Computer Aided Creativity: Practical Experience and Theoretical Concerns

Robert Pepperell
School of Art, Media and Design, University of Wales College, Newport
Caerleon Campus, Newport NP18 3YH UK
+44 (0)1633 432642 pepperell@ntlworld.com

ABSTRACT
In this paper I will outline some of the practical experiences and theoretical concerns that have informed some 15 years of research into the relationship between human creativity and technology. I will discuss a number of approaches to the design of effective creativity enhancing systems and identify the key theoretical concerns that have informed the practical research. Finally, I will present some conclusions about the nature of human and synthetic creativity arising from my published work. At conference the paper will be presented using a variety of audio-visual illustrations.

Keywords
Ambiguity, collaboration, complexity, discontinuity, post-humanism, randomness

INTRODUCTION
My first encounter with computer technology within the context of art practice came at the end of my graduate programme in Fine Art at Newport School of Art in 1986. The course leader at that time was Roy Ascott, the influential telematic theorist, who invited me to assist in a number of international computer networking projects at venues such as the Venice Biennale and Ars Electronica. During my subsequent postgraduate studies at the Slade School of Art in London I became increasingly interested in the artistic and creative potential of computer technologies, not just as a medium of global communication but also in the direct production and manipulation of sound, text and images. There were two issues that intrigued me: first, the potential for automation of various creative processes such as image generation, music sequencing or writing and, second, the potential for the creation of images of semantic ambiguity and indeterminacy.

AUTONOMOUS AUTOMATED CREATIVITY
The first issue stemmed from the proposition that many of the creative decisions made in video editing suites, music composition studios and during graphic layout exercises often involve a significant degree of randomness. First hand experience gained in making pop videos, composing music with sequencers and producing desktop published artwork in the years immediately following my exit from the Slade confirmed to my mind, and to those of my colleagues, that many time-intensive processes integral to such activities might, to some extent, be susceptible to automation. For example, any designer faced with producing a poster layout will spend a significant amount of their (often expensive) time making choices from numerous possible typefaces, colour schemes, content orientations and the relative positioning of elements. At the same time, these potentially inexhaustible choices are limited by certain constraints such as the paper size, the clarity and balance of organisation, the scale and legibility of elements, conformity to certain stylistic or formal rules, not to say budgets and other financial determinants. Around 1988 we envisioned a general system that would autonomously produce multiple random variations of any creative object within certain limits set by the user who would be then free to ‘select’ the output variation best fitted the design requirements. In many ways the idea was inspired by natural evolution and, in particular, the ‘Biomorphs’ of Richard Dawkins [1], who had previously modeled genetic formulae to striking visual effect, as well as the work of William Latham [2] and the IBM research labs whose computer-evolved organic shapes were widely disseminated at the time. Our early experiments with computer generated images, music and digital typography were necessarily crude given the lack of any research funding and the poor capabilities of the computers we were using (low-specification Acorn Archimedes and Apple Mac Classics). Nevertheless, the results were sufficiently encouraging to spur further investigation, whilst it became clear that problems of producing ‘interesting’ material using random data generation were more profound than we first assumed. Although it was not immediately obvious to us, any information theorist would have been able to point out that the random generation of data will produce a high level of noise in proportion to signal – the signal being the...
interesting material we hoped to generate and the noise being the ‘uninteresting’, i.e. tedious or unintelligible, material which formed the bulk of the computer output. Through these investigations it became increasingly clear that creative activity, whether human or machine-based, would operate in a way consistent with other natural phenomena in the Universe, conforming in particular to the Second Law of Thermodynamics, which describes the relationship between order, randomness and the exchange of energy; in short, you don’t get anything useful for free. The probability of producing noise from a random configuration of any given matter is much greater that the probability of creating a signal; that is, some improbable configuration that would interest a human. Since the creation of human life itself is one striking example of such an improbable configuration of matter and energy in the Universe, it should not be surprising that life-dependent processes such as creativity might operate in a related way. Randomness is comparatively cheap and therefore of less value than order, which can be very expensive in terms of the ‘cost’ of energy required to sustain it. Hence, surface life on Earth needs a continuous source of ‘free’ energy from the Sun. For our part, the energetic cost, as it were, of sustaining interesting output from random data generation was incurred by the need to construct ever-more sophisticated rules, or constraints, which limited the parameters of the random behaviour so as to provide a greater probability of organised output. In the case of music composition for example, one needs to provide rules about tempo, syncopation, harmony, melody and so on, without which one tends to get a formless yet repetitive cacophony. But the excessive imposition of rules can lead equally to tedium of a different kind: a product with no variation, deviation or surprise. As Ernst Gombrich elegantly declared in A Sense of Order [3]:

“... however we analyse the difference between the regular and the irregular, we must ultimately be able to account for the most basic fact of aesthetic experience, the fact that delight lies somewhere between boredom and confusion.”

Since rigid compositional order can be as unstimulating as scattered noise, we are forced to engage with the complicated region between the two extremes where the mathematical certainties of absolute order and disorder no longer pertain — the realm, in fact, of complexity. We pursued our researches into this region of complexity, producing a number of computer generated music and videos works in the late 1980s and early 1990s, which were shown at film festivals, on television, in night-clubs, on videos and interactive CD-ROMs and released as records (see the Web site ‘www.stem-arts.com/hex.htm’ for examples). While these products were of some limited commercial and critical success (and were able to financially sustain our research) we were still unsatisfied with the quality of the output which was not always aesthetically pleasing, while the overheads of coding in rules and constraints were often greater than the savings in effort afforded by the automated creativity. It was almost quicker to do things in the ‘old-fashioned’ way.

**GENERATOR & COLLABORATIVE TECHNOLOGY**

In the mid-1990s my attention turned away from autonomous self-driven systems of automated creativity toward more user activated, dynamic systems that generated their output in response to continuous user input. This research was initiated by a commission from the Glasgow Gallery of Modern Art in 1995, for the construction of an interactive exhibit in their newly built ‘Fire’ gallery — the first purpose built interactive gallery in Britain. Prior to 1995 much of my experimental computer art-work had been exhibited in night-clubs and at festivals rather than conventional galleries, most of whom were paying little attention to computer-based art (which is largely still the case, although some of the blame for this lies with the subsequent proliferation of ‘content-free’, technology fixated works that were little more than demonstrations of devices). In was whilst working in clubs as a ‘VJ’ providing an ever-changing visual backdrop for the DJs that I evolved certain techniques for the live mixing of video sources which paralleled those techniques used by DJs in the cutting and mixing of records. It was these techniques of audio-visual manipulation that I attempted to embed in the work produced for the Gallery of Modern Art, entitled Generator [4].

**Figure 1. Generator at the Glasgow Gallery of Modern Art**
Generator consisted of two consoles supporting button banks, a set of computers, a video projector and speakers. One console controlled sound and the other images. The buttons on the sound console were organised into three rows each representing a channel of audio and into eight columns each representing a common musical genre such as rock, hip-hop, opera, jazz, and so on. By pressing different buttons (each of which was labeled with icons) the user with no previous musical training or aptitude could select, say, a piece of rock music to play at the same time as a piece of opera and a piece of hip-hop. The buttons triggered audio sample loops that were stretched and pitched so as to be compatible in tempo and tuning. The result was an audio mix of three distinct (and unrelated) music styles forming a harmonious, if somewhat unusual, whole based on selections made by the user. Critical to the operation of the system, however, was the fact that although the user could choose a style such as hip-hop or reggae, the actual clip played was chosen randomly by the computer from a database of clips classified by style. The selection of jazz would initiate the playing of one of many possible jazz clips. Consequently, the global output of the system was regulated by collaboration between the user’s choices and the random selections of the computer; neither had complete control. This collaborative aspect of the human-computer interface offered by the Generator distinguishes it from most other forms of machine interaction where user actions normally initiate a predictable response (with the exception of certain PC operating systems). This automaton-like predictability is almost the defining characteristic of a ‘machine’. In the Generator the consequence of pressing a button was not wholly predictable in that the user could influence but not control the activity of the system. The second console supported a similar set of buttons, each of which triggered video sequences arranged and selected in an identical way to the sounds. For the user, then, the overall experience was one of real-time audio-visual mixing in which they were able to significantly influence the composition of the sound and images, but were not able to precisely control them. Private research commissioned by the gallery into the public response to the piece showed a high level of audience satisfaction, with many users reporting a genuine sense of creative excitement when participating.

The experience of designing, constructing, installing and operating Generator convinced me that such unpredictable, collaborative technologies, as opposed to predictable, passive ‘slave’ technologies, offered a potentially rich method of enhancing human creativity. The advantage of the method was that it allowed for a significant degree of randomness, which produced great variation and spontaneity, but was tempered by severe formal constraints (of pitch and tempo) which prevented the descent into noise or confusion. The user acted as an agent of both randomness and order by causing the system to change in ways it would not otherwise do and by creating novel formal combinations that, to the user, were most interesting or pleasing. The net result was a system operating in the region of complexity between stasis and chaos where, arguably, human creativity flourishes.

The success of Generator led to a series of further commissions, most notably a piece called Synoptic on in the JAM exhibition at the Barbican Gallery in London in 1996 [5] and one called RAMJAM at the Nottingham Now! Festival of Arts in 1997 [6]. These pieces extended the methods used in Generator to include wider audience participation. For example, RAMJAM consisted of a room in a club filled with free-standing consoles supporting many buttons, each linked to a sound sampler. As a DJ played a series of backing tracks the audience (numbering some 200) collectively triggered sound samples mixed through the public address system. Thus the audience was, in effect, ‘jamming’ along with the DJ. Initially the results were fairly cacophonous as users simply pressed buttons continuously. However, later in the evening the audience as a whole seemed to realise that if some users left space other users could fill, this would be reciprocated. This is a lesson that anyone playing in a musical ensemble has to learn very quickly. By about 2am the whole room was packed with people ‘jamming’ along with each other and the DJ – a truly exciting experience.

The technique of collaborative interaction pioneered by the Generator piece found further expression in a some commercially released music composition software called Playtime, released as part of the critically acclaimed CD-ROM which accompanied the Let Us Play album produced by Coldcut in 1997 [7]. Playtime, co-written by the author and Miles Visman (who also collaborated on some of the earlier art works) offered a series of sliders which modified three banks of sound; drums loops, bass loops and ‘head noises’. The audio loops would play in sequence with one another to create music with an electronic ‘dance’ flavour.
Changing the position of the various sliders allowed the user to manipulate the way in which the programme ‘cut-up’ or rearranged the sound loops, thus creating complex levels of variation and modulation that kept the music fresh and interesting. Crucially, the actual choice of sound samples and the precise ways in which the sliders interacted with the sounds was partly random and partly user-controlled leading to the same relationship of collaborative influence between user and machine as was present in the Generator. This was in contrast to the more predictable ‘master-slave’ relationship we traditionally expect of technology, especially complex control devices like music sequencers. A customised performance version of Playtime was premiered at the Sonar music festival in Barcelona in 1997 in front of a live audience of about 2000 people [8].

This model of human/machine interaction, I believe, offers a viable model for future information design. Given the exponentially expanding volume of digital information available to us, and the general desire to make machines more intuitive and ‘human-like’, as well as the commercial pressures to automate currently labour intensive and highly skilled tasks, the model of unpredictable interaction discussed here may offer a productive way of interfacing human and machine intelligence.

**AMBIGUITY AND INDETERMINACY**

The second major issue that has occupied my research into computer aided creativity is the potential for the creation of images of semantic ambiguity and indeterminacy. I first became aware of the existence of images that resisted complete recognition sometime in 1985 whilst watching The Cabinet of Dr Caligari, a silent German expressionist film directed by Robert Wiene in 1919 [9]. At some point toward the end of the film the action cuts from an extended shot of a hand-written letter to a shot of a man leaning in despair over a desk (see Figure 3). Due to the contortion of the pose, the surreal backdrop and the grainy quality of the black and white film print, I was temporarily ‘lost’ in the chain of meaning that, up to that point, sustained my involvement in the narrative of the film. Whilst I was sure I was looking at a representation of some ‘thing’ (the image was not ‘abstract’), I was unable to articulate in my own mind what the image was of until the figure on the desk stood up and the overall shape of the scene became clear.

![Figure 3. Scene from The Cabinet of Dr Caligari](image)

This encounter with ambiguous or indeterminate images led to a great deal of research on my part as to the nature of such images and the sensation they invoked. When speaking to others about it (in the UK at least) I was frequently reminded of a segment in a 1970s television quiz show hosted by Robert Robinson called Ask the Family [10]. Each week the contestants were asked to identify a common household object from a photograph taken at extreme close-up. The only example I can remember clearly was the lever on the side of shoe polish tins used to twist them open. As the camera drew back and more of the image was revealed it became easier to identify the object and marks were awarded for the speed with which contestants could name it. One of the reasons this piece of 1970s television trivia seems to have stuck on the minds of those who saw it is because it was one of the rare occasions when they were confronted with an image that had a deliberately indeterminate meaning. Our common experience of commercial images, such as those surrounding us in advertising, television, product packaging and so on, is that we expect almost immediately to be able to securely identify what they are. Yet occasionally, and usually by accident, we come across an image that we can’t resolve and which may cause us some anxiety. Fascinated by the sensation this experience provoked in me I started to try and replicate the conditions that brought it about by constructing and manipulating images so they were devoid of clear meaning without completely destroying their integrity. As with the experiments on automated creativity cited above, I soon realised the difficulties inherent in balancing the right amount of order and confusion within an image so as to create the desired effect. If it was too ‘meaningless’ then it attracted no interest at all; if it was too ‘meaningful’ then there was no anxiety about the depiction and, hence, no effect of the kind I was seeking. After trying several techniques, including photography, drawing, filmmaking, and collage I attempted, in collaboration with Miles Visman, to generate indeterminate images using randomised pixels in an array. I hoped that random sequences of pixels would produce images that did
not ‘represent’ anything (for how could the computer know what to represent?) yet would be sufficiently complex to suggest to the viewer the presence of some object or scene as yet unidentified. Like the random data generation processes described above, the result was largely noisy, with very little in the way of compelling form emerging to attract the viewers’ eye. Gradually, as more rules were introduced to constrain the random behaviour and encourage more information to appear, the results improved. In 1990 we set up a basic video sampler to grab frames live off-air via a UHF aerial and instructed the computer to randomly cut-up and rearrange the images into a new composition — a piece called *Automatic Television* (see Figure 4). The results were immediately more interesting than the autonomously generated random images we had previously created as there were significant hints of residual forms and features detectable in the mangled video captures. In a sense we were ‘importing’ order (in the shape of organised data from TV images) from outside the system in order to create less probable arrangements of pixels in the computer image, similar to the way organisms on Earth import the ordered energy of the Sun in order to sustain the improbable organisation of living tissue.

![Image](image-url)

**Figure 4.** Four stills from *Automatic Television*

The longer-term hope of this research was for a computer system that would continuously generate high quality indeterminate, or ambiguous, images that would engender the sensation I had experienced during the scene in *The Cabinet of Dr Caligari*. Although this hope was never fully realised, the research did lead to the production of a number of works in a variety of media which formed part of a larger investigation into the nature of human perception, creativity and the function of images (see the Web site ‘www.stem-arts.com/robart2.htm’).

It was shortly after the images generated by manipulation of video captures were made that I realised the formal and conceptual similarities between them and the works of the analytical period of cubism (approximately 1909 to 1912), particularly those by Pablo Picasso and Georges Braque executed during their period of close collaboration around 1910 and 1911. It became apparent to me that the paintings, drawings, etchings and collages made during this time had precisely the same purpose as the indeterminate images I was trying to create. In contrast to most western pictorial artists preceding them, Picasso and Braque deliberately obscured the overall coherence of their images through various dislocations, inversions and rotations of objects without resorting to abstraction: cubist painting of this period is always of something. In a Picasso painting such as *The Dresser*[11], painted in the summer of 1910, we are able to read a quite coherent depiction of a woman’s dressing table without ever being able to exactly say where the table is — where it starts or ends, or what precisely does or doesn’t belong to it. Nor were Cubists alone in exploiting visual ambiguity and indeterminacy for producing art; one can find examples in works from artists as diverse and Joseph Turner, Odilon Redon, M C Escher, Cornelius Gijsbrechts, and Marcel Duchamp who stated:

“All in all, the creative act is not performed by the artist alone; the spectator brings the work in contact with the external world by deciphering and interpreting its inner qualification and thus adds his contribution to the creative act.” [12]

The significance of such artworks for the study of human creativity is that they encourage a dynamic collaboration between the artwork (and by implication the artist) and the viewer in the creation of meaning. As with the *Generator* piece described above, it is this collaboration between an indeterminate or unpredictable system (the artwork) and the active viewer (in themselves unpredictable) who is seeking some sort of coherence or form that draws the encounter into the rich area of complexity between total order and chaos. As has been suggested above, it is here that creativity as such, whether mechanical or organic, is most likely to be found.

My ongoing research into the creative relationship between images and viewers informs a wider investigation...
into the nature of human consciousness and human being, which I have described in a number of articles and books as the ‘posthuman condition’.

THE POSTHUMAN CONDITION

The practical research outlined above inevitably involved a great deal of theoretical speculation about the nature of human creativity and how it might be aided or automated with computer technology. For me this, in turn, necessitated a deeper analysis of human consciousness and the condition of our being in the world; for it did not seem possible to say anything useful about creativity without understanding something of the wider circumstances of existence in which creativity is embedded. Ultimately this theoretical investigation emerged in book-form in 1995 as The Post-Human Condition [13]. In this book I argued that the nature of human beings is undergoing a profound transformation, partly as a direct result of developments in technology but also because many of our own conceits about what it is to be human are no longer sustainable. For example, the belief that humans (particularly those of a certain race or class) are the crowning and final achievement of cosmic evolution was once held by many as axiomatic, but is now increasingly seen as a cranky misapprehension. As part of my revaluation of the condition of human existence in an age of rapidly complexifying technologies, I attempted to synthesise current scientific knowledge about the behaviour of reality (specifically Quantum, Catastrophe, Chaos and Complexity theories) and philosophical speculation about the relationship between mind body and the environment with insights gained from my experience in the creative application of technology. Whilst I would direct the reader to the book itself for the full arguments, or the abbreviated manifesto available online at ‘www.stem-arts.com/posthum/main.htm’, it is worth summarising some of the conclusions in this paper.

My overriding concern was to assess the theoretical potential of synthetic, or artificial, creativity. This, I believed, was a somewhat different proposition to studying the wider field of Artificial Intelligence, which continues to be the focus of much intellectual debate. My problem with AI research, particularly the kind promoted by researchers like Marvin Minsky [14] and Daniel Dennett [15], is that it assumes an essentially logical basis for human thought. This kind of assumption, criticised by Roger Penrose [16] and John Searle [17] amongst others, regards human mental processes in algorithmic terms and the human brain as a very complicated thinking ‘machine’, a kind a organic version of the silicon digital computer. Here is not the place to rehearse the debate, save to say that I found such a proposition deeply unsatisfying and highly suspect. My own direct experience of human creative processes led me to believe that they were anything but logical, and were very unlikely to be accurately replicated by rational algorithms. I argued in the book that human creativity was a response by the organism to the unpredictability of the environment. Put briefly, human perception organises sensory data into continuities and discontinuities (things that are the same and things that are different) and human consciousness recognises that the environment behaves in both predictable and unpredictable ways. For example, a footpath may be mainly straight and flat but sometimes there could be a tree in the way or a bend. Humans cannot function well in situations of either extreme monotony or extreme stimulation (sensory deprivation or overload); we function best when balanced between the two. Yet whilst predictability and continuity are fairly straightforward to model in mathematics because quantities and parameters are given, unpredictability and discontinuity pose severe problems since, by their very nature, they contain the unknown. And while qualities like randomness, disorder and chaos can be simulated in computer systems, they can never truly emulate those in the world because computer systems do not contain the inherent dynamic complexity of the world. Human minds, of course, have to cope with the randomness and complexity of real-world events on a daily basis and, I argue, have evolved the capacity for creative acts as a way of defending themselves from, or taking advantage of, hostile or unexpected occurrences. Moreover, the human mind (consisting largely, but not exclusively, of brain activity), being a feature of the natural world itself, is prone to the same contingencies of continuity and discontinuity, stability and unpredictability as any other complex system and is thus able to modify itself, or be modified, in unexpected or incongruous ways. It is this that allows us to generate novel and surprising ideas or connections and ultimately new forms of art, music, mathematics, and so on. Thus randomness, uncertainty, unpredictability, which I argue are all essentially non-computable, are irreducible features of any creative system.

The claim made in The Post-Human Condition, therefore, was that an artificial system attempting to synthetically replicate human creativity would need to function, at least partly, in a non-predictable way. Hence statement 8.6 from the Post-Human Manifesto [18]:

“If we wish to produce a synthetic intelligence that displays creativity then we need it to be able to establish connections between thoughts in a discontinuous way. This will be achieved by making it perpetually sensitive to random stimuli.”

and the following statement 8.7:

“If we wish to produce a synthetic intelligence that displays aesthetic appreciation then it should be able to sense continuity and discontinuity simultaneously – without crashing. While this would cause excitement in the machine, it is yet to be determined to what extent it would be pleasurable.”
The Post-Human Condition, therefore, argues for a model of human creativity (and by extension human consciousness) that is essentially non-computable. Any closed, logical system (such as a digital computer programme or a ‘brain in a vat’) will be able to offer little more than a crude approximation of real mental processes. A more effective system will be one that can respond to the inherent uncertainty of the world (just as we do) and maintain a balance between total confusion and sterile order. In a sense, then, such a system would be importing disorder from the environment, in a reciprocation of the way organised life is sustained by importing order.

SUMMARY

In this paper I have offered an overview of the concerns that have driven my practical and theoretical research into the relationship between human and machine creativity. I have expressed the belief that creativity is phenomenon that flourishes between stasis and incoherence, order and chaos. I have also described some applications and information design techniques that, in my experience, have proved worthwhile in the production of publicly sited artworks that enhance user creativity through computer technology. Finally, I have suggested a theoretical and philosophical framework for the further study and design of artificial, automated or synthetic creative machines.

REFERENCES
