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INTO VIRTUAL SPACE AND BACK TO REALITY

Computation, Interaction and Imagination

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Abstract. *The main aim of the research from which this paper arises is to identify requirements of computer support for creative work by investigating the work of artists and exploring the potential of new creative technology in this field. The paper reports upon an experimental artists-in-residence on the campus of Loughborough University during which events were recorded and analysed. 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 are described. One significant conclusion is that the influence of using computers on the artists' thinking is quite as significant as any direct outcome in terms of product. The paper poses three questions and tries to find an answer to each by exploring the modelling of the results of the study in the context of what we know so far about computational approaches to understanding creativity. The results demonstrate that one aspect of VR may be understood in relation to previous studies of emergence.*

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1. Introduction

The modelling of creative design is complex to the extent of extreme difficulty. Our approach to this problem is to look in parallel at creative practice by human experts, the interactions between experts and computer-based tools and media and the computational models that, at this stage, can be partially generated. In this paper the concern is understanding creative steps that occur in relation to the use of computational systems. The idea is to try to gain that understanding in a way that might illuminate the computational modelling of the complete creative design process. Within one paper only small steps can be made, but the step forward presented here is to show how design strategies can be employed that enable tractable, and hence perhaps computable, creative acts.

The notion of emergence has been discussed frequently in recent years (Edmonds and Moran, 1997). This is the notion of a new unexpected concept appearing during a process. Much of the work has looked at drawing. In such cases, a shape that was not employed or thought about in the construction of a drawing is seen in the result and proves interesting. The acts of drawing and looking at the result are seen to be as important as pure thinking (Soufi and Edmonds, 1996). This paper extend this fundamental idea into the use of virtual reality (VR) systems.

VR provides, in its simplest interpretation, a way of looking at reality that avoids us having to either actually be there or construct the specific artifacts to be considered. Even in its most normal usage it covers more concepts and, although we do not have the space to discuss the broad issues, it is clear that the implications are much deeper than that. Turkle, for example, studied computer-mediated communications in virtual realities. As a result she argues that these systems provoke self-reflection and simulated thought, the emphasis being on social and cultural issues. “Watch for” she says “a culture that leaves a new amount of space for the idea that he or she who plays, argues, and builds is a machine” (Turkle, 1996). Mowshowitz, on the other hand, has looked at the organisational and political implications and effects. He has considered the enabling of the development of virtual organisations and

argues that "In the long term, the social changes will crystallize in virtual feudalism, a system of political authority centered in private, virtual organizations and based on the management of abstract forms of wealth" (Mowshowitz, 1997). From a different, but related, point of view Cicognani has argued for a linguistic perspective. She sees a parallel development between "cyberspace" , the ways that we use language and the ways that we can construct new worlds (Cicognani, 1998). This paper picks up just one implication of VR that arose in the exploration by a sculptor and uses it to explore the creative opportunities, beyond visualisation of the non-existence, that exist in VR.

The Creativity and Cognition 1993 symposium (Candy and Edmonds, 1993) encouraged intersections between art, science and technology. The 1996 symposium (Candy and Edmonds, 1996) included artists who were users of new technology as well as those using more conventional methods. A residency was held which enabled established artists who had not previously used computers in their art, to work in multi-media laboratories. The processes that the artists went through, including the appropriateness of the technologies employed, were studied. The results indicated that no existing applications matched all the needs of the artists and the available technology needed to be modified using research tools. Nevertheless, both artists and technologists benefited as subsequent work has indicated. This later work has formed part of the study that is included in the report below. Using computers in the Arts is now well known (Moser and MacLeod, 1996; Schwartz, 1997) but the main aim of the research programme being undertaken is rather different, in that it is to identify certain future requirements of computer support for creative work by investigating the work of established artists and exploring the potential of new creative technology in this field. This single case provides initial results and an indication of the direction in which the work is likely to proceed

The paper poses three questions and tries to find an answer to each by exploring the modelling of the results of the study in the context of what we know so far about computational approaches to understanding creativity.

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2. Creative Interaction

2.1 CREATIVE SCOPE

Creativity is often concerned with the emergence of new concepts as a result of interaction with existing ideas, models and people. What distinguishes this view from others in the exploration of the nature of human creativity, is the recognition of the role of interaction with the world. This is, therefore, to be differentiated from focusing on 'creativity in the head' without reference to the impact of external factors. A clear and significant example of this is the externalisation process that is involved in emergence seen in design (Schön and Wiggins, 1992). For a discussion of the cognitive modelling of emergence see Soufi and Edmonds (1996).

The idea of *collective creativity* is worth exploring in this context. The word 'collective' on its own suggests that the creativity may be a combined effort between one or more party. If we take the view that the externalising of ideas is significant to creativity, then it can be argued that so is the manner of that externalisation and this brings us to the interaction process (Edmonds, 1993). It is suggested that computer devices and applications may have special qualities that distinguish them from other artifacts that humans interact with in creative work.

The potential for the creativity of every human being is shaped by factors that are both outside our control and within it. Factors such as genetic makeup, geographical location, climate, economic resources, health, education and formative and lifelong experiences contribute in different ways to the scope for creativity that the person enjoys. *Creative scope* can be summed up as : how we interact with what we have at our disposal within the context in which we live and work.

In most cases, research issues relating to creative scope are studied independent of one another. Some studies of creativity have investigated small-scale problem solving abilities and lateral thinking skills, and have attempted to extrapolate the results from those examples into real world situations or as general purpose models of creative thinking. Case studies of individuals of outstanding creative scope have shown, by contrast, that

a combination of factors may contribute to the success or otherwise of the creative effort. Thus, Creative Scope is affected by multiple factors and, if we are to understand how it works, we need to take a wider view of how creativity takes place. In relation to the discussion therefore, contextual issues point to *interaction* with the world, and hence, are a collective contribution to creativity. We, therefore, need to consider both the actors and the artifacts that define the context within which creative thought occurs.

2.2 ACTORS AND ARTIFACTS

Actors represent the roles played by people and their different combinations that drive the activities. The set of actors includes: individual designers, the design team, the organisation. If we take the *artifact*, as an example of a Contributor to the Interaction process and try to envisage how it contributes to concept formation in creative work, it becomes clear that the different roles of the human actor influence how the artifact is used. For each artifact, there are different actor roles and, therefore, different kinds of interaction.

The kind of actor role may be different according to the nature of the artifact. The creativity of the user depends upon the kind of interaction that takes place and this in turn depends upon the aims of the actor. A designer may not be particularly creative in the outstanding sense but, in making modest changes to an existing design, will derive concepts that are new to him or her. The creative role may be integrated with the other roles of user and builder but this depends upon the kind of artifact and the level of complexity involved in designing and constructing it.

The significance of the actors and the artifacts with which they interact within the creative process is important. In the case of the artifact, we can see that the its form and the nature of the medium has an influence, possibly in the form of a constraint, on the resulting product.

2.3 INTERACTION PROCESSES FOR CREATIVITY

If interaction of one kind or another is important in creative knowledge work. then it is worth looking more closely at the word itself and the

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different ways it can be defined. The word 'inter-act' refers to a reciprocal process, that is, something from one party that acts upon the other and vice versa. Thus, 'Interaction' is always two way. It may imply, too, a form of exchange which is not necessarily of the same quality or type in both directions. It implies that *transformations* of the exchanged information may occur during an interaction.

We usually refer to the act of *using* tools or information or ideas, rather than interacting with them. And yet, it is true to say that we experience different kinds of interaction with artifacts that is characterised by the purpose to which we put them and the design of the artifact itself. The act of drawing combined with looking at the paper on which the drawing exists provides an important example of interaction, simple as it might appear to be (Schön, 1983). A traffic management system that guides us towards the best route involves interaction with the device. It also requires a level of skill that is thought to be achievable for most people and which requires an ability to handle a high degree of complexity. The point is that there are many computer systems embodied in the vehicle only some of which are apparent to the driver and, even fewer of which require interaction, as distinct from action or reaction. If there is no interaction, is there any potential for collective creativity? In this case, the answer is likely to be no.

The nature of interaction is often conceived in rather simplistic terms: but interaction with knowledge and artifacts that results in creative concept externalisation is more than simply putting in and taking out. We speak of human to human interaction but to capture the richness and variety of this phenomenon requires more precision. Terms may instead be selected according to the nature and circumstances of the exchange: e.g. communication, sharing discussion, argument, persuasion, exchange, etc. There are ways of characterising interaction that might usefully be considered in relation to the interactive process.

Creativity in the interaction with artifacts, such as computers or musical instruments, is strongly influenced by the actor roles. Composing music and performing it are very different processes. The concert pianist may be highly skilled and more so than the composer but the degree of creativity that he derives from the artifact is not the same. Does a composer interacting with a particular kind of musical instrument derive

creative benefit? If he did not use an instrument, would he compose in his head as well or with the same kind of result? In what way is the interaction different whether a piano, computer music generator or pencil on a score sheet is used?

In looking at these issues in the specific context of VR and the support of human creativity, three key questions are now posed:-

1. Is VR able to provide support for creative interaction and if so, how?
2. What, in contrast with other tools, is special about the computer and VR in relation to creativity?
3. Which interaction processes, between humans and computers, most support creativity processes, between humans and computers, most support creativity?

In the next section we will focus upon one instance that has been studied in some detail. This will help provide insight into the answers to these questions.

3. A Study of the Use of VR by a Sculptor

3.1 THE ARTIST

Fré Ilgen is an artist who is exploring his perception and understanding of 'reality' in its various aspects (Ilgen, 1997). He studies the simulation of complex movements in three dimensional objects to which he applies a complex combination of forms and colors. Most of his work is in sculpture, much of it in suspended forms (see figure 1). He used his experiences with these dynamic objects for exploring the potential of Virtual Reality during Creativity and Cognition 1996. His first request was that the VR system should not impose gravity and that the representations of physical space should be removed. He wanted a black space without the constraints of gravity in which to create sculptural objects, move them about in relation to one another and determine combinations of outcomes.

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Figure 1: Mobile.

The following quotations by him are illustrative of the issues explored during the interviews.

- *Structure and Order*
  "I am looking for the structure at a deeper level of nature, if you like."
  "Our search for understanding wholeness can be translated as a search for structure on a deeper level - although it is hard to speak of *the* structure. A structure which makes it apprehensible how everything and ourselves are interrelated in the whole."

- *Process and Product*

"... you are known as an artist for your next piece, you have an urge to create another one, which doesn't make the former piece unimportant but it explains that your desire is not so fulfilled that you never want to make anything new."

- *Materials and Tools*
  "material is not that important in my work "

- *On the Use of Virtual Reality*
  "In my work I have to emulate the struggle with gravity ... . I never will be able to create real motion which I simulate in my normal art work which I can create and explore in VR.
  "'By hand' I defined a relative complex rotation-movement of every shape around the sphere. This sphere functions quite well as fixed point of reference in the described infinite black space. ...The movement of these few forms make an extremely strong impression of depth and enough sense of orientation. The result was intoxicating. I finally could see the movement I imagined for years!"

3.2 OUTCOMES

The outcomes from the artists in residence were different in each case. However, one factor in common was that none of the artists felt able to use a computer system exactly as it was offered to them. In each case, they had needs which could not be dealt with by a ready made solution. Nevertheless, art work was conceived and carried through to completion albeit with considerable support from other people. Ilgen had created a Virtual Reality sculpture system. Most significant in his work were the facts that he removed gravity and had his piece float in a void. His virtual reality was not reality as we know it.

3.3 SUBSEQUENT DEVELOPMENTS

In Ilgen's case, the role of VR technology as a stimulus to the thinking and practices of this artist was clearly apparent. He was convinced that the VR enabled him to escape from the constraints of physical objects and freed him to consider structures but that was to change later. During

the following year he underwent a change of direction from creating mobile structures made of wood and metal to painting on large canvasses using conventional methods. He has sought out special pigments and become deeply involved in the realization of 'true' color in his works. The experience with VR inspired him to develop a kind of painting that visualizes the simulation of the color space: he calls these 'Virtual Paintings', see figure 2.

Thus we see that, whilst the VR experience was both a promising line of development for Ilgen and a very rich experience in itself, a major outcome occurred in his practice. In his view, this could not have occurred without the VR stimulus.

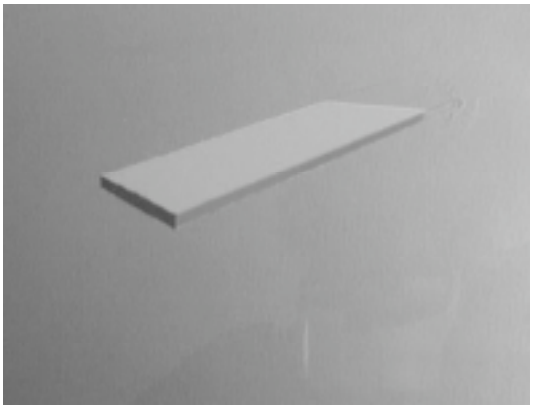

Figure 2: Virtual Painting, Lazy.

4. Towards a Computational Model of Creative Interaction

4.1 REALITY, COMPUTED REALITY AND IMAGINED REALITY

The work of Ilgen discussed above illustrates the three interacting realities at play. One could outline his process in terms of *reality*, the physical world, *imagined reality*, the model of the world that he holds

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and manipulates in his head, and *virtual reality*, the model of the world held in the computer system and experienced by Ilgen. A simplified description of the process that he went through can be given as follows.

He considered and manipulated the *reality* of his sculptures in his studio. Knowing of his opportunity at Loughborough, he created a new *imagined reality* which was the basis of his first steps into *virtual reality*. There followed considerable moves between the *imagined and virtual realities* until he created his new piece in the VR system. Later, whilst thinking over his experience and reflecting upon its implications he manipulated his new *imagined reality* until he found a way of creating a version or view of it in *reality*, but without the computer VR system. Figure 3 illustrates the exchanges between the three realities.

An important question that arises is that of what kind of transformations were at play and how were they performed? In order to do this, let us consider the model of each reality and consider just one aspect of the models that Ilgen transformed.

We can consider the initial model of *reality* to be **M1** and note that this includes laws of physics as well as the particular design constructs, such as cuboids, that were used in the existing sculptures. For the sake of simplicity, let us assume that the first VR system constructed was, as far as practical, a copy of the sculptures, which we can represent as **V(M1)**. Thus, for the most part, **V(M1)** contains a subset of the properties of **M1**. For example, the former does not model tactile experience. The exceptions are where the scientist had to make changes in the interests of implementation, such as using 2.5D or making a gently curved surface flat.

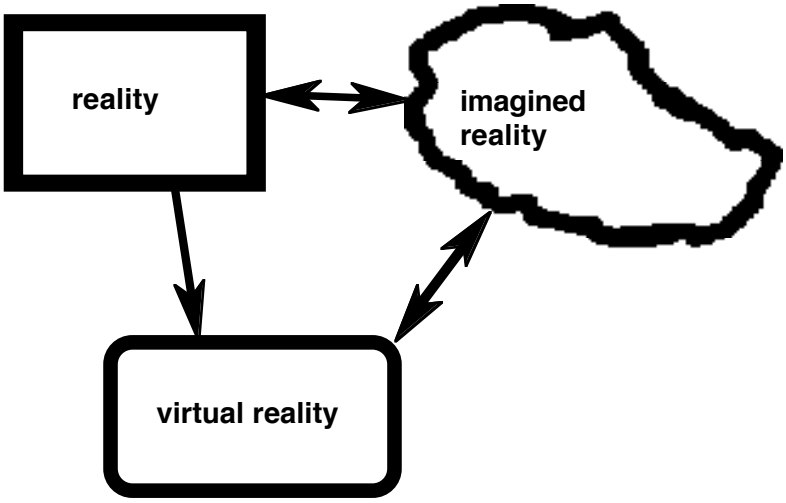

Figure 3: The Three Realities

Now, in working with **V(M1)**, we know that Ilgen made several radical changes. For example, he turned gravity off. Hence he created, let us say, **VM2** which now bore little resemblance to earth bound physics in an important respect. Let us call his model in *imagined reality* of **VM2**, **I(VM2)**. Now, he carried **I(VM2)** away with him from the Loughborough experience.

Back in his studio, he was able to work with **M1** but, at the same time, think about **I(VM2)**. What followed was a transformation of **I(VM2)** into something in his imagined reality, say **IM3**, that he could construct in reality without the VR computer system. In fact, as we noted above, he made paintings. Thus he moved back to a new *reality* in his studio, which we can call **M3**. It is worth noting again that he claims that he would never have made these paintings if it had not been for the VR experience. Hence the transformations that we are considering must be seen to be important steps in the creative process observed.

So what were the key steps in this creative process? They are of a number of types but the ones that seem to have been most significant are

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those that moved the models between the different realities and imagination itself: the transformations within *imagined reality*.

4.2 CREATIVE TRANSFORMATIONS

As the main subject of the paper is creativity, it is appropriate to consider imagination itself first. It is beyond our scope to try to describe the imagination process directly. Instead we will try to illuminate it by discussing the influences upon it in the case in hand. Thus, the question is, what stimulated Ilgen's imagination to operate as it did? Two particular steps can be observed.

Firstly, moving from his observation of **M1** to **V(M1)**, he did not only see the common, or similar elements. Indeed, the interest was in considering the differences. Whilst the explicit nature of **(M1-V(M1))**, was not uninteresting, the most important trigger to imagination was the realisation that certain invariables in **M1** had become variable in **V(M1)**. In particular, whilst both included the constraints of gravity, **V(M1)** need not have.

One mechanism for the generation of creative designs is the introduction of new variables, or the making of a constant a variable (Gero and Maher, 1993). In the application of such mechanisms we always have the problem of the selection of the element to act on; which constant to make variable. In the related case in point we can see at least part of an answer.

The knowledge and observation of the two versions of reality, **M1** and **V(M1)**, focused Ilgen's attention upon a small number of elements that could be changed. The selection process of what to change was bounded in a way that imagination could cope with. Thus, with the sculptor's experience and motivation for exercising his imagination, we can see that it was not so surprising that, in the context of the interactions at play, he imagined **VM2**. The interactions between the models created the scoping context that made the application of his imagination both possible and fruitful.

The next creative action took his imagined picture of **VM2**, **I(VM2)**, and led to the creation of **IM3**. This is more difficult to explain but it is clear again that it was not a matter of the imagination allowed to

run free unencumbered. **I(VM2)** was only realisable within the VR system but Ilgen wanted to continue with his successful artistic development without the VR. What followed was an interaction process between *imagined reality* and *reality* in which **I(VM2)** had transformations applied to it that moved it into line with physics. As is so often the case, the solution of **IM3**, a work conceived as painted on a canvas, looks obvious in retrospect. The fact is, however, that the constraints placed upon imagination by the specifics of the problem were what made this, rather than some other random and less satisfying solution tractable. As Ilgen asserts, the **M3** paintings would never have been made had it not been for the creative transformations that we observed.

As well as imagination itself, transformations within *imagined reality*, we mentioned above the significance of transformations that moved models between the different realities. The point here is that the sculptor's decision to make such a move, e.g. from **M1** to **V(M1)**, is a deliberate act. It was not a random event, nor was it made in an attempt to simply re-create **M1**. Making this transformation was specifically intended to trigger the imagination. It was an application of a specific creative design *strategy*. Thus, although Ilgen had no idea of the outcome, he knew exactly what he was doing.

Creative transformations are scoped and constrained acts taken in order to stimulate creativity. That stimulation, however, is directed in a way that limits possibilities in order to provide tractable scenarios. Thus, we see, in creative transformations, an example of strategic design knowledge applied to assist in concept formation (Candy and Hori, 1997), i.e. in creative design.

5. Implications and Conclusions

Earlier in the paper, three questions were posed:

1. Is VR able to provide support for creative interaction and if so, how?
2. What, in contrast with other tools, is special about the computer and VR in relation to creativity?
3. Which interaction processes, between humans and computers, most support creativity?

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We considered the case of a specific artist's work. This artist did not wish to use VR to simulate "real" reality. Rather, he used it to create movement in a void without gravity. This example points to the main issue that is at the heart of the concern of this paper.

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 visualizations of "real" objects that do not yet exist as a made artifact. Increasingly, however, a different role is being found for the computer. This role is that 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. Ilgen's experience is an example of how using new technologies does not necessarily lead to a dependence or focus upon the technology but rather to a change in understanding.

We have also shown how we can understand the use of VR by the artist in terms of creative transformations. This has demonstrated how strategically selected actions can drive or enable creative thought in ways that may be computationally tractable. The interactions seem to be a significant part in the computation of creative results. It was also noted that we may see VR in the context of emergence. The artists or designer may build virtual models in the same way that they draw as part of the creative process.

So, as a result of our considerations, it is suggested that the answers to our questions might be:

1. Yes, VR is able to provide support for creative interaction, as a reality into which and within which creative transformations may be made.
2. What is special about VR is its ability to flexibly represent models, including models closely relating to what Ilgen terms "real" reality.
3. Transformations and the manipulation in and changes to models of the world are the interactions with VR that most support creativity.

Validating these answers is posed as a set of research challenges that the authors and, we hope, others will address.

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