THE COMPUTER AS A DYNAMIC MEDIUM

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The space represented within the computer screen exists at one remove from physical reality but subsists within its own environment. The computer image is the dynamic result of a process, held in stasis at times but with the potential to be wholly altered without leaving any material record.

INTRODUCTION

Essential to any definition of “Computer Art” is some recognition of the inherent malleability of the virtual space and the computer interface, which makes it difficult to term the computer a “medium”. As the artist Lillian Schwartz describes, the computer can be regarded as a polymorph of tools: “an unlimited supply of brushes, colors, textures rules of perspectives and three dimensional geometry.”[1] The word “medium” has artistic connotations of surface and material, and also refers to channels of communication.

All previous art media shared the artist’s own physical environment to some degree, even film and video which existed physically as footage and tape. Prior to the 20th century, all visual artists operated with physical materials, whether inscribing images on a surface, sculpting objects or capturing the imprint of light on film. Each of these physical media had certain inherent characteristics that conveyed a particular visual quality.

Physical media imposed no restriction on artistic style, but their physical limitations were a factor the artist had to work with – or against – to achieve the desired effect. Moreover, these qualities were irreducible since they were part of the medium’s very structure. Such physical characteristics lent each medium its artistic appeal, even in the case of prints, posters and other mass-produced items.

All art media could be classified as surfaces, structures or materials, including transient ones like light, gases and water. Because they share physical space with the artist, these

media cannot be manipulated below the level of their constituent parts, nor could their characteristics be manipulated outside a certain range. Even at the extremes, this is true. When IBM used a tunnelling electron microscope to arrange individual carbon 88 atoms into the letters “IBM”, they were still operating on the smallest constituent parts of the medium.

The computer is simultaneously tool, interface, surface and material; in this it is quite unlike any previous art medium. The relation of artist to the physical interface is bound up with these characteristics. They also inform other issues which are unique to digital art, such as the difficulties of physically realising computer images, the lack of a digital “original” and the relation of artistic process to computational processes. Because all these questions relate back to the underlying digital structure of all Computer artwork, this may prove to be the computer’s signal contribution to the arts.

With respect to its modes of operation, its specific requirements and the skills needed to master it, the computer should qualify as a medium. However, since its digital basis makes it fundamentally different to previous physical media, I believe the term is not strictly correct, if “medium” refers to an artistic or a communications medium. However Edward Lias holds that any environment of the human mind is a medium, in the sense that it can embody human thoughts and instructions. Building on this environmental approach, he suggests:

The media provide an all-encompassing environment for the mind, just as physical surroundings provide an all-encompassing environment for the body.[2]

In this sense at least, the computer as a whole is a new medium. Yet only in some of its functions could it be seen as a medium for the visual arts; when functioning as a word processor or a spreadsheet the visual aspect is not engaged to any great extent. Lias’s definition is too broad for pinning down the specific nature of the computer’s status as a material or surface for visual art.

The concept of a sole computer medium is too restricting because it is drawn from the lexicon of traditional art terms. It takes for granted the idea that a physical medium has a range of defining characteristics; for reasons laid out above, the computer’s visual characteristics cannot be easily summarised. The space created by computer software and the conceptual operation of the artist’s thoughts could be described as a graphical environment in which a range of artistic actions might take place, inspired by J.J. Gibson’s concept of environmental perception. Alternatively, the properties of the digital image might qualify as a new *substance* with very different characteristics from any physical material.

Theorist Tim Binkley is dismissive of the notion that the computer functions as a “medium”. He considers that computer imagery relates back to existing art media, drawing on different aspects depending on the type of image, even when the content is generated in wholly new ways. He adds “although interactivity epitomizes the unique capabilities of computers, it does not invent a new medium”. [3]

Artist Jean-Pierre Hébert frames a similar idea slightly differently: “[In] Computer Art the real medium is software art, the computer is only a mere thing.” [4] Robert Mallary developed this point, saying that the computer has a variety of functions as an artistic tool, some extending the hand, others extending the artist’s concept. The latter functions – “brain-like” – should be distinguished from the “output instrumentalities” where the image is realised, such as film or on paper. For this reason Mallary did not regard the computer as a medium per se. Rather, he said, “the role of the computer is that of a key cybernetic component in a host medium, art form, or art-generating system.” [5]

For Binkley, art-making with a computer involves modifying the symbolic content of the program rather than the physical processes that constitute it: “electrons shuttling through logic gates or magnetic fields billowing over thin layers of iron oxide.” [6] The material makes little difference so long as it can store and process the code. In this sense, Binkley denies the possibility that the computer qualifies as a medium in the singular, because its visual effects are not bound to its physical components.

THE COMPUTER AS A META-MEDIUM

William Mitchell considers that each level of the digital image might qualify as a different “medium” in some sense. [7] By this, he means that an image may be operated on at the visual level or at the level of its code; both acts are inherent in its digital structure and each may be regarded as a “medium” in terms of its parameters and operation. Binkley’s denial of the computer as a medium does not allow for this possibility, nor for the way that digital images operate in an entirely different “space” to the artist.

It was the first recognised computer artist, Ben Laposky, who realised the nature of the immaterial space he was working with. In the 1950s Laposky was experimenting with an analogue computer – essentially an oscilloscope screen fed by sine waves to achieve specific shapes that Laposky termed ‘oscillons’ – and he recognised that the space shown on the screen had intriguing non-material properties. Laposky considered the twin factors of movement over time, and the impression of 3D imagery on a 2D surface conveyed “an almost sculptural quality” on the oscillons - “luminescent moving masses ... suspended in space” as he put it. [8]

For these reasons, the computer in art could be what Alan Kay (quoted by Larry Cuba) considers to be a *meta-medium* because of its power to simulate other media. For instance, in Cuba's work as an abstract animator, he programs the computer for his animations but has decided not to use it as a display medium, or employ any form of interactivity for the viewer. His films run as linear sequences on video formats. Thus Cuba works *on* the computer rather than working *in* it. [From my interview with Larry Cuba, July 2001, Los Angeles]

Craig Hickman realised that differentiating a wholly new field of Computer Art from the computer's extension of existing areas is important. Even if the computer merely recreated the situations and standards of preceding art media, it would still produce valid art. These recreations of existing media derive from the methods and expectations of their precursors, though they subsist in digital form. They are not judged by standards derived from their computational origins, so much as the visual and experiential connections with older media.[9]

At some point, the line between recreated medium and the products of that medium blurs sufficiently that the computer adds few new facets or results to what has come before. This is a useful dividing point between "Computer Art" and "computer-mediated art". The latter draws on a previous art-medium, transplanting its standards and expectations to the computer, and if the recreation is close enough the computer's role in the resulting artwork is minimal. Even so, the fact that multiple environments and expectations can exist simultaneously on one machine demonstrates its status as a meta-medium.

When computer images are created and displayed, the computer also functions as an intermediary for the artist and viewer to see its visual content. The artist can only interact with computational processes by treating them as program elements – directing their operation and outcomes – or by using physical devices to move proxies around the screen. The artist cannot enter the digital environment itself, but they can influence it from the outside. The viewer, meanwhile, can only see these results displayed on the screen, unless they are printed or recorded on film. In this sense, the computer becomes an "intermedium" – a quasi-physical digital substrate which enables interaction or viewing.

To properly understand the artist's relation to the computer, one must consider the nature of the interaction between the human and the software via this digital intermediary, or image space. Because it is dynamic and often fully three-dimensional, this space is quite different from that of the static surface of a painting, or even the linear sequence of a film. It might be considered an image environment, a space with its own laws and results that (as John Whitney realised) is not subject to the rules of the

physical universe. Stephen R. Ellis considers an environment to be “the theater of human activity” which consists of a *content*, a *geometry* and *dynamics*:

The content consists of both the actors and the objects with which they interact. The geometry is a description of the properties of the stage of action. The dynamics describes the rules of interaction between the actors and the objects. [...] [10]

This definition may be usefully adapted to the computer in an artistic context. Here the *content* is provided by the artist and their interaction with the computer, including the alterations and developments its usage engenders. The *geometry* comes from the structure of the interface, the type of software, the artist’s knowledge and their comprehension of the computer as instrument. Finally, the *dynamics* stems from the properties of the software or programming skills they are using: it provides the parameters within which they work.

Describing the computer as an environment, including its physical devices (keyboard, mouse etc.) and its dynamic non-physical aspects, is closer to its role in art than calling it a “medium”. Rudolf Arnheim notes the comment of computer artist Christopher William Tyler that contemporary artists tend to operate by “selecting from an environment entities that have significance to the artist rather than creating from scratch on a tabula rasa”. By this he means that artists have picked up tools to utilise from foreign contexts and made them part of the artistic process. Tyler believes that such selected instruments “become part of the environment in which the art is produced”, informing its production and extending its possibilities. This prompted Arnheim to note that this situation goes beyond an artist standing in relation to his tools; rather, it is the relation of the mind’s conceptions to the opportunities and constraints presented by the environment.[11]

In the computational environment, the image and its associated tools exist at a higher level than the data: they are the *form* but not the *matter*. The matter – instructions in code – is fundamentally linked to the form and provides its substructure, but it has no direct visual correlation. In this sense, it exists in a different space from the artist and for this reason can be wholly manipulated and altered in a way impossible for physical materials which share the artist’s space.

If computer images can be said to have certain qualities, they are structural characteristics rather than visual ones. They can be freely deleted, rearranged, transformed and returned to their original state, provided that the software allows all these steps. In many programs, the component parts of the image can be edited without affecting the whole, or freely grouped and combined to form new pictorial elements.

The image the artist sees is comprised of an utterly different substance from material reality because it is built up from the first as a visual object and not a physical mass. All computer-generated objects are “hollow”, comprising hierarchical groups of instructions rather than densely-packed physical structures. These model visual appearance and dimensions in the first instance, and physical characteristics from the point of view of their visual interactions.

The peculiarity of computer image space is that not only the tools but the space itself can change its characteristics. This is due to its origins as a sequence of coordinates. Also, specific properties of its organisation (such as layers in *Photoshop*) only apply within a particular program; at other times, the image is completely inert, held in potential in the data.

It prompts the somewhat flippant question: Do all computers running the same program and using the same data set partake of the same image space? Or is it only re-created every time it is displayed?

Every re-running of the image code (especially a 3D image) in different software and hardware environments seemingly shows the viewer the same segment of reality. Users of Internet-based 3D chat rooms experience the “same” 3D space from different viewpoints, though their machines may be running quite different software on entirely separate hardware. In the same way, a 3D CAD plan may be experienced simultaneously on office intranets and modified by group collaboration across the network. Is the image seen at every workstation the same image, or simply the same environment displayed in slightly different ways?

The question does not arise for TV or video footage because it is recorded as an image and thus every iteration is a duplicate. By contrast, the computer re-creates the image every time the code is processed. When objects are moving and the scenes depicted from slightly different viewpoints (as with online games such as *World of Warcraft*), players might be said to be participating in the same space, whilst viewing an iteration of it.

The pioneering computer artist John Whitney Sr considered that this dynamic space only existed “by virtue of the abstract forms that move in it”.[12] For this reason, Timothy Binkley sees the computer’s role not as an inert medium, a resistive surface or material, but rather as conceptual space:

It appears that its function is much closer to the *conceptual contribution of the artist* than to the physical contribution of the medium.[13] [italics mine]

Binkley argues that the computer, functioning simultaneously as the image space, the tools for executing the design and the display medium, contributes to the conceptual creation of the artwork rather than simply providing the means for its reification. After all, until the image is printed or publicly displayed, it may be endlessly edited and modified. In this context, the artist may construe the “tools” either as those constructed within the program, or external hardware interfaces which affect the digital image. Only in the most general sense can the computer be said to be a tool *in itself*.

The computer moves images away from physical materials towards a data structure that can only be interpreted by devices, not directly by the viewer. As Levy describes it in the ACM Transactions on Digital Libraries 1998:

Digital documents are split between an intangible digital object (which is ineffective outside of a complex, technical context) and a set of perceptible but transient manifestations.[14]

It is important that this “intangible digital” visual form cannot be manifested without the computer. Unless it is printed or otherwise materialised, at which point it ceases to be digital, it remains tied to the computer. Nevertheless, this space may correspond with physical space and materials; indeed, much Computer Art has a necessary physical component. Though it is mediated through and by the computer, the artist still remains the decisive factor in its creation and thus in its definition as “art”. In addition, the art’s non-physical existence enables it to be modified, transmitted, displayed and erased in ways that circumvent the limitations of physical materials.

The computer medium can only be penetrated with instruments and worked on at one remove; but insofar as it works to our expectations of scenes and objects beyond our immediate tactile range, it is effective and affective.

JJ GIBSON’S ECOLOGICAL PERCEPTION

The idea of the graphical computer as a reciprocal environment entered by the artist was elucidated for me by the theories of human perception put forward by the psychologist J.J. Gibson. Although his views on pictorial communication were questioned by Ernst Gombrich in *Leonardo*, (Vol. 4, 1971), I found his theories of environmental perception to be useful metaphors when working out the relation of the artist to computer graphics. Certain aspects of Gibson’s psychology had already been noted by pioneers of Virtual Reality such as Michael McGreevy and Jaron Lanier, in relation to tool use. [15]

The word “medium” has artistic connotations of surface and material, and also refers to channels of communication. In a computer context it is instructive to consider JJ

Gibson's usage of "medium" when describing how perception might take place within an environment:

If we understand the notion of medium, I suggest, we come to an entirely new way of thinking about perceptions and behavior. The medium in which animals can move about (and in which objects can *be* moved about) is at the same time the medium for light, sound, and odor coming from sources in the environment. An enclosed medium can be "filled" with light, with sound, and even with odor.[16]

If the computer is a "discrete" or "closed" environment, one that can only be experienced by proxy, it is still comprehended by perceptual mechanisms developed to deal with the physical world, hence the use of metaphors in interfaces. In this sense, the digital medium is both more comprehensive yet more constrained compared to its physical predecessors. As computer artist Aaron Marcus points out, computer graphics "effectively interfaces with man via light. The images have no mass, no physical substance in a sense, but they are perceivable and meaningful to the viewer."[17]

Thomas J. Lombardo noted that Gibson's concept of "ecological vision" meant that vision was understood as part of an ecosystem, as a component of the whole: "The term *ecological* signifies animal-environment reciprocity." [18] In seeking to understand how each environment shaped its inhabitants, Gibson considered the role played by certain substances that demark one medium from another. Water, for instance, functions as a medium for the fish swimming in it, but is a substance for humans who cannot enter the fish's world without breathing apparatus. The artist's position outside the computer's graphical environment parallels Gibson's reflections on the land-dweller's relation to water.

This consideration of substance versus medium is an important one. An artist using the computer can see *into* another medium, and by using interfaces they can operate and affect this medium, even to the extent of being able to feel sensations that correspond to the surfaces and masses of objects therein. But they can never enter this medium, there can never be direct physical contact or immersion in this space, because the medium they inhabit is wholly different. This is the greatest limitation on Virtual Reality, no matter what apparatus is used – even direct signals into the cortex.

The best the artist can ever hope for is a vicarious experience of their visual relations and interactions. They cannot enter their universe except visually; they cannot enter his except through visual displays or being physically rendered into inert objects, at which point they lose their digital basis and are transmuted into chunks of solid matter. Just as one can only work underwater with diving equipment or submarines – another "interface" – so one can only penetrate the digital environment by proxy.

This brings to mind Char Davies's installation *OSMOSE*, which uses breathing as an interface to permit the viewer/user to move within it: the installation is based on "on the intuitive, instinctual, visceral processes of breathing and balance. Through breath, the immersant is able to rise and fall in space with subtlety and precision." This novel interaction places the viewer within the digital domain as if suspended in an ocean; indeed, Davies says it was inspired by her experience of scuba diving. Yet even the most immersive digital artwork can never fully engage the viewer with the non-physical substance within which digital art subsists.[19]

Certainly, the space represented by the graphic display exists in an odd state: it may be flat like the screen that shows it, or have depth as well, and allow for movement in all axes. Meanwhile the artist navigates around using a two-dimensional mouse; three-dimensional pointers like the Polhemus are very rare. For the purposes of making an image, actions in this notional space have observable results that leave a trace on it. Yet the area is itself non-physical; there is no material on which such movements can have an impact, except that which the program simulates. The environment displayed on the screen recalls a description of "space" that attempts to address its special properties:

[Space] so conceived is a very strange kind of thing. It seems to be part of the physical world, since it is not mental or spiritual, and since it is presupposed by physics. However, all objects treated by physics are, it seems, material [...] But if space is something separate, "in which" such objects exist, then it appears that space itself cannot be a material object: if it were, then it could not be the container of all matter, for what would contain it?[...] space seems to be a physical object, *but unlike all other physical objects, it seems not to be material.* [Italics mine] [20]

Likewise, the computer screen is comprehended by GUI-using artists as if it was part of their physical surroundings and had a material basis. Insofar as their actions affect it, it seems to be "there" in front of them; it has an external existence which we would attribute to objects. Yet in other respects its immaterial nature is manifested in its transience and its distance, in the sense that it cannot be touched. In this respect, the computer image is closer to the mental concepts of the visual imagination. Also, its receptiveness to change is complemented by its non-linearity: an image may be endlessly altered and yet returned to its original state. Thus it exists not merely outside our space, but outside our time as well.

Our experience of physical reality is primarily visual (secondarily auditory) and predicated on visual properties: the inference of mass, inertia, speed, etc, from the observable characteristics and relations of objects. They only enter our immediate and physical environment when they get close enough to touch, i.e. when they enter the area bounded by the maximum extension of our limbs and skin surface, which is the extent

of our capabilities for direct physical interaction. Beyond this, the physicality of the world can only be *inferred* from its visual and auditory properties, though we have to assume its physicality because it shares the same space as we do. Mirages and other environmental illusions such as rainbows are examples that defeat such expectations.

We can affect objects at great distances by remote control, or firing projectiles, or using extensions for our limbs; but beyond our immediate physical sphere these interactions too are at one remove and thus indirect. So the environment – even “medium” – in which we exist can also be only partially experienced at first hand.

Overall, the factor of “distance” plays a part in the willing suspension of disbelief which is such a factor in our interactions not only with computer graphics, but with slide projections, film and television.

Trompe l’oeil painting is most instructive in this regard, because it brings the illusion up short, so to speak. At the exhibition “Deceptions and Illusions: Five Centuries of Trompe l’Oeil Painting” at the National Gallery in 2002-3, normally tangible objects were depicted in a highly realistic and almost three-dimensional fashion. But close inspection destroyed the illusion to such an extent that they no longer appeared “real”, no matter how hard one tried to deceive oneself. By contrast, a *trompe l’oeil* ceiling depicting heavenly apparitions remains effective no matter how much one assures oneself that it is painted – not because it is impervious to closer examination, but because the depiction itself is of something we expect to be beyond our normal physical interactions and can thus remain *intangible*.

The computer medium can only be penetrated with instruments and worked on at one remove; but insofar as it works to our expectations of scenes and objects beyond our immediate tactile range, it is an environment which is effective and affective. This environment can be entered either through hardware that converts movement into equivalent motions, or by directly rewriting its properties. Because everything is done at one remove, by proxy and instruction, it is an environment the user never enters themselves, but because of this can see “around” and “through” it. It certainly functions as an environment of the human mind, as Lias would have it.

Whether or not the reconstruction of an image space grants you access to the “same” or “different” space, Gibson’s consideration of *medium* versus *space* is still useful:

As the observer moves from point to point, the optical information, the acoustic information, and the chemical information change accordingly. Each potential point of observation in the medium is unique in this respect. The notion of a medium, therefore, is not the same as the concept of space inasmuch as *the points in space are not unique but equivalent to one another*. [Italics mine] [21]

In one sense, the computer space is only perceptible through a fixed window, whether 2D or 3D. But the view is ever-changing and even the window or host computer may change – though not necessarily affecting the image itself. The only constants are the menus and tools of the GUI. As for the senses through which computer images are perceived, these are primarily vision, sound and touch. All three can be modelled mathematically and reproduced electrically; smell and taste are much harder because they are molecular sensations. Gibson leaves touch out of his list of stimuli, but I suspect he is looking for sensations that can be transmitted rather than those which are tied to particular surfaces. He sums up the characteristics of an environmental medium as the following:

[...]that it affords respiration or breathing; it permits locomotion; it can be filled with illumination so as to permit vision; it allows detection of vibrations and detection of diffusing emanations; it is homogeneous; and finally, it has an absolute axis of reference, up and down. [*Italics mine*] [22]

The computer environment affords movement and the infinite extension of the screen area; it allows one to zoom in and out of a scene; it enables the animation of objects within the environment; it is homogenous insofar as the particular piece of software is concerned – images can be displayed on other computers and platforms; and its absolute axes are determined by the conventions of the screen. In short, it provides the equivalent of an environment even though it is heavily circumscribed by the limitations of the computer hardware.

This is quite different from a “medium” as understood in artistic terms. Although the connections with 3D graphics are obvious, it would seem to me that even 2D abstract images also share in these characteristics. For instance, the generation of algorithmic “environments” is essential to the creation of Jean-Pierre Hébert’s images.

The artist can therefore exercise considerable power over the computational environment. Because the user is outside this environment, they are not subsumed by it and thus can control its every aspect – if they so wish. Decisions to only make use of a limited subset of tools rest entirely with the artist. The advantage of disconnection (or disembodiment) is omniscience.

ACKNOWLEDGEMENTS

This paper incorporates elements from my thesis “A Critical Examination of ‘Computer Art’: Its History and Application” that was submitted to the University of Oxford for my DPhil degree. It can be read online at: <http://thesis.lambertsblog.co.uk>

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