More Power
The Pioneers of British Computer Animation and their Legacy

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Introduction

A short while ago I was asked to help suggest titles for a historical retrospective of British computer animation. The organiser had already compiled a list of possible works but between the early seventies and the late eighties there was an embarrassing gap of almost fifteen years when it appeared that practically no animation had been produced. There were many examples of ground breaking commercial animations and research studies but nothing at all to represent the activities of artists, nothing produced specifically for 'artistic' purposes. Even if the programme had not been limited to British work, the situation would not have been remarkably different apart from a piece each by a few well known names like Ed Emschwiller, Larry Cuba or David Em. Effectively computer animation as an independent artistic practice became invisible from the mid seventies to the mid eighties in stark contrast to its increasing presence in the media industries.

At first the reasons behind this seem obvious: computer animation needs expensive machines and a lot of difficult technical knowledge to make anything worthwhile, so the argument goes. And if this creates problems of access to equipment now, the problems back in the seventies must have been colossal by comparison. Up to a point this has some truth. Until the nineties computer processing power was divided qualitatively between home micros, graphics workstations and mainframes. What you could produce on one level of machine was instantly recognisable as defining the limits of that particular platform. Chunky graphics and day-glo colours had little appeal to artists and film makers - computer animation was something discussed between advertising executives in Soho production offices and it was best to leave them to it. So perhaps after the first flowering of interest in the sixties artists had said all that they had to say by the end of the decade and the medium just ran out of steam. It was too difficult for artists to get involved in such abstruse technology, the rewards were just not worth the effort, and the art world turned its attention instead to the critique of socially and historically constructed realities rather than the celebration of its technological manifestations.

But in fact these years witnessed a long period of slow development of computing in the arts, spearheaded by small groups of artists working in almost complete isolation from the established art world. Indeed, it was work arising directly out of the efforts of these groups which has led to the current high status of the British computer animation industry. It is important to ask therefore, why the work of these artists never found an outlet in arts circles, why the development of computer animation by artists as a cultural practice took forms that seemed so alien to the values and sensibilities of the greater arts community and how far the structural properties of the computer itself have directed how it has or has not been integrated into artistic practices today. Otherwise it can appear that the immense changes in visual culture due to the impact of digital technologies have appeared entirely from outside without any connection to artistic motivations and histories. My aim is to explore how our current perception of these changes have informed our ideas about electronic media arts and how far artists experiences in the recent past can help to provide a model for current practice.

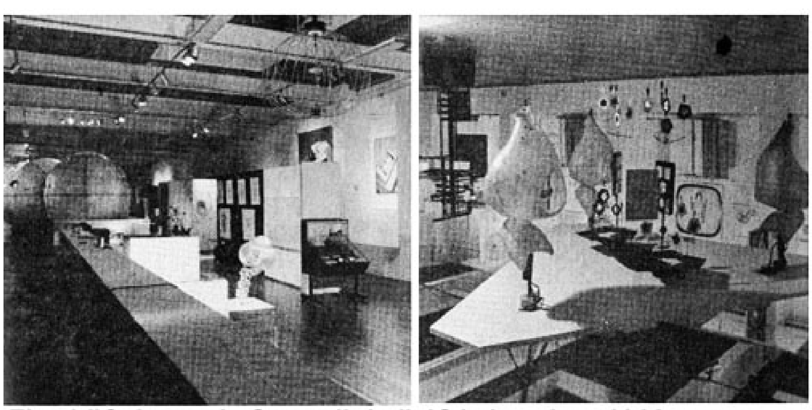


Fig. 1 "Cybernetic Serendipity", ICA, London, 1968.

The Missing Link

The *Cybernetic Serendipity* show hosted by the ICA in 1968 is still acknowledged as a key event in the introduction of computing to the wider arts community. It acted as a spur to many young artists to consider the computer as a creative medium, even though most of the participants in the exhibition were from a science or engineering background [1]. Shortly after this a group of scientists and researchers at an Edinburgh computer science conference decided to found the Computer Arts Society as a branch of the British Computer Society. This group became central in the following years in running courses to introduce artists to computer technology, mounting exhibitions and publishing documents. Artists also began to join and in 1969 the Society organised *EVENT 1* at the Royal College of Art which, unlike the *Cybernetic Serendipity* show, focused on the use of 'live' computer controlled installations and interactive pieces. A sometime newsletter called *PAGE* was produced which even secured a measure of Arts Council support through the editorship of Gustav Metzger, the well known proponent of 'auto-destructive' art. Although the quality of output was at this time extremely limited - usually confined to text printers - these activites generated a degree of excitement among artists interested in the conceptual implications of symbolic representation, automated production and its future possibilities.

The merging of most British art schools with Polytechnics in the sixties meant that art students up and down the country found themselves with potential access to a much wider range of educational and academic resources than would otherwise have been the case. Among these were the large mainframe computer systems on which the academic records and scientific research work was routinely carried out. Those inspired by the art and technology experiments of the sixties were able to gain piecemeal access, though only a very few art institutions such as the Slade School of Art at the University of London, the Design Research department at the Royal College and Middlesex Polytechnic (now Middlesex University) could offer regular access to computer processing equipment.

The artists attracted to the Slade School's Department of Experimental and Electronic Art in the mid seventies were typical of what can be termed a 'second wave' of artists working with technology. They were mainly people from sculptural backgrounds like Darryl Viner, Chris Briscoe and Steve Bell, though some had worked as engineers like Julian Sullivan, or in the case of Paul Brown as an artist building early video synthesizers for light shows and installations. Their attraction to the computer was initially conceptual and focused on the exploration of logical procedures for the generation chiefly of drawings or plot outs. The Slade artists were also deeply committed to the potential of computing in the face of an increasingly hostile arts establishment, in spite of the serious limitations in computer power then available. This faith in the eventual value of their activities gives a clear an indication of their approach to the computer as a medium and why it was ignored by all other artists. It was their theoretical appreciation of the processing power that was waiting to be harnessed, of how mathematical techniques could logically be extended to the point at which they enabled quite a different level of application, that caused them to continue down a road that might have otherwise seemed sheer pigheadedness. The only thing that could sustain such efforts was an understanding of what algorithmic processing could mean to the artist's working methods when taken to its logical conclusion. Though there was little evidence of the general impact of computing on art and design at this time, it was accepted by this small group that what was needed was a period of gradual development of the techniques and methods which would one day find widespread use.

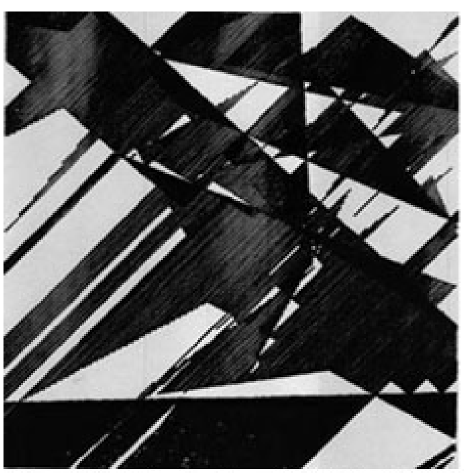


Fig. 2 Still from "Inside/Outside", Darrell Viner 1974.

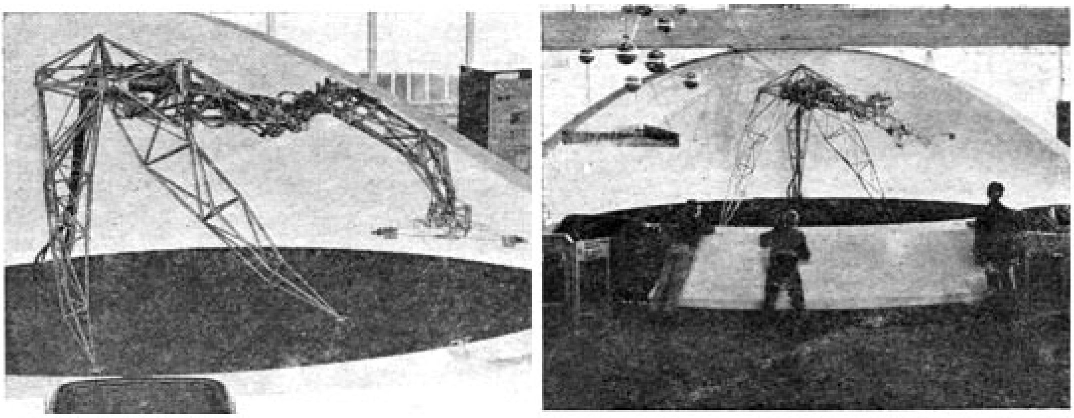


Fig. 3 "Senster", Edward Ihanowicz, 1971.

The position of the Slade School in the University of London put it in a prime spot for access to relatively up to date computer equipment and to the latest scientific and mathematical expertise. Both in terms of physical access to machine time and access to knowledge for writing software and designing custom output devices, a priority for the artists in the Experimental and Electronic Art Department was to forge links with the other disciplines. The computer science building was next door to the art department, and several contacts were developed in the Department of Mechanical and Electrical Engineering such as Edward Ihnatowicz, the expert in interactive sculpture who produced 'Senster' (1970), regarded by some as the first 'masterpiece' in computer art. And the flow of ideas was not only one way. The knowledge of artists familiar with computer techniques and an understanding of visual dynamics was an unusually valuable asset in many scientific projects and the Slade School artists worked on many interdisciplinary projects. Artists like Chris Briscoe began to support their work by writing graphics software for the other departments, such as a laser scanner and facial reconstruction software for the Medical Physics group. When Darryl Viner needed a pen plotter - astronomically expensive to buy in those days - the only recourse was to learn the necessary skills and to build one completely from scratch with the help of the other artists all pooling their knowledge. At this time there was no possibility of conventional arts funding for work of this nature. Not only was the basic will to support the remnants of the art and technology projects of the sixties missing, but the levels of resourcing necessary for this kind of computing were well beyond anything but a nationwide funding effort. It was as though by this point computing in the arts could not survive except by removing itself as far from the arts community as possible.

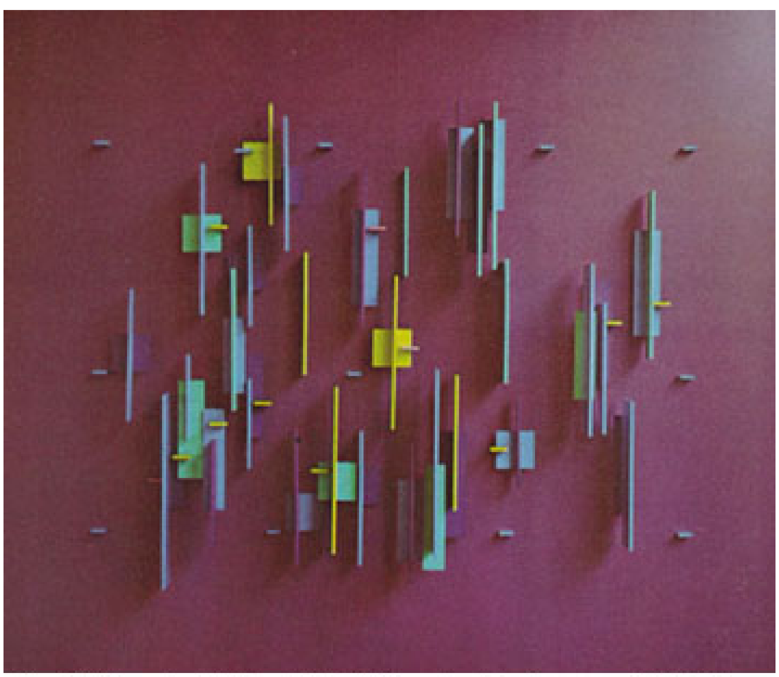


Fig. 4 "Structurist Work #26", Charles Biederman, 1956-68.

The concerns of this group of artists were derived from the conceptual interests of the English Neo-Constructivists and Systems artists, although significant differences were already apparent. The computer artists shared the emphasis on art making as process, on the idea which precedes any material manifestation. For the Constructivist this process must be made explicit, for it is this process which most clearly demonstrates the structural principles of art, and by extension of the world in general. Constructivists art often has a strong epistemological status - it is the artist's duty to discover the elemental relationships by which forms are constructed, natural or man-made, independent of any arbitrary social or historical factors. A key influence at this time was the work of artist and theorist Charles Biederman, who in his book *Art as the Evolution of Visual Knowledge* implored the modern artist to use their art to articulate the latest objective representations of the world [2]. This method involved an extension of the Realist school of art in which the world was analysed at the 'structural process level', and the principles thus obtained used to construct a new object, an artwork which would embody knowledge of the physical world in visual form. Photo-realistic art was regarded as one stage in the development of this ongoing historical project, but was limited to the laws of the superficial 'macro-level' of reality, such as the laws of perspective and of mechanistic balance and composition. Now that new scientific methods had become common currency, the project could be taken to the next stage where the underlying laws of form could be divulged and made explicit in art.

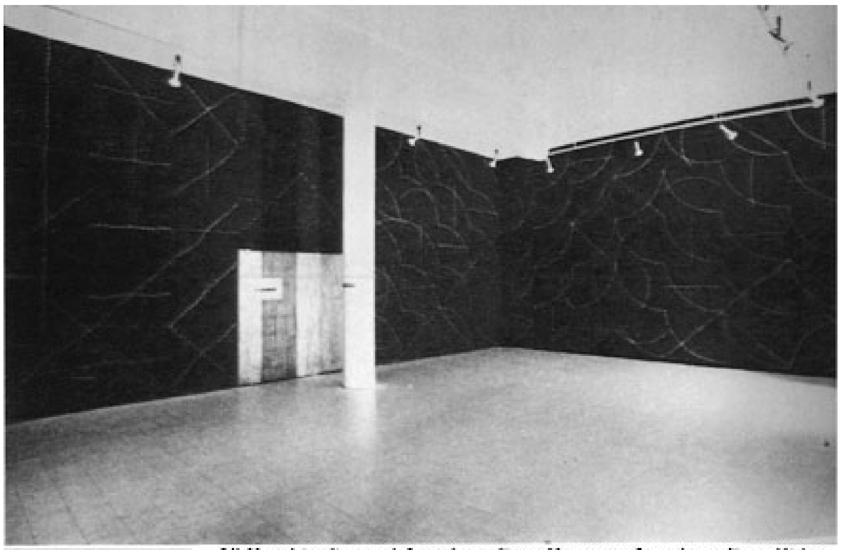


Fig. 5
Sol LeWitt
All Combinations of Arcs from Four Corners, Arcs from Four Sides, Straight Lines, Non-Straight Lines and Broken Lines.
White lines on black wall, 1976.

The primary language of these laws of form was mathematics, and this formed an important part of the work of the English Neo-Constructivists of the sixties and seventies like Anthony Hill, Kenneth Martin and Malcolm Hughes, as they explored the structural potential of logical systems and relationships. An artist like Anthony Hill would take as his starting point a mathematical object such as the set of prime numbers up to a hundred, and use their distribution to construct a set of visual rhythms, resulting not so much in a unique material art object, but a pictorial form which could provide the basis of one of a number of manifestations. The work of the Conceptual artists like Sol le Wit was also very important in this connection, as they mounted exhibitions of descriptions of art works which could not be perceived visually but only experienced as an idea. Classical Constructivism had been concerned with the relations between elements, expressed in various combinations and permutations, of engineering and the physical properties of materials, of visual rhythms and geometric proportions. After the Second World War static geometry had given way to immaterial process and perception, and by the seventies the Systems artists had focused attention more single mindedly on sequences of operations through which forms could be realised.

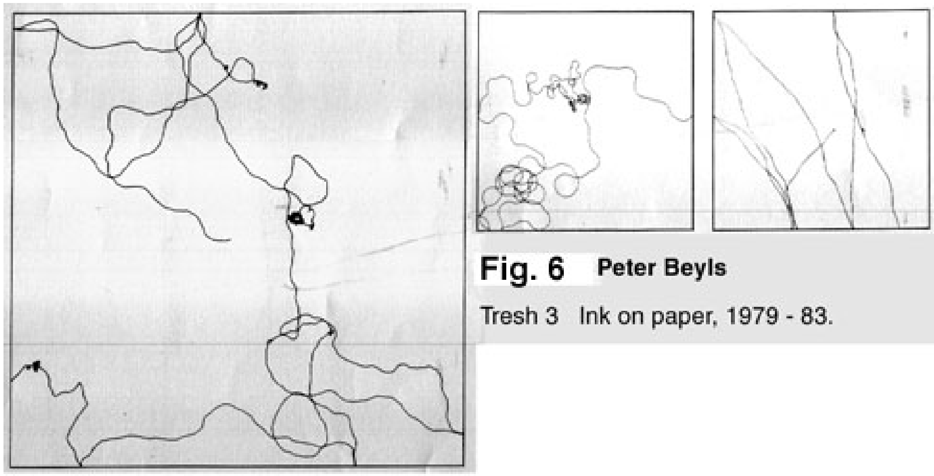


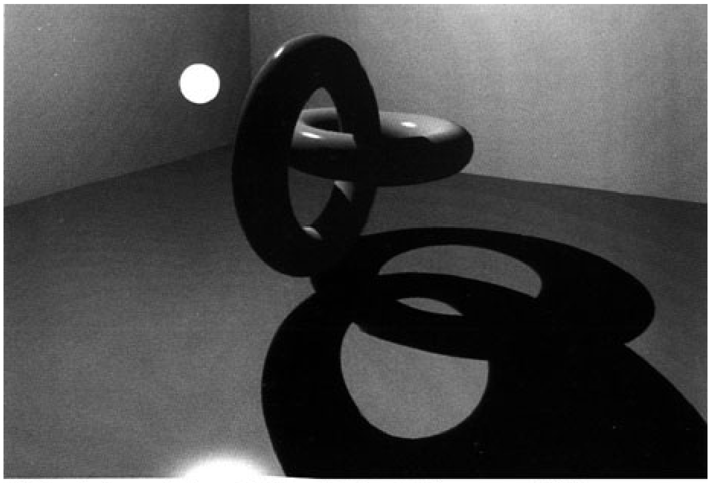
Fig. 6 **Peter Beyls**

Tresh 3 Ink on paper, 1979 - 83.

For the 'computer artists' at the Slade, the process through which art was constructed was exemplified by the algorithm or computer program. This creative process constituted the very essence of art practice, and the computer allowed them to externalise this process as a logical sequence of operations. Various programming techniques were developed which could be used to design a possible art making procedure, and many were based upon experimental mathematical ideas or scientific methods. Automata of various kinds were very popular, systems consisting of simple elements - shapes or pixels - which moved, grew and interacted according to very simple rules. As they were allowed to develop under computer control intricate patterns of interference could be plotted, sometimes dying out, sometimes looping between a small number of regular states and sometimes continuing to grow across the visual plane indefinitely. Much emphasis was placed on defining a simple procedure and then repeating it over and over again to its logical conclusion until visual features became apparent - 'emergent forms' of specific character appearing from out of an obsessive monotony. Other artists undertook early artificial intelligence experiments in behavioral simulation, no doubt stimulated by visiting lecturers such as Harold Cohen, the British painter who had become an expert in artificial intelligence before leaving to work in a southern Californian university.

As noted above, the Constructivist programme could easily be seen as a special case of the Realist programme in art history and also in scientific epistemology. In general Realism usually denotes a belief in the existence of an external world which is accessible to objective analysis. Specific forms of artistic Realism are sympathetic to interpreting this world with reference to scientific methods and structural hypotheses, as opposed to other methods such as that of Social Realism. As early as 1920 leading Constructivists Antoine Pevsner and Naum Gabo published a Realist Manifesto which included statements such as '...we construct our work as the universe constructs its own, as the engineer constructs bridges...' As proposed in texts such as Biedermans, art could function as a means of gaining objective knowledge about the world and could form the basis of a universal language free of the idiosyncracies of social habits and traditions. Biederman was hostile to the work of the Surrealists whom he viewed as filling the world with their personal fantasies. But this did not mean for instance that the dynamics of subjective perception could not be explored in an objective and methodical fashion. This displacement of interest from the material object to its perception helped emphasise the importance of change and interaction and this also became a favourite theme of artists in the postwar period.

For the Conceptual artists of the seventies it was felt sufficient merely to document or represent the conceptual process itself regardless of its possible manifestations. At the Slade also, artists would sometimes exhibit program listings along with their work, but the programs they were now writing were enabling them to model processes which could only be fully appreciated visually and often bore no obvious relation to their algorithmic origins. These techniques of iterative functions, evolving ecologies and growth algorithms which developed into patterns that could not be predicted from their initial conditions were drawn from scientific disciplines that attempted to model the physical world at a new level of abstraction. By the late seventies the underlying logic of computer art practice had also shifted to a new level from structural dynamics to computer simulation. In addition, there was a growing realisation that the increasingly elaborate construction of logical spaces in which these digital entities could exist - what we might currently refer to as 'virtual worlds' - had no obvious limitations in scope. Sculptures might be constructed mathematically in their own logical space according to the laws of alternate physical universes. The theoretical possibility of building such artificial worlds was well known by this time and the challenge of recreating a world from the bottom up was becoming very attractive. The importance of visualisation in these experiments was displacing interest from the concept to the image as the focus of computational 'Realism'.



"Sculpture Simulation" Paul Brown, 1983.

Into the Real World

By the late seventies computer graphics had reached the stage where it was coming out of the research labs and art studios (there was often little difference between the two) and making its first appearance in film special effects. Production costs had finally started to fall and commercial industry became interested in investing in new media technology. Early computer production companies such as System Simulation had created the green-screen vector graphics for the film *Alien* in 1979. System Simulation was co-founded by John Lansdown, originally from an architectural background, who helped run the Computer Arts Society in London. In 1981 Digital Pictures was formed as a university based company at the Slade School with Chris Briscoe and Paul Brown as the main driving force. These joined other companies such as Electronic Arts - formed from researchers in the Electrical Engineering Department at Imperial College - and CAL Videographics where Gareth Edwards from Middlesex Polytechnic via the RCA had become head of 3D computer animation and research. Small units like these formed an intimate community of mainly arts-based production companies which shared the slowly growing body of commercial research, entertainment and advertising. The Channel 4 logo sequence became a symbol of this growing confidence at the dawn of the eighties, involving as it did so many young artists and designers in the emerging computer graphics industry and giving an identity to this new broadcasting venture whose remit was to value the innovative and creative.

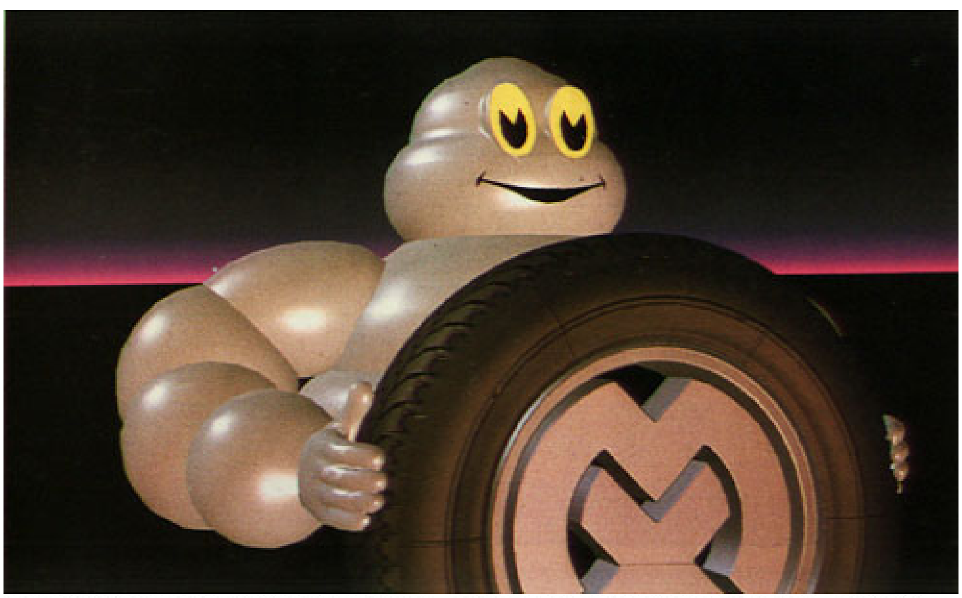


Fig. 8 Still from "Michelin Man", animated by Digital Pictures, 1983.

Digital Pictures was also founded in order to offset the declining funding and support for university based research in the arts. The Slade School had had some success in securing university research funding for equipment, and other academic institutions such as Middlesex Polytechnic were able to contribute a share of the generally available computing facilities to arts courses. But artists working with computers had never been able to rely on the goodwill and interest of the wider arts community. By the early eighties time had almost run out for the experimental work at the Slade and a change of political climate turned the mood from implicit support to indifference. There was also no obvious way in which the work could be judged to have achieved artistic credibility - art critics ignored it, exhibitions were scarce and the role of technology in the arts was simply not yet on the agenda. In addition, the growing involvement of the Experimental and Electronic Art group in commercial ventures led to questions about their artistic loyalties. To believe that computing had a future in art practice was an act of faith shared only by those who had taken the trouble to familiarise themselves with the field and did not have a vested interest in the contrary. Technology was most frequently identified with a logic of control, standardisation and authoritarian coercion which was the very antithesis of artistic and creative values.

Fig. 9 Still from "Thatchit", Keith Waters, 1986

It had originally been intended that Digital Pictures would become a university research centre in computer graphics where academics accross the university could collaborate on projects. Even after the company left the University of London it employed a team of programmers and engineers to perform computer graphics research into areas that had possible commercial application. It was first hoped that income from commercial jobs would allow the artists to continue their own original practice, but production pressures quickly swallowed up all available time. It could be argued that they were the victims of their own success, for the high quality of work produced at Digital Pictures meant that they were never without clients. Just a few years later in 1985 the Design Research Department at the RCA where John Lansdown worked would likewise become a victim of reordered priorities. After the demise of these activities the focus shifted onto work at Middlesex Polytechnic which under John Vince pursued more pragmatic research applications in commercial design and animation for companies such as the BBC. Later in the mid eighties, Paul Brown left Digital Pictures to head the computer graphics section at Middlesex and began Britain's first postgraduate arts courses in computing. By this time computer graphics had become an all pervasive buzz word, taking its momentum from the exposure it received on television through smart looking animation sequences often produced by companies including Digital Pictures and CAL Video and through the special effects work appearing more frequently in Hollywood films. Computer graphics had finally arrived, but the arts community had somehow gotten left behind. So started a long process of rediscovering a field of work with which it had originally been so closely involved but which now looked strange and foreign.

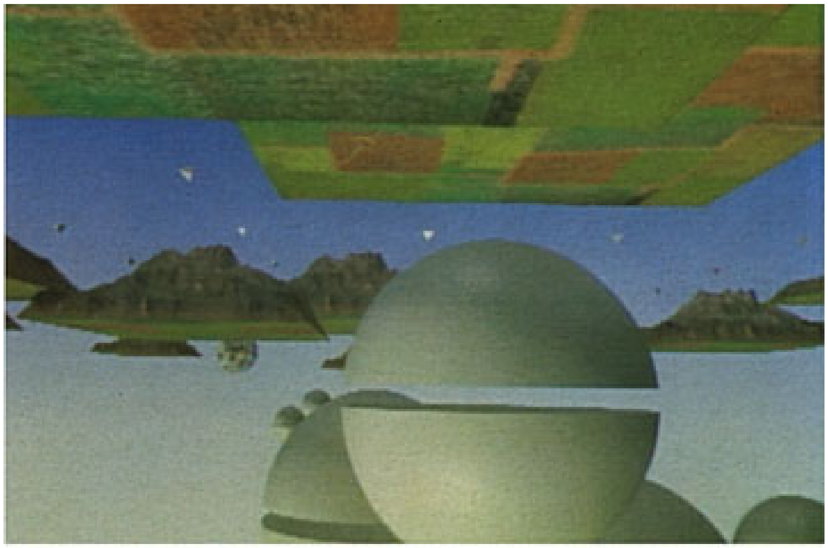


Fig. 11 Still from "Monkey Business", Moving Picture Company, 1987.

As soon as commercial computer graphics became visible in the media it became common to read criticisms in arts circles of its slick, glossy and corporate image, of its obsession with surface finish and three dimensional modelling. Digital imaging was viewed as being directed by business interests and their scientific servants and was impervious to the wishes of artists. It was now difficult to discern a connection with the theoretical aims of the seventies Constructivists, but in many ways it actually represented a culmination of much of the work of that period. This was due to two related reasons - the relevance of the Realist programme to the aims of Constructivist artists and the increasing formal power of algorithmic languages which threatened a postmodernist exhaustion of conventional artistic creativity.

By the beginning of the eighties the prospect of being able to build a space mathematically inside the computers memory was extremely exciting for artists. Precedents for such work had already been established by some Conceptual artists who dealt with language and referentiality. As programming techniques became more elaborate experiments with growth algorithms or behavioral patterns of interaction based on the physical sciences were naturally extended into a fully three dimensional simulated space. Even Charles Biederman had argued that artists should move from static two dimensional canvases into three dimensional relief sculptures to further their analysis of the full diversity of visual form. That this physical space could be addressed in symbolic terms in computer memory rather than in tangible terms seemed to imply all the more potential. In all cases the conquest of the three dimensional world was an artistic priority as well as a technical challenge.

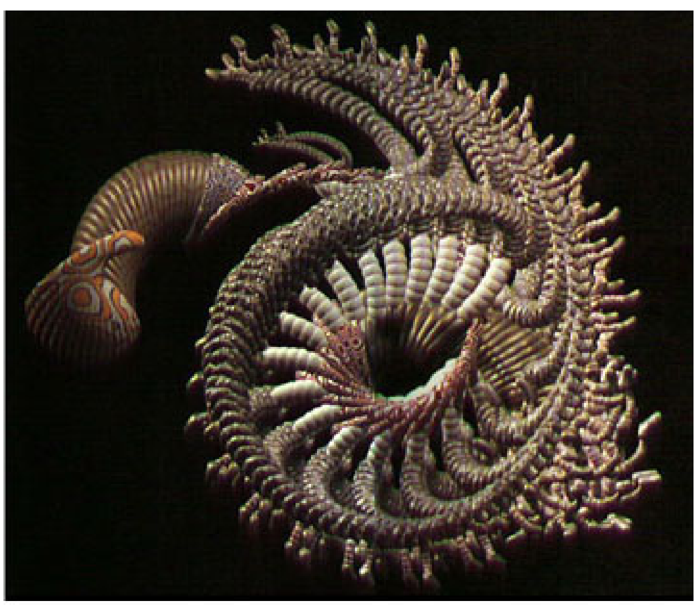
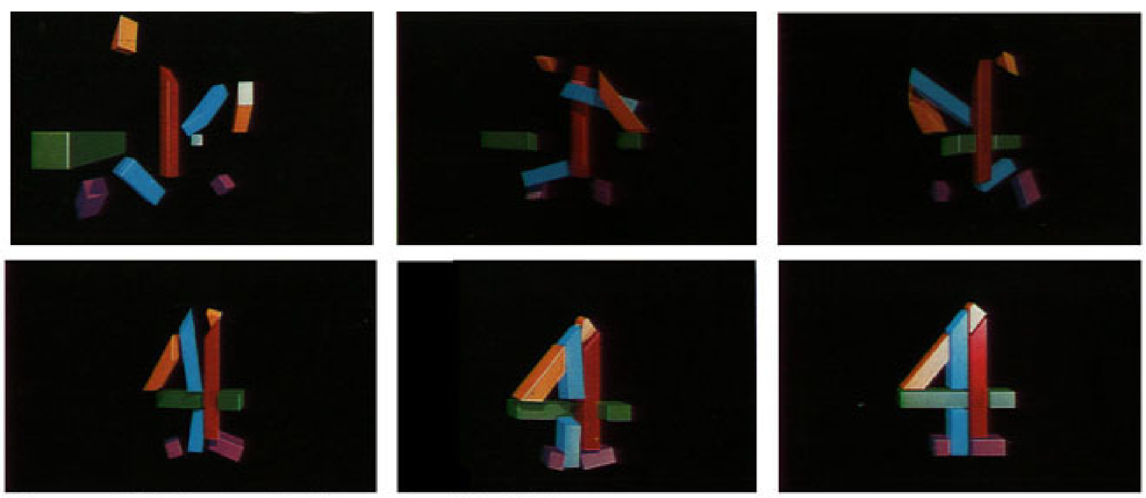


Fig. 10 "Mutation X", William Latham, 1991.

It must not be assumed that this growing focus of activity on 3D simulation and visualisation was necessarily a limitation on experimental work. On the contrary, such was the power and breadth of the Realist programme that almost any field of enquiry could make a contribution to the general effort to recreate the world in its entirety. During the eighties Realism in computer graphics proved remarkably able to absorb the activities of artists and designers into possible applications. It is not uncommon at a large computer graphics conference like ACM SIGGRAPH to find a number of papers from either artists who had turned their computer experiments towards academic disciplines, or people from mixed backgrounds who now found their technical research appropriate to a more cultural exploitation. A well known example is computer animator Karl Sims whose work has risen to international prominence. Sims studied computer science subjects at MIT and has published several papers on the algorithms he has developed for his work which he produces at a computer research company. Over the years several 'safe' areas in realistic computer simulation have emerged where knowledgeable artists can support their work by presenting it as academic research. One popular field is in procedural texture generation, the calculation from mathematical functions of patterns and visual features which can be used to resemble various natural surface phenomena like marble, clouds, wood and many others. Another popular 'artistic' discipline is in procedural modelling and animation, where objects are constructed for example by assembling large numbers of simple elements according to a mathematical function. A common example is in plant growth where the branching patterns of trees, flowers or moulds are simulated algorithmically. The most well known British artist using this approach is William Latham who combines it with a simple model of evolution. In fact certain artists found that the world of scientific research allowed them far greater creative freedom than they would ever have experienced working at a Soho facilities house. Whether we are talking about scientific Realism, a naturalistic Realism or merely a photographic surface finish, forms of 3D computer graphics have allowed artists the opportunities to develop anything from an exotic looking texture, an organic looking blob or a frenetic behavioral animation. The question is how many artists were prepared by their backgrounds to take advantage of this, and how well were they able to integrate cultural objectives with the new academic programmes that they found themselves on. For with the opening up of new forms of arts practice in computer media came creative challenges quite different from those that artists are taught to expect.



Channel 4 ident Robinson Lambie Nairn System Simulation and Information International 1982

The Perfect Medium

In a Channel 4 television documentary transmitted in 1992 entitled *The History of British Computer Animation,* the story is retold in terms of the desire to model the real world as accurately as possible. The question is then posed (amid repeated shots of tumbling 3D shaded geometries) of why 3D?, why Realism? As Gareth Edwards asserts at one point, 'There is no reason why computer graphics should produce photorealistic images, none at all'. Then Chris Briscoe states, 'It's a useful goal for computer graphics if, for no other reason, than it's fairly clear whether or not you're getting it right - we all know what the world looks like...'. Photorealism provides an easily verifiable criterion as to whether a given graphics algorithm has been successful or not. This tendency to present 3D imagery as the default style of computer graphics when all else fails disguises a fundamental problem of the computer as a medium which has become more and more of an issue in artistic practice since the popularisation of computing.

In contemporary art practice much emphasis is still placed on an explication of the properties and visual qualities arising from the structure of the medium itself. Although the specific form of exploration varies with the specific medium, in all cases a degree of formal experimentation is valued as a way of questioning common patterns of perception in the everyday world. The possibility that restructuring conventional ways of looking and by implication challenge conventional ways of thinking has been a popular way of justifying the avant garde project, from Walter Benjamin's theory of 'montaging' in *The Work of Art in the Age of Mechanical Reproduction* [5], to recent accounts of new modes of symbolic representation made feasible by digital imaging. It is normally one of the inherent problems of such artistic practice to find these creative alternatives and is often approached by avoiding current modes of image construction in favour of considering the textual qualities of the chosen medium, i.e its specificity, or the 'language of the medium'. Constructivists developed many well-known concepts for exploring the 'language of the medium' as an objective repository of pictorial possibilities, like their famous call for 'truth to materials' for example. For many years the heavy reliance on programming to produce any results from the computer made its mathematical and logical procedures seem a crucial part of its identity as an independent artistic medium. In Constructivist art before the computer, the structural principles that artists chose to work from always seemed to result in fairly familiar sorts of images - straight lines, simple geometric figures, rhythmic repetitions across the plane. It was also important that these structural processes could be visibly apprehended in the final image. This had the effect of always keeping the intellectual discourse that surrounded Constructivism immediately accessible through its artefacts. It also had the unfortunate effect of giving Constructivist art the reputation of being as exciting as reading a telephone directory and not nearly as useful. But that began to change in the seventies as computer graphics gave the Constructivist project a kick that sent it out of its usual orbit.

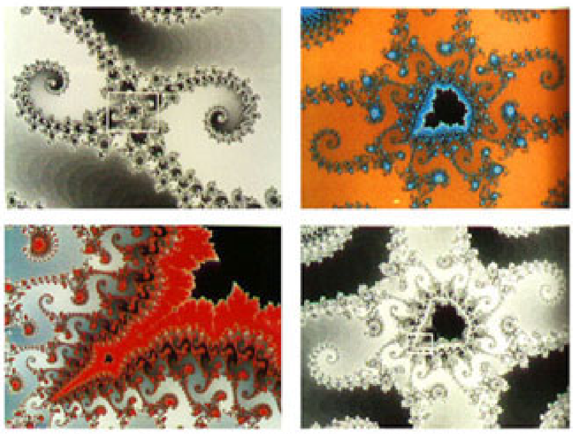


Fig. 12 "Beauty of Fractals", Peitgen & Richter, 1986.

Painter 4 Users Guide, Fractal Design, 1995.

The mathematical procedures that could be encoded and executed on a computer however could lead to far more complex visual results than any that could be done by hand: complex in the sense that the final image bore little obvious relation to the algorithm that generated it, often completely unpredictable from an examination of the original equations alone. This new effect distanced the conceptual level of working from the visual dynamics of the end result. As algorithms became increasingly powerful in the sense of being able to recalculate a wider range of processes and images it became clear that there was no need to stop at the level of physical simulation and visualisation, it would soon be possible to recreate pictorial styles as well. A concern for surface ornamentation had always been an anathema to the Constructivist ethos: such niceties obscured the appreciation of the structural principles in operation. But now it was becoming just another aspect of the mathematical synthesis of pictorial form. Algorithmic Constructivism reached a kind of conceptual endgame where its mathematical processes were now so powerful that they could recalculate all the arbitrary styles and treatments of an infinitely multiple subjectivity, of all of art history if need be. No longer limited to diagrammatic stick figures or smoothly shaded platonic solids, the fractal mathematics that produced the 'Fractal Art' of the mid eighties with its endlessly detailed patterns of bifurcation has now produced the *Fractal Painter* of the nineties [4]. This is a software package using the same basic mathematical formulations to precisely simulate the mark making capabilities of a bewildering array of 'traditional' media from paint and brush strokes to chalk and charcoal. And who is to say now that *Fractal Painter* does not as clearly express the 'truth to materials' with respect to the computers 'universality' as the Fractal Art of ten years previous? It was as though someone dissatisfied with the world of visual art had decided to recreate the whole thing anew from first principles, only to discover that what they ended up with was exactly the same as that which they had hoped to leave behind. But of course the situation would not have been entirely the same as before, because now there was a whole new challenge to the traditional creative model of artistic practice.

At the same time the digitalisation of artistic practice has been pursued commercially in the form of systems developed for any application, design eventuality or stylistic need, providing a software command or menu option for every creative decision. Software manufacturers have essentially inherited a version of the Idea/Expression dichotomy as their model of creativity. In this simple linear model an artist begins with an idea of what they want already preformed in their head and need only to translate it into material form. But this passivity that is required of the computer does not make it an ideal medium, a transparent carrier of pure artistic intentions. This subject centred model of creativity makes the computer 'overexpressive' - each function or menu option accounts for a little part of the landscape of human imagination, eroding differences and points of reference and making aesthetic categories arbitrary. This produces new 'effects' bearing little relation to anything previously known, and appearing remote and meaningless to the uninitiated. Functions multiply so rapidly that enough names for them cannot be thought of fast enough. Techniques are presented to artists that have resulted from the curiosity of scientists in industrial environments, estranged from the context of cultural traditions and sensibilities. Each new graphics system can differ quite radically in its operation, function and application from previous ones, and with a potential that is constantly growing, offering infinite combinations of options and functions, the learning curve never levels out. There are always more possible effects to explore - many are such subtle stylistic variations that there is little hope of finding the criteria on which to base a choice between these arbitrary differences. Ideas are freely absorbed into a multitude of possible channels of expression none of which are really more appropriate than any other. Digital media endlessly subdivides into new options and alternatives, becoming such a powerful tool that it no longer provides the resistance with which to structure cultural forms on the basis of a traditional aesthetic expressivity. Through computer technology, the medium has now surrendered, it offers no resistance to the desires of the user and overwhelms us by its aimless potential. With the absence of a historical tradition to draw upon, such formal experimentation leads to a creative paralysis as much as a creative freedom, and under these conditions realistic 3D graphics becomes a deceptively comforting framework in which aesthetic parameters seem acknowledged and securely in place.

This fundamental problem is perceived by many artists and critics as a lack of 'content' or 'ideas' in computer based work. This suggests a deep rooted confusion in the arts community since such a stress on 'content' belies the fact that formal innovation has always had a very important place in the history of experimental and oppositional artistic practice. Historically formal experimentation has repeatedly been credited with the ability to restructure and challenge stagnating modes of perception. But in the context of today it is as though bizarre new kinds of computer graphics 'restructure' perception so much so that it becomes completely useless, at least to the aims of the mainstream arts world. Although the strident and alien looking imagery of computer graphics has tended to repel the art community, it is exactly this arrogant quality that has been attractive for many of its commercial applications, such as TV videographics, special effects in music videos and the like. Indeed formal innovation is much closer to the driving forces of the commercial world which has come to reply on constant injections of technological development to stimulate its markets. The advancement of imaging technology has in this case become like an engine for formal experimentation - for 'impact aesthetics' as Philip Hayward has described it [5].

When faced with the plethora of digital effects, filters and transformations, it is of no help to the artist to consider which of them are less 'conventional' or more 'subversive' or closer to some unique visual quality of the computer. Formal innovation in this environment becomes trivialised - one could spend a lifetime just cataloguing all the processing options available in a copy of Adobe Photoshop. It is more a question of drawing a distinction between *formal* innovation and *aesthetic* innovation [6]. An artist who is unaware of the *formal* possibilities of their medium can still proceed from the current *aesthetic* issues relevant to their field. But for the computer graphic artist, the formal possibilities are already mapped out in advance - it is just a matter of selecting them from the appropriate menus, which pre-empts the question of an aesthetic choice. The artist is then challenged with the problem of understanding the external forces behind the expansion of software technology that drive these formal developments, implying a far a wider set of issues than the purely artistic.

For the Constructivist artist of the previous generation, their closer intimacy with the conceptual and theoretical foundations of computing helped to postpone the problem of aesthetic innovation because they always tried to work at the forefront of scientific and technical progress. Instead of purchasing graphics software packages to simulate traditional drawing skills, Constructivists had been defining the identity of the medium in terms of algorithmic processes, interactive systems and telecommunications networks. But with the enormous impact that digitalisation has had on all artistic disciplines, the power of the computer to 'recalculate' any other media cannot be ignored as one of its most important properties. Likewise, the contemporary artist's understanding of the wider social and cultural functioning of imagery - in terms of the ideology of representation and its political, economic and psychological underpinnings for example, as analysed by years of poststructuralist debate - is still not sufficient. To fully engage the potential of computer imaging as a transformative force must be added the distinctly technological component. It is not sufficient to simply write off scientific and technical discourse as a socially constructed set of power relations and then be left wondering how to remove the virus that has corrupted our disks. The Constructivist experience can provide a partial model for an artistic practice able to accommodate an unusually high degree of scientific literacy. But only partially, because to this must be added the resources of a fuller understanding of contemporary media dynamics guided as it is by the logic of simulation, not of identity. Computer imaging is not just a set of tools for making pictures, nor just a 'new medium' to be added to all the rest, but an interlocking system of cultural, social, economic and technological forces.

Sometimes artists resort to striving to translate 'traditional' ways of working directly into the new media, which in terms of experimentation is almost an admission of artistic bankruptcy. In fact, the very freedom and flexibility that the formal symbolic processing of computing offers is in danger of regressing artistic practice back into either classical Constructivism or a naive Idea/Expression dichotomy instead of stimulating new practices. It is not a case of choosing between the narrow mathematical confines of Fractal Art and the reconstituted familiarity of *Fractal Painter*, but a question of excavating and articulating the cultural discourse that connects the two. Artists must accept that the promiscuity of media will lead them into contact with different and conflicting discourses and modes of production and that any attempt at artistic preservation will ultimately be self defeating.

The Legacy

It is convenient to divide the history of computer animation into three periods. The first covers the years up until the early seventies, the pioneer years of computer graphics when the priority was to make a case for the application of computers to the arts and to demonstrate its conceptual relevance and its practical feasibility. The 'second wave' covers the mid seventies to the mid eighties - the focus of this chapter - when experimental artists and their collaborators developed a practice with commercial and academic support centred primarily around 3D digital simulation. Now we can talk of a 'third wave' from the late eighties onwards, and start to assess the influence that earlier generations have had on them.

To begin with, the second wave of artists, exemplified by the Slade School's department of Experimental and Electronic Art, have to be credited with courageous dedication at a time when they were almost alone in believing that the computer could have a central role in art and design practice. They also succeeded in playing a pivotal role, along with earlier pioneers, of creating the British commercial computer graphics industry which now enjoys a substantial international reputation for quality and innovation. Their work in the commercial and academic research sectors needs to be represented in any historical survey of artists animation otherwise the peculiar and complex evolution of this discipline can only partially be accounted for. There is a pattern of development through the artistic, academic and industrial fields which provides an illuminating insight into how experimental work has been negotiated in a wide range of often conflicting cultural contexts.

Some writers have tried to suggest that the development of computer graphics was taken out of artists hands during the seventies and became absorbed into systematically funded research projects in institutions [7]. The argument follows from this that if artists had retained a prominent place in computer graphics research then the nature of electronic imaging would have been very different and that presumably by today artists would feel more at home with it. There is, however, no reason to suppose that artists working on their own without commercial considerations would have produced an electronic image culture very different from the one that we see around us today. Realistic image synthesis was already implicit in earlier work notwithstanding the commercial pressures for exploitable production techniques. It is also the case that only the Constructivist artists who intrinsically valued a methodical conceptual approach over immediate visual feedback could sustain the effort over so many years to build the computer into a machine that could feasibly manipulate visual information, and that it was only with the support firstly of academic institutions and later of the media industry that such a project could be resourced.

The 'third wave' of computer artists are characterised as a generation which grew up on the Personal Computer and the Apple Mac and this has made the legacy of the previous generation has been far more problematic. The greater intimacy of the second wave with their equipment, their need to program computers, to build them and repair them and to liaise with other scientific disciplines - these always tended to be justified publicly only in as far as gaining access to machines and the expertise needed to run them. Their role at the leading edge of computer graphics research has caused them always to explain their practice in terms of the latest developments in computing technology, to link the evolution of artistic practice with that of technological advance. To produce the best art you need the best computers. Even today most of the leaders of the computer graphics production industry remain unaware of the way that desktop computers have become practical production bases for all but the most extreme and demanding briefs. The availability of these cheap systems means that there is no longer an argument for the deeper technological education of artists based purely on access. This has resulted in the weakening of the desire for artists to expand their knowledge of the theoretical side of computer graphics and instead becomes an excuse for artists to separate themselves from other disciplines and avoid a 'techie' label. In art colleges now even a job like putting more paper in the laser printer is a task best relegated to a studio technician. Many artists working in video postproduction do not even believe that the sophisticated image processing machines 'Harry' and 'Paintbox' are computers at all, prefering to think of themselves as real artists who have no need to resort to such technical levels. The continual debate of whether artists should learn to program still tends to stumble over the ground of whether the skills learnt will be of measurable practical use in terms of more and more 'tools' rather than the potential of expanding the range of creative stimulation and access to alternative modes of cultural production. Today in the nineties it is quite possible to develop new processes whether in software, in digital techniques as well as imaginative research on no more than a home computer. It is this knowledge - of logical coding, of processing technology and of the digitalisation of the symbolic economy that is the issue now far more than the access to this or that individual computer.

Yet instead of being inspired to expand their practice into new areas of knowledge and cultural agency, the new generation of computer artists have been left with a permanent inferiority complex: that no matter how hard they try their efforts will always pale into insignificance compared to the latest productions from Soho or the West Coast. Much time is spent trying to secure access to unnecessarily advanced workstation technology in the manner of the institutionally bound practices of the early eighties. Artists labour under the impression that only with state-of-the-art resources can their work reach its full potential. As a result the concept of 'downtime' has gained currency, the hypothetical slack period in the schedule of a commercial production company when machine time could be used by independent artists for little or no hiring fee. Although originally a concept of some applicability for post production work for video artists needing some carefully planned final editing or special effects, the idea outlived its usefulness when faced with the intensive periods of study and labour needed for even the briefest of animation works. The notion that occasional bursts of creative activity in the late evenings in an unfamiliar production studio punctuated by lengthy enforced breaks can be a productive environment in which to develop experimental work (or any work) is entirely unrealistic. Although a tiny number of artists that have managed to gain these sporadic periods of access, this still provides no long term basis on which to build a new cultural practice. The situation has encouraged an attitude in which media technology is seen as something for which artists must battle fiercely for privileged access rather than a precocious child with which one should be able to enjoy the experience of learning and creating in an exploratory and playful context.

Fig. 13 'Harold Cohen: Drawing', San Francisco Museum of Modern Art, 1979, showing centre part of mural with the 'turtle' drawing.

The changing face of digital media can be appreciated by a consideration of how the field has been publicly documented. In a book published in 1984 called *The Creative Computer*, two writers - a scientist and a science writer - survey the field of artificial intelligence and speculate on its future impact by focusing on its potential for creative problem solving [8]. One chapter in the book is devoted to the application of the computer to the arts, which in this case fulfils the role of an example of a human activity where creativity can be apprehended in one of its purest and most 'intuitive' forms. Very prominently featured was the work of artists who had recently left the Slade School's Experimental and Electronic Art department with drawings of their 'lifegame' simulations and interactive communities of graphical elements. Also featured was a discussion of the work of Harold Cohen, the British artist who had built his own artificial intelligence system in the seventies called AARON to recreate the style of the paintings he had done during the sixties. Cohen's work was at this time a prime example of a Constructivist analysis of the creative process and its explication in symbolic and logical terms. Cohen himself become a vociferous polemicist for the education of artists in the functioning of the computer so that they could exploit its power for their own specific individual goals. He is quoted thus :

> The more powerfully a technology serves its designed-in purpose, the more the individual is constrained by its use...the individual is constrained intellectually from conceiving of any possibility other than what is given him by the technology...It must surely be the case that technological resources that do not challenge the artists intelligence will not *enable* his intelligence, and through it the production of powerful and original work...[9]

In Cohen's case the work that has resulted is in tangible terms a large number of quite tasteful line drawings ranging from loose calligraphic pieces to childlike figures and simple plants and animals, though it is clear from Cohen's statements that the real point of his work is the idea of machine creation.

Later on in the same chapter a project by computer scientists is described that generalises Cohen's work by designing a software system that composes music for the naive user. Cohen is quoted yet again, this time delivering a stern reaction to this imposition by the scientists.

> There was also a music program at Xerox which, I was told, would enable people to compose music even if they didn't know anything about music...Why would anyone want to compose music without knowing anything about music?...[10]

Perhaps because everyone wants to be an artist? For Cohen the argument for the greater education and awareness of today's artist tends to end at technological and scientific literacy. A project that tries to model the artist's creative processes is a valid artwork but a project that might try to question the role that the artist plays as an embodiment of the creative and entrepreneurial spirit in late capitalist society is dismissed. But what today's artist needs is not only a wider education in technical matters but also an appreciation of how they can transform their practice with respect to the powers that define their place in society.

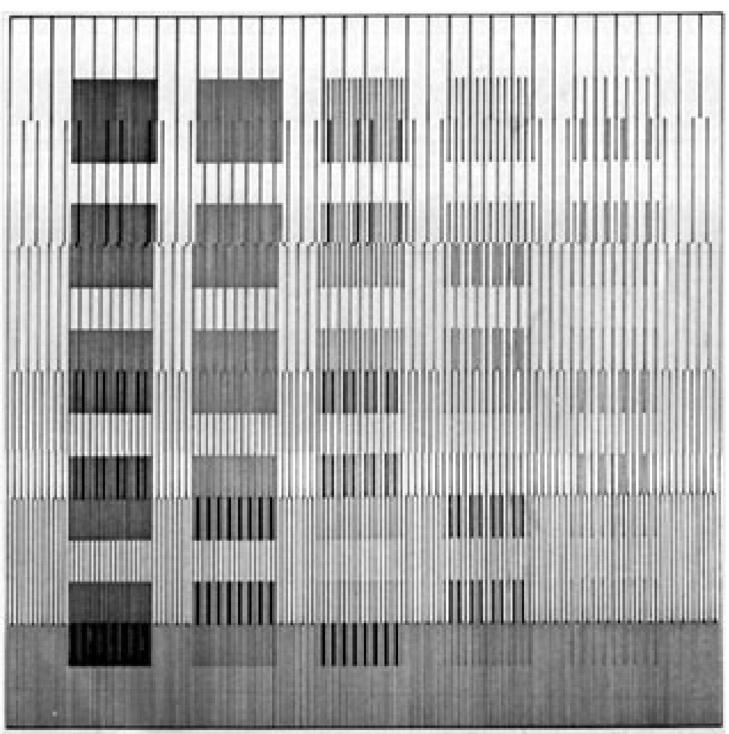


Fig. 14 Dominic Boreham
STOS55 Computer Assisted Drawing 1978 398 mm x 398 mm

Despite our current need to expand the traditional domain of Constructivist thinking there are still some aspects of its original programme that can provide some impetus. An important part of postwar Neo-Constructivism was the shift of emphasis from material object to perception. Abstract art was seen as one way to break through people's mixed modes of registering the 'real world' by presenting them with images which could not easily be resolved into recognisable objects but always teetered on the edge of 'becoming'. Dominic Boreham, another artist working at the Slade School in the seventies had stated,

> ...any visual stimulus-pattern can be produced by an infinity of different external conditions. And yet...usually we see just one...with the plastic form which has no predetermined functional probability, the interpretations of the viewer take on a new importance...ambiguous images clearly demonstrate that the perceptual process is one of interpretation, since the world itself cannot be ambiguous. [11]

Using processes constructed through algorithmic techniques, it would be possible to make an image so different from any other, so outside of familiar cultural and aesthetic discourses that it would present the viewer with almost a *tabula rasa* onto which they could project and acknowledge their own subjectivity.

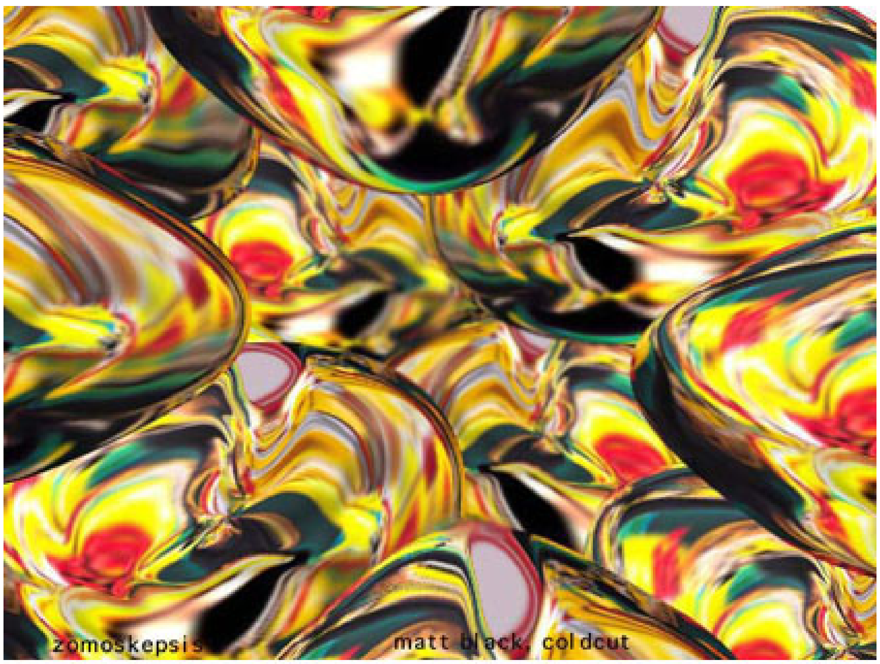


Fig. 15 "Zomoskepsis" Hex Media, 1993.

One artist working consciously with these ideas is Robert Pepperell who along with several other artists and musicians runs a company called Hex specialising in electronic media from rave videos to multimedia projects of various kinds. Pepperell's background in experimental film and as a student of pioneer telecommunications artist Roy Ascott has lead him to propose a type of imagery which is 'non-interpretable' in the sense that it is non-representational but not necessarily abstract either [12]. This approach which is based on the work of the Gestalt psychologists who believed that the mind has its own autonomous constructive processes, is aimed at making images which stand outside the normal linguistic framework, providing a discontinuity or stimulus possibly approaching that of a pure sensation. The algorithmic generation of such imagery also opens ways in which forms of 'automated creativity' can confront the economic rationale for continual novelty and oringinality. The industry in which Hex now operates is geared towards a youth culture which seems increasingly able to absorb very high rates of visual stimuli and richly interactive environments. It is logical therefore that an artist wishing to fully exploit the new qualities of electronic imagery should orientate themselves towards a social group that already support the cultural forms that can accommodate them.

Such a practice requires the recognition of image consumption as a *social* process as well as including technical aspects, a fact which was rarely respected by Constructivist artists except in very abstract terms. The seventies artists did not have the benefits of a techno music scene to connect with, but it is almost certain that they would have ignored it even if they had. What is needed is at the very least an extension into these areas if the positive aspects of Constructivism are not to be lost. The first period of the Constructivist movement of the 1920s and 1930s could be characterised by *geometrics* in which the artists concentrated on defining structural properties of visual elements sometimes to a metaphysical degree. After the war the project changed towards an interest in the *process* that generated the image and ordered the way it would be *perceived* by the viewer. This project was continued into *algorithmic* means of image synthesis and *simulation*, but was somehow never really followed through to its logical conclusion. Any further stage must involve a recognition of the social dynamics that influence image consumption without needing to sacrifice the original objective stance. Instead of being strictly *algorithmic*, the pattern of symbolic production in general expands infinitely in all directions connecting subjects as nodes through which information and materials flow. The logic of *simulation* implies that the representation of these processes depends as much on their construction of experience on many perceptual and cultural levels as on their analytical exactitude. Such an understanding would respect the chaotic dynamics of creative activities, through the algorithms which channel information through networks of functions to places not predicted by their original authors.

As a model of a transformative practice that draws upon many discourses and is able to function at many cultural levels - experimental, commercial, academic - the work of the second wave of computer artists was exemplary. But as a model of an approach to cultural production in a wider context it has been very limited, unable to orient itself towards the enormous social and cultural impact of computing technology beyond discrete technical issues. Because of this lack of a more informed perspective the 'second wave' became victims of their own abilities. Their efforts were always directed towards 'the work' rather than the role it would find for itself outside the confines of the lab-cum-studio. Compare their pattern of development with the activities of the Scratch video makers of the early eighties who took the latest state-of-the-art videographics machines and built up a visual language that articulated the oppositional energy of a whole social group. For the computer animators of the same time, a curious 'funnelling' effect took place instead. After bringing together the work and insights of so many disparate academic fields to bear on the digital image, their work became narrowed down onto a certain range of visualising increasingly identified with corporate conformity. The result was that the most dynamic development in computer animation practice in the early nineties was the rave video scene, but which owed its creative impetus to the Scratch video artists rather than the computer artists. The challenge now is to open up this funnelling and to reconnect with levels of social discourse that can reenergise this area of technoculture and give it a wider agenda. The conceptual intimacy with computer processing and the multidisciplinary approach of the earlier generation must be reclaimed but combined with an understanding of the cultural and historical framework of technological proliferation, so that the result can address as many layers and modes of knowledge and sensibility as the many diverse practices with whose support its evolution was made possible.

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