Computer Sculpture – New Horizons

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This essay focuses on the opportunities for a new approach to computer generated sculpture through the use of the interactive, user participatory attributes associated with virtual reality technology. The text briefly reviews the progress of sculpture from a static, physical art form, through the use of computers as sculpture visualization tools, towards true "virtual sculpture" as a metaphysical three-dimensional experience. The author discusses two of his own recent prototype virtual reality pieces to demonstrate his projection of possible future trends in the viewers' immersion in sculpture as an activity and an art form, not merely as an observer of a set of objects.

Computer technology and artists

The use of computer technology by artists during the last three decades has precipitated a debate within the art establishment over the artistic worth and legitimacy of the products and practices of the techno-arts community. Discussions surrounding digital art have tended to concentrate on the technology itself and the imprint of the technology on the work rather than focus upon the aesthetic and philosophical issues addressed within the art work. Designers have, to a large degree, been able to justify and elicit acceptance of their computer generated works on purely commercial grounds—speed and versatility equate to cost savings and thus legitimacy of process and product—but the fight for recognition by those visual and expressive artists working with computers has not been so easy.

Computer sculptors in particular have had to overcome a great deal of skepticism and prejudice from within the mainstream art world. Even the use of the word "sculpture" to describe their three-dimensional works which exist only as data within the memory of the computer or as images on a screen has been difficult to establish. A broadening of the definition of sculpture, once thought of as limited to work carved in wood or stone or modeled in clay and cast in metal, to include works which are generated using computer technology has been essential. We can compare the following definitions from the *Oxford English Dictionary* (1971) and the *Encyclopaedia Britannica* (1980):

Sculpture

In modern use, that branch of Fine Art which is concerned with the production of figures in the round or in relief, either by carving, by fashioning some plastic substance or by making a mould for casting in metal.[1]

and

Sculpture, Art of

Sculpture is not a fixed term that applies to a permanently circumscribed category of objects or set of activities. It is, rather, the name of an art that grows and changes and is continually extending the range of its activities and evolving new kinds of objects.[2]

Although these definitions in themselves should not be taken as representative opinion of their day, they can be said to represent the shift in the perception of the art form that has been necessary to come to terms with the wider range of objects, methodologies and technologies associated with that one word "sculpture." Indeed, the *Encyclopaedia Britannica* description goes on;

> The scope of the term is much wider in the second half of the 20th century than it was only two or three decades ago, and in the present fluid state of the visual arts nobody can predict what its future extensions are likely to be.

Many sculptors have used and are using computers as design, manipulation, visualization and production tools with the intent and expectation that their creations will eventually be realized as physical pieces of sculpture. Robert Fisher and Michael O'Rourke fall into this category having used computers extensively in the development stages of their work. Fisher's complex spatial forms and environmental sculptures, from *Northern Lights* in 1981 and including *Skyharp* (1986) and *Fandango* (1990), have benefited from computer visualization and the ability of the artist to study form and structure, randomness and chaos theory using the computer to emulate the processes of nature[3].

Michael O'Rourke has written in *Leonardo*[4] of the development of a CAD/CAM system at New York Institute of Technology and its use to facilitate the design and fabrication of his abstract sculptures. The use of such systems to aid the production of "real" sculptures is, perhaps, easier to come to terms with for the technophobes and skeptics than what O'Rourke has called "virtual sculpture."[5] O'Rourke used the term to describe three-dimensional work which does not have and is not intended to have any physical form. He acknowledges that:

> "It is perfectly possible to make such virtual sculpture one's goal and to find an appropriate medium for displaying it." [6]

The creation and display of screen based three-dimensional art works has been the goal of British sculptor William Latham[7] while working as research fellow at the IBM UK Scientific Centre since 1987. The use of the term "virtual sculpture" to describe such work has been overtaken by the rapid development of virtual reality systems and their adoption as a creative arts medium by a growing number of fine artists. Latham's work, evolutionary organic forms, viewed as animated sequences or cibachrome prints, would seem to bridge the gap between the computer visualizations of Fisher and O'Rourke and what I believe to be the future direction of true *virtual sculpture.*

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Virtual sculpture – The future beckons

With the growing sophistication and accessibility of virtual reality systems, more artists are likely to follow the example of Nicole Natalie Stenger and introduce the extra dimensions of interaction and user participation into their creations. Her pioneering virtual reality experience *Les Recontres Angéliques* or *Angels,* based on her film of the same name, points the way and could inspire many other artists to begin working with advanced computer technology. Stenger's piece was produced in collaboration with hardware and software developers including Wavefront Technologies and Silicon Graphics with modeling carried out at the Massachusetts Institute of Technology.[8] While these facilities are not currently available to all who would wish to produce virtual reality art work, it is likely that accessibility will increase as the technology becomes more widely available and subsequently cheaper. *Angels* is probably the first sculptural environment to utilize the virtual reality technology of goggles and data glove and allows the user to explore a "Garden of Eden" environment.

More exciting and inspiring than any individual piece of work is the fact that the element of interactivity has been introduced into what had previously been a largely passive spectator art form. What new horizons do virtual reality and interactivity open up to the computer sculptor? At the present time, I see two distinct avenues of exploration opening up.

The first involves the creation of immersive, three-dimensional environments where the viewer can travel through areas of computer space such as sculpture parks of the type produced by Nicole Stenger. These might entail the creation of, movement through or around and interaction with individual pieces or groups of sculpture of a size or complexity not possible with conventional physical works.

The second scenario is that some sculptors will become orchestrators or designers of sculptural "experiences" or "events" which enable the viewer, through the interactive capabilities of the technology, to originate, change and manipulate elements of the work itself. The sculptor, possibly through the provision of a toolbox facility, may empower the user to change the structures' colors, textures, scale and materials or even to assemble a complete structure of their own design. The participant will become an element in the creative process.

The first of the two avenues described is, perhaps, the least contentious in terms of its acceptance as an extension to the range of traditional sculptural concepts. It is quite reasonable to visualize a movement towards the production of immersive computer environments, similar to the physical environmental art of the 1960's but with a potentially even greater sense of physicality than those spaces. Parallels can be drawn between the desire of artists such as James Seawright with *Walk-in Infinity Chamber* in 1968 and Nicole Stenger with *Angels* in 1991 to create participatory art using the technologies of their day. Both works are clearly attempts by the artists to stimulate reactive responses through human/technology and technology/human interplay.

Artists have traditionally been willing and often eager to experiment and exploit new developments in materials, techniques and technologies as a means to express ideas and explore new concepts in their work. It is inconceivable that a new generation of electronic artist/sculptors will not emerge as the opportunities for the stimulation of mind and senses through the use of advanced computers and peripherals becomes apparent to more art college graduates and practicing artists.

As the sensory equipment associated with virtual reality becomes more refined, so the possibilities for the use of tactile stimuli as well as visual and aural stimuli will emulate and then surpass what "real world" environments can offer to the sculptor. By this, I mean that sensitive data gloves and body suits will be able to deliver changing tactile perception of an object's material composition. We will be able to alter the "feel" of an object from soft to sharp, rough, hard or smooth and back to soft again, as the user explores the surface of the sculpture or environment.

Not only can the senses of the participant be stimulated through the programming of attributes to the digital forms within the virtual space but the viewer can be immersed within the sculpture itself. We have the example of *Legible City* (1990) and *Virtual Museum* (1991) both conceived by Jeffrey Shaw[9] and generated in collaboration with Dirk Groenveld.

Legible City places the participant within a network of streets to embark on a simulated bicycle ride through a city of words and sentences. Large, three-dimensional letter forms make up the architecture and ground plan of Manhattan and the "cyclist" controls the speed and direction of his journey through the streets. The virtual reality artist is able to scale his environment and the objects within it to suit his needs, permitting the viewer to travel over, under, through or around his metaphysical creations. Different aesthetic, emotional and intellectual responses to the piece can be stimulated by means of these changes in the scale relationship between the viewer and the work. The actions and reactions of both the viewer and the art objects, images and sounds within the artificial space can be designed to generate an organic, evolutionary relationship between the artist, viewer and artwork.

Many of the early manifestations of virtual reality environments are concerned as much with the process of interaction and the interface between the user and the environment as they are with the visual qualities of the work. Virtual reality art works can be seen to function on many different levels: a passive journey through a space, an aesthetic but largely passive experience, a two way responsive experience or a voyage of discovery which invites the viewer to become involved in the creative process itself rather than be a spectator to it.

It is precisely this concern with the creative process which I believe is at the center of the second strand of exploration and exploitation emerging in parallel with the development of interactive technologies. There now exists the opportunity for artists to become orchestrators of artistic events or activities which fully immerse the

viewer and draws them into the act of creating or controlling the evolution of the work. A number of artists and scientists have been exploring these ideas as they have worked towards the advancement of the technology needed to stage their productions.

One of the pioneers of virtual reality, Myron Krueger, has been at the forefront of the development of interactive creative and performance processes. He conceived *Video Place*[10] as early as 1969 and it has evolved into a multifaceted environmental play space where visitors interface with video images of themselves, other users and graphical objects, sounds etc. The artist provides the environment, the types and ranges of effects and responses to the users actions and movements within the space. Thus the artist, through the programming of reactive options, retains control over the experience while still providing a wide range of interactive scenarios and participatory experiences. *Video Place* is essentially a two-dimensional video and painterly space but Michel Bret's *Anyflo*[11] is a three-dimensional production system providing the tools for the manufacture and animation of sculptural objects.

It is a preoccupation with the concept of user participation and control over the nature of the structures and their attributes which has driven the development of my own computer sculpture over the last two years. From the production of physical, geometric, abstract sculpture, my work moved towards computer generated and animated pieces in the late 1980's and is now primarily concerned with the potentiality of user participation and involvement in the production, manipulation and evolution of the sculptures themselves. My aim has been the construction of a number of virtual sculpture environments as prototypes or simulations of fully immersive user experiences. These environments are designed to be experienced as screen based interactive media or simulated as video pieces to demonstrate the projected participatory elements within the work. The two most recent pieces, *FormSpace* (1992) and *Interactive Sculpture Gallery* (1993)[12], can be used to illustrate some of the potential areas of exploitation of virtual reality technology as I see them.

FormSpace is comprised of a number of geometric sculptural forms linked together by a grid structure which defines the space and provides a means of orientation for the viewer. The participants are able to navigate through the space towards each of the sculptures and as they approach them each sculpture goes through a predetermined animated routine. Because of the non-physicality of the objects, it is possible to merge shapes and pass one object through another as part of the animations, producing an illusory quality enhanced by the unearthly character of the space within which they are found.

In the full virtual reality version of *FormSpace,* the animated sequences would be set off by the approach and proximity of the viewer and could be made to repeat by the withdrawal and advancement of the viewer, thus instigating a cause and effect story line. An approach from another direction or some other movement of a body part, action, reaction or sound from the viewer could be made to instigate a different animated sequence or event, drawing the viewer into a exploratory journey of experimentation and learned experiences. It is the promotion of a more positive form of interaction, rather than a passive participation in the experience, that I wish to encourage through the work.

Interactive Sculpture Gallery is a screen based interactive environment in which the viewer can determine the nature of the sculptural works he/she wishes to produce through the selection of attributes including shapes, number of elements, colors, materials and movements within the composition. I see this piece as the prototype for a wide ranging, multi-layered toolbox of options for the creation of sculptures by one or more participants in a virtual studio space. The role of the artist becomes that of a provider of the opportunity to participate in the creative process, to communicate through actions and deeds and to explore the act of art making rather than the work of art. The artist is able to control and manipulate this process to a greater or lesser extent, depending on the desired outcomes, by determining the range and type of options available at any particular time or for a particular event or user.

At the present time, *Interactive Sculpture Gallery* comprises a choice of four animated sculptural works with which the user can experiment and interact. Each of the sculpture "rooms" contains the means for the viewer to alter aspects of the work through a mouse click or the movement of a pointer over a symbol or representation of the options available. By clicking on the moving pictures of the sculpture, the user can activate a change in the shapes of the constituent parts of the object while the movement of the whole continues. The movement of the forms can be speeded up or slowed down by the user and the colors of groups of elements can be altered by a click or a pointer movement.

One of the "rooms" contains a single spinning object, the shape of which can be changed by interaction, and a second and a third object can be added to the space, each object spinning independently and existing in its own space. This area has been designed as a prototype for a kinetic assemblage space in which the user is able to select from a wide range of object shapes and colors to put together a collection of linked, articulated or independent mobile sculpture elements within the space. The objects, as they move around the space, could be made to avoid each other, collide and bounce away, or pass through each other when they come into contact. Individual shapes or collections of shapes could also be scaled to alter the relationship between the user, his/her creation and any other users who might enter the space.

Currently, each animated sequence associated with the variables and options available are stored and retrieved, when selected, from the hard disc. Alterations to the colors of the sculptural elements are initiated by palette changes within the system and are almost instantaneous, but other changes which rely on hard disk retrieval give a delayed feedback to the user. The problems inherent in using a system not designed for the production of virtual reality environments are evident. However, the system is suffi-

ciently sophisticated to enable the production of a convincing working prototype. The speed with which virtual reality equipment and software has progressed over the last few years suggests that a system capable of the full three-dimensional interactive manipulation that would be required to generate a sculpture gallery of the type I envisage is either already a reality or will be available soon.

A system which will allow the reshaping of illusory computer "material" by carving into it, adding "material" to it or modeling it at the will of the user would open new and exciting creative opportunities, breaking down the distinction between artist and non-artist. Realtime generation and transformation of complex three-dimensional forms complete with programmable and changeable material shaders, texturing and lighting effects and inherent properties such as gravitational pull and inertia, will facilitate the synthesis of a sculpture making medium of a type to revolutionize the art form.

The shift in the perception of the art form that has taken place during the second half of the 20th century with the acceptance of computer sculpting, its products and methodologies, is nothing compared to the leap of imagination that is needed to comprehend the directions and distance that virtual reality technology is capable of taking the visual and performance arts, and sculpture in particular. As the technology comes on stream, the artists will be there to push back the boundaries of each and every art form as far as that technology will allow.

After thousands of years of slow evolution, the rate of development and change of sculpture as an art form has accelerated during the 20th century. We have seen work of a non-representational and abstract nature accepted into what had previously been thought of as a representational art form; work which moved, used light and sound established into what had been a essentially a static, silent form of expressive art. The constant review and redefinition of the term can not be appropriate when the progress of computer art and associated technologies continues at such a devastating pace. Sculpture is surely now a medium without restriction of material or physical presence, a term for the many forms of art which are not purely two-dimensional; work which occupies or uses a space either physical or metaphysical. The mere perception of an object's being or a discernible presence whether of light, sound, movement, color or shape may justify its existence and acceptance as a piece of "sculpture."

Virtual reality systems with their capacity for immersion and interaction have propelled the sculpture viewer from a passive spectator role into a key player in the art work itself. Sculpture can now be a performance of generation, elaboration and manipulation of insubstantial objects in an immaterial world. The viewer is a part of that performance and consequently an integral element in the origination of the sculpture and the sculptures' existence as a work of art.

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Footnotes

[1] Compact Ed *Oxford English Dictionary* (1971), Vol. II. p. 2687, Oxford University Press

[2] *Encyclopaedia Britannica* (1980), 15th edition. Vol. 16. p. 421, Chicago: Helen Hemingway Benton

[3] An account of the role of the computer in the development of *Northern Lights*, (1981) can be found in: Robert N. Fisher and Raymon J. Masters, *Leonardo*, Vol. 18, No. 3, pp. 133-143, "Computer-Aided Sculpture: Visual and Technical Considerations."

[4] M. O'Rourke, 1988, "Sculpting with Computer Graphics: An Approach to the Design and Fabrication of Abstract Sculpture," *Leonardo*, Vol. 21, No. 4, pp. 343-350.

[5] M. O'Rourke, 1985, "Computers, Sculpture and Three Dimensionality," *SIGGRAPH Tutorial Notes*, ACM 21, pp. 237-249.

[6] M. O'Rourke, 1988, ibid. p. 347.

[7] Latham has worked with Mike King, author of *Sculptor* and programmers Peter Quarendon and Stephen Todd of the IBM Graphics Applications Group using their ESME and WINSOM solid modeling software. Further information can be found in: William Latham, 1988, "The Computer Evolution of Imaginary Sculpture," *The Conquest of Form*, Bristol, Arnolfini

[8] Further technical information can be found in: Anne Barclay Morgan, 1991, "Interactivity in the Electronic Age," *Sculpture - Art and Technology*, May-June pp. 36-43.

[9] Information from: Frank Popper, 1993, *Art of the Electronic Age*, pp. 110-111, London. Thames and Hudson

[10] Further information can be found in: Myron W. Krueger, 1991, *Artificial Reality II*, Addison Wesley

[11] Information from: Frank Popper, 1993, *ibid.* p. 100.

[12] "Form Space," 1992, and "Interactive Sculpture Gallery," 1993, were both produced using Swivel 3-D Pro and RenderMan and animated and interactive sequences have been compiled in Macro-Media Director on Apple Macintosh equipment.