Computer Stereographics: The Coalescence of Virtual Space and Artistic Expression

Vibeke Sorensen

with Robert Russett

INTRODUCTION BY ROBERT RUSSETT

Vibeke Sorensen’s polysensory and multi-dimensional media projects, particularly those involving three-dimensional (3D) computer stereographics, are compelling and innovative works. Collaborating with scientists as well as artists, Sorensen has produced films, videotapes and computer-generated graphics that have been exhibited internationally in galleries and museums, aired on broadcast and cable television and shown in conjunction with live performance.

Born in Denmark in 1954, Sorensen came to the United States in 1974 to further her education in media arts and to seek out new and emerging imaging technology. While a graduate student at the State University of New York at Buffalo, she worked mainly with film and video, but also produced several animated works using analog technology. Eventually, she added to her vocabulary the technique of 3D motion graphics, a form of digital imaging that has become an integral part of her ongoing research on stereoscopic visualization [1].

As her work evolved, Sorensen began to think more about the long-range potential of new media and envisioned a kind of real-time electronic painting—in effect, an expanded form of lumino-kinetic art in which pictorial elements would come off the canvas and move out into physical space. Sorensen’s search for this hyper-advanced medium led to interdisciplinary collaborative projects with scientists at the San Diego Supercomputer Center in 1989. While at the Supercomputer Center, Sorensen helped research and design an interactive stereoscopic animation system, a powerful means of visualization that she subsequently used to produce Maya, her most recent and ambitious excursion into the realm of spatial imaging.

The following discussion grew out of a lengthy and frequent correspondence between the authors that began in the spring of 1992.

EARLY WORK

My interest in computers began in 1971, when I was an architecture student and musician living in Copenhagen. It became apparent to me at that time that computers, along with other electronic media such as video and broadcast television, were going to radically alter the fields of art and communication and have an immense impact on contemporary life. Technology and art were beginning to merge in unprecedented ways, and new opportunities for creative expression and experimentation were opening up. I felt constrained by architectural concepts of construction and functionality and began to explore the rapidly expanding creative capabilities of new media. I went from studying architecture to studying film and video. My work began to develop in a personal direction, away from practical or commercial applications, and I started to use my training in music and graphic design to produce motion pictures that were composed of abstract animated images and electronic sound.

My work continued to evolve, and in the mid-1970s I began to focus, in particular, on the long-range potential of new media. I envisioned an advanced, light-based art form—a kind of 3D painting that would come off the canvas, surround me and move in response to my commands, similar to the way a musician uses an instrument to control and shape the parameters of sound. It would be an interactive and immersive experience, a liquid type of architecture that could be created in real time and produced with some kind of stereoscopic computer animation system. I began concentrating on video imaging techniques and analog computer animation in order to realize the real-time component of this dream, and I turned to stereo- scopy as a way to arrive at mobile 3D spatial effects.

Later on, in the late 1970s, I began to see even more expansive possibilities for new media. I imagined that through the use of rapidly developing communications technology, it would be possible one day for artists around the globe to interact and perform in a common, 3D stereoscopic space, bringing to this shared experience their own visual and cultural traditions. I think it is reasonable to assume, especially in light of recent developments, that the inherent immateriality and malleability of interactive and telematic art will eventually conjoin with computer stereographics, allowing on-line users, empowered and enlightened, to dwell on entirely new planes of 3D reality.

Vibeke Sorensen describes her technical approach to computer stereographics and discusses in detail the actual genesis of several specific projects. She also discusses the history and future of spatial imaging, including its potential for challenging the centuries-old domination of two-dimensional pictorial expression. Sorensen concludes her remarks on a cautionary note, stressing the need to place at least as much emphasis on the exploration of personal ideas and feelings as on the development of new hardware and computational processes. Robert Russett provides an introduction and background to Sorensen’s life and work.

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OBSERVATIONS ABOUT THE STEREOSCOPIC PROCESS

Stereoscopy has certain innate features that could significantly alter the way we think about art and communication in the years ahead. As imagery, stereography is a palpable construct with concrete physical characteristics, but because it is an illusory impression, it also has a certain ethereal quality similar to music.

In order to create a stereoscopic image using computer graphics—or any other technique for that matter—one for each eye. These two subimages are of the same subject, but vary to a small degree in their perspective. By looking at the separate subimages with a stereo viewer or some other type of separation device, each eye sees its own perspective viewpoint. A phenomenon called stereopsis allows for the brain to fuse the two flat subimages into a single picture that is perceived as having a real dimension of depth. With the arrival of the digital computer and 3D software, it became possible synthetically to emulate features of the human visual system that are essential to the stereoscopic process. Computers are capable of creating models of our ocular apparatus—virtual eyes, in effect—that behave remarkably similarly to our real eyes and are able to replicate the complicated function of binocular vision. Each parameter used in these computer models can be explored on an individual basis, helping us to understand better how the two eyes work together to create the effects of stereoscopy. For example, for the effective display of stereoscopic motion pictures, homologous images must be perfectly aligned vertically and shown precisely at the same instant in time; otherwise the illusion of depth breaks down and the viewing experience becomes confusing and uncomfortable. An advantage of the digital computer is that it can quickly and accurately calculate these types of requirements and eliminate many of the problems and limitations that are so often encountered in this and other forms of stereoscopic imaging.

Undoubtedly, an important and inextricable link exists between our knowledge about perception and the development of technological art forms. For example, if the scientific community during the nineteenth century had not discovered persistence of vision and stereopsis, we would not have motion pictures and stereoscopic imagery today. Obviously, in this case, science provided essential information about the mechanics of vision that helped revolutionize the making and viewing of art. In the future, other aspects of our sensorium could be uncovered that further alter and expand our methods of perception and change our approach to the creative process. I am convinced that the human visual system and psyche bear far more potential than we presently realize.

HISTORICAL MILESTONES IN THE EVOLUTION OF MEDIA AND PICTORIAL SPACE

While picture-making has always been restricted essentially to a two-dimensional (2D) surface, interest in 3D vision and the phenomenon of binocular parallax can be traced back through the centuries to ancient Greece and the time of Euclid. Even Leonardo da Vinci, in his “Paragone” (from the Treatise on Painting), described the binocular visual system and related it to the art of his time, lamenting that despite the invention of perspective, paintings were ultimately flat and, therefore, not identical to reality as we perceive it. However, while Leonardo was clearly aware of binocular vision, he apparently never made the next logical step and produced a stereoscopic picture. Another 300 years passed before Sir Charles Wheatstone, a scientist researching perception, discovered the principles of stereopsis and invented the first stereopticon [2]. More recently, some of the best-known artists of the twentieth century have worked with various forms of stereoscopy, including Marcel Duchamp, Salvador Dali and René Magritte. During the 1940s and 1950s, innovative stereoscopic motion pictures were made by pioneering filmmakers Oskar Fischinger [3], Dwinnell Grant [4], Norman McLaren [5] and others.

Over the years, many artists and scientists have deeply questioned the nature of reality and perception and have contributed in a great variety of ways to the
In the fifteenth century, for example, Leon Battista Alberti and other Florentine theoreticians introduced the geometric framework for classical, linear perspective. This framework initiated an entirely new approach to pictorial representation, a systematic way to create a highly convincing illusion of depth on a 2D surface. By transforming the picture plane of a painting into what appears to be a transparent window, linear perspective provided a powerful, monoscopic metaphor for real, observable 3D space. As an imaging system and organizing principle for European painting, the geometric rules of perspective went unchallenged for nearly five centuries. It was not until the early 1900s that Western artists began moving away from classical perspective as a model of reality and inventing new concepts for delineating pictorial space. Cubism, for instance, fragmented depth and volume, introduced the element of time and brought multiple viewpoints to a single image; it was an artistic movement that in many ways paralleled the immense changes in scientific philosophy that began in the late 1800s. The static, single, measurable view of the world created by Renaissance perspective was deposed as the dominant theory for describing reality: its premodern set of axioms was considered incapable of handling contemporary non-Euclidean issues such as motion, tempo and simultaneity. Cubism, on the other hand, dealt effectively with these issues by redefining the parameters of painting using the technique of mapping time to space—that is, applying four dimensions \((x, y, z \text{ and time})\) to two dimensions \((x \text{ and } y)\). It was an artistic strategy as radical and innovative as any of the revolutionary ideas being advanced at the time by modern science. Cubism opened up new possibilities, expanded perceptual awareness and brought a kind of democracy to the eye of both creator and beholder. While the Cubist movement never challenged the monoscopic tradition of painting, ideas central to stereoscopy are included in Cubism—particularly the notions that multiple points of view exist and can be presented to the eyes simultaneously and that these multiple views provide important information about time, space and human experience.

As new electromechanical media emerged during the twentieth century and took their place alongside traditional art forms, the plasticity of pictorial space underwent yet further changes. Motion pictures, for example, expanded the spatiotemporal features of visual expression, making it possible to display a kinetic, transitory 2D image in linear time. In effect, film maps four dimensions \((x, y, z \text{ and time})\) on to three dimensions \((x, y \text{ and time})\). More recently, computer stereographics and related binocular processes (such as virtual reality) have contributed to the evolution of pictorial space by using advanced technological procedures to explore a new and dynamic range of depth perception. Since these computer-based stereoscopic systems are capable of delivering a viewing experience in five dimensions \((x, y, z \text{ views plus time and the illusion of real depth})\), it is now possible to transmit a great deal more information than with monoscopic images. For example, a wide range of source material—including data drawn from the rich legacy of art history—can be synthesized, compressed and embedded into computer-generated stereoscopic environments. However, to date, surprisingly little has been done along these lines. Instead, the primary focus of most digital imaging—including computer stereographics—has been on the development of optical realism, a form of visual representation based on classical, linear perspective. Although the search for optical realism or naturalism in computer graphics has led to important technical developments (such as radiosity and texture mapping) there is presently a real need to expand our conceptual capabilities and to investigate new ideas about the inherent structural possibilities of the image and the interpretation of sensory data in its multiple and kinetic forms. In short, it is simply inappropriate to use a model of realism from the fifteenth century to represent a late twentieth-century view of reality.

**Fig. 2. Reflection Study No. 11, 35-mm stereoscopic slides and Cibachrome prints, 20 x 24 in, 1988. Digital images produced at the CalArts Computer Animation Laboratory. (Software: Wavefront. Hardware: Silicon Graphics Iris VGX.) In this series of compositions, 3D scenes were reflected in the surface of organic forms, creating compound shapes and altered spatial effects. (See the Appendix for viewing instructions.)**
with equipment and processes that would be considered very primitive by today's standards. For example, I did not use off-the-shelf software to produce the animated sequences for Hot Wax because, very simply, there were no graphic applications or animation programs available at that time.

When I began working with a new generation of digital computers [8] in the early 1980s, some fundamental changes took place in my work and in my methods of visualizing graphic form. I found that the 3D software that was being developed for digital computers was a direct descendent of photography and that it was modeled after the camera's capability to render detailed subject matter and perspectival space. Of course, a critical difference between photography and digital imaging is that a camera can only record what is there, while the computer is like a paint brush and can create imagery that never existed. In any case, these new digital computer systems and their 3D graphics software provided me with new opportunities to explore an advanced form of visualization created by the intersecting attributes of light-based media—still and motion picture photography—and the powerful new 3D graphics techniques of the digital computer. During the 1980s, for example, I was involved in the production of The Magic Egg [9], the world's first 3D computer-animated film. I produced a short segment for the film in which I used the NASA star database and James Blinn's software to animate the constellations, delineating the transformation of our old anthropocentric view of space to our current understanding of how the universe looks. Although The Magic Egg was not a stereoscopic project, it gave me an opportunity to gain valuable experience with 3D motion graphics, the same type of imaging technique used to generate the binocular effects of computer stereoscopic animation. Ever since my involvement with The Magic Egg, my interest in astronomy has continued, and I often consult work for space exploration projects at the NASA Jet Propulsion Laboratory (JPL). Recently I produced seven 3D computer-animated scenes for JPL, simulating the unmanned space probe to Mars and depicting how the mission will undertake the task of mapping that entire planet.

Shortly after my work on The Magic Egg, I began using 3D computer-graphic techniques to make a series of stereo stills, including Fish and Chips (Fig. 1) [10] and Microfishe. Since then I have continued to produce stereo slides as well as stereo prints on a regular basis. From 1987–1992, I created the Reflection Studies Series (Fig. 2), a group of 15 thematically related abstract works. In 1994 I produced another collection of stereo slides called the Earth Consciousness Series (Fig. 3).

DEVELOPING AN INTERACTIVE STEREOSCOPIC ANIMATION SYSTEM

In 1989, I joined crystallographer Lynn TenEyk and computer scientist Phil Mercurio at the San Diego Supercomputer Center [11] to design an interactive stereoscopic animation system. It would be, in effect, a computer-based production facility capable of rendering stereo imagery and outputting it to tape. The goal of the project was to develop improved methods for interacting with complex models by taking advantage of large-scale visualization techniques and stereoscopy. I was included in the project to set up a complementary relationship that would exploit the innate features and working methods of both art and science. For example, it was felt that, as an artist, my perceptual demands on the stereoscopic system would benefit the technical work and engineering done by the scientists. I was involved in the conceptualization of the project, as well as the research and development of the system. As a final test of the system's interactive imaging capability, I was to produce an animated stereoscopic work of art on videotape—which turned out to be Maya, a 7-minute abstract motion picture composed of mutating 3D organic forms (Fig. 4 and Color Plate A No. 1) [12].

We designed and built a special input device that we named “the Banana,” mainly because of its shape and color. The Banana looks like a cross between a musical instrument, a telephone and a pointer. It is a modified toy guitar neck with 12 buttons on it labeled like a telephone keypad. A six-degree-of-freedom locator, called a Polhemus tracker, is attached to the bottom of the Banana for the purpose of establishing the coordinates of each computer-generated object and positioning it in 3D space. The pushbuttons allow the person creating the computer-animated imagery to choose any degree of freedom and to arbitrarily indicate the required parameters for controlling and interacting with the scene. All of the movement in Maya was designed using various features of the Banana. For example, I could control the motion of a 3D computer-generated object that was being displayed by simply moving the hand-
held Banana in various directions. By repeatedly pressing the buttons on the Banana during this process, I could digitally set and save, in real time, the intermediate key frames needed to generate the motion path of the object. The calculations made during this interactive process were recorded at varying intervals along a computer timeline, and our customized software supplied all of the in-between frames required to produce a smooth animation sequence. The 3D computer-generated objects that I moved and orchestrated were projected onto a large-scale reflective screen. To view the imagery, liquid-crystal glasses were worn to separate the left- and right-eye images to allow the stereographic effect (Fig. 5). The computer displayed alternating stereo views, each with half the vertical resolution of a normal frame. I used a projector designed to handle the refresh rate of the computer in stereo mode to screen the work. Our original software [13] included new solutions to the problems of convergence correction, interaxial eye spacing and flexible user control.

Another unique aspect of our 3D stereoscopic animation system involved using a slider bar to set the space between the computer’s two virtual eyes. The person creating the animated imagery adjusts this interaxial space according to how far he or she is from the display screen—the farther the user is from the screen, the wider the separation required between the computer’s virtual eyes. This variable interaxial capability was also used to control the depth of the virtual scene and the objects within it. For example, if the virtual objects that composed a particular scene in Maya occupied a great volume of space and included things that were very close and very far away, the eye spacing would be adjusted with the slider bar so that the scene was visually comfortable and set to the proper scale. As a precise and easy-to-use instrument, the slider bar became an integral part of the creative process and was used on a regular basis to design and produce stereoscopic effects throughout the making of Maya.

**The Form and Content of Maya**

*Maya* was conceived as a non-narrative work that functions on several levels simultaneously. On one level, it pays homage to the continuing tradition of abstract art and to the liberating effects of new and developing technology. On another level, it is a personal meditation, an introspective work that focuses on my own inner rhythms and spirit. In terms of *Maya’s* visual and spatiotemporal form, my intention was to use sustained permutations of light, color and shape to create an experience that is reflective of life and its continuously changing natural cycles.

During the production of *Maya*, I had to deal with a number of compositional issues unique to the technique of stereoscopy. For instance, there is the “stereo window” that defines where the borders of the picture plane are to be located in space. I had to decide what would appear in front of or behind the “stereo window” and how I would use various depth cues—such as overlap and size variation—to mobilize and articulate the composition. I also had to consider issues of “accommodation,” or the work the eyes have to do in order to fuse shapes and objects at various levels of depth in a scene. This aspect of stereoscopic imaging—which involves organizing the sequential movement and depth location of image elements—was extremely critical and had to be executed with sensitivity and precision in order to minimize eye strain and create a clear and comprehensible orchestration of space.

The fact that, unlike human eyes, a computer’s virtual eyes can vary their interaxial separation was another facet of the stereoscopic process that had to be considered. In reality, our eyes are separated by approximately 2 ½ inches and are fixed in their relationship to each other, while computer eyes can be moved horizontally, changing the distance between them and, subsequently, altering their interaxial separation. What happens perceptually when computer eyes vary from the normal 2½-inch separation is that objects and the spaces they inhabit are significantly changed in terms of their scale. By using interaxial separation to scale up or down objects and scenes, I was able to better understand the structure and continuity of space and to have very fine control over the abstract visual elements that I used to compose *Maya*. Of course, many other factors—both scientific and artistic—were at work during the project, not the least of which was my own personal judgment about the emotional and aesthetic content of imagery.

**Current Work**

Recently, I began work on a stereoscopic film project that will revisit and extend...
Fig. 5. A diagram of the interactive stereoscopic animation system used to produce *Maya*. 

Large-screen video projection display of stereoscopic images

Stereoscopic Computer Display with infrared sync emitter on top

Left- and right-eye views alternate display at 1/120 second each

Screen border is the "stereo window"

Modified toy guitar neck has a telephone keypad and Polhemus position tracker on it. It is fixed with respect to the monitor. Its position establishes the origin (0, 0, 0) of the physical coordinate space.

Apparent spacial position of object

Origin (0, 0, 0) of virtual coordinate space is placed in center of 3D box

Liquid Crystal shutters in the 3D glasses open and close at 1/120 second and alternate in sync with the computer display, allowing the left and right eyes to see only one image on the display: the left eye sees the left view and the right eye sees the right view of the object. An infrared sensor is built into the glasses to maintain sync.
an idea I began to explore in my earlier series of stereo stills called Earth Consciousness (see Fig. 3). I plan to interview five artists and five scientists about their feelings, thoughts and concerns regarding the natural environment, then scan their heads into 3D databases and animate the heads in a way that will enhance and amplify what they are saying. I will also incorporate 3D photography and personal writings into the film. The project will require special software that I plan to base on a 3D drawing program. I wrote a few years ago called Drawstereo [14]; I will also need to formulate new and inexpensive techniques for making head models. I cannot afford to have the heads of the participating artists and scientists scanned at a commercial production facility, so I plan to experiment with various improvised techniques. For instance, one possible approach would involve using a video camera to digitize the changing silhouettes of a person revolving in a chair. I could then convert the recorded data into a head model. While this would be a relatively low-cost procedure, I anticipate that it will take a considerable amount of time and effort to develop fully. In any case, I am very excited about the project and its potential for exploring new approaches to form and content.

THE FUTURE OF COMPUTER STEREOGRAPHICS

New fields arise from the synthesis of other fields—computer stereographics is obviously the result of this kind of evolutionary process. It combines the psycho-optical phenomenon of stereopsis, a nineteenth-century discovery, with twentieth-century technology. Although computer stereographics is relatively new and in an early stage of development, it is already being absorbed into other fields, merging with recent technical and conceptual developments such as virtual reality, interactivity and tele-communications. In light of these advances and their implications, it seems to me inevitable that stereoscopic imaging will become an important part of our visual lexicon in the future. Even now, certain types of research activity in chemistry and biology, for example, require stereoscopic visualization. Perhaps some day, computer and TV screens will be dimensional, telephones will become stereoscopic videophones, and we will even have fiber-optic clothing that will serve as 3D video screens as well as body coverings. Exactly how stereoscopy will affect creative expression is, of course, a matter of speculation. Certain forms of art making, for instance, could take place in collaborative 3D spaces on the Internet or via other telecommunications media. This kind of electronic connectivity could provide a radical alternative to the traditional art triad—artist, object and audience—forming a new type of relationship that emphasizes interactive participation [15]. Art making, in this sense, would be totally virtual. Forms and figures would be capable of moving within a mutable and multidimensional environment without physical limitations or the constraints of linear time. In this context, on-line forms of stereoscopic imaging would be constructed from multiple and diverse sources, generating a dynamic feedback process that would potentially allow us to see ourselves and others during the act of creation.

CONCLUDING REMARKS

When I began to work with stereoscopy about 20 years ago, computer equipment was extremely limited, and interdisciplinary collaboration like the alliance that contributed to the production of Maya would have been virtually impossible. However, through recent developments in computer technology and subsequent advances in computer graphics and animation, old ideas about the art and science of stereoscopy have been revitalized and the creation of new modes of spatial imaging have been set in motion. My early views about a future stereoscopic art form—in effect, a dynamic mode of painting that would come off the canvas, move fluidly in space and immerse the viewer in an interactive and polysensory environment—now seem well within the realm of possibility. The artistic and technical preconditions for developing this kind of experience already exist, and we are moving ever closer to realizing a new type of stereoscopy that could significantly expand the definition and distribution of art. However, notwithstanding these promising developments, the extent to which new technology-based art media are capable of generating insights and energizing experiences will depend on the artists, scientists and engineers who articulate strategies and define content. The worlds of art and technology are struggling to shape each other and the future. As we redefine and reconstruct our media with new technologies, we redefine and reconstruct ourselves, our identities, our bodies and our environment. Therefore, we need to place at least as much emphasis on exploring personal ideas and feelings as we do on the development of new hardware and computational processes. Now and in the future, it will take free-thinking individuals with powerful imaginations to make the fusion of art and technology a vital part of human experience.

APPENDIX: INSTRUCTIONS FOR VIEWING STEREOSCOPIC ILLUSTRATIONS

Since special spectacles do not come with this article, the authors would like to point out that the 3D effect possible with the stereo illustrations can be achieved by free viewing. Free viewing is a technique that allows one to see depth without the aid of glasses or devices of any kind. The correct procedure for free viewing the stereo pairs in this article is to cross one’s eyes while looking straight-on at the two images from a distance of approximately 16 inches. When one sees three images, one should focus and concentrate on the “fused” image in the middle. It will appear to have a real dimension of depth. It is important to hold the image plane (the page) parallel to one’s face, as well as to hold the x axis of one’s eyes parallel to the x axis of the stereo pair.

References and Notes

1. Sorensen is currently chair of the Division of Animation and Digital Arts of the School of Cinema-Television at the University of Southern California.
2. English physicist Charles Wheatstone found that by preparing two drawings from slightly different viewpoints and viewing them through a device of mirrors that simulated binocular vision, the illusion of three dimensions could be artificially produced. Wheatstone’s device, which he called a stereoscope, was publicly demonstrated for the first time in 1833.
3. In 1952, Oskar Fischinger produced Stereo Film, a 30-second 3D animated work composed of precisely orchestrated abstract colored patterns. Stereo Film was the culmination of 4 years of experimentation with drawn and painted stereoscopic pictures.
4. In 1945 Dwimnell Grant made Composition 4 (Stereoscopic Study #1). A 4-minute abstract animated film, Composition 4 was made entirely of paper cutouts. Grant’s technique consisted of photographing two pictures, side by side, on each frame of film. The relative positioning of identical forms in the two pictures determined their 3D spatial location when the film was projected through a prism. The added dimension of depth in Composition 4 allowed Grant to extend his ongoing formal research with abstract animation and the use of visual counterpoint as a method of composition.
To achieve the illusion of depth in these films, McLaren discarded the standard stop-motion approach of making two sets of drawings, one for each eye. Instead, he devised a simpler method that involved moving his artwork different distances to the left or to the right in order to create the second view that is needed for the stereo effect. Now Is the Time employed a system of moveable cutouts to create the two views necessary for stereoscopic parallax, while Around Is Around used animated cells with double sets of punch holes for repositioning the artwork and creating a second perspective.


11. “Maya” is a Hindu term that refers to the conflict between illusion and reality. Maya was premiered in the Perspectives Proximities Perceptions exhibition at the Strong Museum in Rochester, New York, 11 July–7 August 1995. Curated by Lance Speer, this show was part of Montage ’95, the International Festival of the Image. The music for Maya was made by Rand Steiger with assistance from Tim Labor and was generated with Csound running on a NeXT computer. Reverberation was later added using a Lexicon PCM70 processor. The score file was generated with a program that chooses randomly from among a range of harmonics, specified by the composer. The music was intended to reinforce the formal structure of the animation. Sections are differentiated by changes in fundamental frequency, rate, length and range of harmonics. Maya was made possible through funding from the National Science Foundation for the project.

12. Phil Mercurio wrote Stereo Preview, customized software for the interactive stereoscopic animation system, based on Wavefront’s Advanced Visualizer. I generated all of the imagery on a Silicon Graphics Inc. (SGI) computer.

13. Drawstereo was first demonstrated at Montage ’93 in Rochester, New York. The software itself has not been published and is not in distribution. Sorensen used Drawstereo to produce a short stereoscopic animation commissioned by Absolute Vodka for their Web site celebrating experimental animation as an art form. Drawstereo has become the departure point for an improved stereoscopic rotoscope program that Sorensen is developing in collaboration with computer scientist Steve Lamont as part of a research project funded by the Zambeere Foundation of the University of Southern California.

14. The prescient first steps in the creation of interactive telematic art took place in the late 1970s. Since then artists and technicians such as Carl Eugene Loeffler, Kit Galloway, Sherrie Rabinowitz and Roy Ascott have organized numerous telematic projects using computer networks, slow-scan video, satellites, videotex and other kinds of telecommunications media.