qualitative data were collected and analysed in relation to the strengths and weaknesses in terms of practicalities, novelty and the potential to enhance design for sustainability.

Flick (2006: 14) provides a comprehensive overview of qualitative research, describing it as a reflective process where the perspective of the researcher forms an important aspect of theory building. The first author, referred to as the designer, was positioned at the centre of the study by engaging in and reporting on creative practice. As a trained woven textile designer with four years of professional footwear design experience, this design expertise was integral to the decision to employ practice to support data collection. A number of design proposals were generated during this activity but they did not in themselves constitute research outcomes as their role was to be used during data analysis to support and add context in reference to the written data.

Langrish (2000) discusses the difference between artistic and academic research. In relation to Ph.D. research, but applicable to wider academic design research, the importance of the generation of new knowledge that is communicable to others is highlighted. This definition of research is widely accepted and in terms of this study, the practice itself is not claimed to be a research outcome. Instead it is used to generate data relating to an enquiry into novel methods and approaches to creative practice. The analysis and reporting of the resulting data are vital in ensuring that the study aligns with accepted academic research conventions. This methodological approach, which uses creative practice to support data collection, can lead to discovery through reflection (Nimkulrat 2012: 1). It can provide access to first-hand insights into the creative process that enables access to information that is not derivable from other sources (Evans 2010: 8; Archer 1995: 11). The study employs qualitative research as an approach that values and acknowledges the importance of the researcher's perspective and facilitates the investigation of rare and complex issues (Flick 2006: 15).

3.2 Case study

The design project is treated and reported on as a case study. This was informed by Eisenhardt, who describes it as a 'strategy which focuses on understanding the dynamics present within single settings' (2002: 8). Yin describes how this research method 'allows investigators to retain the holistic and meaningful characteristics of real-life events' (2009: 3). This was an important factor within this research, which was undertaken through a series of stages consisting of research design, data collection, data analysis and reporting.

The case study took the form of a design project undertaken by the first author. The use of case studies can support the generation of novel theory

through emergent processes and the close relationship of theory to first-hand evidence makes it probable that the hypotheses are 'empirically valid' (Eisenhardt 2002: 29). Empirical relevance was a key component of this study, making the findings transferable to design practice.

Design activity took place over a period of 34.5 weeks, 30 of which were recorded in detail and 4.5 took place before documentation had commenced. The activity in the first 4.5 weeks consisted of initial contextual research that was undertaken to provide direction and inspiration for the project theme. The 30 weeks of recorded activity was carried out on 23 separate days with an average of 4.12 hours per day. During the 4.5 weeks that were not recorded in detail, approximately twenty hours of practice was undertaken.

3.3 Design process and documentation

The women's footwear market was targeted due to the relevance of woven footwear and opportunity for novel design outcomes. Figure 1 shows an example of a digital mood board that depicts the selected market and products gathered for inspiration. Narrow weaving was identified as being an appropriate method of manufacture and a method of weaving to shape was used for the development of fully fashioned footwear uppers (see Figure 2).

Figure 1: Digital mood board of footwear inspiration. Copyright Jenny Pinski.

Figure 2: Fully fashioned woven sandal upper visualized on a hand-drawn sole. Copyright Jenny Pinski.

Documentation	Design outcomes
Diary sheets × 16	Physical artefacts × 15
Diary log entries × 27	Sketchbook pages × 10
Supporting documents × 5	Digital files × 19
	Design sheets × 19

Table 1: Overview of data collection formats and quantity collected.

The design process was recorded and reflected on in an approach aligned with Frayling's 'research through art and design' (1993: 5). The outcomes of practice were also treated as data and a total of seven formats were utilized. These included three types of documentation that were supplementary to the normal design process and four types of design outcome. An overview of these formats is presented along with the amount of data collected in Table 1.

The documentation methods were based on those developed by Pedgley (2007: 473–74) and consisted of a diary log, diary sheets and supporting documents. Diary writing was used as a method of reflection and allowed 'self-conversation' (2007: 472) in response to a day of designing. An overview of the design activity was recorded via a diary log in a format that was adapted from Pedgley's 'no detailed entry' pro-forma (2007: 474).

3.4 Analysis

The data were analysed using qualitative methods informed by Miles and Huberman (1994), Dey (1993) and Eisenhardt (2002). The process required the completion of the four stages of data reduction, clustering, coding and display. The diary log and diary sheets were used to inform the main structure of the analysis as they contained information of all of the activities undertaken. The supporting documents and outcomes of practice were referred to throughout, adding detail and context.

Individual activities were identified within the data and the outcomes, consequences or what was involved and the relationship and links between them were then investigated. Activities were assigned to a stage of the design process and then further categorized by the type of approach used, i.e. 2D or 3D and digital, non-digital or a digital/non-digital hybrid. Different stages of the design process were also considered to allow for the varying priorities associated with them. These were identified in relation to a general model of design processes developed by Wilson (2011: 58) and to the data itself. Due to the nonlinear nature of design processes (Wilson 2011: 44), this categorization was done according to the function/priorities as opposed to the order in which activities took place. The second stage of categorization involved data relating to the outcomes, consequences or what was involved. The codes were developed in relation to the data. They were coded and linked to the design stage and approaches used with three types of link being identified i.e. 'led to/provided/aided', 'involved/used' and 'informed'. It was possible to apply these links to the majority of data, thereby viewing each in relation to the others.

3.5 Findings

To identify and evaluate the approaches used, each stage of the design process was considered in turn. Figure 3 shows an overview of the project and its structure in terms of these stages. This diagram was developed using the

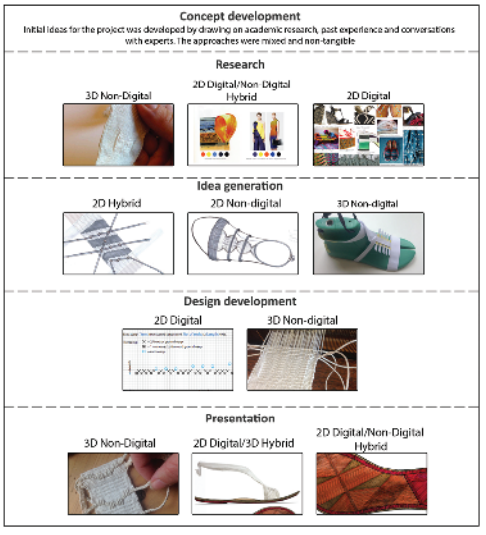

Figure 3: Diagram of the design stages and approaches used.

design stage and design approach codes that were applied to the diary and diary log data. Although it depicts the general order in which the stages took place, the design process was not linear and stages were revisited throughout.

This case study provided an example of a craft-based approach to design in the context of woven textiles and footwear. It was possible to draw a number of detailed insights due to the depth of analysis undertaken. However, for the purpose of clarity a summary of the key findings is presented. When researching a problem or a theme, digital methods were identified as providing access to a wide range of information. This time-efficient approach provided a breadth of information but lacked depth in understanding. At the research stage of the design process, an Internet search was used to gather imagery for initial inspiration boards. The designer noted in the diary reflection that this was, 'a quick way of gathering imagery from a number of locations and sources', but that it was also 'confusing'. Introducing initial parameters to the design problem aids designers in dealing with the high levels of uncertainty associated with the design process (Schön 1983: 72). However, with access to a wide range of possibilities and information, digital methods may not always support this effectively. In contrast, the use of hands-on making at the research stage was an appropriate method with which to explore more focused subject matter but in greater depth. The designer noted that this approach enabled them to 'learn the behaviour of new materials' and this was a significant benefit. This aligns with Cross' (1982: 224) theory that objects provide access to a wealth of knowledge. By prioritizing this over the efficiency experienced with digital methods it was possible to gain greater focus and consequently manage the complexity of the design activity.

During idea generation the weave and sandal constructions were planned in parallel. Digital processes aided accuracy and the ability to produce scale drawings with relative ease was identified as a benefit of the approach. There were a number of references in the data to gaining measurements for the creation of woven samples. The designer noted that by, 'creating [digital] scale

drawings […] I was able to get the measurements for the weave. These illustrations will also inform the lifting plan'. In this case study digital methods contributed to design by capitalizing on the ability to create scale drawings that could be worked back into using hand drawing and/or 3D modelling. The initial form was generated through sketching by hand and the ideas were translated into a more accurate digital format for further development through additional hands-on methods. This supports a theory that digital processes can support the design of construction and form in parallel through the contribution of detail and accuracy when used in conjunction with more intuitive and less precise methods such as sketching and model making. Figure 4 shows an example of a digital scale drawing that has been used as a base to enable further model-making. 3D making using representational media was also found to be beneficial in supporting the management of the complexity of the craft-based design process. It provided a method of quick visualization that enabled the designer to judge immediately whether the design was likely to work in practice. In comparison, when using 2D hybrid methods, although the digital element aided accuracy, the process was noted as being more complex within the data.

At the design development stage prototypes were sampled on the loom where, in addition to refining existing design ideas, engagement in hands-on making enabled further idea generation. Possibilities were discovered whilst weaving and ideas were generated through reflective craft-based practice. References to idea generation were prominent within the data and thus indicating an additional benefit when refining design ideas through making. For example the designer noted, 'seeing the physical sample in front of you can help to spark ideas'. Treadaway (2007: 35) identified that hands-on making can inform creative thought and this was the case during the design project. The literature review found that constructing prototypes by hand can provide access to new knowledge and understanding (McCullough 1998; Sennett 2009). This was achieved in the case study by engaging in the process of physically

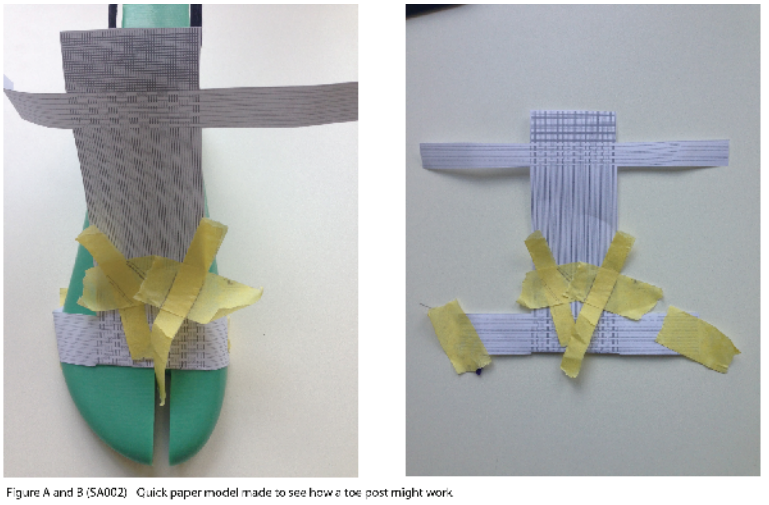

Figure 4: Outcomes of the quick 3D modelling process used to support design idea generation. Copyright Jenny Pinski.

Figure 5: Final design concept visualized in 2D using Adobe Photoshop. Copyright Jenny Pinski.

constructing the uppers and in the preparatory task of setting up the loom. The designer noted that,'this gave me a thorough understanding of the woven construction of the uppers and potential problems', thereby helping to test ideas whilst learning more about the materials and processes at hand. This indicated the value that can be experienced in developing first-hand knowledge of constructions and materials in providing a more informed approach to the design process. It is possible for this to support innovation by generating new ideas that would not be conceived through the more conventional approach where sampling is carried out by a manufacturer.

Digital processes supported the presentation stage. The final design ideas, which consisted of a number of formats, were brought together into a final design proposal using digital design software. Consisting of 3D hand-woven uppers and 2D hand-drawn outsoles, digital methods were integral to the coherent visualization of the designs in a 2D format. Figure 5 shows an example of a final design proposal where Adobe Photoshop was utilized to bring together the two elements. The resulting designs consisted of fully fashioned, zero-waste sandal uppers. The construction of the upper was integrated with material design and form creation. This made it possible to engineer the material to shape using a stitch-free construction consisting of multiple upper straps. This illustrated the potential for craft-based approaches to support design for sustainability through more informed decision-making and less wasteful use of materials.

4. DISCUSSION

The literature review indicated that it is not typical practice for footwear designers to construct 3D samples. Instead, digital and hand drawing is employed, with sampling being undertaken by the manufacturer. In addition, with the ongoing emergence of 3D digital processes, the implications of limiting materiality in the design process do not appear to have been considered

in related research. Instead, it is highly technology and process focused. The potential for automation through the integration of CAD with CAM is also an area of current research and development. This is likely to impact on understanding of the associated processes and could lead to subsequent gaps in knowledge. In contrast, woven textile designers often engage in hands-on making in which the construction of small woven samples enables designers to experiment before progressing on to larger development pieces. When approached in this way, there are benefits in high levels of control experienced by designers and the ability to make informed decisions based on first-hand experience. This approach also leads to heightened understanding of aspects such as production processes and behaviour of materials.

In design research, it is commonly accepted that hands-on making can lead to new knowledge and, in the field of architecture, the construction of physical models has been found to provide a deeper understanding of space and structure. Through making, it is possible to consider a problem from a number of different perspectives. Tactile experience generates embodied knowledge and when materials are considered at the early stages of a project, there may be a higher degree of success in the outcomes through heightened consideration of materials and their appropriateness for production.

In the case study, rapid methods of paper modelling and digital and non-digital drawing were used for idea generation. One of the key attributes of such methods at this stage of the process was speed. Whether 2D or 3D, the methods used were time and cost effective, allowing for ideas to flow intuitively. The 2D methods were identified as being more complex in comparison to the 3D ones used here. Once the design had been conceived on the last, the models could be flattened down to provide details and measurements for weaving. Observations from these two approaches related to the theories presented in the literature review that a craft-based logic could be implemented with or without the use of hands-on making. In this case, where 3D models were constructed by hand, the complexity of the situation was more manageable. However, knowledge and understanding of how a design, construction or material might work was also gained using drawing as a thinking tool. Digital methods aided accuracy and hand drawing was used in conjunction with this to generate ideas intuitively. Quick and inexpensive paper models were created, demonstrating that hands-on making was not always slow and expensive as discussed in the literature review. However, this refers to an approach using representational media and the process of hand weaving was less time and cost efficient.

Hand weaving was utilized in the development and sampling of the sandal uppers where the designer gained knowledge of the woven constructions, identified potential problems and tested ideas. In addition, new ideas were generated whilst engaging in the weaving process through increased understanding of the creative possibilities. The presentation of design proposals was supported by digital processes and it was found that digital software could support the bringing together of design outcomes consisting of different formats. Therefore, hands-on practice provided knowledge, understanding and inspiration, and helped to manage complexity but digital and representational methods were key in supporting craft-based practice.

There were also some difficulties identified in the use of craft-based approaches. Craft processes generally require a very specific skill set and in this case, hand weaving and footwear design are considered specialist areas. This has the potential to be addressed through collaboration and craft-based

approaches and logic may involve a team of people as opposed to an individual designer for this reason. However, close collaboration that enables the integration of specialist areas as opposed to practitioners working separately on different aspects would be vital. In addition, hand weaving is a time-consuming process, with the availability of equipment being a potential issue. More broadly, this points to the theory that availability of expertise and resources is a key consideration.

Craft-based approaches can be conducted in a number of formats including hands-on and digital. The ability to use craft-based logic in considering form, construction and material in parallel can enable more informed design decisions irrespective of the media used. However, digital methods may not return the same depth of knowledge as hand processes as evident at the research stage of the case study. Digital methods provided access to a wide range of information but were lacking in depth. In contrast, hands-on making was narrower in terms of subject matter but enabled high levels of depth in material and physical understanding. The in-depth research in this case took place in the form of weaving to trial and test materials and constructions. However, this may be conducted in a number of ways depending on the project. For example, directly engaging with end users would provide a depth of insight into how they use the type of product or service to be designed. Alternatively, engaging with the people who would eventually produce the design outcomes would provide a depth of knowledge in relation to that context. In this respect, craft-based approaches encourage a depth of exploration in focused areas of concern; they can facilitate more informed decision-making through holistic awareness of the problem or design situation at hand. This may impact positively on novelty, quality and sustainable practice through the heightened consideration of alternative perspectives and the wider context. Fletcher (2016: 21–22) identifies the unsustainable and unethical practice that has become synonymous with the fashion industry and current attempts for improvement. Fletcher goes on to discuss that whilst developments in this area are commonly technology based and incremental, more fundamental and all-encompassing cultural changes are required. This presents a future research opportunity to investigate the broader potential of a craft-based approach, particularly to support design for sustainability through more informed and holistic decision-making.

5. CONCLUSIONS

The consideration of material, form and construction in parallel was identified as being central to a craft-based woven textile approach to sandal design. It was also discovered that it was possible to implement this strategy using a variety of methods and the overarching principles may be transferable to other disciplines and design specialisms. Figure 6 provides a depiction of a craft-based approach where 'form' represents the problem as a whole or the overall aesthetic of a product; 'material' represents the various component parts involved and may include, but is not limited to, raw materials, people, equipment or any other aspect that makes up the product or service being designed; and finally, 'construction' refers to the way everything fits together and how different elements or components relate to or interact with one another. For example, this may be the interaction of yarns in weaving that also relate to a particular type of strap design, or it could relate to the interaction of people with equipment, products or each other. The actual methods used would

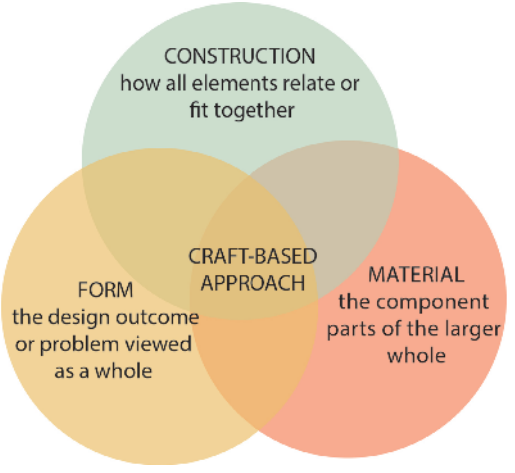

Figure 6: Venn diagram showing the structure of a craft-based approach. Copyright Jenny Pinski.

vary hugely depending on the specific project; however, these three areas of concern may act as a framework or starting point for the implementation of a craft-based approach.

Relating the case study findings to the literature review has enabled the identification of some specific opportunities and considerations associated with the implementation of a craft-based approach and these are as follows:

Opportunities:

- High levels of control
- Depth in knowledge and understanding
- Heightened consideration of alternative perspectives
- Heightened consideration of production and end use
- Ability to manage complexity
- Reducing environmental impact
- Effective visualization of ideas
- Implementation using a variety of approaches (e.g. digital, non-digital, 2D or 3D)
- Early identification of problems
- Supporting informed decision-making

Considerations

- Potential skill gaps
- Availability and cost of equipment and resources
- Time inefficiencies

The majority of opportunities listed relate to knowledge, control and high levels of focus in approach that can facilitate depth of understanding to make more informed decisions. In terms of craft, this aligns with the concept of mastering a specific skill and focusing on quality rather than breadth. The generation of new knowledge in particular has the potential to facilitate novelty and innovation in design and the ability to consider the wider context. For

example, knowledge associated with production may enable more sustainable design decisions to be made. In this particular case, this is evidenced through the production of zero-waste design proposals. However, it is common for industry priorities to relate to efficiency. Therefore, if a craft-based approach is to be applicable, priorities would need to lie in novel design and innovation as opposed to price and volume. Finally, specialist skills may be required depending on the project and in the case of a woven textile approach to sandal design, knowledge of both textile and footwear design was essential. Therefore, in some cases, there may be gaps in knowledge of the appropriate skills and knowledge required.

During the data analysis, the key generalizable themes of material/physical understanding, focus/inspiration/exploration, design idea generation, visualization, inefficiency and complexity were all identified when evaluating a craft-based approach. The study also identified the potential for enhanced novelty, quality and sustainability via the use of craft-based approaches. This is achieved by focusing on depth of investigation through heightened consideration of material and construction at the early stages of a design project. Based on a case study in footwear and woven textiles and supported by a literature review, three key areas of consideration, form, materials and construction, were identified. These can be used as a starting point for engagement in a craft-based approach. Having developed an initial framework and identified the potential, there now exists an opportunity for further studies within different disciplines and design specialisms. This will enable further generalization, development and testing of the theory developed and presented in this article.

REFERENCES

Afirm Group (2010), 'Waste management in footwear', http://www.afirm-group.com/hongkong/17%5C%20Hengstmann%5C%20Waste%5C%202010.pdf. Accessed 17 July 2018.

Albers, Annie (1961), *On Designing*, Middletown: Wesleyan University Press.

Archer, Bruce (1995), 'The nature of research', *Co-Design, Interdisciplinary Journal of Design*, 2:11, pp. 6–13.

Benson, Anna and Warburton, Neil (1986), *Looms and Weaving*, Princes Risborough: Shire Publications.

Bezooyen, Aart van (2014), 'Materials driven design', in E. Karana, O. Pedgley and V. Rognoli (eds), *Materials Experience: Fundamentals of Materials and Design*, Oxford: Butterworth-Heinemann, pp. 277–86.

Buchanan, D. Richard (1995), 'Manufacturing innovation, automation and robotics in the fibre, textile, and apparel industries', in D. R. Buchanan, G. A. Berkstresser, and P. L. Grady (eds), *Automation in the Textile Industry: From Fibres to Apparel*, Manchester: Textile Institute, pp. 3–15.

Cross, Nigel (1982), 'Designerly ways of knowing', *Design Studies*, 3:4, pp. 221–27.

—— (2004), 'Expertise in design: An overview', *Design Studies*, 25:5, pp. 427–41.

Dey, Ian (1993), *Qualitative Data Analysis: A User-Friendly Guide for Social Scientists*, London: Routledge.

Eisenhardt, Kathleen M. (2002), 'Building theories from case study research', in M. Huberman and M. B. Miles (eds), *The Qualitative Researchers Companion*, London: Sage, pp. 5–35.

Evans, Mark (2010), 'Researcher practice: Embedding creative practice within doctoral research in industrial design', *Journal of Research Practice*, 6:2,

Article M16, http://jrp.icaap.org/index.php/jrp/article/view/200. Accessed 1 March 2019.
Fletcher, Kate (2016), *Craft of Use: Post-Growth Fashion*, Abingdon: Routledge.
Flick, Uwe (2006), *An Introduction to Qualitative Research*, 3rd ed., London: Sage.
Frayling, Christopher (1993), 'Research in art and design', *Royal College of Art Research Papers*, 1:1, pp. 1–5.
Hemmings, Jessica (2012), *Warp & Weft: Woven Textiles in Fashion, Art and Interiors*, London: Bloomsbury.
Holyoke, Julie (2013), *Digital Jacquard Design*, London: Bloomsbury.
Huey, Sue and Kenny, Kathryn (2014), *Shoetopia: Contemporary Footwear*, London: Laurence King.
Joneja, Ajay and Kit, Fan Sai (2013), 'Computer-aided design of footwear', in R. S. Goonetilleke (ed.), *The Science of Footwear*, Boca Raton: CRC Press, pp. 213–60.
Kadish, David and Dulic, Aleksandra (2015), 'Crafting sustainability: Approaching wicked environmental problems through high–low tech practice', *Digital Creativity*, 26:1, https://doi.org/10.1080/14626268.2014.998682. Accessed 10 July 2018.
Karana, Elvin, Barati, Bahareh, Rognoli, Valentina and Zeeuw van der Laan, Anouk (2015), 'Material driven design (MDD): A method to design for material experiences', *International Journal of Design*, 9:2, pp. 35–54.
Langrish, John (2000), 'Not everything made of steel is a battleship', in *Proceedings of Doctoral Education for Design: Foundation for the Future*, Stoke-on-Trent: Staffordshire University Press, pp. 297–305.
Lawson, Brian (2002), 'CAD and creativity: Does the computer really help?', *Leonardo*, 35:3, pp. 327–31.
Lawson, Brian and Loke, Shee Ming (1997), 'Computers, words and pictures', *Design Studies*, 18:2, pp. 171–83.
Leader, Einat (2010), 'Materializing craft: Evaluating the effects of experiencing actual materials during the design process', *Design Principles and Practices*, 4:4, pp. 405–18.
McCullough, Malcolm (1998), *Abstracting Craft: The Practiced Digital Hand*, Massachusetts: MIT Press.
Miles, Matthew B. and Huberman, A. Michael (1994), *Qualitative Data Analysis: An Expanded Sourcebook*, London: Sage.
Niinimäki, Kirsi (2013), 'A renaissance in material appreciation: Case study in zero waste fashion', *Journal of Textile Design Research and Practice*, 1:1, pp. 77–92.
Nike (2012), 'Nike engineers knit for performance', http://nikeinc.com/news/nike-flyknit. Accessed 16 March 2013.
Nimkulrat, Nithikul (2012), 'Hands-on intellect: Integrating craft practice into design research', *International Journal of Design*, 6:3, pp. 1–14.
Oxman, Rivka (2012), 'Informed tectonics in material-based design', *Design Studies*, 33:5, pp. 427–455.
Pallasmaa, Juhani (2009), *The Thinking Hand: Existential and Embodied Wisdom in Architecture*, Chichester: Wiley.
Pedgley, Owain (2007), 'Capturing and analysing own design activity', *Design Studies*, 28:5, pp. 463–83.
Piper, Anna and Townsend, Katherine (2016), 'Crafting the composite garment: The role of hand weaving in digital creation', *Journal of Textile Design Research and Practice*, 3:1&2, pp. 3–26.

Pye, David (1968), *The Nature and Art of Workmanship*, London: Cambridge University Press.
Rissanen, Timo and McQuillan, Holly (2016), *Zero Waste Fashion Design*, London: Fairchild Books.
Schaffer, Jane and Saunders, Sue (2012), *Fashion Design Course, Accessories: Design Practice and Processes for Creating Hats, Bags, Shoes and More*, London: Thames and Hudson.
Schön, Donald (1983), *The Reflective Practitioner: How Professionals Think in Action*, London: Maurice Temple Smith.
Sennett, Richard (2009), *The Craftsman*, London: Penguin.
Spuybroek, Lars (ed.) (2011), *Textile Tectonics*, Rotterdam: NAi Publishers.
Treadaway, Cathy (2007), 'Digital crafting and crafting the digital', *Design Journal*, 10:2, pp. 35–48.
Walford, Jonathan (2007), *The Seductive Shoe: Four Centuries of Fashion Footwear*, London: Thames and Hudson.
Walker, Stuart (2014), *Designing Sustainability: Making Radical Changes in a Material World*, Abingdon: Routledge.
Wang, Jin, Zhang, Haining, Lu, Guodong and Liu, Zheng (2011), 'Rapid parametric design methods for shoe-last customization', *International Journal of Advanced Manufacturing Technology*, 54:1–4, pp. 173–86.
Wilson, Jacquie A. (2001), *A Handbook of Textile Design: Principle, Process and Practice*, Cambridge: Woodhead Publishing.
—— (2011), 'Core design aspects', Ph.D. thesis, Manchester: The University of Manchester.
Yair, Karen and Schwarz, Mary (2011), 'Making value: Craft in changing times', *Cultural Trends*, 20:3&4, pp. 309–16.
Yin, Robert K. (2009), *Case Study Research: Design and Methods*, 4th ed., London: Sage.
Zhang, Yifan, Luximon, Ameersing, Ma, Xiao, Guo, Xiaoling and Zhang, Ming (2011), 'Mass customization methodology for footwear design', in V. G. Duffy (ed.), *International Conference on Digital Human Modeling*, Berlin: Springer, pp. 367–75.

SUGGESTED CITATION

Pinski, J., Kane, F. and Evans, M. (2018), 'Craft-based design for innovation: Potential in novelty, quality and sustainability through hands-on interaction', *Artifact: Journal of Design Practice,* 5:2, pp. 3.1–3.20, doi: 10.1386/art_00003_1

CONTRIBUTOR DETAILS

Jenny Pinski is a lecturer in textiles at Loughborough University; she is leader of the woven textiles pathway and member of the Textile Design Research Group. Her research interests revolve around hands-on, craft-based approaches to design and the application of textile approaches in other disciplines. She has experience as a designer and developer for an international footwear brand and her expertise in footwear and woven textiles informs her research. Currently, this focuses on the application of hands-on woven textile approaches to commercial sandal design. In particular she is interested in the potential for craft-based textile approaches to support design innovation and sustainable practice. She uses her experience as a practitioner to engage in practice-led research and is interested in the role of design practice in academic

research. She has presented her research and practice internationally and has recently joint-organized an international textile conference, *Intersections 2017*.

Contact: Loughborough University, School of the Arts, Epinal Way, Loughborough, LE11 3TU, UK.
E-mail: j.pinski@lboro.ac.uk

https://orcid.org/0000-0002-7063-6536

Faith Kane is a design researcher and educator working in the area of textiles and materials. Her research interests include design for sustainability; interdisciplinary and transdisciplinary working in the design/science space; and the role and value of craft knowledge within these contexts. Projects include 'Laser Enhanced Biotechnology for Textile Design' funded by the Arts and Humanities Research Council UK (2012–15) and Materials Design for Sustainability New Zealand (NZ) funded by Massey University, which focuses on establishing place-based approaches to textiles and materials design, with specific reference to Harakeke (NZ Flax). She is a senior lecturer and programme coordinator for textiles at the School of Design, College of Creative Arts at Massey University in Wellington, NZ. Prior to this she was a lecturer and led the Textile Design Research Group at The School of the Arts, Loughborough University UK (2008–16). Faith is also a founder editor of the *Journal of Textile Design Research and Practice*, published by Routledge Taylor Francis. More information about her work can be found at: www.faithkane.com.

Contact: School of Design, CoCA, Massey University, Block 1 Te Whare Pukākā, Mount Cook, Wellington 6021, New Zealand.
E-mail: f.kane@massey.ac.nz

https://orcid.org/0000-0001-8232-8496

Mark Evans is a reader in industrial design and leader of the Design Practice Research Group, with interests in the development of resources to enhance design practice and its use to support data collection. Positions have been held as corporate and consultant industrial designer, with clients that include British Airways, Unilever and Honda. Designed research outputs have been exhibited at the National Centre for Craft and Design and London Design Festival; recognized through International Design Excellence Awards and Impact Case Study for the Research Excellence Framework; and promoted by organizations that include the Industrial Designers Society of America, German Design Council and Design Denmark. He has over 100 academic publications and has supervised/examined 26 Ph.D.s. External appointments include the Arts and Humanities Research Council Peer Review College; British Council reviewer; visiting professor at Rhode Island School of Design; editorial board member for *The Design Journal*; and international scholar at Massachusetts Institute of Technology. In 2016 he received the Industrial Designers Society of America Educator of the Year Award.

Contact: Loughborough University, Design School, Epinal Way, Loughborough, LE11 3TU, UK.
E-mail: m.a.evans@lboro.ac.uk

https://orcid.org/0000-0002-1378-8998