

Computer Imagery: Imitation and Representation of Realities

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Computer-generated images, objects and events have existed a short time relative to theoretical stances that are embedded in them. This paper will explore the views of traditional and contemporary philosophers and art theorists that

- (1) appear related to the form or content of computer-generated or -processed images, objects or events
- (2) bear some relation to imitational and representational theories of art and/or reality
- (3) illustrate the embedment of historic and representational theories of art and/or reality.

These conventions may have been intentionally embedded or may have been unconsciously employed by the person or group who generated the computer creations. The broad definition of computer art that will be used here is "any aesthetic formation which has arisen on the basis of logical or numerical transposition of given data with the aid of electronic mechanism" [1]. This definition allows for inclusion of the greatest variety of forms. Generated or processed screen graphics, computer-controlled environments and sculptures, three-dimensional artifacts designed or executed with the aid of the computer, conceptual art displays including computer programs, and interactive performances are included within this definition. Also included are computer images and objects that have been created for nonartistic purposes by individuals who may or may not have any formal artistic training. Consequently, works included in SIGGRAPH slides and tapes in either technical or artistic categories would be included as potential candidates for analysis.

BACKGROUND OF THE STUDY

Media and Theory

Computer-related imagery is facing some of the same theoretical controversies and dilemmas that photography, film and video have faced. For example, Galassi described one point of view as follows: "The object here is to show that photography was not a bastard left by science on the doorstep of art, but a legitimate child of the Western pictorial tradition" [2]. In contrast Sekula's work [3,4] in the history of photography stresses the need to study the photographic archive, the set of practices, institutions and relations to which photographic practice belonged, rather than reassembling the archive in categories constituted by art and its history. Rosler extends Sekula's concerns to the world of video:

It is the self-imposed mission of the art world to tie video into its boundaries and cut out more than passing reference to film, photography, and broadcast television, as the artworld's competition, and to quash questions of reception, praxis, and

meaning in favour of the ordinary questions of 'originality' and 'touch' [5].

She states her disapproval of separating video art from the other ways that videototechnology is used. To do so, she believes, is to accept the idea that the transformations of art are formal, cognitive and perceptual. Gouldner describes the relation between art and media in terms of the separation of cultural and technical facets of modern culture [6]. He sees those who are surrounded by the most powerful, advanced, expensive hardware as optimistic technicians and contrasts this with pessimistic, politically impotent representatives of the cultural apparatus. All of these views, except Galassi's, express concern for the larger cultural context.

Lucas studied evolving aesthetic criteria for computer-generated art via the Delphi strategy. He chose eight prominent computer artists as participants. In the conclusions of phase one of his study, he states, "If there is a hidden quorum here, it may be the commonly held belief that regardless of innovative properties which may or may not require new aesthetic models about computer imaging, traditional criteria remain an integral part of the aesthetic evaluation of this art form"; in phase two of his study, he raises the question, "Are there traditional aesthetic criteria which are adequate for evaluating computer art?" [7]. In response, five of eight experts agreed that visual basics of harmony, symmetry and balance were applicable, six of eight agreed that computer art had roots in traditional fine arts considerations and five of eight agreed that computer art has not elicited the need for new aesthetics. However, in the course of the study, interactivity was mentioned several times as a potential source of need for new aesthetic criteria.

In this paper I advance the view that computer imagery should not be separated into aesthetic/artistic formations and technical/scientific formations. Embedded in computer imagery are cultural and historical conventions which affect both aesthetic/artistic and technical/scientific formations. In addition, these conventions reflect larger models of cultural reality. Both art and technology are affected by these models of reality. This view is in accord with post-

ABSTRACT

Contemporary theory in philosophy, aesthetics and cognitive/social sciences stresses the embedment of cultural and historical conventions in art and technology. Computer imagery for aesthetic/artistic or technical/scientific purposes have these conventions embedded in them and consequently reflect larger models of humanly constructed cultural reality. Careful analyses of the form, content and practice of computer graphics are proposed to reveal views of reality embedded in technology and in models generated by the technology.

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structuralist theory. For example, M. Foucault discusses archeological analysis of archives as revealing “the set of conditions in accordance with which a practice is exercised, in accordance with which that practice gives rise to partially or totally new statements, and in accordance with which it can be modified” [8]. In other words there are rules operating which were not invented or formulated by the participants, relations which provide their practice with support but which may remain invisible to some, if not all, of the participants because they have not been consciously articulated. Members of the Yale school of literary criticism, especially de Man, stress the ways in which texts containing these rules may be seen as deconstructing themselves (as these rules are revealed and demystification follows from close examination of the text) [9,10]. Norris describes de Man’s later work as revealing a stance that “equates right reading with the power to demystify forms of aesthetic ideology” [11]. Post-structuralists, such as Foucault, as well as some neo-Marxist and feminist critics, stress the political and social consequences of ignoring the existence of these rules.

The view that such models or rules exist may be found to some degree in various traditional and contemporary theories. For example, the art historian Wölfflin [12] claimed that style could be detected in areas that escape attention, stating that the whole development of world views might be found in the relationship of gables [13–15]. Kaplan describes two post-modern theories that stress cultural relationships in context rather than stressing decontextualizing fragmentations and binary oppositions. According to Kaplan both “involve a thinking that transcends the very binarisms of Western philosophical, metaphysical and literary traditions which have been put into question by poststructuralism and deconstruction” [16]. The literary and feminist theory, labeled by Kaplan as utopian, involves a search for a liberatory new position. This position may be found in the work of Bakhtin [17], Derrida [18], Lacan [19], Cixous [20], Kristeva [21], and Barthes [22,23]. The discourse, labeled by Kaplan as commercial or co-opted, warns about the psychological effect of new technologies in the service of consumer culture. This position is held by Baudril-

lard [24–28] and Kroker and Cook [29].

This paper describes a position related to those described above. I hypothesize that selections of images and modes of presentation are made by the creator, and these selections are inherently related to aesthetic and technological conventions established within the culture of the creator whether or not the creator is consciously aware of these conventions. The creator may be acting in accord with these conventions, critically examining, them, or reacting against them. In all cases, the work reflects the historical cultural setting in which it is created. This position is supported by recent literature stressing the contextual character of art and other aspects of culture. It appears in sociology of knowledge, anthropology, archeology, history, art history, folklore, literary criticism and psychology. From this stance, the work of individuals creating computer images can be examined as expressing cultural conventions. This holds true whether the training of the creators is entirely in the sciences, entirely within the arts or in both arts and sciences.

In the early days of computer graphics, systems were built primarily for scientific and practical purposes. Few artists had access to them. However, their users, primarily scientific or technical personnel with no formal art background, made images that expressed conscious or unconscious aesthetic conventions. Currently computers are much more accessible to artists. Teams of artists and programmers collaborate in advertising, film companies and government projects utilizing state-of-the-art technology. Artists frequently use software that includes algorithms developed for technical scientific purposes. Consequently their work may express reality constructs from technical/scientific areas of which they may or may not be aware.

Development of hardware and software usually originates in research done by government and large corporations. Over time and with amortization of research and development costs they are simplified first for mid-sized- and later for microcomputers. Simplified versions of the originals become available to smaller companies and individuals at lower and lower costs. End users, for example individual artists with no institutional or industrial affiliations, frequently use microcomputers—as the credits for

the SIGGRAPH art slides makes evident. Hardware and software that have been simplified remain influenced by their origins, although they are frequently referred to as ‘degraded’. It is to these origins, practices and embedded conventions that theorists such as Sekula, Rosler, Foucault and I refer.

Aesthetic Theories

Art as imitation is one of the oldest and most varied of theoretical purposes. Plato [30,31] discussed imitation of the Ideal, preferring it and contrasting it to literal imitation of physical reality. Aristotle [32] and Plotinus [33] discussed imitation of essences. Further variations of imitational theory have been discussed by Sir Joshua Reynolds [34] and others. The two classical traditions of Idealism and Realism are most commonly associated with art as imitation. Idealism eschews literal representation of physical reality and Realism seeks essential or scientific correspondence with physical reality. Contemporary art theorists continue to examine questions of imitation and representation of art and reality. Their concerns are with ‘the new realism’, simulation, simulacra, reproduction and appropriation. The generation of modernists that preceded contemporary theorists was concerned with nonliteral representation, i.e. representing that which could not be literally imitated. As technology changed and traditional media such as painting and sculpture were joined by printmaking, photography, film, video and computer imagery, new concerns evolved in art theory. Contemporary theorists are concerned not only with the image, but with its role in the broader context. They frequently stress the cultural embedment of art. The edges between art and philosophy, criticism, politics and social theories have become less distinct.

ART AS IMITATION

Platonic Idealism

The writings of Plato, Aristotle and Plotinus present early versions of imitationalism or mimesis. Their views, like those of contemporary theorists, are concerned with the function of art in its cultural context. Acknowledging the power of art to influence the citizenry, especially the young, Plato cautioned against art that literally imitated the physical world or that could overly excite the emotions.

Consequently, he approved art that would represent the Perfect Idea of an object, that is, the ideal representation of an object, rather than attempt to imitate a specific physical object in the physical world. Being an Idealist, Plato regarded specific physical objects as inferior copies of their ideal counterpart in the world of ideas. A literal representation of these would represent a copy of an inferior copy. However, he approved the work of artists who, through intuition, were capable of representing images of the Perfect Idea of an object. In his view this work would represent perfect harmonies intuited from the Ideal world of ideas. These forms would have perfect proportions; consequently they would embody *Kalokagathia*, that is, goodness, truth and beauty. Analyses of Greek architecture and statuary, which some believe attempted the physical embodiment of Plato's theory, reveal consistent proportions. Most commonly cited is the golden rectangle. Both the Pythagoreans and the Platonists were concerned with the relation of number, proportion and harmony to beauty. They also assumed a relationship between beauty, truth, and goodness.

Among later writers, Spengler provided a 40-page historical review of the relationships between the arts and mathematics [35]. L. von Bertalanffy [36] cites Spengler in his *General System Theory*. G. D. Birkhoff [37] contributed mathematical analysis of visual art, especially that of the Greeks, in *Aesthetic Measure*. J. Hambidge [38] in his work on Dynamic Symmetry also examined mathematical constructs underlying Greek aesthetics. The influence of these theorists on later work involving information science and cybernetics as related to aesthetics may not be readily evident. However, Hill states, "Nevertheless, more than an echo of Birkhoff's work is found in the ideas proposed by, for example, N. Rashevsky, H. J. Eysenk, A. Moles, M. Bense, H. W. Franke and F. Nake" [39-41]. It is my belief that these individuals and others are not necessarily influenced by Birkhoff. Rather they and Birkhoff are engaged in a search for a formulation of universals in terms of mathematics that may be applied to aesthetic objects or responses to aesthetic objects. The work of Moles and Bense are responsible for the formation of information theory aesthetics and exact aesthetics [42]. Eysenk searched for universals in experimen-

tal aesthetics [43,44]. Early computer artists Franke and Nake utilized computers in attempting to create aesthetic forms [45]. The work of Stiny and Gips in algorithmic aesthetics is a contemporary link to the underlying belief that beauty, form and number may be linked [46-48]. Plato's concept of intuition of perfect form may be applied to an interpretation of the discussion in Clive Bell's [49] book of 'pure form'. Bell's discussion has been important to modernist art, especially that of the formalists. Many examples of early computer art bear resemblance to the work of modern formalists, emphasizing purely formal relations of elements and principles of design. Many works of early computer art may be considered to express a concern for the relations of pure form, possibly ideal forms, generated with a concern for the beauty and based in numerical relations.

Modern artists who utilized mathematics in their work include Duchamp, Arp, Lissitzky, Pevsner, Naum Gabo, Vantongerloo, Bill, Lohs and Gerstner. Some of these may be considered influenced by imitation of ideals or essences. For example, Duchamp's piece, *Large Glass* is based upon the golden rectangle, which is prominent in Greek art and in Birkhoff's analyses. Many of the other artists are considered Constructivists, whose art consists of mathematically based explorations of the relationships of plastic rhythms to aesthetically pleasing form.

Many individuals working with computers in the 1960s were not artists, but scientists. However, they had seen and were influenced by modernist artworks. Consequently, they were conscious of the similarities in form between the geometric shapes generated by the computer and the gallery art with which they were familiar. An interesting project would be an analysis of this early computer art in terms of its appropriation of aesthetic structures and conventions.

Aristotle's Imitation of Essences

Aristotle, considered the originator of realism, posited that works of art should not be literal copies of nature but should express the essence of the subject portrayed. Plotinus, a neo-Platonic idealist, also stressed imitation of essences. The underlying geometric forms in nature have served to recall the essences of some forms.

D'Arcy Thompson [50] has explored these underlying structures. An example of recent computer graphics that could be regarded as imitation of essences would be the work of Kawaguchi [51], who, by studying Thompson and Izuhara [52], has written computer programs that describe the growth and form of plants, shells, coral, tusks and claws. He generates these forms using algorithmic structures based on the laws of nature. Consequently he generates images of forms that have never existed but follow natural laws. These may be considered imitation of essences, if we consider that underlying structures are essential to these forms. Examples of other work imitating the essential structural patterns in nature are found in Prusinkiewicz, Lindenmayer and Hanan's [53] developmental models of herbaceous plants and de Reffe et al.'s [54] plant models of botanical structure and development. Other computer graphic techniques that may be considered to imitate patterns of regularity and irregularity to create underlying structural or visual patterns constituting the essence of natural forms use concepts that include fractals, particle system modeling, chaos theory, and fourth dimensional (time) modeling. Visual essence rather than the structural essence is involved in these techniques. An overview of visual simulation techniques was presented in 1985 by Doenges [55]. These techniques are most frequently utilized in entertainment, educational, commercial and aesthetic applications.

Probably the most widely known of visual simulation techniques are fractal curves that may imitate the visual essence of natural forms such as planet surfaces, mountain ranges, clouds and trees. The originator of this procedural model is Mandelbrot, a French mathematician [56]. According to Tucker, "Fractal geometry provides simple mathematical descriptions for highly irregular or fragmented structures, finding a deeper order in the bewildering complexity of natural forms. . . . A unique characteristic of fractal curves is that they have detail at all levels of resolution" [57].

Reeves' work on particle systems [58-60], Gomez' on chaos theory and Hunter's algorithms that model phenomena in time provided models for representation of such nebulous dynamic events as wind, fire and

explosions. The discussions of Papatomas, Schiavone, and Julesz [61] focus on application of computer graphics to the visualization of meteorological data. They describe computer graphics animation sequences representing weather episodes. These models can represent motion, changes of form and dynamics. Techniques that model literal surface representations of objects would require too much computer time and memory if applied to dynamic phenomena. Papatomas et al. describe Gardner's work [62] in which he sought to resolve the conflict between realistic images and computational time by adopting the impressionists' approach of representing the essence of natural scenes as simply as possible. Gardner achieved remarkable results using textured quadratic surfaces bounded by planes to portray clouds and trees; his work is an example of visual simulation. Gelberg and Stephenson [63] created *SuperSeer*, a cloud prediction and display system that presents and interacts with data from earth and planetary science. This work attempts simulation that is both visual and based upon physical laws.

Do the computer models described in this section imitate, model or simulate the phenomena involved or do they provide approximate visual or conceptual correspondence because of correspondences in underlying belief systems of the creators and observers? The answer depends upon whether reality is seen as a set of conventions and constructs *invented by humans* or whether it *exists independent of human understanding*.

Realist Imitation: Objective

Basic philosophical realism involves belief in some sort of link between human conceptual systems and other aspects of reality. In the objective realist's view, reality is structured in such a way that it can be modeled by set theoretical models. That is, the world consists of entities, the properties of those entities and the relations holding among those entities. In the corresponding version of imitational theory, it is assumed that the relationships of objects depicted on a three-dimensional grid (a conceptual system) can depict areal view of phenomena. It is assumed that this structure exists as *real in itself, independent of human understanding*. Consequently, it is *the correct way* to portray reality. It requires that artists who wish

to portray an object or event realistically utilize the conventions common to Western Europe. These are in turn assumed to be based upon the best scientific knowledge of the time, which also is assumed to correspond to the structure of reality. These ideas dominated European art criticism from the mid-fifteenth to the mid-eighteenth centuries [64].

Sir Joshua Reynolds articulated this view, claiming that the artists must derive his ideal of beauty from the physical world through direct observation, thereby discovering the ideal, which is true nature. In his Discourse Two, Reynolds discusses the mastery of painting. He insists that mastery necessitates that comparison should not be between performances of art with each other, but that by examining "Art itself by the standards of Nature, he [the artist] corrects what is erroneous, supplies what is scanty and adds by his own observation what the industry of his predecessors may have yet left wanting to perfection"; he also states, "Invention, strictly speaking, is little more than a new combination of those images which have been previously gathered and deposited in the memory: nothing can come of nothing: he who has laid up no materials can produce no combinations"[65]. In Discourse One he advocates a method of instruction that requires students to draw exactly from the appearance of the model before them, stressing exactness and precision in representation. He further states that students should not change the form according to vague and uncertain ideas of beauty. He also castigates those whose drawing resemble the model only in attitude.

These remarks coincide with the scientific realist's orientation to imitation that contrasts sharply with both imitation of ideals and imitation of essences. In traditional artworks this view may be said to appear in Roman portraiture and Roman illusionism. It informed the work of Renaissance artists as they explored the creation of illusions of space on the flat surfaces of paintings. Brunelleschi is usually accorded the honor of its rediscovery or invention. All of the underlying rules of three-dimensional rationalized space are given in Alberti's *De Pittura* and later treatises by Viator, Dürer and others. Dürer's work depicts an artist drawing upon a surface with a grid imposed between it and the scene to be drawn. In effect, he is creating an

illusionary z axis upon an x y planar surface. He is attempting an isomorphic representation of reality. This is the *visual version of scientific objective realism*. A belief that symbolic representations may form an objective, one-to-one, value-free correspondence to reality is the basis for scientific objective realism. The symbols utilized may be mathematical or graphic.

Western European cultural conventions for depicting visual reality have influenced the development of camera and video technology. They also have influenced the development of computer algorithms and hardware that are now being used extensively in countries outside Western Europe. The historical development of computer imagery in Japan, for example, appears influenced by these conventions. A review of the images presented at international computer graphic conferences prior to the development of sophisticated three-dimensional solid modeling and lighting techniques reveals greater variety; for example, depiction of space and designed surfaces in Japanese computer graphics of this period show more similarity to traditional Japanese artworks than do Japanese computer graphics shown after the development of these techniques. After introduction of algorithms that portray illusory space, a greater international homogeneity in computer graphic imagery seems apparent.

Early computer graphics were primarily geometric and planar. In the 1960s three-dimensional wire frame graphics were developed. With the consequent development of hidden line algorithms, solid modeling, and lighting and texturing techniques it was possible to attempt depiction of illusory three-dimensional 'reality' in computer graphics. Hardware development, including sufficient memory and speed, was also necessary for this depiction. To a large extent these developments were funded by federal defense-related research. Consequently, the changes in international imagery may be viewed as a form of cultural colonialism.

Foster [66] states, "The critique of perspectivalism, the concern with corporeal vision, the analysis of the gaze . . . are not new. Decades have passed since Panofsky [67,68] pointed to the conventionality of perspective, and Heidegger [69] to its complicity with a subject willed to master; years since Merleau-Ponty [70] stressed the

bodiliness of sight, Lacan [71] the psychic cost of the gaze, and Fanon [72,73] its colonialist import.” Other scholars including Ivins [74], Krautheimer [75], Edgerton [76,77], White [78] and Kubovy [79] have investigated technical, aesthetic, psychological, religious, economic and political impacts of perspectivalism. Heidegger [80] postulates that the natural world was transformed through the technological world view into a ‘standing reserve’ for the surveillance and manipulation of a dominating subject. The latter view serves as background to the postmodern aesthetic positions of Baudrillard [81] and Kroker and Cook [82].

Digitized imagery derived from conventional art media, or newer media such as photography, film, and video, may be used to generate computer graphic images that fall into the category of realist imitation. Artists may also utilize digitizing devices for drawing images based upon realist conventions. Photographically derived data (digitized or non-digitized) may be combined with algorithmically generated computer graphics. For example, in the film industry, *Tron*, produced in 1982, used computer-generated imagery as a backdrop for live actors. In 1984 *The Last Starfighter* included 27 minutes of computer-generated effects that were intercut with live action. A spokesman for Digital Productions claimed that the computer-generated images were so life-like that when they were intercut with live action the audience would not be able to tell the difference [83]. Digital recording and alteration of photographic and video data that is virtually undetectable has led to ethical controversies in law and journalism. In effect, the problem or the opportunity exists of making images that appear real but have no correspondence to phenomenal objects and events. In the pessimistic or commodity postmodern view, film, photography and television constitute technologies of domination and spectacle. A less pessimistic view is that we may create illusory or virtual realities with current aesthetic, educational, commercial or entertainment value or we may create ‘utopian’ models for future cultural constructs. *However, conventions of cultural reality embedded in hardware, software, and mental constructs of human participants may inhibit or preclude development of some models.* Conscious awareness of these conventions and constructs reduces

their power to influence human behavior.

Computer graphic algorithms based upon laws of optics for depiction of light sources, reflection, transparency, etc. and upon laws of physics for force and motion and upon medical and biological research for depiction of living forms are based upon the philosophical premises underlying scientific realism. Early solid modeling and ray tracing algorithms made use of memory storage and calculating ability to describe the way a surface would look as it moved in relation to a light source and view point. Techniques allowing changes in light quality, atmospheric quality and textural surfaces all improved realist imitation in computer graphics. A complaint that the images generated are too real and too perfect (that is, hyperreal) has caused recent attention to be focused on introduction of small irregularities to make computer-generated imagery look more naturally real (i.e. simulate literal portrayal of individually imperfect instances). Some form of randomization, or stochasticism, is introduced in the surface quality, movement or boundaries of images. This would correspond to the visual differences between Greek statues, which attempted portrayal of perfect models with no counterpart in the phenomenal world (imitations of Ideals or Essences), versus Roman portraiture, which portrayed a single living individual, warts and all (isomorphic representation of physical reality). Simulations and representations of reality are made by traditional artists by drawing, painting, sculpting and so forth. Simulations and representations of reality are made by humans using computers by digitizing images and by inventing algorithms that imitate images and events. Both of these may be based upon scientific realism, a view of the world that derives information from scientific research to make the most perfect representation of the world based upon the best information to date. They may also be based upon visual modeling. The SIGGRAPH '87 panel on natural phenomena addressed this issue in terms of science and entertainment applications. Springmeyer [84] states, “The goal of the entertainment researcher is the simulation of visual reality, whereas the goal of the physical scientist is the accurate simulation of physical processes” and, further, “*The two approaches have begun to reach the limits of*

their ability to work without each other” (italics mine). Reeves [85] phrases this difference as “*simulation vs. faking it” (italics mine).* This phrasing in the first instance points to a necessity for both kinds of simulation and in the second to the culturally embedded valuation of scientific simulation over visual simulation.

Jackson [86], an early optimistic researcher in artificial intelligence stated, “By suitably programming a fast enough digital computer, one can simulate any finitely describable phenomenon.” In effect this means that various aspects of reality or concepts of reality can be simulated on the computer and displayed graphically if they can be sufficiently defined. Putnam [87–89] is credited by some as being among the first philosophers to offer a computational or functionalist model for human reality. In his most recent work *Representation and Reality*, he renounces his earlier certainty that any phenomenon can be so represented. He describes why he found the realist view so appealing: “What I used to find seductive about metaphysical realism is the idea the *the way to solve philosophical problems is to construct a better scientific picture of the world” (italics mine).* In a sense, computer graphics that simulate or model natural phenomena consider their success dependent upon a better scientific picture of the world. The portrayed model may look too perfect or appear too abstract, as, for example, in imitation of ideals (dependent upon numerical harmonies) or as in imitation of essences (dependent upon natural laws which may be represented mathematically). Note that both of these positions involve a belief in aesthetic universals. When images appear too perfect, the appearance of isomorphic visual realism may be sought and small imperfections added so that a more natural or literal imitation of reality may be attempted. The crux of the problem that Putnam has recognized and that contemporary artists and scholars in many disciplines have explored is that the definitions of the parameters of what is real are based upon human definitions; that is, objective realism has no basis. Objective realism claims the existence of a structure of reality independent of human belief, knowledge, perception and modes of understanding. This position is not supported by contemporary research in the cognitive sciences,

especially anthropology, linguistics and psychology [90].

CONTEMPORARY PROBLEMS IN IMITATION

Human cognition and human social and cultural structures are important in the determination of beliefs about reality and hence what may stand for a model, simulation, imitation or representation. Emphasis is placed upon the human role of definition. In some works of art and in some philosophical work, self-reflexive studies occur. That is, by examining previously executed work, human participation and underlying belief systems are made evident. Artists create self-conscious art: art about art, art institutions, relations of gallery art to mass media, and relations of contemporary art to historical art. Photographers are engaged in rephotography, painters are engaged in appropriation of historical works of art. Literary critics stress the conventionality of texts. Texts are demonstrated to have deconstructed themselves, revealing the conventions embedded in them.

Simulation, Simulacra and Appropriation

Deleuze [91] discusses Plato's critical description of literal imitation as a copy of a copy. However, he claims, "The factitious is always a copy of a copy, which must be pushed to the point where it changes its nature and turns into a simulacrum (the moment of Pop Art)" He views this as a destruction of models and copies that set up a creative chaos rather than as a Platonic destruction of models that conserves and perpetuates the established order. Warhol's imitation of a Campbell soup can is an initial example of this. Acceptance came to the copy of a copy, which served as an ironic comment upon the production of mass culture and mass production and especially upon the technology of reproduction.

Considering Deleuze, deBord [92] and Baudrillard's [93] descriptions of simulacra in light of the discussion of realistic simulations (both visual and scientific) in computer imagery in the previous section of this paper, it may be posited that the hyperreal simulations of reality and some of the artistic works based upon the algorithms involved in these may be examined as

constituting simulacra. This requires disregarding the conscious intentionality of the artist or creator from the perspectives discussed in the first part of this paper or from the more commonly employed modernist aesthetic perspective of Wimsatt and Beardsley [94]. From these perspectives the hyperreal imagery may be seen as simulacra (critical artistic comments on the insufficiency of the model of reality embedded in scientific realism from a human perspective). It may account, in part, for the appropriation of artistic techniques drawn from traditional animation and employed in computer graphic imagery, for example those described by Lasseter [95] and Pixar's 1986 film, *Luxo, Jr.*, and Zeltzer's animation of a human skeleton [96]. In some cases, 'faking it' improves the human perceptual and cognitive reality of computer graphics.

Another quite different example of 'faking it' that may be considered a simulacrum is the construction of the character Max Headroom. In this case, digitized imagery of an actor utilizing extensive makeup is subjected to picture processing to imitate computer-generated imagery. That is, the appearance of computer-generated imagery is appropriated for use. This may be considered a simulacrum from two perspectives: (1) In spite of work in computer graphics such as that of Waters [97], computer generation of human facial expression is laborious, is expensive and lacks human reality. Consequently this may reveal the insufficiency of current models from a human perspective in the same manner as the hyperreal simulations involving scientific laws in examples above. (2) Berko [98] assumes a position congruent with Baudrillard's postmodern view of technological consumer culture. She offers "Max Headroom as a case study of the high concept image, the site upon which the codes of simulation have been able to produce, 'by dint of being more real than the real itself' [99] the absolute image of the process of consumption, the hyperreal Max Headroom". Berko further states that in the United States today "the image seems unreal, unclear, impure, i.e. un-simulated, if it has not been video-enhanced, digitized, and processed" [100]. Although Berko uses hyperreality in a way seemingly contrary to the utilization in example one above, both examples stress insufficiency or negativity of hyperreal models in human terms.

Both examples accent and make apparent the conventions used in reality construction. The difference between the examples lies in the use of 'reality'. Examples of hyperreal ray traced surfaces accentuate human constructs of perceptual cognitive reality. The Max Headroom example accentuates human constructs of social, political and economic reality as they impact cognitive perceptual constructs.

As is illustrated above, appropriation may involve computer imagery borrowing from the artistic/aesthetic or from the technical/scientific realm. An early use of artistic appropriation is the plotter image of the *Mona Lisa* produced as an advertisement to legitimate technologically produced imagery. This is quite different from Duchamp's or Warhol's appropriation of the same image. Relatively transparent uses of appropriation involve early simulations of artistic style by Nake and Nolls [101] and current stylistic simulations by Kirsch and Kirsch [102,103]. Appropriations of stylistic conventions of earlier art forms, especially modernist formalism, Op art and Renaissance perspective, are in evidence throughout the early history of computer graphics. Extensive use of digitally scanned images of paintings, photographs, film and video assure that many creators of computer imagery deal directly with issues such as appropriation, blurring of authorship, dematerialization of the art object and questioning the relation of 'original' to copy.

CONCLUSIONS

This paper has raised questions that a much longer study must address more fully. It has pointed to the need for a multidisciplinary approach to computer art. It may be no coincidence that Greenberg's 1987 Steven A. Coons Award Lecture [104] called for cross-disciplinary education of students in computer graphics. Belting [105], an art historian, has cited the need for studies of newer media. Post-structuralist theory is not bound by disciplinary boundaries, considering them remnants expressing an earlier conceptual scheme that is no longer appropriate. All of these issues are embodied in problems faced by artists, technicians and scientists involved in producing computer imagery. As Brook states, "Pictures are the most

potent of those nonverbal representations by means of which we ambivalently seek to open and close the gap between what is actual and what is only possible, and to discover in the space what our values are" [106].

This paper is an attempt to begin analysis of the form, content, and practice of computer imagery. It has pointed to the embedment of previous aesthetic theories and reality constructs in historical and recent computer graphic imagery. It has advocated the necessity of viewing computer imagery in a holistic manner rather than dividing it into disciplinary applications. Deconstructionists object to disciplinary divisions as arbitrary, valueless, falsifying and obscuring. Post-structuralists, especially feminist and neo-Marxists, object to disciplinary divisions because of their political and social ramifications. This paper posits that ignoring human participation in the creation and utilization of cultural conventions has important implications. The conventions embedded in the hardware, software and imagery of computer graphics limit the models that may be generated. Is it possible for consciously generated cultural goals to affect the development of technology and consequent models generated? A necessary step in that direction is careful analysis of the conceptual forms already embedded in the technology.

This paper posits that computer imagery is an excellent ground for contemporary multidisciplinary work that will include thoughtful analysis of form, content and practice. These analyses are important to larger philosophical questions involving the nature of reality, human-reality relationships, and roles of art and technology in representing these relationships.

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