# Using Empathy to Research Creativity: collaborative investigations into distributed digital textile art and design practice

**Dr. Cathy Treadaway**

Cardiff School of Art and Design
University of Wales Institute Cardiff
Cardiff, CF24 0SP Wales, UK
+44 (0) 2920 417014
ctreadaway@uwic.ac.uk

## ABSTRACT
This paper describes the use of practice-based distributed collaborative investigations to examine ways in which digital technology can support creative visual art practice. The development of artworks through digital collaboration has enabled empathy to be used as a tool in the research process. The focus of this study concerns how digital technology impacts upon the creative strategies deployed by art practitioners and the resulting effect on creative cognition. Data gathered through qualitative ethnographic research methods has been verified through a series of practical investigations. Findings from this research indicate the importance of mutual experience and memory in the collaborative process. The investigations demonstrate how shared physical experience stimulates imagination through the building of visual concepts, enabling common values, language and trust to be developed concurrently.

## Author Keywords
Creativity, collaboration, digital art practice, empathy, textile design

## ACM Classification Keywords
H. Information Systems: H5 Information Interfaces and Presentation: user interfaces; evaluation/methodology; input devices and strategies

J. Computer Applications: J5 [Arts and Humanities]: Fine arts

## INTRODUCTION
New models of creative practice are emerging in a world that has become increasingly connected through the power of digital communications technology [18]. Digital tools are

being integrated into the artist's studio and are used increasingly to innovate visual concepts, manipulate ideas and to facilitate creative collaboration [6]. The goal of this research has been to illuminate how these developments affect creative practice and explain ways in which digital technology is able to support creative cognition.

This paper presents selected strands of a recently completed doctoral research project investigating the impact of digital imaging technology on the creative practice of printed textile artists and designers. The research examines how digital technology can be used to assist the stimulation, review and manipulation of visual concepts. It draws evidence from analysis of data resulting from practical collaborative investigations involving distributed creative practice. These findings reflect the specialist nature of the domain where tactile qualities, handcrafting and visual stimulation are fundamental to creative action. Nevertheless, issues that have arisen as a result of the research are of significance beyond the visual arts field, providing insight into how digital technology is being used and might be developed further, to support creative cognition and collaborative practice.

Observations of art practice can yield insight into the ways in which digital tools support creative processes as well as providing a deeper understanding of individual approaches to heuristic tasks [11]. To actively participate in the creative act as a collaborator provides the researcher with an empathic experience, illuminating how it *feels* to be physically, emotionally and intellectually involved in this process. Through *disciplined noticing* [19] and qualitative ethnographic research methods, a collaborative creative investigation is able to reveal issues that might escape notice in a more formal research environment [16]. By using the '*studio as laboratory*' and utilizing the mutual creative experience of artist and artist-researcher it is possible to make an analysis of observed and experienced creative processes [11]. This approach facilitates understanding of the ways digital tools impact on practice

and at the same time generates novel artifacts that exhibit the creative act.

## Background – problem definition

Considerable changes in the working practice of those artists involved in this study have occurred over the last ten years. The process of creating artwork for printed textiles has, until recently, been constrained by the limitations of the manufacturing and craft processes used to translate visual imagery as printed surface [3]. Economic limitations on the numbers of colors that can be used in a design and the dimensions of the substrate have, until recently, defined the visual characteristics of a printed artifact [2]. Textile artists and designers have traditionally worked with paint brushes and paper to create artwork in repeat and with identifiable and restricted numbers of colors that can be separated with ease for print production purposes. Until recently CAD (computer aided design) has been used in industry and design studios to amend hand rendered artwork for production; its use has been largely algorithmic and uncreative [17, 3]. Generation of visual concepts and subsequent preliminary artwork development has routinely taken place in the artist's studio via hand rendering techniques using traditional wet media, watercolor and gouache paint. At this generative stage of design development textile art and design practice is fundamentally a solitary process. It is not usually until a visual concept has been selected from a range of proposed ideas that collaboration with other designers occurs and product development begins.

Production of printed textiles will become increasingly dominated by digital ink-jet printing in the very near future, due to the recent development of high-speed machines capable of meeting the demands of mass production [8]. Inevitably this will impact on the type of artwork required by manufacturers and consequently it will affect the work textile artists and designers create. Digital images can be translated with ease onto the fabric surface; there is no longer any economic advantage for artwork to be in repeat or have reduced colors [7]. There are also no economies of scale; it is equally cost effective to produce a short run of a design as to manufacture huge lengths. Individual products can be designed and digitally printed reducing waste and providing the potential for innovative customized products printed on demand [4]. Independent artist-makers have access to this technology through bureaus that provide print-on-demand services; files can be uploaded over the Internet and the printed product returned to the artist by post. There is now significant advantage to using digital imaging technology in the development of artwork for printed textiles and practitioners are beginning to embrace the technology and explore ways of working creatively with it [30]. Digital tools are no longer useful solely for pre-print design development but are also being used in the early stages of concept formation and visual idea generation. To date there has been little quantitative research into the ways in which technology can support creative thinking in textile art practice at the generative stage of visual concept formation.

Developments in rapid prototyping technology and three-dimensional printing indicate that future textile technology may involve the downloading of design data from the Internet. This will enable three-dimensional garments and textile products to be printed on demand locally or even at home [9]. Designers using this technology would be required to produce concepts that consider garment shape and textural surface as well as decorative embellishments in one form [30]. Delamore [9] contends that this new design and manufacturing paradigm will depend on user-friendly software and interface design. It will also require designers to engage in teamwork and collaboration at many stages in their creative practice and to orchestrate the range of technical skills and design abilities that would be required. It is important therefore, to understand the ways in which computational support tools are able to aid creative collaboration.

Previous studies by Polvinen [22] and Campbell and Parsons [4] have investigated collaboration as a tool in the design process for the development of printed textiles and *art to wear*. Research by Polvinen [22] investigated distributed collaborative practice for the development of printed apparel fabrics, with artists working independently to originate design concepts from a web based image store. Work by Campbell and Parsons [4] has investigated the potential of co-located collaboration in which complementary skills and expertise have been used to generate designs for garments. The research presented in this paper builds on these studies, investigating not simply the working processes used but also the impact digital tools have on creative cognition.

## Methodology

This research addresses a number of questions including: how digital technology supports the generation and creative manipulation of visual ideas; how technology performs in the creative process compared to physical tools and traditional media; and how the potential to share virtual imagery across physical space via the Internet challenges previous preconceptions about creative practice.

Qualitative research methods were used and case study chosen as the principal method to obtain data. Three artists were selected for participation in the case study following a contextual and literature review. Each is regarded internationally as a respected practitioner and was selected following recommendations from academia, industry and professional organizations. These practitioners were chosen to reflect the diversity of the field, which ranges from textile design for industry (involving working to industrial and

market limitations), to textile art in which the only constraints are self imposed.

Following an initial analysis of the case study data, a series of collaborative task exercises were devised in which the researcher and each of the three artists developed a series of co-authored artworks together. This enabled issues arising from the case study data to be interrogated through creative practice. They provided the researcher with an opportunity to share experiences of the artist's creative process and to participate in the real life tensions, frustrations and delight of working creatively with digital technology. The collaborative investigations provided the researcher with an empathic engagement in which the emotional and psychological issues arising through the creative making process could be experienced and analyzed. The following sections of this paper describe instances from two strands of the collaborative investigations. The practical examples described reveal the ways in which digital tools have been found to support creative practice at the generative stage of concept development and facilitate convergent thinking in the design phase. The final section describes how digital communication has supported distributed creative practice. These sections comprise part of a wider doctoral study.

## DIGITAL TOOLS TO SUPPORT CONCEPT GENERATION
### Memory and lived experience

Findings from research in experimental neuroscience have revealed the importance of memory in the human ability to make sense of lived experience [24]. Ward [31] describes how *new* ideas rely on *stored* information for their creation. The importance of memory of human experience and the sensory stimulation it provides is fundamental to a visual artist's creative action. Emotional responses to lived experience have been found to enhance the strength of memories due to the release of neuro-chemicals in the brain [25]. Norman [21 p.10] asserts that this results in the modification of perception, decision-making and behavior; emotions *'change the parameters of thought'*.

Analysis of the case study data reveals that the ability to experience sensory stimulation, to engage in an emotional response and then remember it, is crucial in the germinal phase of concept development [30]. An indication of the importance of memory in the creative process emerged from the case study findings. The subsequent collaborative exercises were devised to investigate empathically how memory of a shared experience influenced the generation of ideas and how digital tools could be used to support this. The case study field visits were able to provide memories of a mutual experience that were used to stimulate a body of artwork with each practitioner.

### Instance 1 'Kilmory'

The following section describes the development of collaborative textile art with the Scottish textile artist Alison Bell. Figures 1-4 provide a series of visual snapshots of the development of 'Kilmory' a digitally ink-jet printed silk artwork.

The collaborative exercise used the shoreline at Kilmory, Arran, as a visual starting point for the development of an image to express a shared memory of that particular location. The field study visit provided the researcher with an opportunity to video record, draw and photograph the site and the resulting visual data was collated in a sketchbook. Sedivy and Johnson [27] note that the production of rough sketches in the initial stages of creative thinking is *'extremely common'* in the visual arts.

The experience of being situated in the location for a period of time; to physically sense the sound of the sea and sea birds; feel the texture of rock and sand and note the changes in light across the horizon were found to influence the development of ideas. In particular the researcher noted the disconnection between the recollection of her perception of light on the shoreline, expressed in a watercolor sketch, and a digital photograph of the same time and location. The sketch was found to rekindle the emotional response to the environment that the digital photograph failed to evoke and this formed the key concept that generated the initial visual ideas for the artwork.



**Figure 1 Watercolor sketch – Kilmory (layer 1)**

The computer assisted the review of digital photographs and enabled connections to be made between the memories of the shoreline experience and the drawings recorded in the sketchbook made in situ. The watercolor sketch (Figure 1 *(left)*) was scanned into the computer and manipulated using Adobe Photoshop® software. Colors were selected from images scanned from the sketchbook and the first layer of the image developed. This layer was saved onto a CD (compact disc) and mailed to Bell.

*Conceptual blending and idea association*
All three artists who participated in the case study were observed to use the computer to review imagery from a

variety of sources in order to playfully generate visual concepts. In the video recording of the first case study interview, Bell states that she purchased her computer to function as an *'electronic sketchbook'* and she states:

*'It's like a doodle pad, I play with ideas, I play with colors ….I do this for hours...I just sit and play, like I do with a sketchbook'*

Unlike a physical sketchbook however, the digital medium facilitates imagery from multiple sources to be virtually mixed on the computer screen; images can be combined from still and video cameras, scanned imagery and objects, the Internet and electronically rendered artwork. Ideas and associations can be merged into a single image. Fauconnier and Turner [12] state that routine cognition requires compression of experience and this occurs through a process of conceptual blending. Gombrich [13] contends that the brain uses techniques including perceptual redundancy to cluster visual cues. This filtration and amalgamation of ideas stimulates creative or imaginative thought; the potential to visualize and restructure concepts through sketches, symbols and diagrams proliferates generation of further ideas [15, 27].

*Play*
Play is a vital component in the development of visual concepts and an essential ingredient in creative thinking [1]. Both researcher and artist describe a playful approach to using the technology in this collaboration; the word *'play'* recurs throughout the recorded verbal protocol. Access to digital tools that provided creative freedom to change shape, scale and color enable playful, risk free, manipulation of visual elements within the developing image. When building the second layer of the image (Figure 2 *(left)*) Bell introduced photographic imagery: flotsam and jetsam found on the beach and a textural area of rippled sand. These were layered onto the researcher's image and combined through the addition of digital line-work created using a tablet and pen.

In non-digital rendering of design ideas this method of creating imagery would be difficult and time consuming if not impossible to achieve; layering of photographic imagery would require laborious print techniques or collage work. The facility to save images at each stage of development, to step backwards, to undo and change a layer provides the visual artist with a risk free environment in which to explore ideas. The emotional response to this is positive; it feels good to play with ideas and experiment with imagery. Research by Isen outlined in Norman [21 p.19] affirms the benefit of positive emotions in creative thinking *'when people are relaxed and happy their thought processes expand becoming more creative, more imaginative.'*
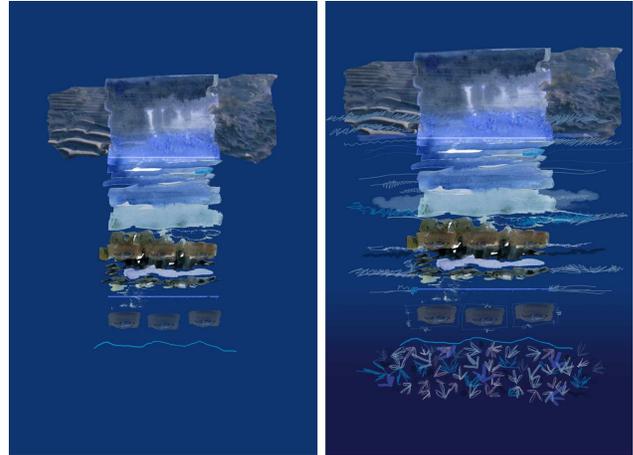


**Figure 2 'Kilmory' Layer 2 (left) and Layer 3 (right)**

*Spontaneity, happy accident and intuition*
The researcher's response to the photographic elements introduced by Bell was to review the digital photographs and images in the sketchbook to refresh the shared memory. The video documentation of this stage records two particular sensory prompts that stimulate the researcher's addition to the developing image. A photograph of imprints made by seagulls on the soft sand was noticed during the review of images in the sketchbook; at the same time sea gulls can be heard outside the artist's studio. Although the researcher is not aware at the time of the connection of the two prompts, the video recorded evidence reveals the production of spontaneous and rapid electronic sketches resembling impressions of seabird feet, made using a digital drawing tablet and pen. A variety of weights of line, brush shapes, opacity and color were used in the sketches (see bottom section of Figure 2 *(right)*). In addition, random line-work was incorporated into the image; this was saved and returned to Bell on CD.

The importance of spontaneity, happy accident and intuition in the creative process were key findings from the case study. Bell in particular stressed the significance of spontaneity in her non-digital practice where the craft technique of silk painting forces the artist to relinquish full control of the color, which moves and bleeds through the wicking effect of the fiber. The digital craft is less spontaneous. Nevertheless Bell has developed a digital working practice in which she engineers spontaneity through complex layering, scanning techniques or the post-printing embellishment of the artifact by hand with colored dyes or stitch. Evidence of the role that intuition plays in the critical selection and decision-making process that follows spontaneous creation is revealed on the video recorded data and is described in the following section.

*Idea selection and evaluation*
Subjective judgments, rooted in tacit knowledge and connoisseurship, help to define whether a line, mark or image is considered a happy accident or mistake. Dormer describes *tacit knowledge* as a body of knowledge gained through experience; *connoisseurship* however, can only be experienced through the senses and cannot be taught [10]. Experience of this emotional valuation is difficult for artists to express or explain verbally. Norman [21] contends that the affective system provides critical assistance to decision making, enabling rapid value judgments to be made. Recorded data from this investigation indicates that the selection of ideas at the generative stage of image development can be rooted in memory; sensory prompts, such as the sound of sea gulls, stimulate recognition of previous experience. In this particular instance, recognition and attention focused on this particular memory results in the subsequent action: spontaneous rapid sketching of impressions of sea bird feet (see bottom section of Figure 4).
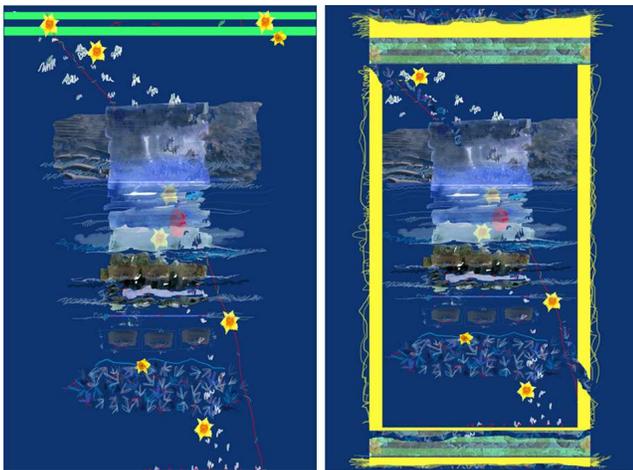


**Figure 3 'Kilmory' Layer 4 (left) and Layer 5 (right)**

Bell's response was the introduction of a daffodil motif and two horizontal green lines (as shown at top of Figure 3 *Layer 4 (left)*). This change in subject matter emanated from the artist's desire to incorporate elements that reflected the location as she saw it currently, in the springtime. The original predefined agreed framework for the work was to express a shared memory of *time* and *location*. The introduction of the new motif felt inappropriate to the researcher and inhibited further development of the image. Although the video recording documents the researcher's intention to alter the image dramatically in the subsequent layer, in reality only small changes were made to the image with the inclusion of additional line work and textural effects (Figure 3 Layer 5 *(right)*).

The final layer by Bell included only very subtle minor additions to the image. The momentum had been lost and it was decided that the image could go no further. It was agreed that the third layer was most successful in conveying the shared memory theme and so this image was chosen to be digitally ink-jet printed onto silk satin (Figure 4).

The importance of the predefined and mutually agreed framework within which the work had been created is evident from this investigation. The appropriateness of imagery within this framework had formed an important tool for evaluating the selection of ideas. Although this decision making process could be articulated at the end of the research, at the time of making the image, the knowledge that the work was no longer evolving successfully remained intuitive, it was a gut reaction that the image no longer *felt* right.



**Figure 4 'Kilmory' - Digital ink-jet printed silk**
**120x 200cm**

*Surprise, excitement, freshness and fixation*
Unilateral introduction of new imagery into the developing digital image provided the creative process with momentum. The element of visual surprise provided each practitioner with excitement, kept the creative process fresh and inhibited fixation on any particular idea. Analysis of post-investigation questionnaire data reveals that all three artists found the collaborative working process stimulated ideas and provided a sense of excitement. One artist said she felt like she was '*getting presents all the time*', and another described her excitement in receiving each layer as '*an expectation, sort of like Christmas Eve?--anticipation and curiosity about what you had done,*' and another that '*the spontaneity was motivating.*'

*Making by hand*

The importance of making by hand, hand rendering and manipulative skill in the creative process was another key finding from analysis of the case study data. All those interviewed for the research stressed the importance of manipulative and tactile making skills in the development of visual ideas. The physical action of grasping a drawing implement and feeling the friction of tool upon surface; the sensory feedback of hand on surface; the manipulation of paper and fabric were all considered important stimulants for deriving novel visual ideas. Wilson [32] asserts the connection between hand and brain in developing imaginative thought. Recent research in neuroscience has identified that separate streams of sensory information are fed to the brain from visual stimulation [33]. These have been shown to enable both physical manipulative action and also the perception of objects. Prytherch [23] links the sense of touch with sight and perception and asserts that both provide information to the brain in different ways. Haptic senses result from successive experiences in which substance is encoded; vision provides information concerning shape and location. Research by Goodale and Milner cited in Wing [33] identifies how visual control of prehension informs perception and cognition in order to mediate physical action. These connections between *vision*, *touch* and *cognition* inevitably impact on perception of physical experience and influence imaginative thought [30]. Harris [14] contends that those practitioners that have learnt haptic skills, such as textile handcrafting, are more likely to feel constrained by the lack of sensory stimuli inherent in digital crafting.

The collaborative investigations provided an opportunity to evaluate digital tools to support sketching and visualization of developing concepts. Each of the practitioners involved in the research commented on frustrations in the physical use of digital drawing input devices. The lack of perceived haptic sensory feedback was cited as a major concern. In some instances frustration was expressed with the disconnection between hand use and visual feedback on a computer monitor. The researcher found that co-location of hand and eyes when working on a tablet PC enabled a more fluid drawing experience. The limitations of bimanual coordination in digital working were also expressed. The most experienced digital practitioner found this less of an issue due to her use of *hot keys* with non-dominant hand and drawing input device in the dominant. However, she also expressed the need to work with her hands, away from the computer for periods of time, to stimulate novel thinking. The same artist used her non-dominant hand occasionally for drawing to create different kinds of spontaneous digital marks and also to rest her over-worked dominant hand.

## DIGITAL TOOLS TO SUPPORT CONVERGENT THINKING

The previous section has identified issues impacting upon creative cognition in digital textile art practice at the earliest stages of visual concept development. The collaborative investigation with Bell provided the researcher with an empathic tool to gain personal and emotional experience of these issues. The following section highlights the use of digital tools to support the developmental phase in creative thinking: the narrowing and refinement of visual ideas and the appraisal of verifiable solutions.

### Instance 2 'Wales design project'

The following section describes a part of a collaborative investigation with a New York based textile designer Debra Bernath. Following the case study interview the artist visited the researcher's home in Wales, UK, and an investigation into how digital tools can be used to support distributed creative design collaboration was undertaken. Consistent with previous investigations, the stimulus for the visual imagery used in the work was a shared memory of the visit. The exercise also provided the practitioners with an opportunity to experiment with using electronic methods of transferring digital design data and to examine how digital communication is able to support creative collaboration.

Visual reference material including photographs and scanned imagery were posted on the researcher's website following the artist's visit. Over the following weeks visual ideas were shared. The file transfer process provided a quick and efficient method of delivering design data and enabled collaborative generative concepts to be explored.

### Visualization

A number of ideas based on photographic imagery of architectural details began to be developed; however, at this stage the project lacked momentum and the generation of visual ideas was slow. A further *face-to-face* meeting of the collaborators in New York, in which floral imagery from Wales was introduced, provided the necessary stimulation to inspire rapid development of ideas. This imagery rekindled memory. It also provided fresh color inspiration and motifs considered appropriate for the target end product since *floral* design continues to dominate the apparel textile design market. These changes motivated the design development stage.

Over the following two months numerous design ideas were refined into a collection of six apparel designs. Their development was non-sequential with concepts being created in parallel by both practitioners. Designs were developed and refined in numerous stages without the need for substantial investment in time that is usually required in non-digital work. Use of layers and rapid manipulation of colors, backgrounds and motifs made the co-ordination of individual designs straightforward, resulting in numerous

design options. The processes of reflection and selection became key elements in the creative process.

'Poppy', a large-scale non-repeating design for apparel fabric, was the first of six design ideas to be developed for the Wales design collection and was influential in the creation of all subsequent design concepts. Numerous initial visual ideas were explored based on the photograph of a stained window. The repeating pattern, (Figure 5 *(right)*), was developed from an initial concept using this motif by Bernath.



**Figure 5 Photograph of stained glass (left) and resulting repeating pattern (right)**

Refinement of the motif was aided through the use of precision measurement and copying tools in the software and the repeating unit devised to flow perfectly within the dimensions of the final design work. Although time consuming, this digital process would be virtually impossible to hand render when equivalent complex tonal imagery is used.



**Figure 6 'Poppy': apparel textile design (90x90cm)**

The poppy motif was scanned and manipulated by Bernath and refined by the researcher. The sequence of developments that followed enabled the floral elements to be integrated, repeating top to bottom, over the window pattern (Figure 6). A mutual decision was made that this design would not repeat between the selvedges (width of the fabric) but would be developed as a large-scale design.

The intention was to explore the potential of digital ink-jet printing to provide tonal and color gamut on fabric that would be difficult if not impossible to achieve via analogue print processes. The opportunity to share the developing imagery via the website and receive feedback through regular email and telephone conversations assisted the decision making process.

### Reflection

Other designs were being developed concurrently with the 'Poppy' design and imagery was translated between the evolving ideas. The necessity to upload artwork and pause the creative process, while awaiting a response from the collaborator, provided opportunity for periods of reflection on the emergent design. Schön [26] describes how iterative periods of reflection are fundamental to creative practice and are used to inform future actions.

One characteristic of digital visual art practice is the rapid proliferation of visual ideas: iterations can be quickly modified to create multiple options for further exploration. Findings from the research indicate that the subsequent decision making process can be exhausting for the artist. In non-digital practice, the hand rendering process takes time and provides periods of reflection in parallel to fabrication of the artwork. Sternberg and Tardiff [29 p.430] contend that *'creativity takes time'*. Slowness of making in hand craft provides opportunity for idea association and imaginative thought to develop, and critical aesthetic decisions to be considered. The digital crafting process has been observed to encourage non-reflective thinking [20].

Findings from this investigation indicate that the punctuated collaborative working process enables reflection to occur when work is exchanged and forces appraisal of the developing concept. The reflective periods also stimulate renewed vigor in the design development process. Designs can be re-evaluated, re-conceptualized and refined. Changes in color, scale and repeat pattern construction can be applied and visualized with ease when working digitally. Each iterative stage in development can be saved and earlier renditions of a design reinstated if the subsequent changes do not work. Research cited by Amabile [1] has found that extrinsic factors such as *fear* and *risk* can have a detrimental effect on creative thinking. The fear of ruining hours of laborious rendering is eliminated in digital practice; risk is reduced and risk-taking enhanced. This marks a considerable change when compared to non-digital practice, benefiting innovative thinking in the development stage of product or artifact.

### Verification and sampling

At various stages in the investigation, work-in-progress was digitally ink-jet sampled, either on paper by the designer or on fabric by the researcher. The facility to digitally share design imagery enables multiple copies of the artwork to be available for simultaneous sampling. This is a great

advantage compared to hand rendered artwork where usually only one original copy exists. Nevertheless, there are also significant difficulties concerning the communication of color across networks and media. For those visual arts practitioners' working outside industry, with no access to commercial calibration tools, this impacts creative practice in a variety of ways. Findings from the research as a whole reveal that creative practice is enhanced when color issues are regarded in a positive way and considered to be potential avenues for further exploitation. Campbell [5] and Polvinen [22] confirm these findings recommending that color management difficulties be approached empirically. Campbell [5] gives a thorough assessment of these issues. Accuracy in color data transfer across networks and between digital monitors, peripherals and printing devices is a major concern for those involved in professional creative collaborative practice. Within the Wales design project, accuracy in color calibration was not considered a primary concern although some color matching was attempted using paper hardcopy.

As a creative tool, the facility to rapidly modify color hue, tone and saturation proved invaluable in the design development stage. Color plays a vital role in the co-ordination of design concepts and digital tools were used to enable color data to be transferred with ease across a range of developing design concepts. The creative framework, agreed at the outset of the investigation, provided certain fixed criteria for the selection of successful design ideas and provided direction for appropriate development. Decision-making was guided by the practitioners' tacit knowledge of designing for apparel fabrics and knowledge that both collaborators had a proven track record of designing for industry. Although certain objectives had been set at the outset of the investigation, it was considered important to keep the end goals dynamic and refrain from restricting the visual characteristics to any preconceived solution in the end product.

The final verification stage of design development took the form of prototype sampling onto a variety of woven substrates using a Mimaki TX2 digital ink-jet printer. Photographs of the printed samples were emailed to the designer to provide rapid feedback prior to the mailing of fabric samples New York. At this stage considerable adjustments to color and changes in scale were made before the final lengths of fabric were printed. The digital process enabled selection from a far wider variety of choices in design solutions than would have been available using analogue design methods; to create a variety of prototype fabric samples via traditional processes would have been both costly and time consuming.

## DISTRIBUTED COLLABORATIVE PRACTICE
The previous sections have identified how digital tools have been used to support collaborative creative practice from concept generation through to design development and verification. The subsequent section summarizes findings arising from the investigations, highlighting issues that impact on distributed collaborative digital creative practice.

### Shared skills and values
Dormer [10, p.102] describes the creative process as *'the interplay between what we see now and how we interpret what we have seen in the past'*. Memory of experience has provided a crucial stimulant to the creative work produced during the investigations. The opportunity to digitally exploit visual imagery, collected with the collaborators during the case study visits, proved invaluable in the origination of concepts. The visits were also fundamental to the mutual understanding of common values and skills; commonalities in definition and description of aesthetic characteristics and values were identified and alignment of ideals and goals was possible as a result. The collaborative investigations also provided opportunity to utilize complementary as well as shared skills and knowledge, combining professional experiences of both practitioners. The united intention of both practitioners to make work that evolved from the shared experience and memory provided clear end goal focus and added momentum to the project.

In each investigation critical aesthetic judgments were possible due to the mutual respect and reciprocal appreciation of knowledge and skill between collaborators. The importance of human qualities in successful creative collaborative practice was identified in data obtained from a post-investigation feedback questionnaire. All three practitioners cited *trust* and *empathy* as being essential attributes for successful collaboration. The shared physical experience of the case study interview enabled this trust to be established and an empathic relationship to develop. Mamykina et al. and Olsen and Olsen report comparable findings in research cited in Edmonds, Weakley et al. [11].

### Decision-making, leadership and appropriation
The decision that *closure* had been reached in each investigation proved particularly difficult. Digital working methods ensured that the process of idea generation could be swift and imagery was found to develop rapidly in great complexity. Knowing when to stop exploring multiple ideas and begin to refine selected concepts became a key issue in each of the investigations. In commercial design work, the customer often imposes time limitations; nevertheless the practitioner more often decides the amount of time spent on idea generation in any creative project. Findings from this research indicate that the decision making process in digital practice is particularly intensive and the punctuated reflective method of sharing imagery between practitioners can be beneficial.

All those involved in the collaborative investigations described the decision-making process as being '*less inhibiting*' than working independently; it was also felt to be '*liberating*'. There was a reduction in the sense of

responsibility for the final outcome which one of the artists describes as being *'surprisingly satisfying and sort of a relief…I became more playful and adventurous'*. In parallel with this came reciprocal responsibility expressed as a desire to leave concepts open and unresolved to permit subsequent addition or manipulation of imagery. The collaborative working process required a willingness to assume and relinquish control and direction of the evolving visual concept. Some leadership was necessary to achieve a final output and the researcher felt it was her responsibility to sensitively orchestrate the co-operative process without imposing restrictions on the development or flow of ideas.

Issues concerning authorship and ownership of collaborative digital artwork are highlighted by this investigation. All three collaborators denied that they considered authorship of the work a difficulty in this project, preferring to regard the output as a result of a *'shared experience'*. Nevertheless, the capacity to integrate responses from more than one individual via the digital medium, and replicate this with accuracy, has considerable implications for the way an artifact is perceived and for its monetary value

### Data transfer and digital tool use

Digital systems, including local and wide area networks and telephone communications used in conjunction with other electronic devices, are providing a technological environment that is increasingly fluid and ubiquitous. During the course of the investigations described in this paper, which span the two-year period 2003-5, new, faster and more efficient methods of data transfer developed and became readily available. In the first investigation files were transferred on compact disc and sent by mail as access to web based transfer of large image files was unavailable. In the second investigation websites were successfully used for file transfer. This pace of change indicates likely future collaborative working practice will engage in increasingly sophisticated methods of data transfer and communication, enabling artists to be involved in *real-time* distributed creative collaboration.

The importance of relationship building and shared experience in creative collaboration has been a key finding of the research. Digital and communication tools that can build social interaction, enhance and maintain personal relationships will be invaluable for stimulating and fuelling creative thought in distributed working environments. Email and telephone conversations assisted the process of feedback and orchestration of the creative process. Video conferencing and instant messaging are likely to enhance future distributed collaborations.

### CONCLUSION

Investigations have been described in which practical collaborative art making has been used as a means of empathically evaluating digital tool use in creative practice.

The facility to collaborate in a distributed environment, using the Internet for visual data transfer, as well as communication of feedback and project management, has enabled the influence of technology on creative practice to be assessed. Findings from the investigations highlight the importance of physical experience and memory in creative cognition. Shared experience is a useful prerequisite for fostering of relationships in which shared values and trust can be developed; this has been found to impact upon the selection of visual concepts in evolving artwork. The opportunity for the researcher to contribute to the creative action as *participant* rather than solely as an *observer* has provided insight into the importance of the emotional factors that affect the creative process that might otherwise be difficult to perceive. Appreciation of how visual concepts are stimulated and refined, as well as how it *feels* to be actively participating in their development, has enabled case study findings to be interrogated and verified.

Future creative practice of visual artists, designers and craft practitioners is likely to become increasingly collaborative [18, 22]. Environmental concerns are encouraging distributed working practice using networked environments. Findings from this research illuminate the ways in which digital technology can be used to support distributed creative practice. Empathy, experienced through practical collaboration, has provided the researcher with a sensitive tool with which to evaluate and respond to the findings that have emerged from the research.

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