This is the published version


Available from Deakin Research Online

http://hdl.handle.net/10536/DRO/DU:30009755

Reproduced with the kind permission of the copyright owner

Copyright: 2006, IADIS
E-CREATIVITY: INVESTIGATING COMPUTER-SUPPORTED CREATIVITY

Dr. R. T. Jim Eales  
School of Computing Science, Middlesex University  
London, NW4 3BT, UK.  
j.eales@mdx.ac.uk

Sophie Nichol, Dharani Perera  
School of Engineering and Information Technology, Deakin University  
Pigdons Rd, Geelong, VIC 3215  
sophie.cl_dp@deakin.edu.au

ABSTRACT
A fusion of the power of modern information and communication technology with the potential of human creativity provides an important and interesting area for research. In this paper, we outline this general research area that we term e-creativity. In particular, we describe our own focus of interest that we label computer supported creativity and the design of creativity support systems. As this is a largely uncharted territory, further research is of vital importance. We describe our research approach in this area and illustrate this with extracts from a case study of an artist who makes extensive and novel use of information technology in her creation of paintings.

KEYWORDS
e-Creativity, creativity, creativity support systems, computer-supported creativity.

1. INTRODUCTION

Mitchell et al. (2004) have suggested that information technology (IT) is forming a powerful alliance with creative practices in the arts and design to establish the exciting new domain of information technology and creative practices—ITCP. While we agree that a powerful alliance is forming and that this domain is certainly exciting, we prefer the term e-creativity to describe this general field of study. Our working definition for e-creativity is the application of information and communication technology to support and enhance human creativity. Clearly there are many factors that can have an influence on creativity other than technology. Various social, cultural, economic and other influences can enhance or stifle human creativity. However, the support of creativity by information and communications technology is our chosen focus for research, and our ultimate objective is the design and development of technological systems to support and enhance creativity. We do not believe that these systems will generate creativity where none exists or that people cannot be equally creative without technological support. We take essentially a non-elitist stance on human creativity. We believe that everyone is potentially creative and not just those with “great minds” or those that are divinely inspired. We leave it to history to evaluate the significance of their creativity. Shneiderman (2002b) uses the term mega-creativity to describe the phenomenon of enabling more people to be more creative more often.

Why should we attempt to support creativity? Creativity is a defining human characteristic and a fundamental part of human development. There is a strong argument for supporting creativity because of its intrinsic value. However, recent studies have also highlighted the increasing economic significance of creativity. Florida (2003) maintains that creativity is the driving force of economic growth; it is the decisive source of competitive advantage. Industries such as publishing, TV and films, software, music, design and fashion are playing an increasingly important role in advanced economies. Florida argues that creative
industries develop and flourish in creative communities. Countries and regions that do not support and embrace creative communities - in all their various facets and dimensions - are doomed to economic stagnation.

In this paper, we attempt to outline our particular research focus within the general domain of e-creativity. Specifically we define and describe what we term computer-supported creativity and creativity support systems (or tools). We freely admit that our notion of what a creativity support system is, or could be, is somewhat unformed and vague. In many ways the term is a placeholder for us, while we investigate the many possibilities for the technological support of creativity. An important issue for us is just how we go about studying the potential for the technological support of creativity. Although we discuss a number of theories or models of creativity, our research approach is essentially pragmatic. We have set out to study creativity in action through a series of descriptive case studies of creative practice and the influence of technology on that practice.

We outline one particular case study in this paper. We consider Jill Lewis, an Australian artist working with paint on canvas, to be an exemplar case of information technology being used to more-or-less successfully support creativity. We have described her case in greater detail elsewhere (*, **). As Candy and Edmonds (2002) pointed out, case studies of the creative processes of artists are rare; therefore we believe case studies of artists working in traditional media, and using information technology as part of their creative practice, must be extremely rare.

2. WHAT IS CREATIVITY?

"Creativity is a bit like pornography; it is hard to define but we think we know it when we see it." Mitchell et al. (2004), p. 16.

Before we can discuss the idea of e-creativity in more depth we need to consider the issue of just what is creativity. Farooq et al. (2005) suggest that design requirements for creativity support tools should be more guided by the vast creativity literature that exists. In our own design explorations of ideas for creativity support systems, it seemed a logical step to investigate existing theories and models of creativity. Perhaps a widely accepted model of creativity could form the basis for a conceptual model of an IT-based system to support creativity. However, as Boden (1994) has pointed out creativity is a particularly difficult concept to even define let alone understand. There may be a vast literature on creativity, but the more one investigates the area the more theories and models one finds. Producing a new model of creativity appears to be a popular pastime amongst psychologists and others working in the area. Creativity has been researched from numerous perspectives, using a variety of research approaches. For example, Boden (2004) presents a cognitive science approach, whereas, at the other end of the spectrum, Czikszentmihalyi (1996) advocates a systems or contextual approach to studying creativity. However, there does seem to be a general consensus that the two defining characteristics of creativity are originality and usefulness or value.

Arieti (1976) has reviewed the numerous major theories of creativity. One of the most enduring theories has been that proposed by Wallas in 1926. He outlined four essential stages in creativity:

- Preparation
- Incubation
- Illumination
- Verification

This theory has probably had more influence than any other and has been the basis of many subsequent theories. However, Arieti also points out that there have been a number of severe critics of the attempt to define models of creativity, particularly those models with discrete stages. For example, Vinacke argued that the creative process does not always unfold in a given sequence of stages. He suggested that, particularly in fine art, the creative process could be seen as a series of illuminations from conception to completion. So our model of creativity becomes:
If models of creativity are numerous and most probably specific to individual areas of creativity, perhaps we would have more success investigating models proposed specifically by researchers working in the area of computer-supported creativity. Ben Shneiderman, one of the founding fathers of human-computer interaction, has taken a recent interest in creativity support tools (2002a, 2002b). He has proposed yet another model of creativity (2000b, p. 219):

- **Searching** and browsing digital libraries, the Web and other resources
- **Visualizing** data and processes to understand and discover relationships
- **Consulting** with peers and mentors for intellectual and emotional support
- **Thinking** by free association to make new combinations of ideas
- **Exploring** solutions – what-if tools and simulation models
- **Composing** artefacts and performances step by step
- **Reviewing** and replaying session histories to support reflection
- **Disseminating** results to gain recognition and add to the searchable resources

Anyone who has written a conference or journal paper will quickly recognise the stages in Shneiderman’s model. This seems to suggest that he has been strongly influenced by his own personal area of creative endeavour. We suggest his model has little value in interpreting other areas of creativity. It has few points of reference with our own studies of artistic creativity. Edmonds and Candy (2002), also working in the area of creativity support, have proposed a simple and generic model that seems to get closer to capturing artistic practice and perhaps other areas of creative practice.

- **Exploration** of the problem
- **Generation** of possible solutions
- **Evaluation** against constraints

In summary, we can say that there is a plethora of creativity theories and models, only a few of which we have described here. One thing seems certain; there is no single indisputable theory or model of creativity that we can use to form the basis for the design of technology to support human creativity.

### 3. E-CREATIVITY

Our working definition for e-creativity is the application of information and communication technology to support and enhance human creativity. There are many ways in which creativity and IT interact, and all these areas have a justifiable claim to be considered as a part of e-creativity. Firstly we will outline a number of these areas that are possibly a part of e-creativity before describing our own particular area of interest and investigation.

Surprisingly when one mentions the general idea of computers supporting creativity, most people seem to conjure up notions of computer programs generating creative ideas using artificial intelligence techniques. Boden (2004) describes this area of study as *machine 'creativity'*. Programs have been developed that draw pictures, write poetry, compose music and design buildings. Boden argues that regardless of whether these programs can be considered creative or not, they do shed light on the mental processes underlying human creativity. An area of growing significance is *digital art*. This is generally considered to be art created on a computer (the process) and in a digital form (the product). In this case the computer can justifiably be termed
a creativity support tool. Related areas of artistic endeavour include (modified) digital photography, digital special effects in filmmaking and electronic music, to name but a few. One way of encouraging and studying the use of technology in digital art is to invite artists into technical institutions as “artists-in-residence” (See Candy and Edmonds (2002), Harris (1999)). Computer aided design (CAD) systems can also be considered as “creativity support systems”, particularly when they include features to support concept design and analysis. In business, decision support systems have been around since the 70’s and 80’s. These systems can encourage business insight by providing various forms of data analysis and project evaluation. These are just some of the ways in which information and communication technology can interact with creativity and are thus a part of the e-creativity area. We will now describe our own particular area of interest within e-creativity.

4. COMPUTER-SUPPORTED CREATIVITY

Our research focuses on the IT-based support of creativity and we term our area of investigation computer-supported creativity. We emphasise the word support because we are certainly not attempting to develop software or hardware incorporating creativity. Indeed, our approach is largely non-cognitive. We treat the creative human mind largely as a black box. We do however believe that information technology has an important potential role as a tool (or a system) to support people working in many different areas of creative endeavour. Our specific objective is the design and development of what we term creativity support systems.

![Diagram of Creativity Support Systems](image)

We consider figure 1 to be a useful way of illustrating our particular area of interest. We will attempt to explain this diagram. The horizontal scale represents what we term the scope of creativity, from individual to collective. Creativity is often considered to be a very individual experience; for example, many artists insist on working in isolation. But on the other hand many created objects such as software, architectural or engineering designs and advertising campaigns are the collective result of whole teams of workers. This horizontal scale serves as a valuable reminder that we must consider the collective as well as the individual dimension when considering the support of creativity.

The vertical scale represents the level of application of technology in the support of creativity, from specific tools to general environments. At the bottom of the scale we are thinking of specific tools such as paint programs or perhaps mind-mapping software. At the top of the scale we are thinking of what we term computer-supported creative environments. Many creative people find that the best way to support their own creativity is to organise a conducive environment. Czikszentmihalyi (1996) has suggested that it is easier to
enhance creativity by changing the conditions in an environment than it is by trying to make people think more creatively. So this scale reminds us to think not only about specific computer tools but also about developing technology-enhanced creative environments.

An interesting development of our model (figure 1) is to consider what the four corners or quadrants of the diagram might represent in technological terms.

- **Individual tools** – Computer-based tools that support the individual to be creative in various ways.
- **Collective tools** – Distributed tools that support widely distributed groups to work on collective designs.
- **Collective environments** – Computer-supported collective creative environments using communications technology to allow widely distributed groups of people to share a virtual creative environment.
- **Individual environments** – Computer-supported creative environments perhaps using ubiquitous and pervasive technology to generate inspirational physical environments.

5. RESEARCHING E-CREATIVITY

In spite of considerable research effort, human creativity remains an elusive concept. Mayer (1999, p. 458) suggests that “although creativity researchers have managed to ask some deep questions. They have generally not succeeded in answering them.” An important part of our investigation is to ascertain the particular functionality and usability needs of the creative computer user. Although people’s creativity may be very different, our hope is that the attributes of information technology that creative users find useful may be reasonably constant and generalisable.

To advance our general understanding of this research area we have initially set out to study examples of creativity in action in various natural settings. At this stage in our research, we are primarily studying the creative practice of acknowledged artists. Even at the best of times creativity is hard to find. We consider artists to be specialists in creativity, normally with clearly defined creative output and well-developed and largely stable creative processes, so artists offer a number of advantages when studying creativity in action. On the negative side, artists do tend to work mostly as individuals and we have to keep in mind the importance of collective creativity. Our studies of the creative practice of artists are just a starting point in our research. Although there are some interesting prospects for information technology in art and design, we are interested in a whole range of human creative activities and the potential support that technology might provide for these activities.

6. JILL LEWIS – AN EXEMPLAR CASE

Many times during our research we have been tempted to declare that supporting creativity with technology is impossible, particularly because it seems impossible to successfully model creativity. However, what has driven us on in our design quest is the knowledge that one artist, Jill Lewis, has effectively created her own ad hoc creativity support system. This is not some research prototype but a working system that she finds useful and often uses in her creation of paintings. Here we briefly describe her art, her use of computers in her work and her ad hoc creativity support system.

Jill Lewis is a mid-career Australian artist working in the traditional medium of paint on large canvases (see [www.libbyedwardsgalleries.com](http://www.libbyedwardsgalleries.com) for examples of her work). We have described Jill’s creative process in more detail in previous publications (*,**). She has painted full-time since 1999, after previously lecturing in painting and art history. She regularly exhibits in Melbourne, Sydney and Brisbane. Jill’s paintings are generally large colourful canvases depicting primitive animal characters and human figures. These images represent people and situations from Jill’s memories, dreams and relationships. This undoubtedly has implications for her general creative practice since she needs to create the conditions for these images to emerge from her conscious and unconscious mind. Jill has created a large studio in her house. Her computer and peripherals are situated in a corner of the studio. We have identified two separate and significant uses of digital technology in Jill’s creative practice. We have termed these uses electronic collaging and media switching.
6.1 Electronic Collaging

Sometimes, when she is in need of fresh inspiration, Jill will investigate ideas for new paintings using her computer. She may spend a week on the computer just playing with ideas. She generally starts by collecting a series of mostly random scanned images. For example, she will open a magazine at a random page and scan that page. She will also scan random images from books, her paintings, her sketchbook and even physical objects such as leaves. These images, or more likely just parts of these images, will be arranged into collages on the computer screen. The computer allows her to easily manipulate a variety of images, she can quickly rescale these images and she even welcomes the occasional chance error. If she particularly likes an image generated on the computer this will form the basis of a new painting.

6.2 Media Switching

When she has not used the computer for initial inspiration, Jill generally does not start with a clear idea of the painting she wants to create; rather the painting evolves slowly as she works on the canvas. During this process of evolution, switching from paint on canvas to a digital representation of her painting offers her a number of advantages. For example, she can simply undo changes, she can quickly put new colours over old and she can even rotate the canvas. To achieve this she takes a photograph of her painting using a standard digital camera. She uploads this image into image editing software on her computer. Jill then uses the software tools to work on the digital image in various ways exploring possible compositional changes. Generally a switch to digital is prompted by a perceived major problem with the composition of her painting. After she has decided on the changes she wants to make to her painting, she produces a coloured printout of the image generated on the computer. This then becomes a “working sketch” for changes to her painting.

7. JILL’S AD HOC CREATIVITY SUPPORT SYSTEM

Perhaps the most important point about Jill’s use of digital technology is that she freely chooses to make use of it in her artistic practice. Our own research involvement with Jill has been simply to observe and record her creative practice. There are numerous cases of well-meaning technologists studying a supposed need and then developing a technical solution (along with numerous research publications) only for the system to be completely rejected by the intended users, an example of technology chasing a problem. In this instance, Jill has realised that various pieces of digital technology can be useful to her in her overall creative pursuit of painting pictures on canvas. Jill, who does not have a background in information technology, has effectively assembled her own “ad hoc” creativity support system (see figure 2).

When Jill switches media during a painting (represented by the right side of the figure), she uses a digital camera, the computer and image-editing software, and the VDU or printer for output. When she uses electronic collaging to explore ideas for new paintings (the left side of the figure) she normally also makes use of a scanner. In Jill’s ad hoc system, it is tempting to focus on the image-editing software and think of this as the creativity support system. It perhaps most closely resembles what we think of as a creativity support tool. Although the image-editing software is, of course, very important, it is clear that all the digital elements should be seen as forming the complete system. She did not start electronic collaging until she bought a scanner and she did not transfer her paintings onto the computer during their development, until she had acquired a digital camera.

If we consider all the different digital elements that make up Jill’s creativity support system we can also see that the system is incomplete. She really needs some way of transferring images from the computer to the canvas. In media switching, this is not particularly difficult because she has the existing painting to provide points of reference. It is more of a problem when she has been using the computer for electronic collaging. One would expect that she might welcome the additional randomness introduced by transferring from the screen to canvas, but she does not want additional compositional disorder at this stage, because she has already applied her rules of artistic order to the image on the computer. She wants to transfer the image from the computer to the canvas without any distortion. This currently presents her with a problem.
We have focused on the artistic practice of Jill Lewis in some detail. For us she is an exemplar case. Her case is more than just a specific study of artistic practice involving the use of information technology. For us, her freely-chosen and self-developed use of technology in her creation of paintings has become a powerful motivational force that convinces us that creativity support systems are not only possible but that they are also needed and will be used providing we get the design right.

8. SUMMARY AND FURTHER WORK

We believe we have demonstrated in this paper that e-creativity is an important, interesting and viable area for research and development. We agree with Candy and Edmonds (2000) that there are immense opportunities for the creators of innovative technologies to expand the repertoire of tools and toys that amplify the creative process. To further this research area clearly there is a need for more studies of creativity in action and the part played by existing tools and technology in creative practices.

We are currently investigating:
- the creative practices of a range of artists working in different media
- possible methods of interaction to support artistic expression for disabled artists
- the creative culture of computer games designers

We have also been working on a number of ideas for prototypes particularly in the area of computer-supported creative environments.

In conclusion, we can say that research into the area of e-creativity may well be extremely difficult with numerous problems to overcome, both in understanding creativity and designing supporting technology, but the potential benefits of successful creativity support systems are enormous.

ACKNOWLEDGEMENT

We would like to thank Jill Lewis for her co-operation and patience.

REFERENCES