The 2nd International Conference on Design Creativity (ICDC2012)
Glasgow, UK, 18th-20th September 2012

# CREATIVITY IN CRAFT LED DESIGN: THE TOOLS ARE THE RULES

L. MacLachlan, C. Earl and C. Eckert

Depatment of Design and Innovation, Open University, Milton Keynes, UK

**Abstract:** The co-evolution of new forms with specified tools characterises craft led design. Formal views of design and creativity may be characterised by the manipulation of the rules of a knowledge domain. This paper proposes that tools are one form of rules, and the selection, modification and invention of tools corresponds to the definition, transformation and creation of spaces for exploration in accordance with Boden's framework of creativity and other accepted creativity literature. Evidence from interviews with designer-makers who work directly with tools demonstrates this phenomenon. Finally the discussion proposes that knowledge from the results of this study could enhance the creativity of designers working in craft-led design by providing an explicit rationalisation of a particular design process of which they may have been previously unaware.

***Keywords:*** *craft, rules, tools, transformation, emergence, synthesis, prototyping*

## 1. Introduction

Designers employ various kinds of tools to inspire, prototype and fabricate designs for products. These range from traditional hand tools to computer software to complex manufacturing systems. Many designers also adapt or make their tools.

It follows that tools may often play a part in creative design outcomes and the aim of this research was to explore the role of tools in creative moments in the design process. To do this it seemed appropriate to examine design situations where tool use is a dominant feature of the design process; termed for the purposes of this investigation as 'craft-led design'.

The industrial revolution transformed the way everyday objects came into being, despite this, craft has continued to play a pivotal role in the discipline of design. It has featured in the ideology of the Arts and Crafts movement, in the manifesto of the Bauhaus, and continued in the sensibilities of the designer-craftsmen of the 1950s, finally right up to the current working practices of many contemporary designers (Adamson, 2009). Today there is a breed of designer who makes working prototypes and/or all of their products for the market. These designers bring together conceptual ideas

alongside their knowledge of physical making with tools, materials and techniques, and their existence is not surprising given the studio and workshop based nature of most design education.

To try and discover explicitly how the use of physical tools in such design situations corresponded with frameworks in established creativity literature a series of interviews with designer-makers was undertaken. The aim was to find evidence how of tools were involved in creative discoveries in the design processes. The final section of this paper opens a discussion on the implications of these findings for designer makers and how theoretical knowledge of the role of their tools in the design process may support creativity. This investigation was done to support a larger research project concerning creativity and generative design software tools for use with digital fabrication, a discussion of how the findings relate to this area is included.

## 2. Literature review

A brief review of frequently referenced literature on the subject of craft, focusing on tools, is presented to give the reader a grounding in the subject. Supporting literature about design creativity is dispersed in the main sections of the paper to corroborate the ways tools were used to creative ends by the interviewed designers.

### 2.1. Tools and craft

There are many complex ideas and connotations associated with the word 'craft' in the general domain stemming from how it has been appropriated in different contexts. These range from the epistemological, to the theoretical and even the political (Greenhalgh, 1997). But what is craft? Craft researcher Glen Adamson (2009) describes craft as '*a way of doing things….an amalgamation of interrelated core principles*', specifically craft is supplemental to art and design, secondly it is entrenched in material experience and thirdly it is skilled.

One well-known attempt at a formal definition of craft is David Pye's thesis on 'workmanship' (Pye, 1968). He defines making along two dimensions, first as the 'workmanship of risk' where the end result is down to the skill and dexterity of the maker, and second as the 'workmanship of certainty' carried out by machines. The implication is that direct and flexible control over one's tools is a feature of craftsmanship, which in turn tends to give the opportunity for freer and more diverse aesthetic outcomes.

Peter Dormer is another author on the subject of craft. In his book The Culture of Craft (Dormer, 1997) he echoes some of Pye's concerns in suggesting that one of the differences between craft and design is the 'personal knowhow' of craft in contrast with the 'distributed knowledge' of industrial design. Again the issue of direct control over tools is raised. In a similar argument to Pye, Dormer articulates that his main concern about technology is that ubiquitous tools, such as standardised machines and software, produce ubiquitous objects.

An earlier essay (Dormer, 1994) on craft knowledge, heavily influence by philosopher Michael Polanyi's work on personal knowledge, is an in-depth study of skill in craft. Dormer personally investigated the process of becoming learning a 'plastic art' – through pragmatic, structured, learning of 'recipes' or rules from a master in order to accumulate the tacit knowledge or feel for an activity. Dormer reported the signs of skilled craftsmanship as the seemingly effortless use and manipulation of domain conventions for expressive effect.

More recently researchers such as Rust (2004) and Wood (et al., 2009) have addressed the importance of tacit knowledge also with reference to Polanyi, particularly centring around ways of explicating the tacit knowledge of skilled practitioners which can provide valuable insights.

Finally, McCullough (1998) proposed that the way we work with digital technologies is analogous to craft practice, with the computer and its software being a toolbox. The difference being that the tools operate on symbolic systems rather than material structures. However, he noted that important aspects of craft such as dexterity, skill, dynamic feedback and an aptitude for aesthetics all play a large part in digital media.

## 3. Methods

This paper has arisen from research currently being carried out by the first author into the development of digital generative design tools in conjunction with 3D printing. As part of this an attempt has been made to find information about the role of tools in designers' practice by undertaking interviews with designer- makers who use tools and materials as their main source of inspiration. These were semi structured interviews carried out in the designers' studios with the intention of finding out about their design processes with particular emphasis on tools and a chronological discussion through the steps of one or more design projects. The first author is a designer herself in a similar domain and has known the designers' interviewed and their work for several years as part of a peer group. This gave a deeper understanding of the designers' work and also established familiarity and trust between interviewee and interviewer, resulting in very close case studies of the designers' working practices.

The first interviewee was a ceramics tableware designer, Ian McIntyre, who designs by making his own full ceramic prototypes for production and some of his finished products in his studio. From experience of internships the designer explained that many tableware designers work by making foam models and computer aided design drawings despite the difficulties in translating such representations into clay. He prefers to work directly with the manufacturing tools and materials of industry to design and terms this '*design through making*'.

The second interviewee was jewellery designer Eleanor Bolton, who works with textiles. Her current body of work has come from developing her own craft technique of hand stitching soft cotton rope into coils to create large scale, tactile neckpieces and bangles.

Thirdly silverware designer Kathryn Hinton was interviewed who has two bodies of work in progress. The first body of work is designed through sketching and then produced with traditional silversmithing techniques such as hammering and forging. Recently as part of a research project she has developed her own haptic digital tool, a hammer with internal motion sensors that plugs into a computer via a USB port and works in conjunction with computer modelling software, these designs are then realised with various digital fabrication tools.

Evidence from the interviews has been analysed to attempt to find similarities in cognitive processes of those working in closely with tools to produce objects. This in turn has been corresponded with Boden's (2003) typologies of creative ideas and other creativity literature.

## 4. The domain

Domains are an essential aspect of creativity. Csikszentmihalyi's (2006) definition of creativity is '*when a person, using the symbols of a given domain such as music, engineering, business, or mathematics, has a new idea or sees a new pattern.*' Similarly the world of craft contains various sub domains, each described as a 'medium' - a range of tools and materials (McCullough, 1998). Dormer (1994) provides a neat dovetail with Csikszentmihalyi's summation by stating that craft activity 'follows rules, conventions and patterns', in craft these are physical techniques and tools as well as conceptual or symbolic conventions.

Boden's first specification of creativity is what she calls 'exploring conceptual spaces'; searching within formalised sets of rules. She considers this search as taking place in the mind, describing it as a metaphorical map of terrain to be explored. Examples of widely known 'conceptual spaces' are haiku poetry or jazz music, where certain stylistic rules are followed to create works, but also define a problem to be solved.

The designer-makers interviewed were very concerned with their position in domains; particularly how their work would be perceived by peers and public and often throughout the interviews the conversation would come back to the nuances of the domains they were working in, perhaps partly as the interviewer is also very conscious of the same domains. This careful positioning seemed to be important for the initial direction of any design activities, the aim seemed to be to adhere to certain expectations of a community yet at the same time situate a niche position within that. The ceramics tableware designer had previously made what he called '*experimental products*' but had then decided he wanted to be the designer of everyday, functional tableware. He wanted to make sure he addressed details such as capacities, ergonomics and practicalities such as the size of microwaves, however the niche part of his position was a desire to help bolster the ailing British ceramic manufacturing industry, making use of the skills available within it. These domain decisions influenced the ceramics designer's choice of tool, the jigger-jolly machine, '*it was the closest thing we had that mirrored real life production… things are still produced on those machines in industry*'. The use of this tool also allowed him to '*design a range of products that nipped into a little gap in the market that otherwise would be incredibly hard to get into*' as he could initially produce the products himself to get them into the market while still having the possibility of having them produced in a factory once some confidence in his designs was gained.

The jewellery designer also stated that she had wanted to change the domain position of her work as '*I found that what I was previously doing, there was a lot of people combining found objects… I felt like I am not adding to this in anyway*' Her reaction was a desire to make less '*conceptually laden*' work that was more fashion led with an emphasis on aesthetics and tactility and reduction in the number of different processes used on one piece of work. To do this she moved towards textile materials, tools and techniques.

In both these cases the tools the designers selected were a crucial part of the domains selected by the designers. They not only embodied larger ideals about their design work but also became part of their personal domain to be explored for creative ends.

## 5. Constraints, rules and tools

Under-constrained design problems, such as those usually found in craft-led design, are approached by designers in a significantly different ways from over-constrained problems, such as those found in engineering design. Stacey and Eckert, (2010) compare processes and describe a process of dealing with under-constrained design problems, using evidence from interviews with knitwear designers. This process first finds implicit constraints in a design brief, which is then followed by a tactic of self-imposing explicit constraints to frame the design problem.

The descriptions of the designer-makers interviewed in this study corresponded with these theoretical ideas. Beyond the broader domain positioning discussed in the previous section the designers seemed to go through a process of further restriction within their design process, each restriction with the intention of moving closer to a solution; in the cases of the designer-makers most of these were related to the selection of tools. The jewellery designer restricted herself to a particular set of materials and tools and then finally to one making technique she had then developed: '*it was literally*

*just, right here's a ball of yarn, here's a needle and here's the rope and I wasn't allowed to use anything else'*

This procedure of building or formulating a 'space' appears regularly in design theory, such as Schön's (1992) 'design worlds' and as the co-evolution of problem and solution (Dorst & Cross, 2001). Also Boden (2003) talks of creativity as exploring, transforming or constructing a new conceptual space. The way this is achieved ranges from bending or tweaking accepted rules, to complete remapping, when surprising, even shocking, new ideas are formed. In the case of the designer makers the tools are often the 'rules' that defined their personalised conceptual spaces, guiding and focussing attention and actions.

### 5.1. Tools and design synthesis

One of the widely known ways that creativity occurs in the synthesis phase of design is through analogy (Boden, 2003, Cross, 2000 & Gero, 1996). Designers also use metaphorical comparisons in order to view the situation differently in the hope of achieving a paradigm shift in viewpoint and consequently an original idea.

In the case of the designer-makers this analogical shift took place through tools and was most demonstrably apparent in the conversation with the silversmith when discussing the haptic digital hammer she had envisioned, made and used to create vessels and jewellery. When describing the new tool she used several 'like' comparisons with other tools, '*like a hammer….like a (Nintendo) Wii…like a Wacom pad'* Analogies which had led towards the creative idea of a digital silversmithing hammer, achieved by mapping the workings of known digital interface tools that that are driven by hand movement to make the bridge between the analogue hammer and the digital hammer.

**Figure 2.** Digital hammer in use, rapid prototyped and cast silver bowl.

Another way of producing creative insights is 'concept blending' where a new concept is produced by combining two base concepts, the 'blend' inherits structural aspects of each (Nagai et al. 2009). Again this took place through tools and techniques, in particular in the work of the jewellery designer at the start of her idea generation process. The initial concept she started with was one of chains, an archetype of jewellery design, the other concept was that of stitching with a needle. The 'blended' concept is a coiling technique where the cotton rope is stitched onto itself to create a soft tube. She describes it thus: '*I can create something that looks like a chain but it's just one continuous piece, so that was the idea to make these sort of loops and then stitch them together*' Creative ideas can come about through using analogy and concept synthesizing of the actual tools the designer is using applying them in new combinations or contexts.

**Figure 1.** Close up of stitching technique and examples of form variations from altering stitch counts

### 5.2. Transforming tools

Boden (2003) also describes how creativity occurs by less dramatic domain shifting by transforming rules. A similar concept is named as 'mutation' by Gero (1996). Again this approach was seen in the designer-makers practice. The silversmith interviewed described the common practice of altering tools to suit, '*I guess with traditional tools you adapt them If it's a stake that's not right for your job you file it until it gives you the right shape…… you shape hammers and cut them or take off the sharp edges*', an example of transformation or mutation of rules in the most basic sense. Actively customising or hacking tools corresponds to the creative activity as described by Boden (2003) and Gero (1996), a process deforming rules for new ends.

### 5.3 Breaking the tools

Boden (2006) also cites deliberate rule breaking as route to creative work, similarly Dormer (1994) describes how once learned rules of craft techniques can be knowingly broken to convey certain meanings in an artefact. Purposeful rule breaking was also very much apparent in the designer-makers' design process. The ceramics tableware designer had done an earlier project where he made plaster standardised plaster moulds each of which he chiselled into to create individualised design features on a cast porcelain vase, see Figure 3.

**Figure 3.** 'Broken Vase': chiselling process and finished objects

This is almost a literal example of creativity found in the breaking of a tools or a rule, by physically breaking a mould to create something new. Describing a later project he stated '*I don't really like to add a step because I feel that makes it a little bit more complicated and not quite as clever. I usually try and remove a step, so putting in less clay to an existing mould*'. This particular breaking of convention was used in a plate design where a pleasing irregular, organic edge to each plate was created by slightly under filling the mould that the clay was pressed into. This had the added benefit of gaining efficiency in the production process by removing the step of trimming excess clay at the edge of the mould. These examples highlight that creative rule breaking can occur not only in a very literal way with tools but also with the conventions associated with their use, present the opportunity for fresh concepts for the designers.

### 5.4. Emergence from tool use

Sets of rules, once coupled together often exhibit emergent properties that may previously not been recognised or intended. Emergence can be serendipitous to the design process; new information can provide the bridge between the gradually co-evolved problem and solution; spurring a creative leap (Dorst & Cross, 2001).

Most of the creative ideas generated by the designer who were interviewed were the result of emergent properties of the tools they were using. After the jewellery designer 'blended' together her original concepts she discovered an emergent property of the technique she had developed, increasing or decreasing the stiches on successive coils expanded and retracted the overall forms of the jewellery: *'so it just started off that I was making these tubes….then using the idea that like in knitting and crochet you add and drop stitches to create different shapes and forms*'. The silversmith also experienced emergent aesthetics from her tool, the nature of the digital mesh that was 'hammered' into resulted in the facetted aesthetics of the work made with it. These forms were a pleasing contrast to the smooth surface of hand raised silver vessels and belied the partly digital process behind them. The ceramics designer found more conceptual emergent properties through his creative tool use, namely the bonus of several of his products having individualised features, adding perceived value over what would normally be identical manufactured ceramics.

An aspect of making use of such emergent properties is a requirement of the user to anticipate and, critically, to recognise their presence (Schön, 1992). Oxman (2008) goes further than this and suggests that emergence is to some extent guided by designer's domain knowledge. Certainly the ceramics designer was searching for such emergent properties in his experimentation with tools and materials '*the idea was to elevate the quality of the material and elevate the process as well, so it was about finding a quality that only could be produced on the jigger-jolly machine and a quality that could only be produced in clay*'

Gero (1996) defines emergence as an implicit property which can be made explicit, interestingly echoing the concept of tacit knowledge, something considered to be a cornerstone of craft and tool use, gained through practice with tools (Dormer, 1994). Rust's (2004) interpretation of Michael Polanyi's work on 'personal knowledge' is that leaps of 'illumination' occur from having a deep implicit understanding of something, gained from the direst use and prototyping of artefacts.

However too much skill or expertise can also be to the detriment of creativity, the tableware designer stated that despite the in-depth knowledge of ceramics he now holds '*a lot of my original projects were successful because I didn't know the rules… it's a double edged sword because now I know the material too well so I rule out all of the experimentation that could possibly yield new ideas…which is why the next project I do probably needs to be outside of ceramics, to freshen me up a bit*'. This is an echo of a phenomenon described in creativity literature, designer burnout (Eckert et al., 1999) and the problems of fixation (Wiley, 1998) are associated with lapses in the creativity of expert designers.

Emergence of serendipitous outcomes is not always born of expertise. A particular example of this was the severe error in the design of an expensive mould which left the tableware designer with no choice but to rethink his whole design and process of production, but in turn this yielded one of his most successful products, by casting into the mould in a different way from what was originally intended. This non – guided emergence from a tool, which initially appeared to be a financial disaster, stimulated a reformatting of the designer's whole approach. Although the mistake was made by inexperience of making a tool it is likely the situation was perhaps redeemed by the designer's creative abilities.

## 6. Implications

### 6.1. The Tools are the rules

The interviews undertaken sought to look at the use of tools in the design process and how these corresponded with established literature on creativity. The interviews revealed explicitly that tools play an important part in the creative processes of some designers. Tools seem to be embodiments of rules, working alongside more conceptual rules and conventions to transform design problems towards a creative design solution. Analogically viewing tools as rules sits well in frameworks such as Boden's (2006), they appear to perform the same role as more conceptual rules but in a material sense, useful for the designer who is working towards physical objects. The reversal of this is the idea neatly allows the idea of rules being tools for designers, the designers exhibited a tendency to try and constrain themselves in various ways to help formulate a tighter problem space as would be expected in such under-constrained design situations, rules become the tool for such challenges. In particular serendipitous emergence, more often than not guided by the designer's tacit knowledge of their tools, was the key to creative and successful outcomes.

The background hypothesis of this work has also been influenced by shape grammar theory (Stiny, 2011 & Knight, 1995) in which transformative rules concerning shapes and their positional relationships are formalised to describe and generate new shapes. Stiny (2011) has discussed how shape rules are creative; they take, recombine and make use of emergent shapes to create new shapes, a similar process to the tools use discussed throughout this paper.

### 6.2. Pedagogical implications in craft-led design

An understanding of creative frameworks and the role of tools within them would be of use to designers. The designers interviewed had undertaken these processes in the most part intuitively. Only one seemed explicitly aware of how they had gone through a process of constraining herself, yet formulating unusual combinations of tools and techniques. She had also mentioned that this way was a successful but new way of working for her she had almost stumbled upon recently and had previously done quite different, less successful work that followed a known style rather than being particularly original. From the first authors experience and conversations with other designers with similar educational backgrounds it seems apparent that creativity theory in terms of rules and tools is not something particularly spelled out in under constrained, craft led design education such as jewellery, textiles and ceramics. When asked the designer-makers had very vague definitions concerning rules and tools that they might use, however as the conversations progressed it was revealed there were quite strict about following certain rules and their conventions either from their domains or their of their own choosing. Also of note was when asked what their tools were the designers answered with materials as well as conventional tools, this suggests that materials may also play a similar role in creativity. As has been mentioned the designers were undertaking these processes apparently intuitively or under slightly different cognitive guises, however perhaps knowledge of these theoretical concepts may have helped at times and may help new designer understand ways of fruitfully using tools creatively.

## 7. Future work

This study has come about as part of a wider research project into the use of computational generative systems, in particular shape grammars, in conjunction with digital fabrication technologies by designers and how creative outcomes can be achieved. The first author has moved from a similar craft-led practice as the designers interviewed to developing and using her own generative software tools and digital fabrication and found an affinity in the ways of working during this transition.

Oxman (2006) states in that a '*new generation of digital design specialists is emerging*' these are designers who are '*digital toolmakers*': designers who have the ability to create and customise digital tools and that the accepted design theory paradigms, which were generally established from research around paper based activities such as those developed by Schön & Wiggins (1992) may need revising (Oxman, 2008). It is the first author's hypothesis for the research project that something may be learned by carefully looking the designer's interaction with traditional and generative tools during design processes.

More interviews with designers using tools both traditional and generative, along with reflection on the first author's design practice is planned to give further insight into the relationship between creativity and tools, particularly generative design tools.

## References


Adamson, G. (2007). *Thinking Through Craft*. Oxford:Berg Publishers.

Boden, M. A. (2003). *The Creative Mind: Myths and Mechanisms* (2nd Ed.). London: Routledge.

Csikszentmihalyi, M. (1996). *Creativity: Flow and the Psychology of Discovery and Invention*. New York, NY: HarperCollins.

Dormer, P. (1994). *The Art of the Maker: Skill and Its Meaning in Art, Craft and Design*. London: Thames & Hudson Ltd.

Dormer, P. (1997). *The Culture of Craft: Status and Future*. Manchester: Manchester University Press.

Dorst, K.. & Cross, N. (2001). Creativity in the design process: co-evolution of problem-solution. *Design Studies*, *22*(5), 425–437.

Eckert, C., Stacey, M., & Wiley, J. (1999). Expertise and designer burnout. *Proceedings of the 12th International Conference on Engineering Design*. Vol. 1, 195–200.

Gero, J. S. (1996). Creativity, emergence and evolution in design. *Knowledge-Based Systems*, *9*(7), 435–448.

Greenhalgh, Paul. (1997). The History of Craft. In P. Dormer (Ed.), *The Culture of Craft: Status and Future*. Manchester: Manchester University Press.

Hey, J., Linsey, J., Agogino, A. M., & Wood, K. L. (2008). Analogies and metaphors in creative design. International Journal of Engineering Education, 24(2), 283.

Jansson, D. G. & Smith, S. M. (1991). Design fixation. Design Studies, 12(1), 3–11.

Knight, T. W. (1995). *Transformations in Design: A Formal Approach to Stylistic Change and Innovation in the Visual Arts*. New York, NY, USA: Cambridge University Press.

McCullough, M. (1998). Abstracting Craft: The Practiced Digital Hand (New Ed.). Cambridge, MA: MIT Press.

Nagai, Y., Taura, T., & Mukai, F. (2009). Concept blending and dissimilarity: factors for creative concept generation process. Design Studies, 30(6), 648–675.

Oxman, R. (2006). Theory and design in the first digital age. Design Studies, 27(3), 229–265.

Oxman, R. (2008). Digital architecture as a challenge for design pedagogy: theory, knowledge, models and medium. *Design Studies*, *29*(2), 99–120.

Oxman, R. (2002). The thinking eye: visual re-cognition in design emergence. *Design Studies*, *23*(2), 135–164.

Pye, D. (1968). *The Nature and Art of Workmanship*. London: Herbert Press Ltd.

Rust, C. (2004). Design enquiry: Tacit knowledge and invention in science. Design issues, 20(4), 76–85.

Schön, D. A. (1992). Designing as reflective conversation with the materials of a design situation. Knowledge-Based Systems, 5(1), 3–14.

Schön, D. A. & Wiggins, G. (1992). Kinds of seeing and their functions in designing. Design studies, 13(2), 135–156.

Stacey, M., & Eckert, C. (2010). Reshaping the box: creative designing as constraint management. International Journal of Product Development, 11(3), 241–255.

Stiny, G. (2006). Shape: Talking About Seeing and Doing. Cambridge, MA: MIT Press.

Stiny, G. (2011). What Rule(s) Should I Use? Nexus Network Journal, 13(1), 15–47.

Wiley, J. (1998). Expertise as mental set: The effects of domain knowledge in creative problem solving. Memory & Cognition, 26(4), 716–730.

Wood, N., Rust, C., & Horne, G. (2009). A tacit understanding: The designer's role in capturing and passing on the skilled knowledge of master craftsmen. International Journal of Design, 3(3), 65–78.