Art practice augmented by digital agents

Ernest Edmonds
LUTCHI Research Centre, Loughborough University, UK
Ernest@ernestedmonds.org.uk

Abstract
Computers can be very helpful to us by performing tasks on our behalf. For example, they are very good at performing calculations, storing information and producing visualisations of objects that do not yet exist as a made artifact. Increasingly, however, a different role is being found for the computer. It is the role of a catalyst, or a stimulant, to our own creative thinking. In such cases the computer is not primarily performing a task for us and generating an answer within itself, rather it is helping us to generate answers within ourselves. The computer helps us think creatively. This role for the computer can be illustrated in the context of computer support to creative design. In order to design computer systems that support the creative process, it is important to understand that process well enough to predict what might help, rather than hinder. Given such research, we may begin to define the characteristics of what the computer must do in order to augment creative thinking. The paper explores a particular application of intelligent user interfaces — the augmentation of creative thought in artists.

Keywords: agent, art, creativity, intelligent user interface

1. Introduction
Fundamental to the argument of the paper is an understanding of how creativity in art practice works. Often, the initial creative process does not concentrate upon the surface qualities of the work, such as the texture of the paint or the quality of sound from a particular instrument. Stravinsky, for example, frequently composed at the piano and orchestrated, even in such works as The Rite of Spring, at a later stage.

Rather than start with surface considerations, the artist may well start with fundamental structuring considerations. The problem is to understand the concrete implications (through to the surface) of the structural decisions. This is where a significant opportunity for augmentation arises. By using intelligent agents to generate the concrete realisations of the structure decisions the artist can see the implications within very short intervals of time. The significant role of the agents in the user interface is to enable the artist to think and act in terms of the structures whilst, as a result of the agents’ work, easily and quickly see the implications.

Following an introductory discussion of creative thought and the role of computer systems, the paper explores these ideas by illustrations of their significance in art practice drawn from a number of empirical studies and personal explorations. The key argument is that intelligent user interfaces can enable the artist to lift the level of concern in a way that promotes enhanced creative thinking.

2. Creative thought
Thought is not a means of solving the problems
of this world as they arise. Thought is not a problem solver but a great process of realisation that is forever transcending, transformed, changed, developed.
(Mead 1917)

One way of viewing the subject of this paper is in terms of computer creativity for creative computation. By computer creativity is meant the possibility of computers doing things that humans might consider to be creative and by creative computation is meant humans being able to do creative things with the help of computers.

Computers help us in many ways and we are used to the support they give us in performing different tasks: taking burdens away from us, doing something that is rather hard easily for us, etc. For example, they are good at doing calculations and we have spreadsheets that save us from doing sums. They are good at storing and retrieving data and we use databases to save us from time consuming searching and remembering. They are good at constructing visualisations of things which, whilst they could be constructed by an artist with pens, can be produced more easily with computer systems.

The above examples are all of tasks that are very helpful to us but they are not the primary subject of this paper. It is concerned instead with computer support that stimulates our thinking rather than that saves us work. The concern is with how to provide support that stimulates us to think in new ways and so helps, in part, our creative lives.

The formulation of a problem is often more essential than its solution, which maybe merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science. (Einstein and Infeld 1938)

That is what creativity is about, formulating new problems or possibilities rather than solving old problems.

Often in great discoveries the most important thing is that a certain question is found. Envisaging putting the productivity towards the question is often more important, often a greater achievement than the solution of a set question. (Wertheimer 1959)

Hence, in supporting creativity it is important to understand this aspect. In this context it is interesting to note the results from a study of art students who were asked to draw a still life as part of an experiment (Getzels and Csikszentmihalyi 1969). A table was produced full of items from which they could select whatever objects they wanted and arrange them in whatever way they wanted. They then had to draw the still life. The final drawings were anonymously given to experts to judge them and place them in various categories. All of the selection and drawing process was recorded.

One interesting point was the observations on manipulation and exploration. Times were taken on how long they spent on exploring the objects, and manipulating them, before they decided what to draw. So the pre-drawing process, we might say the problem finding process, where they tried to decide what they were going to draw, was measured. These times were correlated against the final results in the sense of the creativity, etc., of the result as judged by the expert panel. The results showed that originality correlated very highly with the time spent on this pre-drawing/problem finding phase. As a matter of fact, craftsmanship does rather badly in correlating with innovation, so these things do not necessarily go together. This is, in itself, very interesting point. Thus, psychologists working in this area came to realise that problem finding might be as important as problem solving for creativity.

3. Supporting creative users

In his keynote presentation at the Artificial Intelligence in Design Conference held in Edinburgh in 1991, Donald Schön discussed intelligent support for design in the context of
what is known empirically about design. His analysis of the complexity of design was notable but, in particular, his stress on the roles of action and perception as well as cognition was significant. He concluded with the remarks that:

The design of design assistant is an approach that has not in the past attracted the best minds in AI. Perhaps the time has come when it can and should do so.

(Schön 1992)

In response to this challenge, a special issue of the journal Knowledge-Based Systems was published which included Schön's address and seven responses from researchers actively investigating intelligent assistants (Edmonds 1992). The crucial point was to advocate a shift of focus away from using artificial intelligence (AI) to automate, to using it to enhance human activities, such as design. This point has been widely recognised in the Intelligent User Interface community.

Taking a more general view, creative thought, in any discipline, is hard to model. In terms of achieving benefit it can be argued, following Schön, that the most interesting avenue is to investigate support systems, or assistants. Candy (1992) drew particular attention to the distinction between creative product and creative process. It is not sufficient to be able to recognise a creative product. Rather, we wish to understand the process that led to it. In fact the research issue that is of central concern in this paper, with its concern for art, is to understand that process sufficiently to be able to provide computer support that can enhance it.

Looking beyond art or design, creative thinking in management, science, engineering and other fields is mostly conducted with minimum computer support. It is only when an initial concept has been defined, such as "Support the monitor by a wall bracket" or "Minimise the stock held in the warehouse", that a clear enough problem has been defined for most computer-aided methods to apply. Technicians might carry out tasks according to well specified procedures but experts are continually reflecting upon the implications of existing knowledge in the light of new circumstances (Schön 1983). In the main, experts do not work with static, tightly defined knowledge. The evolution of expert knowledge is central to how they make significant contributions to the field and, thus, gain advantage. Thus fixed systems that do not allow end users to manipulate and modify the internal knowledge are not appropriate for the support of many creative knowledge workers.

Interactive Knowledge Support Systems (Gaines 1990, Candy et al. 1993) can assist expert knowledge workers in the more creative aspects of their work. The key advantage of such systems is that they enable experts to extend the domain knowledge of any system that supports them. The definition of that knowledge, in fact, is close to the definition of their personal expertise.

Interactive knowledge support systems, where the end user manipulates machine representations of knowledge directly (Edmonds and Candy 1993), have been applied to scientific exploration (O'Brien et al. 1992). This work has clearly demonstrated a potential for supporting creative work.

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4. A study: structure in art

Before discussing the development of computer support and augmenting agents for artists it is important to take a small diversion to look at a particular aspect of art practice. The issue is the role of underlying structure in contrast with surface appearance for many artists. This section is drawn from a number of discussions, between artists and this author, as well as contributions by artists to the Creativity & Cognition series (Candy and Edmonds 1993, 1996, 1999). The artists quoted in this section broadly belong to the constructivist tradition. George Rickey took a catholic view of the term in his important book on the subject (Rickey 1967). He uses the term to refer to the long twentieth century theme of abstract (but not abstracted from nature) visual art. Whilst noting this point, it is important to recognise that the concerns of these artists do not differ very much, in terms of this argument, from many others and, indeed, for most music.

In January 1996 four established artists who had not previously used a computer in their art practice spent a week at an artists-in-residence on the Loughborough Campus in order to explore the potential for their art of the computer. The artists were Jean-Pierre Husquinet (Liège), Fré Ilgen (Eindhoven), Michael Kidner (London) and Birgitta Weimer (Cologne). Each artist was paired with a technical expert who worked with them, identified appropriate computer systems and drew in other experts when necessary. By the end of the week Birgitta Weimer had produced computer generated prints to her artistic satisfaction. Fré Ilgen was making virtual sculptures that resided in a void and were not subject to gravity. Michael Kidner and Jean-Pierre Husquinet had not completed new works but both had begun a new exploration that has been continued since.

The nature of the interchanges between artist and technologist as well as the artists' perspectives upon the use of the technologies and what they gained from it were recorded. Both positive and negative aspects can be observed but in all cases the nature of the art practice involved was illuminated. One example of the results to be reported is that, despite the apparent simplicity of the artists' demands, it proved to be quite a technological challenge to provide the computing support needed. It seems that very few standard computing systems can adequately support established artists such as those participating. The positive side of this observation is that, largely because of the technical support provided, one week was sufficient to overcome the initial problems that were faced.

In various ways, each artist was concerned with the structures that underlie the works produced. Also a concern for process — one might suggest the exploration of these structures — is evident. Each of these artists is involved in an exploration in which the products form a notable but not supreme part. In this sense, the computer's ability to handle structure might be quite significant. This point is illustrated by a set of quotations from the discussions held with Edmonds at Loughborough University in 1996.

Kidner: I mean structure becomes the nature of the composition and there was a lot of discussion I think with the Russian constructivists in around 1920 as to the difference between composition and construction. They were all trying to make structures and were criticising composition.

Well there are two things. I think one is that composition is designed to make the work attractive or interesting for the viewer to see. Well I have never thought very much about the viewer except that I am the viewer, so it seems to me that I make things and I have no idea what they will look like or very little idea. I don't really care because I am more interested in resolving my problem and seeing, confirming, my theory or not.
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Husquinet: Yes, probably the best word would be structure because everything is based on structure. It’s built either visually or musically in structures.

If it wasn’t for the process there would be no interest in the work anyway, so I wouldn’t do anything. So it’s clear that the process is much more important than the work itself. You can probably relate that to having a musical score that you have written, in this case it is a visual score which I have painted and every time you develop that broken space you are building another structure of course, but if you think of it in musical terms it is like, if you were thinking of a musical score again, and play it again it will wait just like jazz. They play the score and then they improvise upon the score. Every time you hear a jazz musician live he plays the same piece but differently. It’s a good parallel.

Weimer: I want to find not strict rules but to have my own rules in my work, and to find basic structures in things what I experience and what I see so I always add a different angle in my work or for what I was really looking for. I think that it is an inner necessity to find rules.

I think process is important, I mean on the one hand you can say that process influences the product, for example if I had an idea and I start to realise that sometimes I find other material I choose can not do what I wanted it to do so I have to change then, this is the process which can change the back idea I had in my mind before I started to work.

Ilgen: When you see my works you have the feeling that something really argumentative, if you like kind of order, kind of system, maybe, but you can not find the rules of the system because they are based mainly on visual experience.

You have processes which should also reach temporarily moments of equilibrium and maybe a finished piece is that you are satisfied: your desire for making this thing reaches equilibrium.

At the same time as these studies were made, a number of other artists were involved in the 1996 Creativity and Cognition conference. Manfred Mohr was one of these and he made the following statement in the proceedings.

My art is not a mathematical art, but an expression of my artistic experiences. I invent rules which reflect my thinking and feelings. These algorithms can become very complex, that is to say, complicated and difficult to survey. In order to master this problem, the use of a computer is necessary in my work. Only in this way is it possible to overlay as many rules as necessary without losing control. It is inevitable that the results — that is, my images — are not readable at first glance. The information is deeply buried and a certain participation is demanded from the spectator, a readiness to interrogate this material.

(Candy and Edmonds 1996 280)

Thus it is clear that the concerns of the artist can often be with the deeper structures of their art rather than with the surface representations that make up the final artwork itself. The lesson that is to be drawn from this is that intelligent user interfaces may well have a significant role to play in easing the transition from those structures to the form of the artifact. This point will be returned to after another, more specifically relevant, discussion about art practice.
5. A personal case

This section will review something of what the author has done in relation to the visual arts and computers. The production of an art work is partly concerned with minimising the variables that one is trying to handle in order deal with more complex things. This is similarly to what many scientists do. Harold Cohen once said that someone had offered him a computer system that enabled him to use 4 million colours but he said that “the trouble was that it did not have the six colours that I wanted” (private communication).

More than thirty years ago the author used a computer for the first time to perform an art task for the construction of a work. I had a problem. I had many bits and pieces and I wanted to arrange them according to certain rules. I found it very hard. Always, when I made an arrangement, it broke one of the rules I wanted to satisfy.

However, I had access to a computer and I managed to obtain three hours of computer time which was almost enough to solve the problem for me. It is interesting, actually, because I had to switch the computer program off after three hours because someone else needed it. But I had not quite solved the problem. There was one problem remaining, but I had reduced it into something I could solve myself. So I finished the job off by hand (Cornock and Edmonds 1973).

That was good but did not excite me very much in terms of using computers. Much later it became clear that many of the structural issues that had concerned me, such as the co-existence of two colour in the same space, could be tackled by moving from static to time-based work. By this time, such work was made a possibility by the fact that computing technology had moved on and could support it in a unique way.

The use of computers in constructive art has mostly been in the production of static objects or series of objects, yet an important property of the computer is that it can handle complex activity developing in time. Indeed, computer technology has had an important impact in music from the specialised IRCAM endeavour to extensive exploitation in rock. It is true that computer-generated images and videos abound, but in so far as they aspire to art, they generally fall into the category that has become known as ‘computer art’, which is widely understood to refer to work that has a technological feel about it. Recent developments have often placed their strongest emphasis on constructing abstract models of three-dimensional worlds from which views are selected to make the final work. That may be too simple a description, but it certainly is the case that most of that work is not constructive, even though it might be surrealist, art. The use of the computer to feed fantasy has been dominant. This situation has been encouraged by the developments in the technology itself.

The use of computers in the handling of images has received considerable attention and there is no doubt that most of us are quite amazed at what can be achieved technically. The exploitation of these possibilities in art practice, so far, has been largely influenced by one brand of computer graphics, known as geometric graphics. In this approach, the basic elements that are manipulated in order to produce images are geometric abstractions such as lines, circles and polygons or three-dimensional entities such as spheres, cuboids and surface patches of one sort or another. We are so used to these notions that often, even mostly, we forget that they are abstract. A line, for example, has no thickness and yet when we draw one it unavoidably has one. Of course, the real line has many other qualities not attributable to the abstract one. Why else would we care about the difference between a 3B and a 2H pencil? Thus, in using geometric computer graphics, careful attention has to be given to how the abstract descriptions of images so
constructed are realised as perceivable images. The technology itself encourages a view that the realisation of the image is only an approximation to the perfectly formed abstraction. In the early days of the use of computer in the visual arts, this approach was used in order to generate drawings produced by automatic drawing machines called graph plotters. Inevitably, when it came to producing the drawing, one of the key concerns was the particular pen to be used and how it drew, given the speed that it was driven at. Typical of modern work of this type are computer generated video images, or sequences, showing views of imagined worlds constructed within the computer. The concrete reality of the work is, here, somewhat subsidiary to the abstract notion of it.

A quite different approach to computer graphics has been the pixel-based one. In this view, the centre of concern is the construction of the actual image as it appears on a screen. In practice, this consists of a matrix of coloured dots known as pixels and it is these that are the basis of the representations manipulated in the computer. In this way of producing images, the precise outcome is deliberately considered as part of the core concern because the actual dots that make up the image must be specified, in some way, as part of the process. In this, something has emerged that has great potential for constructive art. The computer offers a unique facility for manipulating complex systems of symbols, that is, abstract formal structures, whilst, through pixel-based graphics, precisely handling the physical reality of the images. What is more, the computer can develop and realise structures in time as is now often done in music.

A key point that must concern artists in this choice of computer graphics system is the control that they may or may not have over the underlying structure and the fine details of what they are constructing. There is little point in offering artists a computer system with a choice...
of more than a thousand colours if, amongst
them, the six that they actually require are not
to be found. The issue is not so much one of
computer power but of artistic control. This is
not a matter of debate in respect of most media,
but somehow in the case of computers it is often
compromised and may perhaps be the reason
why so little ‘computer art’ is seen as art. In this
context, the real potential is with the pixel-based
graphics.

The work that I am concerned with now
is what I have come to call ‘video constructs’.
These pieces are time-based, that is, they exist in
time just as music and film do. The concrete
and final destination of the images is a video
monitor. In no sense whatever are the images
seen on the screen a view of some other reality.
They do not represent paintings or drawings any
more than they relate to images seen in televi-
sion news programmes. The work is concerned
with precisely what exists on the monitor.
However, the fact that it is generated through a
computer system allows considerable attention
to be paid to the structures that underlie the
images, and their movement in time, but in
contrast to much of the geometric-based work,
the image is not a view of an abstract world. In
video constructs, the logic in the computer
provides the underlying structure that leads to
the form of the work. The image on the screen is
the concrete reality.

To take a specific example, the video
construct Jasper (Figure 1) is based upon a
number of overlapping squares of reducing
dimensions, each of a different grey tone. The
work starts with the grey levels stepping evenly
from black to white, starting with the largest
square and ending with the smallest. This order
is disrupted at the beginning and the work
proceeds in a search for a new resolution, and it
is the search itself that is the basis of the work.
The image pulsates as the tones shift between
the static squares in a way that is, perhaps, closer
to the so-called minimalist music than normal
video material.

In a later example, fragments version 5
(Figure 2), a matrix of squares is explored in a
similar way, except in colour. Here, the piece
moves through a portion of the colour space.
Whilst the local rate of change can be fast, with
some specific images only lasting for a fraction
of a second, the general shift of colour is slow
enough for the work to be quite different in the
mid-afternoon to mid-morning. This work,
therefore, cannot be seen very satisfactorily in
the context of, for example, film. Rather, it is a
changing exhibit having, perhaps, more in
common with light dappling on water as the
sun slowly rises and eventually sets than with the
simple geometry that is, at first sight, its basis.

What has become clear is that a very
detailed technical control of the computer
system is as important in producing video
constructs as control over oil paint is when
producing oil paintings. Having control is
largely a matter of the availability of descriptions
that are clear and brief enough to be under-
stood. The most exciting element of the
constructive video is, perhaps, the careful and
very terse way in which a specification of what
occurs in time is possible. The brevity of the
specification is extremely important in the
development of ideas. The inevitable explora-
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The exploration of time-based constructive work made possible by modern computer technology is more than a new way of doing something. The conceptual development that goes along with the art practice is something new that has implications beyond video constructs. The new understandings will inevitably influence drawing, painting and construction as much as they are influencing the video.

The point is that what the computer enabled me to do was to express, at a much higher level than I was used to, what I was after: so I could talk about structures.

What one could do with the system was express structure and have the system generate the implications of that structure which one can then look at and think about and evaluate. What that means is that one can start to think about the implications of the structures in ways that were not possible without computers. Generating time-based work of this kind was transformed by the computer. It was not just a matter of a speeded up process but one that was changed in kind.

Figure 3 contains three stills from one of these time-based work, Sydney (1995). The structures provided to the system specified the colour and physical relationships that can be used in any single still, the transformations that can be used between stills and the strategy for progressing through time. The system has knowledge built into it that can be used to move from these structures to the actual realisation of a work. (Edmonds 1988).

This work developed into a specific approach to the use of computing to augment creativity in which the expression of knowledge in the system and the interactive development of that knowledge was seen to be very important (Edmonds 1993).
6. Agents for artists

Any attempt to build a creative computer program will necessarily be knowledge-based in three areas: what the program needs to know about the things it seeks to represent; what it knows about its own performance; and how to do the things it decides to do. [Cohen] demonstrates through his AARON program that what the program knows and what it can do are closely interdependent. Feedback is central to creativity, both in the long sweep of the individual's career and in the stepwise construction of new material, and we should therefore expect any attempt to build a creative program to be rule-based. Rules are informed by criteria, which are not simply standards of performance but standards of performance with respect to specific issues.

(Cohen, in Candy and Edmonds 1999 14)

The program written by Harold Cohen produces images without his direct intervention in any way. See, for example, Figure 4. Although Cohen does not talk in terms of agents, his program can be thought of as a hierarchical set of just such objects. One might say that it contains agents that know about hands, faces and so on. It has agents that know about bodies and others that know about the relationships between bodies in space. Other agents know about spatial and colour composition etc. etc. In the case of AARON, the goal is to have the program do all of the work of generating the image. Of course, AARON can only do what it does because of the knowledge that Cohen has built into it. Taking this work as a clear proof that programs can be constructed to perform the extremely complex task of, at least in some sense, making art let us consider a slightly more modest possibility. AARON works from a very high level but even not going that far real new avenues of creative exploration exist.

7. Conclusion

True co-operation between human and machine in the context of creative tasks must involve the manipulation of knowledge in the system at quite a deep level. In particular, domain specific expertise must be explicitly addressed in a way that allows the expert user to modify and extend it. Knowledge support systems, which allow end users to manipulate knowledge represented in the system, are therefore proposed as the way forward for the support of creative thought.
In the view of the author, augmenting the artist by agents does not make life any easier for the artist, but it might make it more interesting. Further advances in our understanding of creativity, and in the development of computer systems that enhance creative skills, can only be made by the bringing together of ideas and understandings from all of the relevant fields. Thus the relevant research must be multidisciplinary. That includes art!

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Ernest Edmonds is a professor and the Director of the Creativity and Cognition Research Studios at Loughborough University, U.K. He has used computers in art practice since 1968, his latest exhibition being ‘Constructs and reconstructions’, Loughborough University Gallery, May 2000. Ernest Edmonds’ research in human-computer interaction and creativity has led to more than 150 publications. He was Chairman of the Access and Creativity Task Group for the U.K.’s Technology Foresight programme and leader of its mission to Japan: The interaction of art and technology. He is a member of the Visual Arts and Media research panel of the U.K. Arts and Humanities Research Board. He is Chairman of the ‘Creativity and Cognition’ conference series, which are now ACM events.