

Computer Art in the Context of the Journal *Leonardo*

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In a recent editorial, *Leonardo* Co-Editor David Carrier made the bold statement "... it is genuinely unclear to me whether any art using computers is truly significant" [1]. This statement made by a sympathetic art theorist, almost 25 years after the first computer art exhibitions, could be construed as discouraging. The response to this provocation, I believe, is in part context-dependent. It is still early in the development of computer art, and still earlier in the development of a theoretical and critical understanding of the revolutionary role of computers, electronics and telecommunications in the arts of the future. I will discuss these contexts by citing pertinent articles published in *Leonardo* over the past 22 years.

COMPUTER ART WITHIN THE CONTEXT OF THE DEVELOPMENT OF THE COMPUTER

A review of the evolution of computer art [2,3] reveals that many of the key artistic ideas were understood very rapidly by pioneers such as Herbert Franke [4], although primitive computer systems were difficult to control for specific artistic purposes. Computer artists were heirs to theoretical ideas developed in algorithmic and generative aesthetics, constructivism and the longstanding connections between art and mathematics. In 1979 Frank J. Malina published the book *Visual Art, Mathematics and Computers*, a collection of 54 articles originally published in *Leonardo* from 1968 to 1979 [5]. The initial section of this book, "Art, Science, Mathematics - General", included articles dealing with entropy and art, formal generators of structure, aesthetic tree patterns in graph theory, chirality and symmetry, a scientific theory for aesthetics, and topics connecting mathematics and science to art. The computer was a labor saving device that allowed these ideas to be explored exhaustively and rapidly.

Major achievements in computer graphics and animation have occurred in the past 30 years, as demonstrated by the SIGGRAPH '89 Art Show works illustrated in this issue of *Leonardo*. These developments will continue, and the capabilities of special-purpose graphics workstations will gradually become more accessible to artists through general-purpose systems. However, these developments, at least in static media, are unlikely to be relevant in answering David Carrier's challenge. High resolution, rendering, color range, 3-D perspective systems, ray-tracing and paint 'programs' were developed to the satisfaction of the artist long before the advent of the computer. Few of the current developments in computer graphics have been initiated in response to contemporary artistic goals. Trying out old ideas

more quickly, more realistically, on a larger scale—these are not issues that will determine tomorrow's significant art. The fantastic landscapes produced using the most advanced computer graphics systems reveal the use of no new tools by the artist and no visual languages that were not already available to the surrealists over half a century ago. Ironically, just when computers are finally able to reproduce artworks of the nineteenth century, computer graphics courses are being introduced rapidly into art schools to train the artists of the twenty-first century. These observations do not aim to minimise the huge advances in computer graphics and animation or to discourage the use of these systems by artists and art schools. However, computer graphics systems are having a significant impact, primarily on applied and commercial art.

COMPUTER ART WITHIN THE CONTEXT OF ARTISTS COLONISING TECHNOLOGY

Marshall McLuhan once said that "the conscious role of the artist is to explore and create awareness of the new environment created by new technology" [6]. A similar thought was expressed by Frank J. Malina in the introduction of *Visual Art, Mathematics and Computers*, when he argued that the contents of this book had "to be taken into account by those who dream of a world in which the arts will help more effectively to mellow the applications of science and mathematics" [7]. Seen in this context there is already a great amount of significant computer art being generated. ● One need look no further than the current excitement about

Since 1968, the journal *Leonardo* has published over 150 articles dealing with the uses of computers in the fine arts. Discussing the work of artists published in *Leonardo*, the author responds to a recent assertion by art theorist David Carrier that "... it is genuinely unclear to me whether any art using computers is truly significant". It is argued that the significance of computer art must be viewed in a number of contexts. Within the context of the development of the computer itself, advances in computer graphics and animation have provided the artist with a powerful plastic medium under the artist's control. Most artworks produced, except in animation, either realise artistic ideas developed before the advent of the computer or are artistically equivalent to work produced in other media. The impact is significant in the context of the commercial and applied arts. Contemporary artists, as the colonisers of technology, are producing significant artworks as collaborators in Renaissance teams of artists, scientists and technologists. In the larger context of the history of art, however, the significance of contemporary computer art work is not yet clear. It is argued that artistic significance should be sought in works that could not have been made *without* the use of a computer. Such works must involve the particular attributes of computers, such as their application in interactive situations, their capability for artificial intelligence, their function in networks with telecommunications media, and their ability to allow the synthesis of sound and vision in time-based art forms. The lack of adequate theoretical, historical and critical frameworks is currently the largest impediment in assessing the significance of computer art.

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fractals and chaos mathematics to see a whole new generation of artists for whom there is no 'two-cultures' division and for whom the computer has become the tool of choice for new explorations of visual material.

The main issue here is not an aesthetic one, but one that involves the artists' ability to control the most advanced technological tools and involves as well the interest of scientists and technologists in understanding that visualisation is an important facet of communication. In the field of scientific visualisation, as championed by artist Donna Cox [8], not only have artists successfully colonised the technology, but scientists are now realising that they need to colonise some of the traditional domains of the artist [9]. When Experiments in Art and Technology was founded 20 years ago by Billy Kluver and Robert Rauschenberg, the issue of artists' access to high technology was a key issue. At that time, an artist could rarely be an equal creative participant, as pointed out by A. Michael Noll:

The fallacy of collaborations is clearly evident when the computer is involved as a third party. Here the artist must communicate his ideas to a computer scientist or programmer who must then communicate his interpretations of the artist's ideas to a computer. This is most certainly a noisy process [10].

Since the advent of the home computer and a generation of artists who are sufficiently computer literate to do their own programming, access to technology is no longer the obstacle in the creation of significant computer art. One answer to David Carrier is that significant art is now being made within the context of the artist's social role as humaniser, commentator and coloniser of technology.

COMPUTER ART WITHIN THE CONTEXT OF THE HISTORY OF ART

Science writer and mathematician François le Lionnais defined the plastic fine arts as "a group of activities that aim at producing—through the use of appropriate techniques and procedures—emotions of an aesthetic character (that is, emotions independent of the quest for truth, of the search for utility and of obtaining sentimental satisfaction) by means of visual stimu-

lation" [11]. Within the context of the corresponding definition of computer art, the question must then be whether significant art has been made that could not have been created *without* the use of computers. It is highly unlikely, in this context, that significant computer art will be displayed as static images on the walls of galleries within the confines of a picture frame. If computer art is just another medium like watercolor, oils or acrylics, then it will be only as significant as all other post-modernist attempts to create significant art within the limitations of the static canvas.

In searching for significant computer art I would ask whether the artwork could have been made without the use of a computer and whether it takes advantage of unique new capabilities made possible by the computer. This argues that the computer is not just another tool, but a 'meta-tool' that can lead to new modes of artistic activity [12]. The computer's key attributes include the ability to have an in-built learning capability (artificial intelligence); the ability to be connected to other computers over short or global distances; the ability to collect information from the environment and issue information through a large number of sensory modes, many of them not available directly to human sense organs; the ability to be used in a real-time interactive interplay with humans or other input devices. Finally, in time-based arts, including computer animation, the computer makes possible work that would be practically impossible to realise by other methods, particularly in exploiting connections between sound and vision. The computer has the potential to extend aesthetic issues into a number of totally new domains and eventually to connect directly with the human brain [13]. At some point the computer will allow one to bypass, or supplement, the existing human senses that have formed the bases of all the arts.

ARTIFICIAL INTELLIGENCE

Have significant artworks of this kind been created? I believe that the answer is a tentative 'yes', but without a historical tradition or a critical context it is very difficult to assess current work. One important line of artistic research is being carried out by artists such as Harold Cohen [14] and Roman Ve-

rostko [15]. These artists are developing new software containing artistic rules concerning form and structure, coloring and other ideas that the artist embeds in the program. Under the tutelage of the artists, the programs have become more and more sophisticated, to such an extent that Cohen's program AARON is able to generate endless variations on a theme and produce colored drawings that are as interesting as most prints sold in art galleries. Verostko's system now paints with a paint brush and is able to paint in a large number of styles. What is exciting about this work is that the software will continue to evolve with the artist as a member of a creative team. The artist is forced to make explicit the creative process in order to instruct the computer, and this may lead the artist in totally new directions [16].

The kinds of sophistication that these programs (which use techniques of artificial intelligence) may acquire can be seen in the theoretical work by researchers such as Joan and Russell Kirsch [17] and Raymond Lauzzana and Lynn Pocock-Williams [18]. These researchers have been able to codify the stylistic grammars of works by such artists as Diebenkorn, Kandinsky and Klee. These 'rule systems' and 'shape grammars' provide new tools that artists can incorporate into programs like AARON. The works by Cohen and Verostko are recognisably characteristic of the artist who has been making the choices in concert with the computer. This is in contradistinction to most computer art, where the particular computer hardware and commercial software provide the recognisable 'signature' on the work produced.

MULTI-MEDIA AND TIME-BASED ARTS

A natural extension of these systems will include sound and evolution-in-time. Within the field of computer music there are already sophisticated programs that can be used to generate music within rule systems [19]. John Whitney Sr. [20] and Edward Zajec [21] are recent examples of artists who attempt to synthesise sound and visual art forms [22,23]. Computer animation techniques now make it possible to realise artistic ideas, many established by artists in early abstract film, that would be practically impossible to realise using traditional film

animation methods. The increased realism of computer animation, including the creation of synthetic human-like actors [24], is perhaps less significant from an artistic viewpoint than from a commercial viewpoint. However, it illustrates the degree of control that computer animation artists are now exerting over desired visual scenes. The computer, with its ability to control visual or aural output devices with equal flexibility and using similar coding strategies, breaks down many of the existing theoretical divisions between time-based visual and sound arts. The computer, as a processing system that can generate outputs in any number of sensory modes, may provide the first practical way to develop significant synaesthetic art forms.

NETWORKS AND TELECOMMUNICATIONS

Networks of individual computers and people add interesting complexity to the situation. The artistic team 'bcd' has created a number of works based on networks of computers carrying out independent parallel processing [25]. The complex and rich visual displays that result lead the artists to use words such as 'transcendence' to explain the visual experience. The viewer's ability to find pattern and structure in the rich vocabulary of visual data is perhaps closest to the experience of listening to music.

On a larger scale, artists are becoming involved in computer networks connected by various types of telecommunications links. A pioneer in such artforms, *Leonardo* Honorary Editor Roy Ascott, describes the new composite role of the artist as "participant in a system creating meaning seen as art. This contrasts forcibly with the Renaissance paradigm of the artist standing apart from the world and depicting it and the observer standing outside of the artwork and receiving this depiction" [26]. In the work *La Plissure du Texte*, organised by Ascott for the Electra exhibition in Paris in 1983, the work was created in 'dispersed authorship' by groups of artists located in 11 cities around the world. Artworks of this type are so new that there is little vocabulary or theoretical structure—indeed hardly a body of work—to assess their significance. Few institutions are even capable of displaying the works. A determination of

significance will have to take into account the role of the artist as the designer of a *system* created for aesthetic reasons, rather than as the creator of a *product* for contemplation. We are on the threshold of a whole range of new artistic questions, as artists take advantage of the combination of computers and telecommunications, or 'telematics', to use Simon Nora's term. *Leonardo* Guest Editors Carl Loeffler, founder of the ArtCom Electronic Network, and Roy Ascott are currently engaged in a project to produce a Special Issue of *Leonardo* on Art and Telecommunications. Many of the works described would not even be recognised as artworks according to most art historians. For example, some software art is made manifest only by the behavior of the computer network and not as specific sensory outputs.

INTERACTIVITY

Interactive art has a fairly long history and is connected to parallel work in 'artificial life'. Nicolas Schöffer's early robotic sculptural pieces in his *Cysp* series, for example, were created in 1954 [27]. The behavior of the works was dependent upon a complex interaction of visual and aural stimulæ. *Leonardo* Co-Editor Stephen Wilson has described a number of such ideas and has realised artworks that interact both with their environment and with the viewer [28]. Myron Krueger, in his 'Artificial Reality Laboratory' has created humorous pieces that introduce a real element of play into the viewer's interaction with the computer [29]. Artist Joel Slayton has been involved with a team of NASA engineers and scientists developing an artificial environment viewed through goggles worn by the viewer. The viewer's hands and body are connected through the computer to this virtual space. As the viewer walks around and handles objects, the view in the goggles is adjusted correspondingly [30]. New interactive optical disk technology is introducing further artworks of this type. If we look forward to the combination of computer-generated holographic cinema, interactive branching associated with hypertext and hypermedia software structures [31] and advanced computer animation techniques, these interactive media will surely lead to significant new art. Yet, at this point, to be honest, these speculations are based on my belief that

these media offer such radically new artistic possibilities that eventually artists will produce significant works. Current work does not yet fulfill the promise of the new media.

CONCLUSION

Over the past 22 years *Leonardo* published over 150 articles dealing with computer art [32]. Within the context of the development of the computer itself, current work depends upon realising the dreams of the pioneer computer artists and creating visual displays of significant aesthetic interest. Artists can now use computer graphics as a plastic art medium to create realistic and imaginary landscapes and to reproduce various visual art styles. As graphic tools continue to evolve, these media will continue to fall under the control of the artist. Ironically, the majority of this work is ahistorical in the sense that it allows the artist to address issues that are no longer central to the development of the art of the future. The primary arbiter of significance in this context will be the art marketplace, which today functions primarily as a commodity market [33]. As computer art competitions, such as SIGGRAPH or Ars Electronica, develop a history and a critical context, we can expect computer art to be collected by museums and galleries. The ideas of algorithmic and generative aesthetics, of mathematical art and constructivist programs, can now be realised. Recent works using fractals and chaos theory are likely to become part of a rapidly expanding vocabulary of generative art.

In the larger context of the history of art, computer art of significance is imminent. A key issue to be considered is that the context for assessing significance for the new kinds of art forms has not been developed. It is not yet clear what kind of exhibiting context is necessary. A few forward-looking museums, such as the Museum of the Bronx, have provided regular venues for display and assessment of computer art. There have been a few recent major museum shows such as Electra, Les Immateriaux and Digital Visions. It may be that the truly significant computer art of the future is incompatible with the exhibiting context designed for static painting and sculpture, or even for film and video. An institutional context very different

from the contemporary museum, such as the new media parks in Karlsruhe, Cologne and Frankfurt in Germany, will be needed; often science museums have provided more suitable contexts for displaying new forms of computer art—even public spaces such as airports have been used to good effect. There is also a need for a new generation of art theorists and art historians to develop the critical and historical context within which the significance of individual computer artworks can be assessed. These theorists and historians should pay particular attention to art that could not have been made *without* the use of a computer and that exploits the unique capabilities of computers, electronics and telecommunications systems [34].

References and Notes

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30. Joel Slayton, presentation at the First International Symposium on Electronic Art, Utrecht, Holland, October 1988.
31. Edward Barrett, ed., *The Society of Text: Hypertext, Hypermedia and the Social Construction of Information* (Cambridge, MA: MIT Press, 1989).
32. George Agoston, *Leonardo Author/Subject Index 1968–1987* (Oxford: Pergamon Press, 1989).
33. David Carrier, "On the Possibility of Aesthetic Atheism: Philosophy and the Market in Art" *Leonardo* 18 (1985) p. 35.
34. I believe that establishing 'significance', in David Carrier's terms, involves assessing at least three aspects of the artwork. First, the work should produce strong emotions of an aesthetic character in the viewer or participant, as characterized by François le Lionnais (see Ref. [11]). Art produced in previous epochs can maintain significance, although such works may produce different aesthetic emotions in later epochs. Second, an artwork must be truly contemporary, in the sense that it could not have been, or was not, produced in a previous epoch. Art in the Impressionist style painted today is not significant in this aspect. Third, in a purely art-historical sense, 'significant' artworks must be identified where an artist has produced an innovative or original masterpiece not produced by previous artists. Artworks that achieve significance in all three aspects, I believe, deserve the attention of aestheticians, art theorists and art historians.