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THE EMERGENCE OF A 3D OBJECT AESTHETICS IN COMPUTER MEDIA

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

Todor Kafala, MA

The Ohio State University
2000

Dissertation Committee:

Professor Suzanne Damarin, Adviser
Professor Terry Barrett
Assistant Professor Mary Leach

Approved by

Suzanne K. Damarin
Adviser

Educational Policy and Leadership
ABSTRACT

Computer animations incorporate a diversity of spatial events in a variety of organic and geometric forms, juxtaposing and then unfolding them in sequence as disparate bodies, masses and objects within three-dimensional space. Digital spaces are visionary architectures that offer an excess of possibility in shape, contour and topological construction. In practice, the application of simulationist aesthetics in computer media expand on the 3D computer game aesthetic in part by pushing the limits of photorealism and "life-like" behaviors. In the creation of an apparent realism, a nested hierarchy of perceptual cues that organize light, space, color, form, movement, texture, sound, and object behavior in 3D mediascapes correspond to our shared understanding of everyday events and things.

I identify the archaeological object of my study as the value-based and critically-determined art polemics surrounding 3D objects from the 1960's onwards. Rather than engaging in an endless tracing in search of origins, or silent beginnings, the implicit intentions of this method work toward identifying the possible displacements and transformations in aesthetic concepts that suspend the continuous accumulation of late modernist knowledge. I begin
with the premise that the art aesthetics of 3D graphical forms is largely the academic enterprise of critics, curators, art historians and other academics vested in the production of evaluative and theoretical knowledges of graphical figures. I view aesthetic criticism as the description, persuasive interpretation and judgement of creative work in terms of its form and content. The critic uses value-laden evaluators to articulate assumptions about the art work, and therefore expresses implicitly an aesthetical, theoretical and/or ethical agenda. Aesthetic theories and approaches do not combine into a single, cohesive theory of criticism, but exhibit a plurality of knowledges and practices that reflect the culture-specific contexts of meanings and values.

My dissertation contrasts the focus on the form of the autonomous material object as defined by its medium with more conceptual ideas that challenge the limitations of such a focus. Minimalism particularly confronts formalist restrictions on the critical aesthetics of art objects, allowing for more conceptual and valuative discussions of interactive 3D avatars. My dissertation engages in the rewriting of art critical knowledge and evaluative criteria surrounding the 3D object.

The central debate in art aesthetics in the 1960's and 1970's revolves around formalist and minimalist debates over the autonomy of the art object and its "normative" condition of "flatness" or abstraction as opposed to the arbitrary, everyday "object" that may hold conceptual, perceptual, utilitarian or instructional information. A paradox exists within formalism that is in part the
legacy of Kantian aesthetics: the aesthetic judgement of what is "beauty," or what is "art" is dictated and ascribable only to the form of the work. Therefore, the self-critical tendency that Clement Greenberg calls "modernism" values form for the sake of form: its experience of art objects is merely phenomenal and logical.

Minimalist work departs from the prescriptive two-dimensionality of abstract expressionism by adding the 3D element. As formalism reached its peak in the 1960's, conceptual art (minimalism, simulationism) challenged some restrictions on form and aesthetics. The critical aesthetics of 3D computer interactive avatars emerged from this disorderly, potentially transmuting exchange of ideas, concepts and objects.

The simulationist aesthetics of 3D objects are where form meets content in concrete cultural practices that include the design and use of interactive media. Both ideas and their effects are superficial in simulationist new media that express seriality and reproduction: The "depth" of meaning is realized on the surface in the domain of visual, auditory and tactile representations. Regarding these aesthetics, I select four threads of thought to sum up my presentation of ideas: They are 1) the modulation of topological surfaces in 3D media, 2) the object-concept and the conceptual uses of the constructivist computer interface, 3) the evolution of the intelligent 3D avatar, and 4) the cinematic, topological space of informatics and knowledge in computer media. Creating concepts in/with computer media is a kind of creative constructivism
whereby the extension and unfolding of lines of thought lead to the production of new patterns and framings of meaning.

Deleuze and other constructivists argue that the cinematic use of transitions foster plural versions and frames of mind. Creating new connections or junctions in art means creating them in the mind too! Its no great leap of faith to believe that variations in spatial and temporal dimensions as part of larger conceptual frameworks may be possible in some future digital media. The designer should also consider the possibilities of intuitive gaming and constructivist learning outcomes in learner to object and object to object interaction and navigation. The material automatism of images that imposes a thought from the outside constructs both the twisting and folding of informatic substance and new cerebral connections in thought. In a "paradigm" of folding and unfolding, I try to emphasize the value of a creative aesthetic in the intuitive and nonlinear construction of knowledge and information in computer media.
For Michael, Bess and Katina
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VITA

1999 MA Cultural Studies in Education: Instructional Media and Technology, Ohio State University. Extensive course work in the humanities.

1988 MA Urban Anthropology, City University of New York Graduate School.


1982-1995 Learning Therapist, Occupational Trainer, Public Health Worker

1997-2000 Graduate Teaching Associate, Ohio State University

PUBLICATIONS


FIELDS OF STUDY

Major Field: Educational Policy and Leadership
   Cultural Studies in Education
   Studies in Instructional Media and Technology
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CHAPTER 1

INTRODUCTION

Computer animations incorporate a diversity of spatial events in a variety of organic and geometric forms, juxtaposing and then unfolding them in sequence as disparate bodies, masses and objects within three-dimensional space. Digital spaces are visionary architectures that offer an excess of possibility in shape, contour and topological construction. With the emergence of the “next generation” of computer animations, which employ the latest technical advances in real-time engines and 3D polygon-rendering, animation begins to engage a late modernist aesthetics of virtual objects, surfaces and spaces. In practice, the application of simulationist aesthetics in computer media expand on the 3D computer game aesthetic in part by pushing the limits of photorealism and “life-like” behaviors. In the creation of an apparent realism, a nested hierarchy of perceptual cues that organize light, space, color, form, movement, texture, sound, and object behavior in 3D mediascapes correspond to our shared understanding of everyday events and things.
My dissertation project reconstructs the modernist aesthetics of 3D shapes and surfaces in art products, computer media and entertainment, and examines how the techno-sensual, kinaesthetic interaction between players and avatars in intuitive computer interfaces that use 3D animated cinematic sequences can become a practical model for non-game instructional media.

The use of multiple intuitive interfaces in computer media contest to the pliability of digital-symbolic material and to the flexible, plastic nature of cybersurfaces in digital space. Multisensorial media simulations push the envelope of the "pictorial turn" and a culture saturated with images by inventing new kinds of interactive narrative structures comprised of a series of transitions and temporal figurations of image, sound, touch and thought. As an intuitive, responsive representation machine, the 3D interactive cinema bridges the chasm between computer games and instructional media in terms of the pleasure of real-time interaction, the satisfaction of attainable expertise, and the visualization of salient content.

1.1 The Archeology of late twentieth century 3D object aesthetics

Although it has evolved alongside digital technologies, the visual aesthetics of 3D animated objects exhibit a relative autonomy which can be traced to art polemics in the 1960's. Following Barrett (1990), aesthetic criticism is viewed as the description, persuasive interpretation and judgement of creative work in terms of its form and content. The critic uses value-laden evaluators to articulate assumptions about the art work, and therefore
expresses implicitly an aesthetic, theoretical and/or ethical agenda. As my primary avenue of inquiry, I undertake the archaeological reconstruction of the written statements from the object aesthetics in the arts and entertainment media since the 1960's. This project appears to take on an immanent importance at this pivotal moment when art aesthetics is beginning to intersect the popular market.

Critical reviews of computer media have been popping up in the pages of art journals during the past few years, most conspicuously in Afterimage, Art and Design, Artforum, Domus and Leonardo. Previously, art critics had reason to ignore popular culture market products, such as computer games, because they failed to meet the criteria established for sculpture, painting and digital art: they do not resemble the critically-determined standards and values for 3D objects and sculptural forms. In many instances, the critical theories of modernist discourse define these evaluative criteria: the aesthetics of new forms of creative, digital media codify form, space, tactile and kinaesthetic interaction, and time into discrete concepts and fluid, integrated statements (Search 1995).

The central debate in art aesthetics in the 1960's and 1970's revolves around formalist and minimalist debates over the autonomy of the art object and its “normative” condition of “flatness” or abstraction as opposed to the arbitrary, everyday “object” that may hold conceptual, perceptual, utilitarian or didactic information. Minimalist work departs from the prescriptive two-
dimensionality of abstract expressionism by adding the 3D element. Minimalist artists deliberately transgress the boundary where, according to Greenberg (1993), art becomes an arbitrary object: they then assume the quality of arbitrariness for themselves. The term “art” derives from the artificial, the unreal, unnatural, constructed, invented, predetermined, objective and conceptual. Art critic Mel Bochner (1967) suggests that minimalism is not just another style or phase in modernist art history, but a conceptual paradigm shift that allows for the visual presentation of ideas rather than the exercise of traditional aesthetics. The leap into three-dimensionality expands the ontological definition of art into new domains, creating confusions with everyday, non-art objects, but also opening up new spaces for hybrid forms.

Minimalist artists and art theorists set the ground for recent aesthetic criticism of 3D animated simulations in the cyberspace worlds of art that conceptualize topologies of virtual objects and are concerned with the techno-sensuality of the post-mechanical body. These seemingly discrete discourses are not mutually exclusive: they share overlapping genealogies that can be traced to aesthetic arguments in the 1960's between and among formalism (which emphasizes shape, space, light, color, texture, weight, relationality, assemblage and the appearance of flatness in sculptural forms) and minimalism (which emphasizes gesture, sensitivity, gestalt, size, square geometry, space, simplicity, wholeness, seriality and intuitive process).
In his formalist theories, Greenberg tries to establish objective criteria for the interaction of art based on the interaction of form and medium. Modernist theory is highly deterministic in nature, with only one approach to evaluating the aesthetic quality of art and media. The formalist program dictates that the work of art be a totally autonomous material object, which makes no reference to anything beyond its boundaries: the surface itself, its color, its consistency and its gesture are to be the only “content” of the work. Greenberg’s doctrine, its successes, controversies and countertheories, becomes an archeological object in my analysis of important art critical texts.

As formalism reached its peak in the 1960’s, conceptual art (minimalism, body, pop, simulationism) challenged some restrictions on form and aesthetics. The critical aesthetics of 3D computer interactive avatars emerged from this disorderly, potentially transmuting exchange of ideas, concepts and objects. The aesthetic arguments from the 1960’s have never been resolved, but instead evolve, change, become entangled, or continue to reinforce each other in a circular manner as new digital 3D modeling, morphing and animation technologies have made their appearances on the new media scene.

1.1.1 Aesthetics and criticism

Formalist aesthetics dictate that a work of art must be suggested, inspired, or evoked by the medium itself. The medium is the only subject matter of formalism and the locus of the artist’s aesthetic constraints. A paradox exists within formalism that is in part the legacy of Kantian aesthetics:
the aesthetic judgement of what is "beauty," or what is "art" is dictated and
ascrivable only to the form of the work. Therefore, the self-critical tendency
that Greenberg calls "modernism" values form for the sake of form: its
experience of art objects is merely phenomenal and logical. de Duve (1996)
suggests that the emergence of modernity became tied to the idea that art is
autonomous and the intellectual object of the institutionalized museum; the
word "art" became the name of an ineffable quality that does not obey
established rules. "Art" does not necessarily correspond to the beautiful or
sublime, but is often substituted for them.

Transcending the weaknesses of formalism and the Kantian aesthetics
that preceded them, Barrett (1990) demonstrates that art aesthetics and
criticism are both interpretive and evaluative: a thorough understanding of a
work of art requires adequate and accurate description and implies a
judgement. He suggests that critics struggle to translate complex jumbles of
thoughts and feelings about artworks into articulate words that can be
understood and shared by others, as opposed to minimal responses,
unarticulated feelings, or incomplete thoughts. By continuing to recycle
subjectivist arguments over the roles of cognition, feeling and private
the influences of culture, interpretation and critic/audience response (Barrett
1989, 1990, Sekula 1984, Solomon-Godeau 1991), art aesthetics is mired and
weighted down by arguments over epistemology, language and the philosophy
of mind. Subjectivist arguments over aesthetics converge on the central thesis that "truth" and "reality" are relative to internal thought, or some particular private language at any given time. They reify private thoughts about art objects going on in the mind as a nonphysical entity, or a quasi-mystical consciousness. Barrett affirms that aesthetic theories and approaches do not combine into a single, cohesive theory of criticism, but exhibit a plurality of knowledges and practices that reflect the culture-specific contexts of meanings and values. A sharp distinction between language and the arts is not apparent, because both language and the arts are constituted and constructed off/within cultural practices (an amalgam).

Sekula (1984) also disputes the Kantian separation of the cognitive and affective faculties (the cleavage between epistemology and aesthetics), which provides the metaphysical basis for both subjectivism and romanticism, stands behind the modernist premise of artist as genius, and promotes art as an entirely imaginary transcendence (a false harmony) that is offered for

1 Examples of subjectivist/mentalist arguments over aesthetics include Eisner (1981), who recognizes the alleged importance of the philosophy of mind with respect to the justification of the arts in education, which consists in showing that art contributes to mental development. People invent forms of representation, which are privately-held conceptions capable of being transferred into public images so that the meanings they embody can be shared (Eisner assumes that thoughts and concepts are prior to language). Best (1989) also disputes the Kantian duality of emotive mental faculties and cognitive, conceptual and rational faculties, suggesting that the arts are as "rational" and as much the objects of thought as mathematics and science. Goodman (1978) also dismisses the Kantian theme of plural frames of mind, proposing instead the irrealist, or ultra-conventionalist plasticity of multiple actual worlds, versions that are actual depictions rather than descriptions of the world, alternatives to a single world rather than (only) mutually exclusive truths.
consumption to docile, isolated spectators. The meaning of the art object, according to Sekula, is always immanent, fixed and universally given, as opposed to something contingent, politically active or ideologically subversive (Sekula 1984, p. 53). One of the pitfalls of modernism, besides its penchant for professional elitism and narrowness of concern, is its problem of its “immanent critique”, which ultimately reduces every practice to a formalism that infects and nullifies every artistic practice. Sekula suggests that the production of art is subject to the “unifying semantic regime” of formalism, the modernist metanarrative that attempts to relegate the field to a specialized colony of the capitalist market (Sekula 1984, p. 59).

Similarly, Solomon-Godeau (1991) is also concerned with the aesthetic validation of art objects by critics and curators from a cultural and historical perspective. Her bottom line critical agenda is twofold: to disclose the process by which a new canonical configuration emerges and to make conspicuous the relative absence of women from virtually all the canons in the field of cultural production. The modernist canon masks its own traces, effaces its own manufacture, and presents itself as a natural, teleological phenomenon instead of making transparent the contingency, historical determinacy and private interests which actively produce it (Solomon-Godeau 1991, p. 51). Solomon-Godeau and others want to make visible the relentless ahistoricism, the epistemological exclusiveness and impropriety, and the conceptual incoherence inherent in the production of a modernist canon.
My dissertation engages in all these polemics surrounding art aesthetics by tracing the genealogies of "reason", "subjectivity" and "truth" in criticism as products of discursive definitions, phasic-regimes and cultural practices. Following Foucault (1972), an historical examination of aesthetics uncovers the wholesale aestheticization of ethical discourse in the arts, redefining their "autonomy" in regards to both its private-individualistic terms and its appeal to any wider community of inter-subjective understanding. Despite debates over the depth-ontological issues of animated, 3D "virtual" sequences in terms of their realistic effects on cognition and the senses (themselves part of a discourse that can be traced to Jaron Lanier and others in the 1960's), aesthetics is largely the academic enterprise of critics, curators, art historians and others vested in the production of evaluative and theoretical knowledges of graphical objects.

1.1.2 Methods

My archeology attempts to trace the emergence of a 3D object aesthetics of computer simulations in discursive (textualized statements in print media) and non-discursive practices (artistic, media, commercial market products), and to engage in a re-writing of these aesthetic discourses. The purpose of archeology is to "maintain" discourse in all its irregularities and to expose its spaces of multiple dissension. The archeological method assumes that statements and tangible, visible objects and products are not reducible to each other, but both are important "archival and artifactual evidence" of
discursive emergences and divergences. The articulable and the visible move
to a double rhythm: the visible object contests the primacy of the discursive
statement with its own form and allows itself to be determined without being
reduced (see below). My archeology attempts to show that late twentieth
century aesthetic knowledge is an ethical, practical and constructed
assemblage of statements, visibilities and visible objects.

1.1.3 Of Documents and tangible aesthetic objects

The archeological method also delineates two elements of historical
strata: the articulable and the visible, which correspond to the discursive and
the non-discursive, and forms of expressions and objects of content. Although
Foucault acknowledges that the primacy of discursive statements is essential,
he nowhere writes that visible objects remain reducible to statements: primacy
has never meant reduction. Each historical formation, or practical assemblage
of knowledge, sees and reveals all it can within the conditions laid down for
statements and visibilities, which are mutually exclusive. Both Foucault (1972)
and Wittgenstein (1974) suggest that the articulable and the visible move to a
double rhythm: the visible object contests the primacy of the discursive
statement with its own form and allows itself to be determined without being
reduced. The sculpture, photograph, or digital object all construct their own
irreducible conditions of existence and exist within/in relation to the aesthetic
statements that shed light on them, rendering them the subject of public
visibility.
Both discursive practices and non-discursive practices of visibilities are constitutive of knowledge. In *Discipline and Punish*, Foucault (1977) demonstrates that visibilities are inseparable from technical machines, but those machines do not have to be optical. Visibilities are not defined by sight, but are multi-sensorial complexes or actions, attributes and qualities which emerge into the light of day in the context of discourse. As Foucault (1973) mentions in regards to a letter from Magritte, it is thought, not the object of thought, that sees and can be described visibly. Visibilities are not merely forms of objects, but forms of their luminosity that show up under the light of discursive statements and institutional practices, the self-evidences unique to each historical strata. Foucault (1972) suggests that these visibilities should not be confused with perceptible and elemental objects and things, but isn’t it possible for the new historian to be simultaneously a voyeur and to touch, sense, perceive, or consume tangible aesthetic objects of real matter and substance? My archeology therefore considers both objects in regard to discursive statements and tangible aesthetic objects in their historical contexts.

1.1.4 The Archeology of textualized statements

The archeological method as applied to the historical field of aesthetics attempts to distinguish the particular discontinuities and patterns in late-twentieth century modernist aesthetics (after 1960), and delimit them not only as “historical strata” per se, nor as chronological linear successions, but rather as distributions of ideas, statements of ideas, or knowledge formations. Rather
than engaging in an endless tracing in search of origins, or silent beginnings, the implicit intentions of this method work toward identifying the possible displacements and transformations in aesthetic concepts (even to speak of the possibility of ruptures) that suspend the continuous accumulation of late modernist knowledge. As Foucault (1972) suggests, the archeological method undertakes the description of epistemological acts and thresholds (breaks, mutations, or transformations) that interrupt the slow development of knowledge, a knowledge in the state of stasis and repetition, and force it to enter a new time.

My archaeology of late twentieth century aesthetics looks at the document, the textualized statement, as a surface effect of a distribution of events, an effect which uncovers series of both singular and repetitive events. The archeological method is not interpretive or allegorical: it does not claim to efface itself in a modest reading that brings back the distant purity of origins. It is nothing more than a rewriting, a description, or a regulated transformation of something that has already been written (Foucault 1972, p. 140). The search for discontinuities as a basic element of historical analysis is a double-edged sword, a paradoxical notion: it is both an instrument and an object of research; it divides up the field of which it is an effect; and it enables the historian to individualize different domains, but can be formed only by comparing those domains. The new historian does not seek to dislocate and then remove the discontinuity from coherent histories, but to make the displacement of the
discontinuous a basic feature of dispersive histories.

1.1.5 Strategies

In examining late modernist aesthetics, an absolute degree of the autonomy of art aesthetics is not assumed, but a more or less relative degree of autonomy will be demonstrated while tracing primary discursive distributions and dispersions back to the early 1960's. I have identified two non-mutually exclusive distributions of discursive statements that seem to extend visibly and evidently from their intersections with the most recent generation of 3D animated products, or 3D computer games.

1. My archeology attempts to rewrite the events surrounding arguments and exchanges of ideas over aesthetics as they appear in historical periodicals/print journals; to disclose the evaluative and ethical agendas, to uncover the cracks, points of dissension, discontinuous mutations and possible breaks that configure thresholds within late modernist 3D object aesthetic knowledge. Archival library research focuses on searching for textualized statements in professional journals, periodicals, gallery and exhibition guides/critiques, and popular culture magazines.²

I examine different strains of thought, which include formalism, constructivism and assemblage, kineticism, pop and minimalism and more recent approaches to art and technology. I attempt to locate possible similarities and convergences as well as breaks, deviances and differences in evaluative agenda.

2. My project examines 3D object visualization and the dynamic interaction of participants and synthetic agents within interactive simulations in the recent computer graphics literature. From the perspectives of theory and practical application, my project examines 1) the potential of virtual computer worlds to permit the user to manipulate and alter spatial and temporal relationships, perceptual scale, and observer point-of-view by modifying and using 3D objects; 2) attempts to design interactive, partially autonomous, synthetic 3D avatars capable of responding to internal (computer intelligent) and external (user) influences in ways that are both predictable and consistent with a narrative scenario, through the use of synthetic vision and artificial sensing; 3) aesthetic considerations unique to interactive media, including multidimensional visual languages that capture the dynamic nature of 3D avatars; 4) issues of programming random, nonlinear discontinuity in imaging and sound which affect the senses regarding time and thought (issues of the

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dynamic composition of avatars, operations and knowledge structures in the
graphical user interface) and 5) the use of 3D interactive cinema to build
photorealistic simulations and rich graphical worlds inhabited by autonomous
agents as places for knowledge construction and abstract thought. These
intuitive computer interfaces allow for the selection of appropriate levels of
difficulty and complexity across any knowledge domain, including art,
entertainment, training and teaching.

From the 1960's onwards, my dissertation begins by tracing the value-
based and critically-determined art polemics surrounding 3D objects. It
contrasts the focus on the form of the autonomous material object as defined
by its medium with more conceptual ideas that challenge the limitations of such
a focus. Minimalism particularly confronts formalist restrictions on the critical
aesthetics of art objects, allowing for more conceptual and valuative
discussions of interactive 3D avatars. My dissertation then engages in the
rewriting of art critical knowledge and evaluative criteria surrounding the 3D
object through the play between the articulable and visible. It does not
presume a single cohesive reading or theory of criticism, but a plurality or
readings, "paralogies," and cultural practices. It brings the pragmatic functions
of knowledge to light by making the critics responsible for both the statements
that they propose and the rules to which they submit those statements in order
to render them acceptable. Aesthetic criticism is the practice of critics, art
historians and other producers of evaluative theories of 3D sculptural and
graphical objects; these theories are also practical configurations of critical statements, representations and tangible objects. The archaeology of the aesthetic criticism of 3D mediascapes also contributes part and parcel to the larger literature on the instructional potential of computer media.

1.2 Instructional considerations and applications of computer media

In the domain of interactive computer media, some instructional theorists now suggest that 3D representational worlds collapse the binary between work and recreation, mind and hand, thought and pleasure, which is useful in the design of computer-based training materials. For example, Thomas and Macredie (1994) affirm that training packages are not work, that training is by its very nature transient, and that computer game techniques can be exploited in both short term exposures involving more transient training sequences and longer term exposures requiring more opacity of comprehension. At the same time, we can safely assume that disciplinary boundaries separating the arts and sciences are collapsing and that computer media is playing a role in that process of transgression: it is possible to identify writers and critics concerned with the figuration of 3D objects and bodies in the intersections of art, architecture, the biosciences, feminist studies, media, physics and post-structuralist philosophy (Deleuze 1987, 1990, 1995, Eisenman 1993, Benedikt 1991a, 1991b, Haraway 1997, Stone 1995a, 1995b, Derrida 1984, to name a few). In my initial survey of the literature on computer media and instruction, I find three threads of commonality, which are as follows: 1) a
literature on the simulation of objects, bodies and narrative pleasures on the surfaces of cyberspace, 2) constructivist notions of knowledge-building in 3D mediascapes, and 3) the use and application of animated, game-like features that evoke diverse and intuitive ways of thinking and learning in instructional media.

1.2.1 The Aesthetics of simulations

As computer simulations of real events, things, or environments appear more and more real, a confusing paradox emerges: as we move closer to creating artificial experiences that are as compelling as real ones, we breach the divide between aesthetics and technology with more frequency, realizing that aesthetic issues have engineering consequences. The artificial existence of the virtual object therefore signals an ontological shift to a full-fledged, aggressive surrogate reality comprised of digital symbols. Rheingold (1992) suggests that as reality disappears behind the screen, reality itself becomes a manufactured and metered commodity. Therefore, 3D simulations acquire the qualities of tangibility and use-value in computer spaces, but they also encompass so much more...

Broadly speaking, I define simulations as manifestations of appropriation and serial production in photography, digital animated media and other technological forms. Jameson (1991) reminds us that they are symptoms of our addiction to a culture of image heterotopias that appropriates past styles in a perpetual present. Baudrillard (1983) defines simulations as the ever-
present proliferation of artificial third-order signs, the results of a continual semiotic production that erases all traces of original referents. He presents consistently a view of commodity culture by which marketing signs are the surface forms of third-order hyperreal appearances that have completely erased all real objects of representation. Crowther (1993) likens simulations to myths, whereby "original" or "prior" semiotic images are distorted rather than negated. The production of simulations modifies and changes former connotations to create new signs, making images appear ordinary or "natural" by working subtly and covertly. Dowling (1997) locates all of the above definitions of simulations in the postmodern camp in terms of their acceptance of the "intrinsic reality of simulations and copies," the substitution of signs of the real for the "real" itself, and the belief that these signs provide a more ductile material than any real meanings (as opposed to granting those signs the status of representations). Conversely, Heim (1993) argues that simulations cannot be "dream injections," or Disneyland ventures, just as the concept of the "real" cannot be reduced to pure perception or sensation. Regardless of the point, the issue of the existence of alternative simulated worlds that are contingent on sensory frameworks keeps emerging in the literature on instruction.

Moving closer to the sphere of representations and ideas, Deleuze (1990) describes simulations as constructions devised through a sense of disparity or difference regarding meaningful referents in projection and on the
surface of the computer monitor. He argues that the surface is the realm of ideas as simple incorporeal effects and "phantasms" of thought. This explains how the participant is able to operate in a situation involving total sensory immersion, in a self-contained world within cyberspace; it also helps to explain the ambiguity between 3D simulated objects and "real" bodies, the confusion between actual and virtual created by a high degree of realism, by the synchronous use of sharp three-dimensional images, photorealistic "real-time" texture mapped worlds, and 3D digital sound space (and certainly many more technological advances are on the horizon). Deleuze (1989) also suggests that the liquid nature of simulations are made up of aberrant movements and false continuity devices and effects that actualize narrative events. These simulations enact, or perform, an exposition of the virtual that makes the event resound in thought. Studies of the capacity for 3D animations to construct cinema-type narratives and narrative pleasures in computer games (Cutrono and Harrell 1996, Gussin 1994, Vered 1998, Wolf 1997) also validate an interest in the role of simulationist aesthetics in computer media.

Digital simulations are also described as visionary architectures that offer an excess of possibility in shape, contour and topological construction. Novak (1991) suggests that cyberspace is intrinsically about the space that we enter; a modulated, artificial, architectural space. Invented, simulated worlds require a full ecology of subjects, objects, space, time and process as basic elements. In physical space, two objects cannot occupy the same space at the
same time, but such a restriction is not strictly necessary in cyberspace. The identity of objects is not merely limited to their physical manifestation, but there can be hidden, small differences in objects and attributes that are not always visible opaquely, which allow for the poetic merging of objects in evocative composites. Deleuze (1990) draws on the stoic pure physics of surfaces, whereby a simulated event is subject to a double causality, a mixture of bodies and incorporeals linked together in a quasi-causal structure that involves some degree of randomness.

The events of a liquid surface depend on molecular transmutations (on the level of matter, the body), and on variations of a simulated surface tension. Novak (1991) describes how entities behave like phantoms, surface appearances that are the results of particular values assigned to tokens, pass through each other freely and interact on the basis of a list of operations vaguely reminiscent of their "real-world" analogues.

Eisenman (1993) acknowledges Deleuze for articulating this new relationship between vertical and horizontal, figure and ground that breaks up the existing Cartesian order of space in digital simulated worlds. Eisenman is inspired by Leibniz's turn away from Cartesian rationalism and in his depiction of the point of the fold as the smallest element in the labyrinth of the continuous. We can now draw an association between sculpture and the manner in which we are accustomed to interacting with computers. The interface is a modulated information space that remains external to us,
although we may construct elaborate spatial visualizations of its inner structure in our minds. Within the dialogue between the aesthetic discourses that surround topological shapes and surfaces and those discourses focusing on bodies, animated simulations reflect both the liquid synthesis of the surface of appearances and the depths of materiality.

The recent critical aesthetics of 3D computer simulations has also been concerned with the nature and character of erotic sensibility and play, as well as the cyborgian "neuromapping" of body figurations within and without "virtual space". Stone (1995a) describes the post-mechanical body as constituent of simultaneous multiple bodies: 1) the "neurobody", or the internal neural impression of an external physical form, 2) the body that acts as the translator between neural impression and physical sensation, and 3) the topological body of 3D, or 4D surfaces (including space-time dimensions). Stone chooses erotics, grounded and authorized by multiple bodies, as her aesthetic problem: the body image, or sense of the "topological self", is mediated partially by both digital mechanisms and cultural contexts.

Haraway (1985, 1997) describes these diverse cyborg figures as hybrids of machine and organism, as human/nonhuman couplings, or as crossovers, boundary transgressions and transmogrifications of the body in cyberspace. Cyborg figurations, which appear and reside in quasi-organic, quasi-machinic interface environments, are important in delineating the ontological nature of virtual worlds in that they pertain to topological
representation and simulated visual forms. Actual and virtual worlds implode, bend our attention, warp our certainties, and sustain our lives in the gravity well of technoscientific. Cyborg figures resist this process of erasure by their parodic placement at pivotal junctures, their existence as knots of knowledge-making and technical/cultural processes. The aesthetics of the post-mechanical bodies has imploded into a vast congeries of organs, surfaces and protuberances, enabling a myriad of somatic and aesthetic responses.

The body possesses multi-dimensional tactile extensionality, every extension of which is potentially an “attractor” and “grounder” for the play of techno-sensuality. Stone (1995a) draws on Deleuze and Guattari (1987) in identifying “virtual technology” as the prime example of “rhizomatic” or “smooth” space, capable of allowing random desire lines and multiple juxtapositions. The simulationist aesthetics acknowledges the post-mechanical body as something “nomadic”, as seeking out new transgressive objects and connections requiring the re(e)valuation of the body’s positioning within creative force(s) and desire(s). Perhaps more importantly in terms of a critical 3D object aesthetics, Stone (1995b) suggests that computer animated interfaces are about remapping the locus of desire to extend an expanded and reconfigured erotic both virtually into the machine and physically into the body. Consequently, assumptions about photorealism in the cinema and, more recently, 3D interactive media are tied to the simulation of objects, bodies and narrative scenarios in the hyperreal worlds of cyberspace, as exhibited and
confirmed by the literature at hand.

1.2.2 Constructivist notions of knowledge-building in computer media

In instructional media, the overlap between art aesthetics and the consumer commodity has important consequences for constructivist notions of knowledge-building within and between multiple microworlds: the observer's sense of reality takes place in computer interfaces, in media-penetrated computer environments or closed-circuit installations, so to speak, where the observer sees herself in the observation devices. Constructivists (von Glassersfeld 1995) take seriously the plasticity of multiple actual and virtual worlds, versions that are actual depictions and alternatives to a single world rather than descriptions of "the world". Plasticity is absorbed as a knowledge-based term in the sense that any internal reality is constructed and reconstructed, stretched and shaped to fit purposeful acts and the instrumental and practical function of knowing. The capacity of immersive, interactive simulations to offer "alternative realities" that are useful as educational tools is therefore a concern of instructional technologists.

The 3D object aesthetics of computer games are beginning to find their way into instructional media (Dede 1995, Homan 1994, Pantelidis 1993) and computer-based training (Filipczak 1997, Stewart 1997, Thomas and Macredie 1994, Triber 1994). The capacity of simulated worlds to offer alternative realities that are useful as educational tools is a primary concern of
instructional technologists, some of whom are optimistic about the potential of
the so-called immersive virtual reality (VR) to allow the user to modify the
virtual world, or to build new worlds which may or may not simulate an actual
software and hardware according to constructivist criteria of their capacity to 1)
explore real things without alterations in time or space, 2) create places and
things with altered qualities, 3) interact with real people in imaginary spaces
and in non-realistic ways, 4) create and manipulate abstract conceptual
representatives, and 5) interact with virtual beings (historical figures and
agents) in simulated negotiations. Dede (1995) suggests that there are three
primary applications for VR in the learning process: 1) visualization, the user’s
ability to manipulate and rearrange information spatially and temporally so it
can be easily understood, 2) the simulation of real world, imaginary, or
constructed phenomena, and 3) the development of constructivist, participatory
environments and activities that can only exist within computer microworlds.

Visualization is an important issue, since it permits the perception of
connections and relationships between ideas and things that may otherwise be
difficult to comprehend. Visualizing within a simulated microworld allows for
the modification of 3D objects through real-time interactions, and permits the
participant to manipulate and alter spatial and temporal relationships,
perceptual scale, and observer point-of-view. Participants engage in
responsive, navigational, full-immersion micro-environments in which they will
become involved in body-mind kinaesthetic learning (Homan 1994, Pantelidis 1993). Educators suggest that participants may be better able to interrelate and integrate content and experience, thus enabling a more personalized and specific awareness of problems and solutions (Dede 1995, Ferrington and Loge 1992).

Dede (1995) asserts that the user's symbolic immersion also triggers powerful semiotic and semantic associations through the content of computer microworlds. Following Heim (1993), he suggests that users remove themselves further from empirical, or physicalist assumptions and observe the simulated world through its digital symbols. Heim himself insists that simulations need to be "not-quite-real" in order to augment reality, or something "other than real" that continues to evoke our imaginations and our capacity for new visualizations. Consequently, Winn et. al. (1995) suggest that immersive environments that surround the observer with sights and sounds in stable, well-constructed 3D space can create the same feelings and thoughts that arise from interacting with signs in the "real" material realm. They follow Cunningham (1992) in their interest in the design and construction of simulated, digital microworlds from the standpoint of constructivist theory. McClellan (1993) also engages in the concepts and uses of avatars (3D objects, icons, or symbols in digital spaces), which offer strong clues to the operation of complex phenomena, or to the design of interactive forms of entertainment and learning.
Rather than excluding the application of animated 3D computer game features to computer-human interface design, animations can be used to build complex representational worlds in training materials (Psotka 1995, Thomas and Macredie 1994, Triber 1994) and VR computer simulations (Auld and Pantelidis 1994, Dowling 1997, Winn and Brecken 1992). Stewart (1997) also explores elements of game design and World Wide Web instructional gaming (entertainment, fantasy, nontargeting reality) for use in courseware and asynchronous learning opportunities. In general, the literature suggests that 3D representational worlds help in knowledge construction without the potential difficulties that can arise from interaction in "real-world" (the physical realm outside of interface) working environments. Breaking down the binaries between work and entertainment, cognition and play, hand and mind, "transience" and "opacity", and other such constructs within the literature on instruction, 3D game features can be used to construct narratives, build spatial and abstract skills, or to develop other skills.

1.2.3 The Use of animated, game-like features in intuitive interface design

Although the literature on the effects of computer games on instruction has been greatly concerned with learner motivation (Caroll and Thomas 1988, Demsey 1994, Westrom and Shaban 1992) and the unsettling, deviant and potentially dangerous nature of the some computer-based phenomena (Ballard 1995, Funk 1993, Irwin and Gross 1995, Griffiths 1997, Kirsh 1997), a shift
toward promoting animated, game-like features in the design of computer
instruction is slowly emerging (D'Amato 1996, Filipczak 1997, Thomas and

The conventional literature on motivation is largely influenced by Bruner
(1966), who examines the capacity of games to motivate intrinsically users to
learn and play. "Intrinsic motivation" does not depend on any reward that lies
outside the activity it impels, but in the "successful termination" of the activity
itself. Malone (1981) suggests that intrinsically motivating environments in
computer-based "adventure games" are made up of a number of components:
these include challenge, the varying levels of difficulty, fantasy, the acting-out
of imaginary scenes and scenarios, curiosity, the searching out of hidden
information, novelty, the discovery of new, or newly transformed information,
complexity, the necessary application of reasoning, and surprisingness, the
element of unpredictability. In quantitative studies, design improvements in the
prototypical adventure game increase metacognitive skills. Dempsey (1994)
concludes that games have been found to serve many instructional functions,
such as tutoring, amusing, exploring new skills, promoting self-esteem, or
seeking to change attitudes. Bruin (1980) suggests that early computer-
gaming simulations held the potential for achieving the following "complex
educational objectives": insight into complex relations and dynamic processes,
learning skills to tackle problems, the development of creativity, the
improvement of convergent and divergent thinking, and the teaching of social
skills (many of these objectives remain undefined).

The aesthetics and metastructural dynamics of animated 3D digital images allude to the paradoxes of physics and mathematics in that they facilitate learning and knowledge-building through the play of abstraction, particularly in a certain genre of computer games which includes Tetris™ and Endorfun™. Winn and Bricken (1992) discuss the possibilities by which the axioms of algebra are built into inclusive, interactive, 3D computer worlds. They explain that spatial algebra, a calculus of signs, creates a mapping between algebraic concepts and spatial objects, including numbers and variables to blocks, operations to spatial proximities, and algebraic relations to space partitions.

In the hybrid techno-aesthetic field of computer animation, Search (1995) suggests that some artists and designers use 3D modeling, rendering and movement to visualize theoretical interpretations of reality by creating metastructural environments that extend the theoretical and paradoxical dimensions of space and time in dynamic, virtual worlds. Artists, like mathematicians and physicists, use visual patterns to improve their knowledge and understanding of logical and perceptual relationships. For example, the grid, which postmodernists reject as an emblem of the empirically grounded unity of art abstraction (its disinterestedness, its promise of autonomy, its lack of movement and stasis, its material determinateness), resurfaces in spatiotemporal cyberspace environments (Krauss 1996).
D'Amato (1996) suggests that contrary to the old "death of abstraction" story, where the medium's inability to engage anything but its own history is read as a sign of art's obsolescence, the language of art abstraction is alive in computer game design. Tetris™, Endorfun™ and other market products permit the player to feel as though she were manipulating abstract patterns, almost on the level of an interactive Bochner or Malevich, rolling a cube like a ghost brush, exploring the grid in a state of heightened thought and attentiveness. D'Amato (1996) explains the success Tetris™ and other similar computer games as a consequence of their paradoxical nature: construction is linked inextricably to destruction in that the player builds only to demolish, a metaphor for war, architecture, social relations, the temporal and procedural relationships between objects and ideas, etc. The metastructural dynamics of the digital images integrates structure and control into a spatiotemporal continuum that defines an infinite, "virtual" space. The 3D images in new versions of Tetris™ embrace space and time from all directions, rather than limiting the vantage point from one perspective. Search (1995) discusses how time becomes the infinite extension of space and form through the mathematical abstraction of lines, angles and curves: the geometrical syntax of the fractal image forms a temporal link between "physical and virtual realities".

My dissertation makes obvious that the disciplinary fields of art aesthetics and technology are not mutually exclusive, but that the aesthetic and critical realms of art content assume primary importance within the context
of technology education (Hicks 1993). 3D object aesthetics also engage, and are connected to, studies of the effects of computer games on the spatial abilities of users, the understanding of the geometrical syntax of shapes, angles and curves, and the abstract and topological relationships between objects and/or ideas, such as the animations of the collapsing of a sphere inside-out, or the smooth deformation of a torus (an inner tube or donut shape). (D'Amato 1996, MacKenzie 1998, McClurg 1992, Pickover 1992). Like MacKenzie (1998), my dissertation is concerned with the interstices of computer aesthetics and topology in demonstrating the use of computer technology in attacking problems of surfaces in 3D space. I actualize the study of computer effects and interactivity within the context of rewriting the archeology of art aesthetics, particular the aesthetics of 3D objects themselves.

1.3 Summary of chapters

The emphasis on surfaces in the aesthetics of 3D computer animations translates consequently into a strong reliance on image mapping to create photorealistic 3D effects in the completed work or sequence. Formalism, the brand of modernist art aesthetics that derives from Greenberg's art critical writings, is recently concerned with the shape, contour, and texture of flat, enfolded, curving, hyperboloid, cylindrical, planar or other stretchable topological surfaces in 3D mediascapes. My chapter 2 examines how Clement Greenberg and his followers attempted to soften their aversion to 3D forms in
the mid-1960's, wavering in their commitment to the essential two-dimensional flatness of any specific art medium. Barbara Rose (1967) tries particularly to twist formalism to a "new illusionism" that alludes to 3D representation or "modality" in mixed-media hybrids such as cyberspace art and animated video. Therefore, my reading of the art critical literature from the 1960's underscores formalism's concern with form, surface and texture in the contemporary aesthetics of 3D computer art and animations. The current vogue and affinity for the language of abstract topology and the curved spaces of non-Euclidean geometries extends formalism's themes and prescriptions in our time, specifically in the rendering of complex 3D geometric objects in cyberspace.

My chapter 3 traces the minimalist countercurrent to formalism, including its affirmation of the arbitrary, concrete object and its expression of the contextual, everyday commodity in art. Minimalism opposes the Kantian judgement of the supersensible form in art with the insertion of the "object-concept," immanent means, technique and intuition into the creation of the plastic form. In my archeology of minimalist thought since the 1960's, I attempt to show connections and common lineages between rigorous conceptualism and the erotic, kinaesthetic interaction between objects and players in intuitive computer interfaces.

An emerging "simulationist aesthetics" in computer media expand minimalism's concern with the plastic, embodied, material nature of 3D objects and the contextual conditions of everyday things. My chapter 4 examines
aspects of simulation and photorealism in 3D mediascapes as discussed in computer journals, with special emphasis on the graphical rendering of objects and composite forms, the texture mapping of those objects' surfaces, advances in artificial intelligence as applied to avatars, and multimedia/ cinematic approaches toward human-object and object-object interactivity. Digital trompe-l'oeil effects, artificial vision, intelligent sensors for navigation, and synthetic emotional and homeostatic drives in posthuman, graphical avatars are all part of multisensorial media simulations that push the envelope of the contemporary "pictorial turn" and a culture saturated with visual sensations.

The use of temporal, cinematic-type transitions of image, sound, and touch in the construction of virtual events in computer media helps elucidate the complex, recursive relationship between thought and narrative. Simulations of "natural" effects and behaviors and of modulating durations in mind and memory inform aesthetic considerations for the design of interactive, concrete, instructional computer media.
CHAPTER 2

FORMALISM AND BEYOND: 3D SURFACE TOPOLOGY

Since the publication of Greenberg's *Art and Culture* in 1961, formalist aesthetics has become known for its commitment to the essential two-dimensional flatness of the surface and the particular formal qualities of the medium regarding texture, shape, lighting, and other features. Greenberg and his followers seem to modify their hard-edged aversion to 3D forms in the mid-1960's under threat from the appearance on the art scene of minimalism or ABC primary structures, which emphasize(s) geometric form as a gestalt, or a conceptual impression from the art or design object, and pop art that accentuates the serial nature and reproduction of mass media forms. The acceptance and inclusion in formalist aesthetics of "optical illusion" or "opticality," as a graphical effect of some 2D surface art that suggests a kind of third dimension, pave the way for the emergence and acceptance of 3D virtual objects and spaces in computer media. This "opticality" permits allusion in work, but forbids the illusion of the human figure, or any kind of tactility or palpability common to conceptualist sculpture: As an example, Barbara Rose
(1967) goes to some length to bend formalism to this "new illusionism" in attempting to reconcile abstraction with illusionism, the flatness of the surface of the medium (whether paper, canvas, celluloid, or computer interface) with a cerebral and not a physical understanding of 3D form. Providing weight to this position, my reading of the art critical literature supports the premise that Greenberg himself permits nonmodernist mixed-media hybrids to salvage formalism.

The formalists, Greenberg (1967), Fried (1968), Krauss (1968), Moffett (1969a,b) and Rose (1967), express some interest in how the 3D sculptural event in "real" Cartesian space creates spatial metaphors between objects. Greenberg chooses the sculptures of Jules Olitski as an epitome of modernist abstraction, because they create the illusion of capturing and folding surfaces of color in 3D space, an effect that seems to render them weightless. "Weightlessness" is a term from abstract art that implies free movement and a sense of not being grounded. Instead of the illusion of things, Olitski's sculptures offer us the illusion of modalities, namely that matter is incorporeal and weightless. These hybrid pleated surfaces raise topological issues concerning 3D virtual composite objects and their relationships to 3D spaces.

The contemporary aesthetics of 3D computer art and animations (as

4 Rosalind Krauss has a long, polemical relationship with formalist aesthetics. Although she began art critical writing in the 1960's, when formalism was on the upswing, Krauss (1988) insists that she has always maintained a critical stance toward formalism, even going as far to repudiate formalism in her recent work.
represented in the journals, *Leonardo, Domus*, or *ArtByte*) extends formalism's concern with form, surface and texture to include the language of abstract topology and the curved spaces of non-Euclidean geometries.

2.1 Greenberg's rigorous formalism

Greenberg's anti-illusionist aesthetics of the early 1960's advocates the abandonment of "3D illusionism" and stresses the real, essential 2D nature of the surface. His aesthetic program of stressing formal results, historical conventions, and flatness of medium quickly gained momentum and credibility in the 1960's and 1970's. Two decades later, Noël Carroll (1988) acknowledges the persistence and longevity of Greenberg's historical interpretation. He points out that formalist aesthetics, the institutionalized language of the art world, categorizes illusions under rubrics such as imitation, mimesis, verisimilitude and copies. Carroll charts the history of modern art chronologically as a movement from the illusionist commitments of Western art in Renaissance realism and naturalism to its demise in abstraction and the presentation of art as everyday things in pop and conceptual art. Mitchell (1994) suggests that we encounter a paradox in the coincidence of a contemporary "pictorial turn" in popular culture at the moment when anti-illusionist postmodern thought is emerging from marginality on the art theoretical scene. He observes that the fantasy of the pictorial turn, of a culture dominated by both visual simulations and mimetic images, has become a real technical possibility on a global scale in an era of post-photographic,
cyberspace technologies. It is not coincidence but irony that people express anxiety over the power of images during the age of electronic reproduction, an era characterized by new forms of illusionism, including digital 3D illusionism. Crary (1990) also observes that imaging technologies are becoming increasingly dominant in global information industries. He writes, “visuality will soon be situated on a cybernetic and electromagnetic terrain where abstract visual and linguistic elements coincide and are consumed, circulated and exchanged globally” (1990, p. 2). Crary suggests that the post-impressionist break with realism involved the adoption of a new model of vision, a massive reorganization of knowledge, and big changes in the productive, cognitive and desiring capacities of the subject unfolding with the invention of the photographic camera.

Greenberg and other formalist critics of the early 1960’s oppose the illusionist trend in aesthetics with their reassertion of the abstract property of flatness in the artificial object: from the post-impressionists onwards, these critics observe the unrelenting march toward more emphatic, more unequivocal affirmations of flatness in art. Carroll (1987) notes that forms of abstract and/or reflexive art that reveal the essentially artificial nature of art and media are anathema, antidote, or replacements for forms of illusionism. Postmodern criticism has taken the left branch extension of formalist aesthetics in continuing to reveal the manner by which the illusionism of mimetic pictorial and sculptural representation is connected to ideological purposes.
Greenberg's brand of formalism searches for a universal formal language that employs visually harmonious relationships between objects, experiments with pure color, and renders visual forms with minimal interest in social issues. It tries to establish objective criteria for art based on the interaction of form and medium. Formalism is highly deterministic in nature, allowing only one approach to evaluating the aesthetic quality of art and media: Its program dictates that the work of art be a totally autonomous material object, which makes no reference to anything beyond its boundaries: the surface itself, its color, its consistency and its gesture are to be the only "content" of the work. Greenberg's *Art and Culture* and his widely known essay, *Modernist Painting*, were both published in 1961 and were almost immediately accepted as an aesthetic canon for a whole generation of artists, designers, historians and critics, even those who chose not to adhere to it (de Duve 1996, p. 201). Throughout his writings, Greenberg emphasizes the importance of cubist collage, which elevates the surface as a substantial object in its own right (rather than a projection). Victor Burgin (1982) suggests that cubism becomes the point of departure for the complete erasure of the sign from the surface in formalist art, and this perhaps reflects Greenberg's original expectations for abstraction as expressed in his writings from the 1950's and early 1960's. For example, Greenberg (1958) explains how the early abstractionists and cubists flattened out the "3D illusionism" assumed in the tradition of Renaissance art. He describes how Brancusi quieted monolithic
sculpture by reducing the image of the human form to geometrically simplified ovoid, tubular or cubic masses (which very much resemble the biomorphic forms that emerged in early digital 3D animations). Greenberg suggests that Arp carried this trend in near abstract sculpture to the cubists, Picasso and Braque, who unlocked the flatness of the literal surface by purely pictorial, graphic means (1958, p. 58). The literal surface of collage does not rely on either representation or three-dimensionality to express its “positive, sensational concreteness.”

In his writings from the early 1960’s, Greenberg insists that contemporary aesthetic tastes for the immediate, the concrete and the irreducible form can only be manifested by unique medium-specific attributes. The medium is the locus of the artist/designer’s aesthetic constraints and possibilities: the modernist artist’s aesthetic judgment has to be inspired by or received from the formal medium itself. de Duve (1996) reads formalism as both dictating and mediating between “genericity” (art as art) and “specificity” (art as medium): The statement, “this is creative” or “this is art” formalizes in language the affect or quality of the work, which leads eventually to aesthetic judgment as if quality were the property of form and visual appearance (de Duve 1996, p. 214). The content of any medium, which is the only subject matter of art, can only be understood as an ineffable aesthetic quality or affect. Formalism’s tropism refers to aesthetic value as such, and to its specific tendency to surrender to the flatness of each medium, whether it is graphics,
film or sculpture. For Greenberg (1960), abstraction consists of the ultimate surrender to each medium's distinctive form of resistance to 3D illusionism or to realistic perspectival space. Although Greenberg (1958) acknowledges that the purity of abstraction is an unattainable ideal, he believes "concrete abstractness" can be an orientation or aim for work in each medium (even sculpture or, ostensibly, computer graphics stand to gain by the modernist reduction to flatness). It follows that a modernist work must try, in principal, to avoid communication with any experience not literally or essentially inherent to its medium, which might involve renouncing illusionism and explicit subject matter (1958, p. 56).

2.2 Cracks in the foundation

In the mid-1960's, under fire from suddenly emerging minimalist (primary structure) and serial pop art forms (which stress the idea or concept as the underlying reason for art or design work), Greenberg and his followers began a subtle and very gradual revision of their aesthetic values in an attempt to both salvage and broaden the appeal of formalism. de Duve (1996) makes obvious how Clement Greenberg and Michael Fried initially rejected minimal or minimalist art (which they perceived at the time to be a greater threat to formalism than pop art or new realism), but soon realize that it became pointless to declare minimal art illegitimate. From the mid-1960's on, the formalists had to live with the fact of an art that calls itself minimal, that relies on the perceptual experience of the "real" or the "literal," an experience that is
unmediated by the limitations of a specific medium (de Duve 1996, p. 225). Although this may seem far removed from current preoccupations, it has serious consequences for present art and design practices, particularly because we have never resolved the disagreements and the pendulum swings back and forth between formalist and conceptual art with regularity. Conservative arguments that continue to seek the revival of craftsmanship and traditional authorship are pitted against those artists and designers who retain the right, inherited from debates in the 1960’s, to produce generic art that refuses the reduction to a specific medium, and to engage in appropriation practices often called neoconceptual or postmodern. The artistic and creative works of these artists and designers depart from two-dimensional flatness and “opticality” (the optical, graphical illusion of a kind of third dimension) in multiple and various ways, including the infusion of 3D virtual objects and spaces.

Even formalists (Krauss 1968, Fried 1966, Rose 1967,1968) reluctantly acknowledge the shift in Greenberg’s position on aesthetics during the 1960’s regarding absolute flatness and two-dimensionality. In “Modernist Painting,” Greenberg (1960) admits that the closer the sensuous canvas moves to sculpture, its immediate neighbor, the more difficult it is to trace the borderline between different media and, paradoxically, the more strong anti-structural, 3D, tactile qualities that must delimit the specificity of modernist painting. When reading Greenberg, it becomes obvious that he is wrestling with the
ideational currents surrounding hybrid new media at the turn of the decade, particularly since he flip flops in his commitments to 2D flatness out of chronological order. In 1960, Greenberg writes, 3D is the province of sculpture and painting must divest itself of everything it might share with that art (1960, p. 70). In “Sculpture in Our Time,” published two years earlier, Greenberg (1958) suggests that we permit sculpture greater latitude of figurative allusiveness than other media, because it remains tied to the third dimension. The illusion of organic substance or texture is analogous to 3D in pictorial perspective (such as that in 3D graphics or canvas arts) and, Greenberg continues, this illusionism, literalness, or conceptual content has become an advantage rather than a hindrance (1958, p. 59). Sculptors can confine their art to virtually two dimensions without violating the limitations of the medium if they so choose (as does David Smith, Greenberg says), or they may choose to explore the full three dimensions of the medium, by “drawing in the air with a single strand of wire” (1958, p. 61).

Also, in a rare moment of self-criticism, Greenberg admits that he may have been altogether wrong about sculpture and 3D art, that “construction-sculpture,” or “drawing-in-space sculpture” in the late modernist period is making itself felt as the most representative, fertile visual art of our time (1958, p. 60). Minimalist 3D works depart from 2D pictorial, graphic work by adding a three-dimensional element to it; by deliberately transgressing the boundaries where, Greenberg suggests, the specific medium ends and the arbitrary,
generic 3D object begins. Greenberg now drops his pretension that there is a medium-specific objecthood: artists working in real or virtual 3D spaces breach the boundaries between art and real everyday things.

Greenberg therefore permits nonmodemist mixed-media hybrids to salvage formalism, which later gives birth to its left branch alternative in postmodernism and simulation. Just as Manet allowed early (nineteenth century) photographic simulacra to infect painting from within, postmodernist artists and designers pull art out of abstraction and modernism by acknowledging (albeit critically, reluctantly or antagonistically) a return to imitation and illusionism. As de Duve (1996) concludes from his study of 1960's art polemics, if two dimensionality is the last specific refuge of modernist painting, then three dimensionality must be the domain of new, generic, hybrid arts.

2.3 Illusory hybrid representations: aesthetics or metaphysics?

As early as 1967, Barbara Rose wrote about this return to illusionism, the shift in focus from the acknowledgment of graphical flatness that characterized abstraction of the 1950's and early 1960's in favor of the recognition of the inescapable illusionism of multimedia spaces. At the time, such illusionist devices included two and three point perspective, orthographic drawing, and warm-cool color contrast (Rose 1967, p. 33); but by the 1990's these have expanded to a broad range of digital image, video, and other post-photographic practices. Staying true to the formalism that she sought to
defend, Rose goes to some lengths to show that the "new illusionism" is purely graphical, functioning at the level of the surface. She attempts to reconcile abstractness with illusionism, the flatness of the surface of the medium with the illusion of 3D space. The heightened sensitivity of the surface, its plasticity, does not permit sculptural illusion, but it does and must permit optical illusion, Rose says. In this sense, the new illusionism never tricks the mind, nor is it really any kind of trompe l'oeil that succeeds in deceiving the observer about the real nature of texture or space (Rose 1967, p. 37). On the contrary, the new illusionism makes every effort to insure that the mind grasps at once that there is no real space behind the plane of the picture or computer monitor. Rose suggests that the artificiality and abstractness of the visual space are tacit facts: the 3D space created on the hard, reflective, smooth, "anti-natural" or plastic surface is a purely imaginative projection that bears no relation to reality. Rose writes,

... the mind understands that it is dealing, not with actual space, but with a purely artificial, imagined space. Irrationality, or seeming irrationality, paradoxically becomes the agent or rather the evidence of a rational conception, rather than the mark of a failed illusionism (1967, p. 37).

Consequently, Rose's formalist stance defines one important position in emergent arguments over the nature of virtual reality and virtual 3D art: there is never any failure in the illusion of 3D objects and spaces, rather the explicitness of the artificiality of the surface, whether it is plastic, glass, celluloid or a hybrid of materials, deliberately limits the type of illusionism
possible to one that is abstract, symbolic and conceptual. The arbitrary design object creates neither the illusion of a created world, nor the conditions of an actual, parallel world until the qualities of the media are completely transparent and unperceivable. Simulation can never escape the constraints of formalist new illusionism unless it overrides, or circumvents the artificial nature of the media (the technical context and constraints in which virtual, 3D illusion takes place).

Carroll (1988) helps explain the premises of Rose's interpretation to refute it on philosophical grounds. Rose and other formalists believe, according to Carroll, that art works never have all the qualities of their referents and, conversely, they may hold some properties that their referents lack. As a necessary outcome of formalist assumptions, 3D virtual simulations in cyberspace are consequently always illusory, on the one hand, as are all representations that are not perfect similes of some original in every way, including those with spatial and temporal features. On the other hand, visual representations can only function as pure illusions (trompes l'oeil) if they deceive the observer into believing they are “real”; they are otherwise capable of optical illusion only. For example, the photograph must depict objects within a single, fully consistent perspective space, and the spatial cues given by foreshortening and shading of surfaces must be precisely consistent with each other.
A series of discerning inquiries may distinguish between a photograph and a digital manipulation: Are the shading and cast shadows consistent with the lighting conditions and sources? Are objects in plausible scale relationships? Are geometric and aerial perspective correlative with each other? Are inserted objects betrayed by lack of expected cast shadows or by shadows cast by incorrect angles? Are there unexpected discontinuities in either the foreground or background? Do highly specular (shiny) surfaces show mirror reflections consistent with the observer's spatial interpretation of the scene? Even when the photograph, whether printed from an original negative exposure or a digital simulation, passes such a cursory inspection, we must remember that the surface of a "realistic" photograph supports irregularities, such as scratches, grain, or imperfections created by dust, which observers see through in order to comprehend the representation or conceptual content that has been chemically embedded on the 2D surface. Seeing through such surface distortions presupposes that observers know they are looking at a photograph, not a transparent window on the world. However, Carroll explains that contrary to the viewpoint of "naive" anti-illusionists and formalists, who contend that framing is what allows us to distinguish between visual art and its context, popular imagery never succeeds in presenting itself as real or natural in the sense that the observer could mistake the image for a product of nature rather than culture (she/he is not so easily duped). Further, the important formalist binary between depth and flatness (the articulation of
space, the shallowness of space) is only a metaphorical term of pictorial (graphical) description (Carroll 1988, p. 300,302). This argument over the ontology of the art object has notable ramifications in virtual mediascapes, where designers attempt to overcome the sensorial distinctions between medium and referent.

2.4 A Brief digression: the consideration of virtual mediascapes

Formalism relies on the premise that all graphical environments are always and necessarily illusory hybrid multimedia representations, but formalism became well-entrenched as the dominant art aesthetics long before the emergence of widely-available desktop VR technologies, or the appearance of 3D animations in popular cultural products. Dovey (1996) defines virtual simulations are defined as complex mediaspaces, as multisensory post-photographic representations of reality; but Heim (1993) also defines them as artificial, three-dimensional, animated, symbolic reality that has the capacity to rejoin the mind and body. The ontological premises behind these two definitions are quite far apart, reflecting two opposite sides of a continuum. Heim (1995) insists that CD-ROM media show only desktop through-the-window views of virtual worlds, and as such remain an abridged form of virtual experience. One can argue, however, that virtual immersion systems have existed in one form or another since the 1960's, particularly as 3D immersion headsets. Heim cannot easily refute the formalist presumption
that virtual worlds consist of media representations.\(^5\)

Virtuality raises questions on how to interact with unusual configurations of (dis)embodied informational sensoria, or how to define possible alternative spatio-temporal regimes: Do virtual mediascapes exist within our immediate sensory frameworks, or outside of them? Do they survive in Newtonian space, or do they inhabit other dimensions? How can we posit the virtual object?

By its very nature, then cyberspace (virtual computer space) revivifies and extends some of the more basic techniques and questions having to do with the spatial nature of mathematical entity, and the mathematical nature of spatial entities, that lie at the heart of what we consider both real and measurable. It subverts the implicit notion of space itself as something necessarily physical, revealing that it is only one manifestation of the gravitational and electromagnetic field of play within both actual and virtual worlds. The Cartesian coordinate system is but the first of a number of possible “spatial” topographies with which to explain the animated movement

\(^5\) To address these ontological discrepancies, here are some recent definitions of virtual reality (VR): Heim, reflecting on the most common sense understanding, writes that VR is an event or entity that is real in effect but not in fact: there is a sense that any simulation creates sensual impressions of objects that are not real (1993, p. 109). Michael Benedikt (1991) remarks that VR is as close as one can come in reality to entering a totally synthetic sensorium, to immersion in a totally artificial and/or remote world. Sandy Stone (1995b) defines VR as a link, or a coupling between the phantasmic space that calls into being and the physical space of pain and pleasure that the human body inhabits, and as a technology that produces, organizes, and legitimates a discursive space that has quasi-Cartesian concomitants. The question emerges, then, as to the essential ontological nature of virtual mediaspaces. Any such discussion must engage in some mundane issues, such as knowing the limitations of everyday laws of nature and their effects on perception.
of three-dimensional forms in cyberspace. Benedikt (1991) locates Cartesian coordinate space at the apex of Descartes' long endeavors in optics and mathematics, the fruit of his project in *La Géométrie*, which demonstrates precisely how the theorems of Euclidean geometry are transcribed into symbolic, algebraic language. Descartes' algebra is constrained by Euclid's axiomatics and suppositions regarding his spatial experience of the "real" world. The Cartesian system is only one of many possible, alternative topological paradigms emerging in explanation of virtual spatio-temporal phenomena in cyberspace.

Despite Serres and others' discussions of the Euclidean articulation of work and space as foundational in Western cultures, and the premise that VR mediaspace is but another extension of Euclidean forms through projection, David Tomas (1991) argues for the possibility of non-Euclidean forms of cyberspace. Serres (1983) warrants that cultures can be differentiated by the particular forms of the set of junctions in Euclidean space: its appearance, its locus, its changes of state, and its fluctuations can be mapped in a plastic and objectivistic manner. As a consequence of these mappings, a culture is reduced to a set of homomorphisms: the identity of a culture is to be read on a map, its identification card. In keeping with his one-dimensional model, Serres submits that the body works only in Euclidean space, where it sees in a projective space; it touches, caresses and feels in a topological space (Serres 1983, p. 44). At its most extreme, in its representation within virtual simulation,
the corporeality of “laboring” human bodies is replaced by pure information
whose configurations signify disembodied human sensoria, personality
constructs, and artificial intelligences, Serres says. Tomas is certain that
cyberspace has the capacity to facilitate direct hardwired experience of other
non-Euclidean space and spatialized consciousnesses. He suggests that the
digital domain exhibits the potential for “radical, postcorporeal, economic
transubstantiation of the human body’s traditional organic and sensorial
architecture” (Tomas in Benedikt 1991, p. 35). Within these conceptions,
Gibson’s science fictional works on virtual worlds technologies can therefore
be seen as holding some promise of new spatial configurations and related
postorganic life forms. Serres’s conception of the social is radically modernist
in the sense that it positions organic human bodies as junctures for the
construction of fluid cultural identities: it posits the social realm as a functional
topology governed by a Euclidean master space. Tomas’s conception of the
social is perhaps postmodernist in its consideration of virtuality as something
other, as some kind of new social space.6

6 The voice of reason, Heim (1993) asks us to take a (virtual) reality check: he makes
the distinction between VR in the present and the future, suggesting that today’s
virtual worlds are also symbolic worlds that are anchored in the material, real world.
He presents three hooks that anchor us to reality while we are in virtual worlds: 1) we
all have a sense of being rooted to the earth, a finite planet with fragile ecosystems,
2) we all have a sense of temporality expressed in both memory and foreboding, and
3) the possibility of physicality reminds us of our mortality (Heim 1993, p. 136). No
certainty exists that these hooks actually place parameters around reality. Heim
certainly considers them existential features of the real world as anchor, believing that
they function as plausible limits on the construction and experience of VR. He is
suspicious of the existence of virtual worlds without this ontological security.
Heim seems torn about the definiteness of his convictions as he vacillates between the need for metaphysical guarantees that enhance virtual worlds and the need to keep the virtual *in reality*, something less than real that continues to evoke our imaginations and our capacity for new visualizations. Rather than (re)frameing, or blocking off a piece of reality, VR needs to be *not-quite-real* in order to augment reality. Conversely, Heim suggests that a virtual world can be virtual only *in contrast* to the actual, anchored world, otherwise the breadth of its vision would be maddening to the viewer.

Heim’s position on symbolic worlds has important implications for VR mediaspaces. Firstly, Heim (1995) suggests that virtual objects are not representations: they do not “re-present” or “present again”. There are no originals for graphic images to be copied, because VR images themselves are *the realities*. Once more, VR sensory immersion allows the participant to inhabit the virtual world and interact with virtual entities through her/his telepresence in cyberspace (the idea of virtual reconfiguration, or transfiguration sounds somewhat far-fetched within the current state of technology). Apperceptive VR immersion permits its participants to feel themselves perceiving 3D graphical objects in both a self-reflective and kinaesthetic manner: it creates a spiral telepresence that allows the movement between cyberbody and primary kinetic body (Heim 1995, 72). As an (allegedly) unwanted aftereffect, Heim suggests that this shifting back and forth between natural and artificial worlds, causes a sickness or vertigo as the virtual world injects its “hallucinatory afterimages” into the actual world. This ontological rift (a kind of jet lag) marks the gap between virtual and biological bodies: the virtual body still lingers in the afterimages formed by new neural pathways while the primary body resumes its activities in the actual, material world (Heim 1996, p. 68). Virtual simulations are therefore quasi-mystical environments, vertigo machines, narcotic distractions against the vicissitudes of reality that linger in their afterimages. At the very least, Heim affirms that virtual worlds are experienced as dizzying effects of phantasmagoria. As Kevin Robins (1994) suggests, VR may go beyond the optical illusions of graphical representation, creating a world of *perfect illusion* and *intoxication*, which is transcendent of the messy contradictions of our real Euclidean space and fleshy groundedness.

According to Heim, the artificial existence of the virtual object therefore signals an ontological shift to a full-fledged, aggressive surrogate reality comprised of digital symbols. The movement into a virtual world is more than a paradigm shift, or a shift in epistemological stance, but a shift in symbolic reality where the world or context of the object become meaningful (Heim 1993, p. xiii). The more rational Heim argues that VR is not a dream injection, or a Disneyland venture, just as the concept of the real cannot be, *prima facie*, reduced to pure perception or sensation. This explains how the participant is able to operate in a situation involving total sensory immersion, in a self-sufficient world within cyberspace, but it fails to explain the confusion between actual and virtual created by a high degree of *realism*, by the synchronous use of sharp three-dimensional images, photorealistic “real-time” texture mapped worlds, and 3D digital sound space (and certainly many more technological advances are on the horizon).
Although his argument comes around to agreeing with Heim and then moves beyond him, Zhai (1998) initially questions whether VR really renders perception less real. While he is quick to admit that VR renders perception a little more artificial, Zhai suggests, when probing a little further, that it is possible to "get behind" the alleged physical space and see why the spatial configuration of "reality" is just one of many alternative sensory frameworks. Zhai insists that the "big contained in the small" is not a paradox, rather a relatively small computer, or laptop, can hold "inside it" something comparable to a physical space (1998, p. 2). Consequently, all possible sensory frameworks that support a certain degree of coherence and stability of perception have equal ontological status for organizing our experiences: the natural and virtual are equally real if you anchor your notion of reality in the sensory. Zhai believes that VR does not interrupt sense perception, and therefore does not lead to the illusory distortion of information. Through logical extension of this point, Zhai concludes that 1) any reason that justifies the materiality of the actual world must be equally valid or invalid for justifying the materiality of the virtual world and 2) any reasons used to call the perceived objects in the virtual world(s) illusory are equally applicable or inapplicable in the real world (1998, p. 83-84).

While the computer video monitor is somewhat different than 3D immersion glasses, the fact stands, according to Zhai, that the virtual is no more illusory than the actual, since they are reciprocal in their relationship to the self at the center of sensory perception. But Zhai, following Heim, then suggests that we remove ourselves further from empirical, or physicalist assumptions and observe the virtual world through its digital symbols, which leads to the following set of conclusions:

Zhai says forthrightly that what we have been speculating about all along: virtual and actual worlds are parallel real worlds, with a non-derivative relationship between them. Reciprocity between these worlds is reinforced by the demonstration of how functionality of the actual world can also be implemented in the virtual world, affirming that there are no ontological differences between virtual reality and actual reality (Zhai 1998, p. xiv). Zhai insists that the question of how well today's technology can do the job of a perfect simulated world is not the issue, but the metaphysical possibility of abandoning obsolete physical laws and premises is of vital consequence.

For his skeptics, Zhai provides detailed metaphysical exercises to prove that actual and virtual worlds are ontologically parallel and exhibit reversible symmetry. These tests examine the perception of body image, the tactility of object stimuli, the real movements of objects in real space, the alleged material solidity of the physical world (an ontological programming of reality), the use of energy as a concept to regulate events, and the possibility of harmful, or fatally destructive sensory breakdown in actual and virtual worlds (Zhai 1998, p. 64-74). Zhai finds all worlds co-equal and symmetrically real by the extension of his logical analysis (which I have abbreviated significantly here). Zhai applies an instrumental realism whereby the laws of physics are bent, or re-articulated to fit the course of events. He is faithful to the definition of simulation in suggesting that neither the virtual nor actual is a prototype of the other: there is no need for copies (1998, p. 80).
As formalist aesthetics reaches out to embrace both real, material 3D art forms (such as sculpture) and new hybrid 3D mediascapes (whether they be "valid" or "authentic" virtual simulations or other 3D graphical media), three premises concerning the realism/irrealism debate remain unresolved and counterpose one another: 1) if virtual worlds are unreal, artificial environments that cling to symbolic, existential features in the real world, then we experience them as illusions having no lasting effects on our perception, 2) if virtual worlds are third-order simulations made up of market signs, a plastic, ductile, pliant material that is molded only as pure appearance, as Baudrillard (1983) suggests, then they are spurious worlds which are easy to dismiss, and 3) if virtual worlds are independent, quasi-solipsistic entities, containing looped feedback, and which are able to project their own objects and ideas, then we are just beginning to refine our mathematical understanding and technical know-how to the degree that permits us to construct and/or visit them.  

7 Zhai's (1998) assertion that virtual and actual worlds are parallel real worlds, supported by his tests of perception, tactility, object stimuli, movement, solidity, etc., fits uncertainly and unevenly into formalism's anti-illusionist schema of 3D hybrid objects: 1) it justifies the formalist position that 3D art (virtual or actual) cannot be reduced to deceptive representation or phantasmagoria, because there is no conceptual or sensorial distinction between the medium and the referent, but 2) the formalist premise that media representations are necessarily optical illusions no longer pertains, because VR can never be a copy of some "original" referent. Zhai suggests that virtual worlds are alternative real worlds which exist on their own terms and, as such, they produce material signs. Heim's (1995) assumptions that virtual 3D art is comprised of artificial digital signs is even closer to formalist assumptions about the illusory nature of hybrid mediascapes, which could allegedly include cyberspace/computer media (Greenberg writes that the 3D space created on the artificial plastic surface is a purey imaginative projection which bears no relation to reality). As stated earlier, Heim cannot refute on ontological grounds arguments as to whether or not virtual worlds can be contained in CD-ROM graphical multi-media,
Let's backtrack here and examine the application of formalist aesthetics to 3D objects and spaces, particularly in the form of the “weightless” sculpture that Greenberg is so fond of, which can be equally produced in both actual (wire, metal, plastic, fiberglass) or virtual (3D cyberspace) environments.

Greenberg writes, formalist aesthetics renders substance entirely optical and recognizes form (whether graphical, sculptural, architectural, or digital) as an integral part of ambient space. This brings anti-illusionism full-circle: instead of the illusion of things, we have the illusion of modalities. Matter is weightless, incorporeal and exists only optically (like a mirage). Greenberg comes to respect those “feats of engineering” that aim to provide the greatest amount of visibility with the least possible use of tactile surface (1958, p. 61).

Sculpture and all hybrid media are included in his technical definition of “feats of engineering”.

2.5 Formalist archetypes: Caro’s dynamic 3D forms

Greenberg (1967), Fried (1968), Krauss (1968) and other formalists of the 1960’s became interested in how sculpture, or the self-contained 3D sculptural event, creates a kind of lyricism in terms of spatial metaphors, in different ways of articulating and displacing relationships between objects and spaces. In this regard, formalists have focused mostly on the careers of Anthony Caro and Jules Olitski. Caro, whose productivity spanned three
decades, was responsible for the “St. Martin’s revolution” in sculpture, named after the school of art where he taught for several years (Finch 1966, p. 23). Caro’s progeny include members of the New Generation (including David Annesley, Michael Bolus, Roland Brener, Phillip King, Tim Scott, Bill Tucker and Isaac Witkin). Although they all pursue the clean articulation of objects and spaces, members of the New Generation sometimes express a stylistic irreverence of their teacher (Finch 1966, p. 20). It is probable that Olitski was openly encouraged, if not induced, by Greenberg to turn from painting to sculpture in 1967 as part of formalism’s response to the threat of conceptual art (de Duve 1996, p. 242). The critic Ken Moffett gives his residual illusionism several pages of attention in 1967. For Greenberg and Fried, however, Caro is more emblematic of an artist who anticipated and resisted minimalist ensembles of rigorously rectilinear and spherical objects, in which the third dimension is converted into a kind of “mannerism” or fixed prototype (Greenberg 1967, p. 254). Greenberg and Fried emphasize the radical abstractness, or unlikeness to nature of Caro’s work (a frequently used euphemism in the 1960’s), and the “weightlessness” of his sculptures in the way they are said to resemble Alexander Calder’s mobiles. Again, this kind of weightlessness belongs to the tradition of non-monolithic sculpture that is derived from cubist collage. While some formalist critics, such as Krauss (1968), carry the cubist metaphor of illusionism to extreme conclusions (optical illusion becomes tactile opticality, sensuous to touch, as Krauss pushes the
micrological analysis of the grain of sculptural surfaces to inordinate refinements), others take a different direction as they explore a more topological aesthetics of 3D objects and spaces (discussed below).

In more depth, Greenberg's aesthetics is concerned with the relationality or syntax of Caro's sculptures, the way the planar and linear shapes of steel, or aluminum are configured, juxtaposed, or gathered together in agglomerations. Caro seldom constructs solidly enclosed volumes or enclosures with centers of interest, and these, when they do emerge, appear tangential and decentered. Greenberg suggests that Caro achieves a kind of "sprawling cursiveness" which fuses together disperse elements and objects by tilting and odd-angling rectangular shapes (1965, p. 206). Caro is far less interested in contours and profiles, Greenberg says, then in vectors, lines of force and direction. The syntax or relations of discrete parts achieves the illusion of the movement of geometric objects as an optical effect. The symmetry of geometric objects (spinal and nodal symmetries between rectilinear and cursive, curving forms) enters Caro's work surreptitiously and indirectly at the last moment of observation (Greenberg 1965, p. 206). The angles at which the 3D objects are placed to one another force the observer to move around the sculpture, because no single position affords a complete or satisfactory view. As Edward Lucie-Smith (1966) writes, the eye is kept shuttling between the forms as if the sculpture were a kind of caged construction, but the dynamism of the objects is never completely harnessed.
The result of this "dynamism" is that the hard intractable materials and inflexible shapes used in construction are rendered soft and fluid to the observer's eye. The objects reach out to "embrace the atmosphere": because the objects are rarely balanced around a central axis, the relational angles and spaces between forms dissolve any tightly knit quality of enclosure (Lucie-Smith 1966, p. 25).

Similarly, the critic Charles Harrison (1969) affirms that Caro and the New Generation share a conviction in the power of presentness in a work of art, a sense of presence that supports both the possibility of immortality and a transient and valuable state of consciousness. Harrison suggests that these sculptors interrelate states by which things are formed (in sculptural or graphical process) with meaningful states of mind (Harrison 1969, p. 33).

Expressing a distaste for the indiscriminate manipulation of imagery, Caro and the New Generation endeavor to embody meaning in sculptural form and to keep that meaning direct, real and self-referential. The New Generation turned away from Caro's use of steel in favor of fiberglass and plastics; they also abandoned the use of monumental size for table-top scale, establishing relationships between their sculpture and the non-art objects that surround us in everyday life. The New Generation also chose colors that often created associations with the world of product design and manufacturing, fulfilling the exemplary role Greenberg (1961) advocated of sculpture as an extension of collage with the strong colors of Matisse's paper cut-outs (which acquired
special prestige in the 1960's). Harrison (1969) implies that the New Generation employs a conscious aesthetics and reason to solve the problems of construction, particularly in regards to the relationship between form and meaning. The reassertion of meaning in formalist aesthetics and practices is largely in response to a dialogue with the minimalists over the mystique of sculpture as art object.

Even more "true" to the constructivist mission of the 1920's and 1930's, the sculptor Benni Efrat (1969) attempts to tie together in a cohesive and expanded formalist theory Caro's concerns with form, perceptual stimuli, the 3D object, geometric configurations and the constructive environment. He writes, the visual environment constantly presents a multitude of stimuli (continuous events distributed unevenly in time) which represents a variety of spatial combinations and relationships. More specifically, the "dynamism" or dynamic qualities of the artistic source depend on the relative movement and the relationship of structural shape and color to each other and to their environment (Efrat 1969, p. 20). Efrat therefore regards the entire process of visual perception as a continuous interaction between the observer, the 3D object and the environment: the "visual environment", or field of view, is comprised of a random, non-uniform, but meaningful distribution of events which are the sources of visual stimuli. "Active participation" in the work of art or media simulation requires selecting events and objects, relating them to each other, and forming patterns from them (a conscious ordering of the
environment). Efrat continues,

The conflict between the static three dimensional discipline and the dynamic events bounded by it obtains a new dimension and meaning when the dynamic event is allowed to break, in some places, the set of boundaries and continue its action beyond the frame: thus bringing the whole object configuration into a new type of relationship with the space around it (1969, p. 21).

Efrat extends the "contrast" created by the relative distribution of events within a quasi-bounded volume or configuration to encompass a kind of dynamic complimentarity between the configuration of objects and the spaces that surround it. He acknowledges the use of color to mold dynamic spatial relationships, suggesting that formalists try to "shape" color and create "colorful events", rather than to paint shapes (an analogy that critics use repeatedly in reference to Olitski's work).

Moffett (1969a, 1969b) discusses how Olitski applies 3D forms to color, rather than paint color to the surface. The conventional distinction between color as an essentially optical phenomenon and sculpture as a tactile art breaks down in expanded, hybrid 3D media. Moffett points out that abstract and semi-abstract twentieth century sculpture occasionally employs color as the servant of space and form, always with the feeling that it is "applied", superfluous or incidental. In "Art and Objecthood", Fried (1967) was the first to examine how Caro uses color to cancel texture and help render his pieces weightless and optical. Caro, however, isolates color in his hybrid sculpture, using polychromy in only a limited manner. Fried believes that Caro's sculpture consists solely of its internal syntax (its relationality between
rectilinear objects), while the color relates to the work as a whole: the
determinate choice of color appears to be independent of the formal quality of
the pieces. Benedikt (1967) takes issue with Fried (and other formalist
cousins), arguing that Caro's use of color (usually a single color) works to tie
together the diversity of each piece, helping to relate dissimilar shapes and
objects: color serves as a "welding and affixing process" that moves beyond
the mere juxtaposition of forms. By contrast, Moffett suggests that Olitski
attempts to create color surfaces in space(s), rather than relating color to the
work as a whole. By creating surfaces as bearers of color or multiple color
surfaces in space(s), Olitski reverses Caro's procedure (Moffett 1969a, p. 56).

2.6 Formalist archetypes: Olitski's 3D folding surfaces of color

Color does not merely lie on Olitski's hybrid folding surfaces, Moffett
explains, but creates a new kind of enriched surface and new spatial
relationships. Olitski attempts to demonstrate how color can exist for itself in
abstract sculpture. Moffett reminds us that Olitski is almost exclusively
concerned with color sensation: Olitski once remarked that he would like to
spray color in the air and have it remain there (Moffett 1969a, p. 56).

Greenberg (1966) is interested in how Olitski's work as a whole conforms to
the formalist qualities of optical (residual) illusionism, flatness, and a surface of
color which calls attention to itself as object. Greenberg writes, the grainy,
tactile surfaces of color contrive an illusion of depth as if those surfaces
expand to contain a "world of color" and light differentiations impossible to
flatness, but which manage in some way not to violate flatness (1966, p. 230).

Oliski's folding color surfaces defy the literalness of edge and boundary.

There appear to be no broken surfaces. Moffett suggests that each surface becomes a total field of shape and form which avoids the determinate edges of the rectangle in its flowing, folding convolutions. Olitski's ability to identify fluctuations of color value and hue makes spatially developed 3D configurations appear as shaped color (as opposed to mere colored shapes).

Moffett believes that these "free" shapes and contours convey a "poignant feeling or playful effect": they constitute the first authentic attempt in the history of art to realize pure color in three dimensions (1969a, p. 58, 1969b, p. 44).

The color surfaces seem to emit their own space and light within themselves (enfolding space and light), rendering them eerily weightless. This effect of enfolding, then unfolding space and light (of disposing forms in space) is partially the result of Olitski's subtle *chiaroscuro* hue and shading, which produces an added illusiveness, Moffett says.

Deleuze describes the *chiaroscuro* effect, the way the folding surface catches illumination and varies according to the hour and the light of day, as a function of the fold of matter and texture itself. Following Leibniz, Deleuze affirms that the fold affects all materials (metal, paper, fabrics, water, living tissue, the brain), because it determines and materializes form, becoming "expressive matter" with different scales, speeds and vectors (1993, p. 34). Since folding and the *chiaroscuro* effect are Baroque traits, Olitski's folding,
pleating surfaces of color can be said to resemble the overlaying folds and depths (crevices) of fabric or paper. As Deleuze says, the Baroque is an "operative function" or "trait" which endlessly produces folds, then twisting, turning, and pushing them into infinity, fold over fold, one on the other (1993, p. 3). Concerning the plastic arts, what period or style would fail to recognize the fold as a trait of painting or sculpture (Deleuze asks)? Olitski's hybrid sculptures can therefore be described as elastic bodies in space whose cohering parts that form a fold, or a multiply modulating surface of color. The fold does not appear to be separated into parts, but appears to be divided into an infinity of smaller and smaller folds (an endless folding, an optical illusion, a 3D origami form). Some art historians and critics may dismiss Olitski's work as "sumptuously decorative art", as de Duve (1996) does (although with some reticence), but Deleuze implies that these surfaces of color may offer a form of expression, a gestalt, or a cohesive infinite line of inflection which is not divided as are form and content, but which contrasts the full and the void in a reciprocal becoming (Deleuze 1993, p. 36).

Baroque folding and chiaroscuro effects become an aesthetics for a kind of liquid architecture of 3D objects and spaces whose goal is curvilinearity, the twisting line, the fluidity of matter and the elasticity of bodies. The New Generation's weightless, flowing colored fiberglass or metal planes which twist, play or juxtapose each other in space, and Olitski's fluid ornamental arabesques of color fit well into this emerging 3D aesthetics of objects,
surfaces and spaces. The work of the sculptor Jean-Paul Laenen also epitomizes this aesthetics derived from topology and descriptive geometry, because his luminous, hybrid sculptural pieces are largely concerned with the interactions of light, color and volume in space(s). Laenen’s work from the 1960’s attempts the destruction, or dismantling of the idea of a conventional (Newtonian) unitary space by a series of independent, unconnected spaces. The analogy of (de)construction can be reversed if one thinks of Laenen’s pieces as linking, conjoining or juxtaposing independent spaces to a single interior. The luminosity of his pieces is created by an exacting relationship between color and form: sculptural space or volume seems to be reduced to “linear rhythm” as it is opposed to or underlined by color saturation (Apraxine 1970 argues that the primacy of color is Laenen’s first consideration).

Whether they are found in abstract sculpture, the contours of nature, or 3D simulated cyberspace, Deleuze (following Leibniz) likens these complex folding interactions (inflections) to the solid pleats of a “natural geography”: the curves of conical forms which sometimes end in a circle or an ellipse, or sometimes stretch into a hyperbola or a parabola (1993, p. 6). Eisenman (1993) is inspired by Leibniz’s turn away from Cartesian rationalism and in his depiction of the point of the fold as the smallest element in the labyrinth of the continuous. Eisenman also acknowledges Deleuze for articulating a possible new relationship between vertical and horizontal, figure and ground, breaking up the existing Cartesian order of space in physical and digital worlds. We can
now draw an association between sculpture and the manner in which we are accustomed to interacting with computers. The interface is a modulated information space that remains external to us, although we may construct elaborate spatial visualizations of its inner structure in our minds. The topological sculptures of Caro, Olitski, or the New Generation, for example, which incorporate a surprising diversity of spatial events in a variety of organic and geometric forms, are now easily transferred to 3D digital media with not too much difficulty. Their sculptures juxtapose and then unfold in sequence disparate masses and objects within three-dimensional space. This topological aesthetics of objects/spaces requires that we draw parallels between "real" and artificial domains: to examine how artifacts we make in our reality influence how we build artificial worlds, and how artificial realities raise questions about our physical realm.

Eisenman identifies Gilles Deleuze and mathematician René Thom as the two most important contemporary theorists of folding surfaces. Deleuzean extension is the outward movement of objects or events along the surfaces of planes, rather than downward in depth. Meaning is found at the surface; forms are not defined by their deep essences. Eisenman recounts how Deleuze conceptualizes the idea of the surface object/event in the objectile, a contemporary technological object such as any object which inhabits 3D cyberspace. The surface object goes beyond the static framing of space: it necessarily includes the temporal and topological variation of matter.
(Eisenman 1993. P. 60). In Thom's mathematics, the variable curvature of the fold/unfold is the inflection of the pure event. Transformations of objects or events do not occur according to a privileged plan of projection, but instead are modeled by the neutral surface formed from a variable curvature or fold. Abrupt changes in form can be explained by a complex folding and unfolding, which can often be used to explain sudden or catastrophic events. Eisenman explains, while a tiny grain of sand can trigger a landslide, the conditions leading up to the moment of movement are already seen to be in place in its structure or form (1993, 9. 60). This is obviously a more complicated extension of the idea of the fold/unfold, more complex perhaps than Olitski's folding 3D surfaces of color, more complex than origami, which is linear and sequential. Nonetheless, for Eisenman, the fold holds the potential for explaining and constructing 3D architecture in terms of planar folds and 3D volumes. The fold in this sense contains aspects of both figure and ground, but cannot be reduced to the singular existence of figure or ground by itself. In a media age, the changing surfaces of 3D objects in space(s) are never meaningful as static entities, but in their timely interaction in configuration with one another.

2.7 Beyond formalism: Liquid architectures and object topologies in cyberspace

Similarly, Novak (1991) describes unusual transformations in the liquid architecture of cyberspace as the designer generates and varies objects in time. Cyberspace is therefore either a mediascape or virtual space which we
can actually enter; a modulated, artificial architectural space. Liquid, visionary architectures now offer an excess of possibilities in shape, contour, texture and topological construction. Novak suggests that we can now draw a comparison between sculpture and computer constructions, because liquid architectures, like hybrid abstract sculptures, produce aesthetic beauty or sublimity, structure or lack of structure, weight or weightlessness, lavishness (expense) or economy, details or simplicity, uniqueness or universality (1991, p. 244). Like tangible, plastic, but less durable kinds of digital architecture and construction, modernist artists of the past invented entire worlds without explicit reference to explicit reality. Mondrian, Malevich, Klee and Kandinsky thus prefigure or antecede liquid architecture. One may wonder, what would life be like inside a cubist universe or a Magritte trompe l’oeil? Novak provides the example of Malavich’s architectones, his graphic, grid-like “absolute architectures” which exist in the imagination without functionality or material constraints, in a world that defies gravity or exists against gravity (1991, p. 245). Novak points out that spatialized 3D topologies can be built in material and virtual realities, but as opposed to solid material 3D sculptures, liquid architectures require cyberspace synthesis, the reconciliation of different types of information into a coherent image, and cyberspace rendition, the production of high-resolution graphic representation of that image (1991, p. 229). Liquid architectural constructions are therefore beneficial to aesthetic creation by dissociating data, information, surface appearance and form: appearance is the aftereffect
of layers of representational patterns, data and code. Novak explains,

Form is now governed by representations, data is a binary stream, and information is pattern perceived in the data after the data has been seen through the expectations of a representation scheme or code. A stream of bits, initially formless, is given form by a representation scheme... By reducing selves, objects and processes to the same underlying ground-zero representation as binary streams, cyberspace permits us to uncover previously invisible relations simply by modifying the normal mapping from data to representation (1991, pp. 225,234).

Liquid architecture is consequently a dematerialized, ethereal, modulating architecture which is not satisfied with space, form, light, weight, etc. in the physical, bodily world, but corresponds to the merging or diverging of abstract topological objects and elements in mind spaces.

The Tangible Media Group at the MIT Media Lab has been interested in the interrelationship between selves, objects and digital information within this kind of liquid architecture or tangible object interface. Small and Ishi (1997) discuss how they are attempting to program spatially aware graspable displays which use movement in real physical space to control navigation in cyberspace. Newtonian laws of friction and gravity are simulated in parallel digital spaces. The group combines input and output aspects of the interface into a single object in order to provide a meaningful relationship between body, mind and interface.

In a separate project, the group is designing physical/digital construction kits consisting of a set of identical flat, plastic triangles (each with a microprocessor inside and magnetic edge connectors) that facilitate the manipulation of tangible digital objects with the use of both hands. As
Matthew, Orth and lishi (1998) explain them, the connectors also pass
electricity, allowing the triangles to communicate digital information in
particular configurations to each other and to a desktop computer. The
construction kits enable the embodiment of a 3D digital object-space
topography in the material world as specific two and three-dimensional
configurations of the pieces trigger application events. The group believes that
the infinitely reconfigurable 2D and 3D topographies of the triangles system
hold the potential to create a new language for the tangible human/computer
interface.

Designers and art educators, such as Pat Search (1995), observe a shift
in the aesthetics of 3D animations and digital graphics away from the serial or
fragmented visions of postmodernist art. Presently, digital designers are
intuitively creating and engaging abstract topological objects and forms which
are both mathematical in content and viscerally moving as art. Francis (1992)
attempts to introduce the language of topology into art so as to discover the
mathematical identity of sculptural surfaces and 3D composite objects. He
acknowledges the obscure affinity between topology and art, specifically in
implicitly mathematical art that is constructed by artists who do not intentionally
express mathematical ideas in an aesthetically informed manner (Francis
1992, p. 313). Francis suggests that the presence of spheres, polyhedra,
Platonic forms or spatial relationships in art does not imply that the designer
intended to impress a mathematical sense in her work, but the accomplished
3D animator and sculptor of the new millennium will be required to be aware of (and must utilize) the topological nature of the 3D cyberspace environment. At the other extreme, the explicitly mathematical artist, deeply involved in mathematical theorems, may create aesthetically powerful 3D models (using 3D animation software) or "visual poems" with an awareness of mathematical meaning that the lay observer may only be able to sense (Francis 1992, p. 314). Francis suggests that the higher order symmetries of the integrally woven compositions (or object composites) bring a "logical closure" to the entire intuitive denouement. For most 3D artists and designers, however, the understanding of the topological content of the intuitive model or animation can only happen implicitly as an appreciation of sculptural surfaces and through the use of algorithm-driven 3D modeling and texture-mapping software.

Topology allows us to perform surgery on the surfaces of objects, but this surgery never involves cutting or tearing, but stretching or bending as if every surface had the quality of rubber (topology is sometimes called "rubber sheet geometry"). The possibility that every surface could be stretchable rubber becomes an actuality in 3D modeling and animation spaces. Objects may be deformed, twisted, bended, folded, or have vertices subtracted from it, but they are never "torn away" as such. If a polyhedron is made of rubber, we could easily imagine how to deform it into an ordinary sphere; the surfaces of a cylinder, a hyperboloid, an open annulus, and a sphere with two polar openings can be topologically equivalent to each other, or homeomorphic to
Euclidean space (Armstrong 1983, p. 6). Two or more surfaces can also be connected to produce a connected sum of surfaces. The idea of homeomorphism strongly involves the notion of continuity, meaning that the properties of spaces are left unchanged as surfaces are deformed, bended or lofted into one another. Francis (1992) explains that in deforming one topological object into an equivalent one, we do not allow knots to come apart, or surfaces to pass through another: topologists have been able to solve the classification problems for knots and the surfaces encompassing them, for example, within such tolerable constraints. A surface is considered to be closed and compact if it has finite boundaries and if it fits into a finite portion of space (Francis 1992, p. 315). The "covering" of the sphere or torus, for example, has an infinity of surfaces with or without borders such as an open plane would contain, but its "covering" contains a finite "subcovering" or closed surface.  

If we were to restrict ourselves to the Euclidean space of our physical world, we would concern ourselves only with the bounded configurations which occur "naturally" in that shared environment, such as spheres, cylinders and torii (donut shapes). However, topologists interested in the continuous functions between spaces which may not involve nice, finite geometrical surfaces with discrete sets of points (such as those just mentioned) have

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8 Suzanne Damarin provided this explanation in October, 1999.
expanded their realm of concern beyond Euclidean geometric space to abstract topological spaces. For example, some deformations of the Möbius strip (a single, flat, circular, non-extruded surface with one twist in it) are homeomorphic (have continuous bijections between them, whose inverse is also continuous), but no amount of stretching, bending, or twisting in Euclidean space, our physical world, can deform one into another. In other words, there is no way of extending their homeomorphism over all points of Euclidean space, by using Euclidean distances between points (Armstrong 1983, p. 12). To resolve the problem, topology has rid itself of any dependence on the distance function as it considers spaces and surfaces abstractly, rather than relying on their representations in Euclidean space. Distances are subadditive in Euclidean, Cartesian space and can therefore be measured empirically, but topology preserves a system of neighborhoods or homeomorphisms, a one to one correspondence between points without measure.⁹ Commercial desktop versions of 3D imaging and animation software are capable of visualizing surfaces and spaces as topological invariants in non-Euclidean, virtual environments. Francis is one of the first persons to animate the deformation of the surfaces of a knot in 3D cyberspace (Cox 1988, p. 240). 3D digital spaces enable both artists and topologists to examine conditions that cannot be described by simple functions, 2D perspective, or Newtonian laws of object

⁹ Suzanne Damarin provided this explanation in October, 1999.
behavior; conditions that are manifested elsewhere only in the imagination.

The inclusion of topological ideas in the creation of 3D object art reflects the continuing twentieth century interest in the curved spaces of non-Euclidean geometries (such as Beltrami’s hyperbolic geometry) and new fractal geometric models. Shearer (1992) suggests that non-Euclidean and n-dimensional geometries can inspire new thoughts of space(s) and the relationship between objects and surfaces in 3D space(s). Thinking of space and form in new ways changes the artist’s or designer’s approach to digital creation: Shearer recognizes that artists are already conditioned to thinking in three dimensions, or in the abstract fourth dimension, so that thinking and creating in curved spaces, fractal, or in-between integer dimensions may not be such a sudden leap as might be expected (1992, p. 150). Fractal geometry is the basis for explaining the forms of much of organic life, such as trees, flowers and forests which share similar fractal characteristics with inorganic islands, lakes, snow flakes, rain, star clusters and other particle systems (Midori Kitagawa DeLeon and Karl Sims are well-known for making inroads into the 3D modeling of these “natural” phenomena). In the computer simulation of 3D nonlinear objects, the “natural” world of fractals and the artificial world of human-made geometric figures (spheres, triangles, Platonic solids, etc.) collapse into a new realm of representation and creation. As Shearer remarks, chaos and fractals have redirected geometric abstraction back to the world of everyday objects, and have refocused the “postmodern paradigm shift to chaotic thinking” so as to
emphasize the "real" (1992, p. 151). Following Linda Henderson (1983), Shearer assumes that new geometric models can be viewed as signposts, or markers in peak innovations in art, citing previous historical correlations between the emergence of new geometries and artistic innovation.

Shearer's search for congruence between new geometries and art brings this argument full circle, back to Modernism, abstract art, and the application of formalist aesthetics. She mentions Mondrian, Malevich, Picasso and Duchamp as artists who felt the impact of new geometries on their visions of space and form. Novak (1991) mentions Malevich as pertinent, particularly because his architectones (architectural studies) seem to exist without functional program or physical constraint, in a world which defies conventional notions of gravity and the use of space. The "explosion" of non-Euclidean geometries at the turn of the century mirrored almost simultaneously the emergence of Modernist abstract art movements, including cubism, constructivism, orphism, neoplasticism and kinetic art (Shearer 1992, p. 146). While Poincaré wrote about the tactility of curved space, Picasso's cubism enabled the radical materialization of this new space. Picasso indulged in and extended non-Euclidean paradigms of rounded or curved spaces, translating these dimensional effects into simplified, tactile forms. Shearer (1992) believes that cubism is a revolutionary expression of the influence of new geometries, establishing a decisive break with the traditional way of looking at 3D space through Renaissance perspective. For Crary (1990), this important
rupture emerges with impressionism's turn away from realism and euro-visual culture, but for Jay (1992), digital culture offers a new way of breaking with "bourgeois" perception by deviating from a single, historicist version of linear time and objectified Euclidean space.

We have traced the formalists' concern with the form, contour, texture and relationality of flat and enfolded 2D surfaces to the study of rounded, curving, hyperboloid, cylindrical, planar or other stretchable or deformed topological surfaces in virtual 3D cyberspaces. 3D computer art and animation might take place within a dematerialized, ethereal, or symbolic medium, or they might also be the material-semiotic manifestations of an actual parallel reality: as Haraway (1997) conjectures, they may appear and reside in quasi-organic, quasi-machinic interface environments which pertain specifically to graphical representation and simulated visual forms. Folds, hyperbolas and curving surfaces comprise the substance of transformations and inflections of objects and events in 3D computer architecture; a modulating, synthesizing, liquid architecture capable of representing abstract topological constructions in digital, symbolic spaces. Meaning resides on the surfaces of virtual objects and spaces, on the level of appearances. 3D computer media relies on a pure physics of surfaces, whereby events of a liquid surface depend on digital transmutations on the level of code, but also on variations of a surface appearance of the simulated, ideational quasi-cause.
The emphasis on surfaces in the aesthetics of 3D computer animations translates consequently into a strong reliance on texture (image) mapping to create the photo-realistic, 3D effect in the completed work or sequence. The importance of formalist values is evident in the production of 2D mapping images (digitized photographs, digital illustrations). The artist or designer must establish texture mapping coordinates for each 3D object and surface: for a polygonal object (a common 3D object), texture mapping coordinates are created for each vertex of the surface or object. The surfaces of 3D spaces can also be mapped in vast, planar quadrilinar or trilinar patches. The texture map must be fit, centered, deformed, projected, tiled, or shrink-wrapped on the surfaces of each object, whether it be planar, cylindrical, spherical, tubular, or cubical in nature, or whether it is a unique, invariant topological structure. Bumpiness, displacement, highlight, shadow, reflection, shininess, refraction etc. are subject to complex, computer memory expensive, algorithmic calculations, which are applied to object and surfaces in rendering, but do not alter the objects' geometrical complexity. Diffuse and/or specular reflection, for example, simulate the light which penetrates a surface and then gets reflected in multiple directions by that surface. While the photorealistic cyberspace synthesizer (with varying degrees of computational power) is responsible for rendering surfaces, Novak (1991) points out that the actual synthesis of 3D cyberspace objects occurs in the mind of the user as a mental space, "a spatialization of the sum of affordances into a series of worlds of opportunity"
and restriction, promise and constraint”. Therefore, formalist aesthetics live on
in 3D computer animation in the emphasis on the mentalization of the dynamic
interplay and syntax of form, texture and surface.
CHAPTER 3

MINIMALISM, CONCEPTUAL ART AND BEYOND: THE INTERACTION OF CYBERBODIES IN INTUITIVE COMPUTER INTERFACES

Conceptual art is reflexive and ideational in that its objects refer to the observer in some way, just as the observer engages with its objects in some way. As minimalism itself recedes from us as an archival object of the 1960’s, it conversely moves toward us as artists seek alternatives to recent practices. Minimalism is crucial in reviving the intuitive creative process in art and design by providing elastic, malleable environments in which to work and think, but it also accentuates the importance of preconception and material fabrication in art. This is not a contradiction in terms for artists like Donald Judd, Sol LeWitt and Robert Morris (perhaps the most renown of minimalists). Judd uses industrial material to construct massive, elementary volumes that reify the notion of artifice. He is interested in the literalness or concrete presence of 3D forms. LeWitt creates structures that are real and meaningful, that bridge the gap between conceptuality and visuality by implying the existence of unseen interior facts within objects. Morris is also concerned with the conceptual object in the visual field and in the literal, material nature of 3D forms. He
experiments with the relationship between the surfaces of irregular polyhedrons, kinaesthetics, lighting, ambient space and the observer. Minimalism therefore expands the parameters of the contextual conditions of art so that they embrace everyday, commodity-values. As Frank Stella famously said (Stella in Glaser 1966), things are never as simple as they seem: Its positivism notwithstanding, minimalism renders perception reflexive and complex.

Minimalism’s interests in the presence, movement and interaction of objects in the visual field helped to usher in a technosensual aesthetics of bodies and conceptual cyberforms in the art of the 1990’s. The use of this aesthetics in theory and practice began with attempts by kinetic artists to capture and isolate concepts such as movement with mechanical and conceptual instruments in the 1960’s, and continues with the refigurations of posthuman, post-mechanical bodies as signifying objects and avatars in cyberspace (cf., Haraway 1995, 1997, Stone 1995a). My examination and rewriting of artifacts from art critical writing since the 1960’s attempts to show both linkages and dispersions between minimalist conceptualism and the design of multiple intuitive interfaces in computer games and computer-generated instructional media.

Minimalism dislodges Greenberg’s formalism in its transgression of the pure art object and its affirmation of the arbitrary object. Minimalist artists make suspect the usefulness of the art/anti-art binary, showing that it is often a
perverse tautology, particularly in the work of Donald Judd and Robert Morris. Defying Greenberg’s prescriptions that retain the distinctions between the strong antisculpturalist qualities of Modernist painting and the 3D province of sculpture, the early minimalists pushed their work into the hybrid zones of the third dimension where their pieces became conceptual objects on the verge of pure architecture. Within the generic domain of art and non-art alike, the works of the minimalists struggle to assert their unique specificity while having to acknowledge the genericity of their own conditions of production. deDuve (1996) proclaims the birth of a “new species” of art, which is deliberately confused with non-art and is coined minimal art, literal art, ABC art, primary structures, post-painterly art and sculptecture.

With the minimalism of the 1960's and after, the pendulum swings away from the formalist dictum that to be nonrepresentational or abstract, art cannot be arbitrary or accidental, but must be obedient to some worthwhile paradigm, original, or style. Formalism involves the paradigmatic or exemplary approval of the form in which the work remolds its historical conventions, despite any aesthetic judgement of the content. Minimalism therefore stands on the side of the commodity object or the mass-produced good against the art paradigm or modernist art object; but although the minimalist art of the 1960's and 1970's revolves around a critical stance that sees itself as retrospective, descriptive and transgressive, it has become prospective and prescriptive for the generation of conceptual artists that follows it (deDuve 1996, 204).
Minimalism opposes the Kantian judgement of the supersensible form in art with the insertion of the object-concept, immanent means, technique and intuition into the creation of the plastic form. As Lucy Lippard (1972) demonstrates regarding the *dematerialization* of the reified art object during the late 1960's and early 1970's, the so-called "instructional pieces" are examples of art for anybody and for whatever, since the name "art" was actually removed from each piece and the label "artist" was removed from each author. In the spirit of Duchamp's turn-of-the-century *ready-mades*, minimalist works illustrate the undecidability, the openness and the indeterminacy of art as an ontological form that traverses all possible worlds and mediums. These pieces set precedents for simulationist art and design work that followed in subsequent decades, including computer media. deDuve (1996) acknowledges that Greenberg's stubborn refusal to incorporate Duchamp's *ready-mades* into modernism is a symptom of formalism's blindness and its persistent reduction of pictorial and sculptural art to flatness. In his writings from the late 1960's, Greenberg made some negative references to Duchamp in the context of the slackening standards of style and medium-specificity regarding pop art, minimalism and conceptualism.

Nevertheless, attempts to (re)insert conceptual material into art aesthetics are not new. With the emphasis on the plasticity of technical materials that arose in early twentieth century constructivism, De Stijl and the Bauhaus found renewed vigor during the 1960's in the minimalist approach to
creating art. The epistemological concepts of plasticity and viability were being
tossed around (although in other words) during the 1960's, long before
constructivism became radical through renewed interest in the ideas of Piaget
(von Glasersfeld 1995).

Plasticity is the gauge by which to evaluate the suitability, flexibility and
adaptability of technical ideas and materials to their application in artistic
practice. It therefore relies on viability in the sense that actions, concepts and
conceptual operations are viable if they fit the purposive or descriptive contexts
in which they are used. Both the actual, material world and the microworlds of
virtual computer interfaces are ideally visualized as purely elastic, malleable
environments with which to create and think. Ideally, then, we can imagine
that any world and all objects consist of rubber or some such pliable material
that can be used to design and construct any object, scene or narrative for
whatever instrumental purpose or practical function of knowing. Many
contemporary designers believe (or hope) that digital material is the most
elastic, artificial substance yet created, because it is absolutely flexible while
defying conventional definitions of tangibility and scale.

Whatever the actual degree of pliability of digital-symbolic material, it is
important to point out how many contemporary ideas regarding the intuitive
creative process in art, the visible-integral functioning of specific technical
materials, and the malleable nature of the hypersurfaces of art objects are
derived implicitly from the minimalist work of Donald Judd, Sol LeWitt and
Robert Morris, as art critical writings from the 1960's reveal. Consequently, minimalism was never a style (and we cannot reduce it to a style based on visual similarities between artists' work), but we can better define it in terms of certain modes in art production linked to particular principles and concepts.

3.1 Donald Judd: *Technique makes the Thing visible*

Considering Judd's "non-art" or "nart-art," his sculptures appear as volumes and geometric forms that seem to sit idiosyncratically in space while avoiding any formal relational configurations or compositional effects. Friedman (1967) asserts that Judd's "clinical cubes" represent the bland acceptance of ubiquitous technology and the explicit use of technical materials (industrial materials which evoke artifice). He suggests that Judd's chosen economy of form is intended to focus the observer's eye on the object itself without inviting digressions on the method or process of fabrication, thus rendering the object more immediate to the observer in terms of its *gestalt*, its simple and immediately recognizable shape, its conceptual and emotive essence, its "thingness," or its presence. Michael Fried (1967) equates this kind of minimalist art with the "literalist espousal of objecthood" which attempts to discover and project the object's presence and which stakes everything on shape as a given property of objects. Judd acknowledges that in his pieces he works to eliminate compositional effects in his pieces in open criticism of the dynamic interplay of formal elements which characterize the work of Anthony Caro and David Smith (Glaser 1966, p. 151). Such attempts are made in the
pursuit of "spareness," the primary quality which is the namesake of minimalist art.

Judd maintains that the compositional effects which he repudiates carry with them the structures, values and feelings of an exhausted European rationalist tradition. The irregular and rhythmic use of objects according to chaotic and arbitrary mathematical formulas presents a unified effect of the piece, which replaces the formal relationships of line, value and mass in Western art. The simple components of Judd's pieces are not in active interrelationship or opposition to each other: in a sense, the effects of a Platonic (w)holism and unified presence are substituted for the juxtaposing relations of the dialectic (arguing that one approach is more or less detached from Western traditions than the other would be difficult). Judd insists that he does not repudiate Western logic as such, only a logic that places compositional or structural elements before the integrity of the piece as a whole. He says,

You're getting rid of things that people used to think were essential to art. But the reduction is only incidental. I object to the whole reduction idea . . . If my work is reductionist it's because it doesn't have the elements that people thought should be there. But it has other elements that I like (Judd in Glaser 1966, p. 159).

Friedman (1967) recognizes an aggressive quality in Judd's work because of Judd's open hostility to established traditions of modernism and humanist anthropomorphism. The "part by part" relational configuration of other abstract sculpture is what Friedman associates with anthropomorphism: a beam thrusts,
a piece of iron follows a gesture, and together they form a naturalistic or anthropomorphic image. The kind of indivisibility and coherence achieved through the repetition of identical cubic units in uneven intervals of space is a radical departure from multi-part, inflected sculpture, Friedman suggests. He finds a paradox in Judd’s pieces in that he continually reasserts the displacement of space while appearing to be obsessed with formal purity, so much so that his works become lucid axioms about proportion and rhythm (1967, p. 60).

Friedman (1967) discusses how Judd’s work infers that any massive, elementary volume can be an interesting thing in itself: rectangles of specified size and surface features do not require sensual, human modification to function as sculpture. He believes that Judd rejects the monolithic Western conception of space, an anthropomorphic space, but he does concern himself with developing sculpture with the use of abstract, irregular, non-Euclidean properties of space(s). Judd dislikes the idea of sculpture setting up antagonistic interactions of shapes in space, because such dynamism invests work with superfluous qualities (Friedman 1967, p. 60). He judges art in terms of techniques and materials used, Friedman concludes. Its all a matter of technique which makes the thing visible: an artist should select a method of working that suits her from an infinite number of possible techniques, including new manipulative processes (Friedman 1967, p. 59). Friedman insists that Judd’s conversion of non-art materials into art is never arbitrary, but a matter of
the choice of materials and fabrication processes. Friedman writes, the
textural quality of galvanized tin, the color properties of transparent plastic, and
the surface patterns made by rivets and screws are integral and functioning
qualities of Judd's art (1967, p. 59). Barbara Rose (1965) suggests that the
work of Judd and Morris resembles illustrations of Wittgenstein's propositions
about the assignment of the proper name for the thing in his *Philosophical
Investigations*: the use of elementary, geometrical forms depends on some sort
of "presence" or "concrete thereness" to provide their art quality. The art
object, the "thing," means nothing more than what it is; that is, it suggests
nothing other than itself, denying that there is any need for either the
metaphysical (some non-phenomenal essence) or the metaphoric (the
symbolic or the tropic). Fried (1967) insists conversely that Judd's (and
Morris') emphasis on shape as the basis of artistic impression, the singleness
of shape as depicting the wholeness of the three-dimensional construction,
renders his (their) pieces shallow, hollow and meaningless.

Friedman (1967) reads Judd as wanting his audience to be aware that
his sculptures are hollow objects. Certain features contribute to this
perception, such as 1) the galvanized sheet metal that forms the cubic shapes
is usually a certain thickness to contribute to the observer's awareness of
(en)closed volumes, or 2) transparent plastic is sometimes used to form sides
of the pieces, which helps project the quality of light weight (Friedman 1967, p.
60). Andrew Causey (1998) attributes this minimalist interest in surface, rather
than core or interior, as a throwback to Brancusi, not the linear, non-volumetric sculpture of the 1950’s. He writes about Judd and Morris’s ambivalent attitude to abstract expressionism, their rejection and abandonment of gesture and modulation of surface as compromising unity, and their “coolness” to and disinterest in 1950’s angst (1998, p. 123). Taking issue with Fried, Friedman (1967) praises the dynamic presence of Judd’s pieces which, rather than being dead theoretical shapes, appear to share space with the audience. Minimalist art implicates the observer in relation to the art work and to ambient space. Rosalind Krauss (1966) describes how Judd’s “art objects” seem to proscribe both allusion and illusion: any reference to experiences or ideas beyond the work’s “brute physical presence” is excluded as a reflex of the art’s intentionally blankness and emptiness. Krauss implies that Judd’s art seems to bounce playfully between the sphere of transparently “real” objects (via Wittgenstein’s *Philosophical Investigations*) to the presumptive reduction of art through the illusion of meaning. Judd’s work therefore both compels and gratifies immediate perception, which involves more than just the brute description of the work, assertions about materials or shapes, or the a *priori* conversion of objects into examples of a theorem. The audience grasps an understanding of the “art objects” in the experience of looking at them, plain and simple! While acknowledging that Judd’s work makes reference to knowledge gained from previous confrontation with the object (an *architecture* or situation known from experience) Krauss (1966) reiterates that we can
perceive the sculpture only "in the present coming into being of the object given." Judd's work cannot be perceived rationally in terms of given geometric laws or theorems evolved before the experience of the object. Krauss relies on the phenomenology of Merleau-Ponty when she insists that the object be perceived through its presence. The observer derives meaning from the object when she grasps its "real," "lived" structures as meaningful, whole presences. Foster (1996) agrees that minimalism's emphasis on the here-and-now is not only an embrace of phenomenology, but he believes that its suspicion of artistic subjectivity and the anthropomorphic image is also an accretion of 1960's structuralism. Forster asserts that minimalism projects the eclipse of historicity with its insistence on the externality of contemporary representations, meanings and experiences, reminding us, as Jameson (1991) does, that pastiche and nostalgia are the two "twin reactions" to this putative eclipse of historical depth which dominates the cultural waves of the 1970's and 1980's (Foster 1996, p. 62).

3.2 Sol LeWitt: Ideas discovered through intuition

Lucy Lippard (1967) writes that when confronted by a wholly conceptual art, such as minimalist structures, the observer tends to "turn the eye off and the mind on." It is not a matter of the mind subtly or directly dictating to the eye how to order and associate the objects it perceives, Lippard relates, but the eye perceiving and sending messages to the mind without sacrificing that disorder to an intellectually imposed order. In describing LeWitt's "non-visual"
structures or minimalist grids, Lippard suggests that the artist desires to imply the existence of unseen, conceptual, interior facts or objects (something like Piaget’s notion of the object-concept) through his control and use of negative space. She then designates LeWitt’s rigorous conceptualism as the reverse or opposite of Michaelangelo’s humanist concern to free the figure from inert stone (1967, p. 48).

The modular or grid patterns which are emblematic of LeWitt’s work are not explicitly linked to his rigorous conceptualism, but are interesting only, as Lippard shows, when employed as vehicles for ideas that are not in themselves visually self-evident. Ideas such as enclosure, containment and disorder can neither be pictured mentally in their entirety, nor diagramed nor schematized. Lippard discusses how the exterior components of LeWitt’s minimalist white structural skeletons (for which previous training in 3D design with I. M. Pei provided a strong background) are laid bare to the eye, but the more ambiguous conceptual relationship between order and disorder in the sculptures is not self-evident (1967, 42). The changes enacted on LeWitt’s multipartite skeletons by lighting, placement and point-of-view, renders exterior contour even more important as it establishes firm and ordered boundaries around the interior disorder. Like a kind of dismembered perspective drawing, LeWitt’s open constructions diminish the visual field to its most minimal presence.
Lippard acknowledges that LeWitt’s structures may infer interval, sequence, surface and line, but these features are never absolutely visible. Each frame delimits rather than depicts the surface it contains (1967, 47).

LeWitt (1967) explains that the arrangement of conceptual objects becomes the end, while the form becomes the means to that end. The non-visual logic and “uncontrollable nature” of LeWitt’s modular works undermines any idea that we can only appreciate minimalist art in terms of its self-contained structures. Lippard equates simplicity of structure with openness and non-visuality, and complexity and enclosure with visuality. The more logical, complexly conceptual or closed LeWitt’s premises become, the more visual and self-evident his work appears and vice versa; hence the paradoxical relationship between the visual (or perceptual) and the conceptual emphases in making art (1967, p. 46). As LeWitt (1967) himself writes, when an artist uses the multiple modular method, she/he usually chooses a simple or readily available form; the use of complex forms otherwise disrupts the work’s unity or wholeness.

LeWitt (1967) emphasizes that minimalist art is not theoretical, as mentioned above, but is intuitive, engaging in all types of mental processes. While he insists that intuition discovers ideas and concepts, we can only perceive the work of art after its completion, never during its expression or execution. This may seem like a contradiction, but LeWitt explains that if the artist wants to explore an idea thoroughly, then arbitrary and chance decisions
must be kept to a minimum, and the artist should eliminate caprice, aesthetic
taste and other “whimsies” from the fabrication process. This places minimalist
art quite close to instructional objects. LeWitt (1967) instructs the artist who
chooses to use a conceptual form to make all planning and design decisions
beforehand, which consequently renders the execution a perfunctory affair. He
also suggests that the materiality of the 3D object not be used as an
expressive device, nor be allowed to become a deterrent to the understanding
of an idea; rather, the conceptual artist would want to “ameliorate” the 3D
physicality of the object so it does not detract from the concept. The use of 3D
form itself is relatively unimportant to LeWitt, but he does believe that we
should manufacture and present conceptual art with the most economy of
means, whether we state its ideas with numbers, photographs, words, or signs.

3.3 Robert Morris: Primary, autonomous 3D objects

For LeWitt, the modular skeleton structures of his pieces (the form) are
less important than the simple ideas which they conjure. For both Judd and
Morris, however, shape is the critical factor behind the gestalt impression of
the object. Morris’s “unitary forms” are polyhedrons that resist interpretation as
anything other than as a single, constantly known shape (its gestalt). Morris
(1966) explains that there are simple forms, such as solid polyhedrons, which
create strong gestalt sensations in the observer. Polyhedrons do not highly
differentiate the many relative sensations of color, texture, scale, mass, etc.;
they do not present clearly separated parts of these kinds of relations to be
established in terms of shapes. The formal elements of simple polyhedrons are therefore closely bound together to offer maximum resistance to perceptual separation. Morris (1996) affirms that it is the strength of the constant, known shape, the gestalt, of his pieces that allows for emphatic awareness in these works as compared with previous sculpture. He writes that the apprehension of the gestalt, the essential idea of the work in terms of its shape, is the only aspect of the work which the observer perceives immediately.

Morris (1996) insists that his work is autonomous in the sense of being a self-contained unit for the formation of the gestalt impression, the indivisible wholeness of each shape. If aesthetic qualities are to exist within or around the work, they exist only as unfixed, fluid variables that find their definition in the particular space, light, and positioning of the unitary form in relation to the observer. Object autonomy is therefore determinate of aesthetics. Morris suggests that the aesthetic judgment of his art work be necessarily based on the "sensing" of the specific, non-neutral presence of a particular shape, most ostensibly the regular or irregular polyhedron, as it bears on other formal terms, such as light and scale, in a kind of purposeful or rightness of fit. Morris writes,

Characteristic of the gestalt is that once it is established all the information about it, qua gestalt, is exhausted. (One does not, for example, seek the gestalt of a gestalt.) Furthermore, once it is established it does not disintegrate. One is then both free of the shape and bound to it. Free or released because of the exhaustion of information about it, as shape, and bound to it because it remains constant and indivisible (1996).
The paradoxical nature of the gestalt of a simple shape is that the information about it is obviously limited and quickly exhausted, as in the simple idea or concept, but the impression or sensation it creates has lasting effects on the observer to bind her mentally and kinaesthetically to the object. Consequently, Morris (1966) identifies shape as the simple most important sculptural value which, when magnified and integrated with other formal values and qualities, establishes both a “new limit” and a “new freedom” for sculpture. He strongly believes that his emphasis on the conceptual side of sculpture as embodied in 3D gestalts has the capacity to render extraneous the other multipart, inflected, relational sculpture valued by Greenberg and other formalist critics.

Morris (1966) recognizes that the nature of 3D gestalts varies as they occur in the apprehension of various types of polyhedrons. The observer does not have to move around the simpler polyhedron, such as the cube or pyramid, to get a sense of the whole, the gestalt. Morris suggests that there be a one-to-one correspondence between what the mind apprehends and the existential fact of the object, in this instance. The apperception (intuitive apprehension) of the 3D gestalt impression requires, according to Morris, a kind of “belief” in the object’s spatial extension and the visualization of that extension, which is necessarily the result of the experience of aspects of the object within the visual field. In more perceptual terms, Morris (1966) acknowledges that the formation of this “belief” involves certain perceptual factors, which include kinaesthetic clues, memory traces, perceptual theories of the constancy of
shape, and physiological determinants such as the nature of binocular parallax vision and the neurological structure of the retina and brain, of which he goes into no further detail. The apprehension of the 3D gestalt also depends on specific conditions of light and spatial context in relation to the object and the observer: Morris discusses how the shape and size of the room in which we exhibit the object exert a structuring factor on the apprehension of the 3D gestalt both in its cubic shape and in terms of the kind of compression different sized and proportioned rooms can have on object-observer relations. The presence of the object itself or the aggregate of art objects also alters the total space, Morris reminds us. Like setting up the dynamics of little mise en scène or stage settings, Morris (1966) posits that every internal relationship of space and light, whether it is set up by some structural division or barrier, or enhanced by the richness of surface or light sources, reduces the public, external quality of the object and pulls the observer out of any external space in which the object exists and into a more intimate relationship with the work in question, so contributing to a more immediate understanding of the 3D gestalt.

Regardless of the conditions of light and space, Morris suggests that complex polyhedrons are responsible for weak gestalts because of the greater divisibleness of their parts and the weakening of visualization as the number of polygon surfaces increases. A sixty-four sided irregular figure, or other high-polygon figure, would consequently be complex enough to frustrate visualization almost completely, particularly from a single perspective or
observer point-of-view, in which case experiencing a strong gestalt impression would be difficult (relatedly, high-polygon visualization in 3D computer modeling and animation also creates difficulties in terms of morphing, clarity, smoothness of surface, memory use, portability, speed, conversion, etc.).

Morris chooses simple irregular polyhedrons, such as beams, inclined planes and truncated pyramids, as objects of study, because they are easy to visualize and sense as wholes. Although some are less familiar than the regular geometric forms, Morris (1966) insists that this does not prohibit the apperception of the gestalt: overall, the simpler regular and irregular polygonous shapes enable strong 3D gestalts by maintaining maximal resistance to being confronted as objects with separate, multiple parts.

3.4 Minimalism and constructivism

Morris's notion of the 3D gestalt sensation resembles the radical constructivist (post-Piagetian) idea of figurative abstraction, which refers to the domain of sensation generated by the kinaesthetic relationship between the observer and object. In Morris's (1966) reading of *gestalten* phenomena, as an object moves laterally in the field of perception, its apparent shape and size remain unchanged (they display perceptual constancy), even though its projected image stimulates a changing set of visual receptors. The shape or form depicted by any pattern or configuration of objects changes with its environment or context, such as a change from ambient to directional lighting. The radical constructivist notion of figurative meaning is a kind of conceptual
construction that combines sensorimotor material and the operative processes of the observer, rendering them in some way as "empirical abstractions" (von Glasersfeld 1995, p. 69). There is an element of *presentation* in figurative abstraction in which a literal understanding of its sensation derives the autonomous construction of the object-concept, which appears to come close to the effect of gestalt. Figurative meanings are those that the observer can visualize immediately because they call up incomplete re-representations of the object abstracted from sensorimotor experience. However, once the observer, the "thinking subject" in Piagetian terms, performs and reflects on the material from which she forms the figurative abstractions, she enters the domain of reflective abstraction (von Glasersfeld 1995, p. 70).

To reflect, von Glasersfeld (1995) insists that the mind must "stand still" for a moment in its activity, must grasp what is presented and posit it as an object against itself. Object permanence, the retention of the idea of the object in the mind of the observer, depends on the experience of the object before and after its disappearance from the observer's perceptual domain: radical constructivists suggest the observer derives that object permanence from the observer's visual tracking of the object, from the observer's gaze (von Glasersfeld 1995, p. 84). It is therefore something that may be a part of the 3D gestalt impression, but the observer must understand it as a reflective abstraction, because it no longer directly derives from sensation, but only and entirely from operative conceptual constructs. Morris's notion of 3D gestalt has
little to do with the reflective engagement of imaginary material, however, the experience of the gestalt occurring immediately when the object is within the observer's sensory field. The information associated with a 3D gestalt is literal and quickly exhausted over time: there is no need for the art observer to hold a re-representation (a visualized image) of the object after he has left the immediate environment. Interestingly, then, radical constructivism and gestalt share the rejection of the notion that lasting cognitive structures can reflect any ontological reality. In other words, any presumption that the observer can construct knowledge of the ontic shape of things by measuring their surface criteria is necessarily an illusion, gestalt ostensibly having an influence on Piaget and his followers (cf. von Glasersfeld 1995, p. 74).

In general, experimental gestalt and early abstract art also share a common history in their approach to abstraction, as embodied in the practices of the Bauhaus and DeStijl. Morris (1966) mentions Mondrian's disclaimer about the direct transmission of gestalt phenomena from the object to observer, claiming that sensations are not directly transmissible, or rather their pure qualitative properties are not transmissible; but relations between sensations have an objective value which the observer in the gestalt apperceives. Mondrian, as a representative of the Dutch DeStijl group of the early century, had his doubts about the figure-ground exchange and gestalten effect of overlapping planes in art, suggesting (as do the cubists) that the illusion of depth should be avoided in Modernist abstraction. This problem
eventually inspired Mondrian and Huszar to search for forms that would
destroy the visual illusion of depth and 3D perception (van Campen 1997, p.
134). Although Morris (1966) agrees with some of Mondrian's ideas about
abstraction and with his non-figurative direction in art, he believes that 3D
perception and the spatial nature of observer point-of-view as important
conditions for the 3D gestalt: the ground plane is the necessary support for
maximal awareness of the object, the conditions for knowing that object we
derive from the sensing of the forces acting on it in actual or virtual space.

If the Mondrian of 1920 chose structural abstraction over the idealistic
neoplasticism of the constructivists, as evidenced by the simple act of
rectangular color planes in space, then one can say that the Morris of 1966 did
the converse in choosing to revive the constructivist tradition by pursuing the
plastic and conceptual relationships between objects and spaces, and by
acknowledging that actual space is intrinsically more powerful and specific in
extending information about the work than paint on the flat surface of a canvas.
Fried (1967) writes that Morris conceives of his unmistakably literalist work as
resuming the lapsed tradition of constructivist sculpture and photography as
established by Tatlin, Rodchenko, Gabo, Pevsner and Vantongerloo. Morris
(1966) himself acknowledges his personal descent from the constructivist
legacy of balanced complex plastic structures in non-imagistic sculpture. He
notes the failure of the formalist, relationalist school of sculpture, e.g., Caro
and Smith, in sustaining the constructivist ideals perpetuated by Gabo,
With the constructivists, attention first shifted to new materials (steel, glass and plastics), but also to the consideration of the broader implications of industrial technologies for the future role and function of art. Morris contrasts intuitive, conceptual art, which emphasizes ideas over physical or emotive power of form, against cubism, with its concern for fixed variables, multiple parts, and simultaneous views in one plane. Irving Sandler (1967) explains that both Judd and Morris continue the constructivist aesthetic in their desire for structural lucidity, volume and nonrelational design. Sandler also points out that their construction of single geometric solids and nonrelational organizations differs from earlier cubist-oriented abstraction, including the welded constructions of the 1950’s.

Morris’s work actually shares much with that of Gabo and other constructivists of the 1920’s. Gabo’s Realistic Manifesto presents five fundamental principles for constructivist technique: two of them, relevant to our discussion, reject mass volumes as spatial elements and explore the construction of volumes by means of planes, which, moreover, results in the economic use of materials as advocated by the minimalists of the 1960’s. Corrado (1992) describes how Gabo constructed his sculptures with the use of intersecting planes following a fabrication principle similar to that of the minimalists. Gabo’s ellipsoid structures fulfill the requirements of his manifesto by constructing volumes by means of planes. Corrado affirms that Gabo had the intuitive, conceptual background in physics and mathematics needed to
illustrate abstract properties of surfaces (1992, p. 381). Gabo's model of the ellipsoid is a particular example of a second-order surface constructed with cardboard planes (polygonal shapes). Corrado tells us that second-order surfaces, also called quadrics, are surfaces satisfying a second-order algebraic equation in three Cartesian coordinates. Gabo's 1916-1917 sculptures are artistic variations of the cubic ellipse model (Corrado 1992, p. 381). His constructivist premises in terms of conceptual content of form and shape provide inspiration for the minimalists' "ABC" polygonal and cubic shapes some fifty, sixty years later. Extending constructivism further into the realm of ideas, the minimalist approach to sculpture comes close to abandoning the notion that sculpture is a tangible object at all, as these "idea" works converge the actual or virtual presence of the 3D object with its conceptual impression, its gestalt.

The practice of prefabricating the actual, physical form of a sculpture in a digital, computer graphical model, a process adapted from both constructivist and minimalist sculpture, is more than a decade old. O'Rourke (1988) discusses sculpting with computer graphics as a process of wrapping and then unwrapping 3D objects and shapes before translating that digital code to the construction of the physical object. Like a cardboard box (if I can return to this metaphor), the elements of the 3D sculpture are composed of flat, polygonal surfaces. O'Rourke describes how we can unwrap each 3D element into a 2D pattern of surfaces, lying on a plane: each element is flattened out in scale and
plotted on paper (1988, p. 347). Each of the paper patterns can, in turn, be cut out, folded and taped together into its original 3D configuration, or they can serve as the prefabricated basis for production into metal, plastic or fiberglass. Some objects must be broken into sub-objects because of their complexity, but we can ultimately unwrap and wrap any 3D shape or configuration of shapes in the suggested manner. O'Rourke recognizes his explicit concern for the intersecting relationships between the shapes of his sculptures, as these intersections become very important in the actual, physical world: all the elements of the sculpture, with their intersections correctly "scooped out," fit together like a 3D jigsaw puzzle in its final, manufactured version (1988, p. 346). The reliance on and use of Boolean operators (intersection, complementarity) have become common practice for the construction of elaborate, multi-polygonal 3D forms, whether or not they are destined to remain in the virtual domain of the computer interface. The method which O'Rourke presents handles quite well flat surfaces, tubular curves and abstract compositions, establishing several formal counterpoints between volume and space, straight and curved lines, regular geometrical shapes and irregular complex shapes (1988, p. 344). It may be tediously unsuited for rendering the high-polygon human forms and complex, imaginary creatures that appear in recent 3D animations.

Minimalism continues to influence 3D arts in that it is both a contraction of sculpture to the modernist pure object and the expansion of sculpture
beyond recognition into the realm of hybrid media. The primary structures, simple geometrical forms, modular skeletons and ABC objects were usually single forms made with a hard finish, in sharp contrast to the hybrid material forms which followed in the early 1970's: these were cultural inflections comprising a variety of organic and artificial materials, including industrial light beams and tubes, live plants and animals, the human body, fabric, classical artifacts, sands, liquid and air (the latter require containment to give them form). Causey (1998) describes how new kinds of exhibiting spaces emerged that were neither attached to permanent collection, nor sold commercially. The recovery of base materials appeared in the work of Robert Morris, Bruce Nauman, Michael Asher and others. Exhibitions, such as Anti-illusion, procedures and materials, which ran at New York's Whitney Museum, placed the identity of the art object and the boundary between art and non-art in question (Causey 1998, p. 137). The late 1960's and early 1970's were moments when the greatest pressure was brought to bear on the capitalist art market, when sculpture pushed hardest against its idea of objecthood and physical constraints, but sculpture's critical bite has largely lost its teeth. Causey (1998) singles out 1969 as the pivotal year when minimalism revealed simultaneously two paradoxical and contrary strains: 1) as a re-situation of the observer in relation to artwork as an everyday event, or mundane thing in the world and 2) as the fetish of the art object as another modernist, manufactured piece of artifice with the same kind of exchange value attached to non-art
Judd (1975), in “Specific Objects,” alleges that minimalism exceeds the late-modernist pursuit of objectivity, or objecthood, in Fried’s words. Krauss (1967) contends that minimalism was, as Fried objected, the 60’s art of the bodied, corporeal subject in space-at-large. She suggests that minimalist art choreographed and mobilized the bodied specificity of the subject, affected by the vagaries of ambient light, with a corporeal density guaranteed by the interconnectedness of all its sensory fields (Krauss 1987, p. 63). Krauss believes that minimalism ushered in resistance to abstract “spectatordom” in forms of the gendered body, a site of political and institutional dimensions. Morris (1966) sees minimalism as an attempt at resolving the contradiction between the autonomous (artistic) and literal (material) nature of sculptural forms. This involves the choice of the Wittgensteinian notion of everyday, material things over the Hegelian illusionist space of consciousness in art, but never the rejection or removal of the concept in art. In positing the object-concept, Morris (1966) sometimes privileges the unitary form as prior to the specific object (in a way that the anti-idealist strain of minimalist art otherwise does not), but he more usually presents the two as bound “cohesively and indivisibly together” via gestalt. In its emphasis on the presence and interaction of objects in the visual field, minimalism also announces an interest in the body, not in some renewed form of the anthropomorphic image, but in terms of movement, rhythm and kinaesthetic interaction.
3.5 Kinetic art

The premise that motion is the primary means to achieve different configurations of artistic bodies and sequences of events in the visual domain has been a guiding principle behind kinetic art since the 1960's. Before the possibility of the creation of virtual cyberspace worlds that go beyond the limitations of the Newtonian physics of our perceived, sensed and measured physical world, kinetic artists relied on wind, water and electro-magnetic forces to generate movement in their work. Seiz (1967) lists as progenitors of the legacy of kinetic art Tatlin and Gabo (constructivism), Moholy-Nagy (Bauhaus), Man Ray (dada) and Calder (abstraction), as early twentieth century innovators of art which induces or uses movement. An abundance of work drawing on the kinetic use of light emerged in the 1950's and 1960's, including works of Wilfred, Schöffler, Vardenega, Soto, members of the Paris Groupe Recherche d'Art Visuel (Le Parc, Morellet, Rossi, Sobrino and Yvaral), members of the Düsseldorf Group Zero (Mack, Piene) and members of the Milan Group T (Boriani, Colombo, De Vecchi and Varisco). Darby (1990) constructs historically the dominant thinking of the 1960's, which was one of extreme optimism regarding technology, particularly the new computer-based technology (including the cybernetic discourse that surrounded it) and the promise it held for a radically new age. Seiz reports that discussions among curators and artists at the Museum of Modern Art in New York, the institutional vanguard of formalism in the 1960's (with a aggressive and self-serving
political agenda), resulted in dividing artists with a concern with movement in art into three major groups: 1) artists who work in 2D media, such as paint on canvas, in which actual or apparent optical phenomena produce an intense visual sensation in the observer, such as Vasarely, Albers, Agam and Poons (mostly abstractionists); 2) artists who create moving and kinetic sculpture motivated by air current, magnetism, electricity, or any other source of energy, including most prominently Haacke, Kramer, Lye, Mack, Rickey, Takis, Tinguely and Yvaral; and 3) artists concerned with the play of light and its relationship to movement, including Antonakos, Flavin, Haacke, Le Parc, Martin, and Takis (Selz 1967, p. 26).

Kineticism in the 1960's largely surrounded issues concerning visual experience deriving from physiological perception, the way the movement of objects capture light, moving sculpture as a theatrical spectacle, the harnessing of invisible forces and energies, the relationship between steel bodies and vibration, and possibilities for the use of natural kinetic elements, such as air, fire, fog, ice, smoke and water, to reshape our environment aesthetically (Sharp 1968, p. 358). The widespread use of plastics, perspex, reflecting materials and resin was augmented with electronic technology to create an art which investigated optical effects and controlled movement. The focus on body/object kinaesthetics in the 1960's continues to influence the recent critical concern with the technosensuality of the post-mechanical body, including the cyborgian "neuromapping" of body figurations within and without
"virtual space", and the nature and character of erotic sensation and play in 3D computer animations (e.g., Stone 1995a). The existence of this trajectory is evidence both of the extension and enrichment of artistic work in three dimensions (the hybrid merging of art media in 3D environments), and the strong contribution of motion and/or movement in contributing to the conceptual and formal subject matter of the object(s) in question in a number of ways.

Many kinetic artists of the 1960's attempted to construct objects which are both mechanical and conceptual instruments in their primary concern for movement itself, rather than the shape, appearance or association of the objects. Takis says that he employs the simplest means possible to capture movement as concept, to render visible to perception forces which are otherwise invisible to the human eye. He remarks, "You have to make things appear simpler than they really are; for me, just a piece of magnet and a nail floating there can make me meditate" (interview with Selz 1967, p. 30). Rickey explains that kinetic artists work within the specific human ranges for the perception of sound, light and movement, all of which involve a certain sense of rhythm, speed and repetition. Selz (1967) suggests that such perception and sensation deriving from differing forms of kinetic sculpture create what Kandinsky called a synaesthesia in the observer, a diffusion of kinaesthetic experiences between the object(s) and the human recipient. There are obvious similarities between Kandinsky's synaesthesia and the media
synaesthesia which cognitive scientists suggest accrues from human interaction with computer-based media due to the capacity of the computer to translate between modes of sensory perception (e.g., Waterworth 1997), but we should be cautious of cognitivist assumptions that posit the substitution of artificial intelligence or cognitive prostheses for human faculties. Creativity depends on the interrelatedness of reason, sensation, imagination, emotion, fantasy, etc.; the future potential of cognitive artifacts to increase creativity depends on advances in design efforts focusing on the perceptual possibilities of human-computer interaction.

Irrespective of such future developments, the trend among many kinetic artists of the 1960’s appears to have been the attempt to capture and contemplate movement as an isolated and transcendental element. Rickey describes how twentieth century kinetic art permits the isolation of the concept of movement from other ideas in a work in ways that were never before possible, implicitly because of the coterminous development of “conscious, abstract, non-objective art” (interview with Selz 1967, p. 30). Movement is also a means to achieve a sequence of different object configurations and to create shapes and changes in the composition of formal elements, such as light and shadow. Selz points out that when the curve of movement itself, such as the simple movement of an electromagnetic pendulum system, dominates a work aesthetically, then the visual effects of that movement attract the observer’s attention: this then establishes both the emotive and aesthetic value of the
piece (1967, p. 31). Of course, photography revolutionized the portrayal of motion in art, enabling us to view movement as less physical and more conceptual. Movement enables a kind of dematerialized effect in kinetic art by integrating a fourth dimension (time) with the other three spatial dimensions: the interaction of movement with color, light and mass also gives the art work luminous depth and quality. Mara Bijvoet (1990) points out that the new materials (plastics, acrylics, video) and technologies (synthesizers, electronics) appeared to have just the immaterial, experimental qualities kinetic artists were looking for, enabling them to discard the precious "object d'art" of the gallery for dematerialized, kinaesthetic works.

Kinetic art shares with minimalism an interest in concept, the necessity of intuitive process, and a penchant for the "corporeal condition", for the mechanical, quasi-artificial, nonspecular, imploded subject/object of contemporary production. We can reduce the technosensual emphasis on the kinaesthetic, bodied subject neither to a sensory tactility nor to the fetish fantasies of technology as prosthesis. Guy Debord (1988) sees the 1960's as one moment in a technocultural narrative; the spectacle of the 1960's ironically manifests the technological transformations that Benjamin (1935) anticipated in the 1930's, and envisions the future predicted by cyberpunk writers of the 1990's. Foster (1996) acknowledges that Haraway's refigurative cyborg resists the partial return to the fascistic subjecthood of the techno-sublime, as well as the logic of technology as prosthesis, by attesting to more "fruitful couplings" of
the human-machine interface. The value of such couplings lies in their power
to displace as well as to enhance the world of objects and the world of
subjects, the realms of the political and the technical (Haraway 1997, p. 270).

The technosensual aesthetics that emerges around digital, post-
mechanical media worlds emphasizes the sensual materiality of embodied
objects and forms, but also transcends the corporeal nature of the body by
rendering it immaterial. Bodied subject/objects are cast as plastic, ductile,
conceptual cyberforms and are made visible, instrumental and valuable to the
observer as digital-symbolic avatars and afterimages. In positing that all
bodies, whether actual or virtual, function as signifying surfaces, Clark (1995)
heralds the possibility of generating bodies as signifying objects which do not
take as their reference point those corporeal forms which already inhabit other
mediated environments. The body as signifying object is rearticulated in
cyberspace.

3.6 Possibilities of virtual intuitive interfaces

Grahame Weinbren, digital artist, asks, why has the paradigm of the
interactive interface up to now been the menu of the fast-food chain rather than
windsurfing or rollerblading, activities that reward a measure of practice with
satisfaction? He then alleges that pleasure that comes from mastery or
expertise is essential in the digital arts (1995, p. 407). This resembles Turkle's
(1993) notion that the computer encourages a soft, informal mastery of
knowledge through play and bricolage, the process of tinkering around in
simulated environments. Rather than tackling concepts through rules and abstractions, she suggests that the computer nurtures informal ways of knowing and allows for the acquisition of knowledge through the exploration of surfaces. This analysis also draws on idea of Piaget and others that knowledge is not passively received, but built up by the observer as a thinking subject; consequently the observer's reality is formed continually by means of construction rather than through the accumulation of ready-made structures (von Glasersfeld 1995, p. 58). The idea of (multiple), immediately usable, intuitive interfaces, which Weinbren suggests has been promoted in computer game design over the past ten years, is perhaps a conceptual extension of the minimalist notion of intuitive process, particularly LeWitt's idea that art should be intuitive, engaging in all types of mental processes: its 3D form or expression should never detract from the concept it conveys. Weinbren implies that intuition is phenomenologically closer to mastery than to unlearned immediate comprehensibility (1995, p. 407). It follows, then, that the immediate usability which players value highly in computer games is necessarily a learned process. With computers, the purported intuition comes later, after the user has mastered the program and it feels "natural", like playing the piano, Weinbren suggests. He laments the serious omission of the intuitive interface in non-game instructional media applications, a deficit that debases the expressive and communicative possibilities of interactivity.
What's more, Weinbren contends that many vintage video games, such as the Sega signature series, also fail to live up to the full potential of 3D animated interactivity by not embracing the non-Newtonian, "lighter-than-air" laws of cyberspace. Sonic the Hedgehog (series 1-3), for example, renders virtual versions of mundane, "real" world environments, such as a pool table or a roller coaster, where character and object behaviors simulate a Newtonian physics demonstration, exhibiting the banal laws of high school mechanics. Weinbren describes Sega's conventional physics demonstration in some detail:

They are simulations of springs, ratchets, and pulleys, encumbered by familiar mechanical principles—weight and gravity, linear and angular momentum, elasticity, and leverage. The cartoon characters need air to breathe, rotors, wings, or gyroscopic platforms to fly, angular momentum provided by springs or rocket motors to navigate loop-to-loop tracks, and trampolines to leap to colossal heights (1995, p. 403).

Although there are instructional reasons and purposes for constructing synthetic replications of real-life situations, or the simulation of authentic tasks with "real" world relevance and utility, Weinbren finds many circumstances for aesthetical, instructional, and/or creative reasons where going beyond conventional physical laws and behaviors may be necessary. Ferrington and Loge (1992) suggest that virtual worlds can comprise any responsive environment in which the observer can be engaged in kinaesthetic learning, whether we gear the desired application to simulate actual, imaginary, or constructed phenomena. Both authors and observers can be "world builders" who enter virtual environments to modify, construct, or simulate specific
realities and to conceptualize products, spaces and events (1992, p. 17). The growing availability of 3D animated computer software allows us to contest or ignore the modernist premises of Cartesian common sense and the earthly constraints of Newtonian physics (the everyday laws of gravity, for example) by which every phenomenal event, including thought, takes place within a measured spatial locality.

Weinbren also acknowledges that many new computer games move to a different tempo in that they move to an idealized, nonconventional set of mechanical laws. There are animated object events in these games which go beyond Newtonian parameters and approach the paradoxical behaviors of quantum particles and phenomena: objects transcend dimensions and planes, buildings with no support structure ascend infinitely, so that characters can keep climbing them, while valleys descend equally far into the depths of the virtual earth (1995, p. 403). Conventional spatial continuity and locality appear to be absent. In describing, assessing and appreciating the content and interactivity of some of these virtual computer interfaces, Weinbren suggests that critics must engage in a new kind of aesthetics: gravity and friction may still be opponents; elasticity, balance and momentum may still be allies; but no one bases the rhythms of the new games so much on speed of hand-eye communication as on the managing unknown topographies, engaging the contours on unearthly terrains and domains, resolving imaginary or newly-constructed conceptual problems, or overcoming "dangerous" encounters with
unexpected characters, elements, features and changes in *tempo*. Tim Binkley (1989) writes,

> In analog media, the information is embedded in the physical substrate, but with digital "media" an interface is necessitated because the information is meaningless until the numerical extract is reconstituted in visual form. An interface to some physical device is essential, but no single one is dictated. Computer art seems like an orphan among media. Digital creations are not the offspring of any medium and have no home in physical reality (my italics) (1989, p. 19).

Weinbren suggests that 3D animated cinema, the relatively new interactive cinematic space which makes possible simultaneity of action, multiple strands of time, and the sense that the observer is exploring the mind of another, is the hybrid digital medium in which unconventional, *irreal* and subversive narratives can unfold (1995, p. 407). Such intuitive, responsive representation *machines* bridge the chasm between computer games and instructional media in terms of the pleasure of real-time interaction, the satisfaction of attainable expertise, and the visualization of salient content. They contest to the pliability of digital-symbolic material and to the flexible, plastic nature of *hypersurfaces* in cyberspaces (see chapter four for a discussion of the current limitations of the use of digital material).

D'Amato (1996) discusses the "deep", responsive nature of some interfaces of recent computer games, particularly their use of simple, cubic gestalten forms, their revival of abstraction, their infusion of elastic bodies and objects, and their demonstration of spectacular, paradoxical behaviors that defy Newtonian mechanics. Regarding abstraction, D'Amato acknowledges
that computer game designers may be more than passively familiar with the “classic” modular grids and boxes of Mondrian and Malevich, or the more contemporary color-fill painting of Bochner and Reinhardt. D’Amato writes,

Of course, there’s a difference between an artist and a game programmer (I guess), though some might say that computer game writers and their ilk are changing the world more decisively than painting ever did (1996, p. 26).

Among the computer games that can reasonably be called abstract, D’Amato mentions the “primitive”, austere Asteroids, with its etched polygons and mind-bending torus screen, Atari’s early 80’s *Tempest™* (now out in CD-ROM and web-based versions), with an ominously beautiful crystalline structures, and some recent, spatio-perceptual puzzle-like games, such as *Icebreaker™*, *Zoop™*, *Trytrist™*, and *Endorfun™* (1996, p. 25). D’Amato posits that games like *Tetris™* and *Endorfun™*, with their dispersive cubes, L-shape polygons and Platonic solids, make us feel like were playing with abstraction on the level of an interactive LeWitt or Morris. He reminds us that computer games may have done more to revive abstraction and minimalism in popular design forms that we may first realize: this stands in strong contrast to gallery art’s inability to engage anything but its own history, that is, to reproduce itself through ironic, parodic or simulationist forms, whether in the form of gestural quotation or empty monochromes, all of which is read as a sign of art’s decline and obsolescence.

*Tetris Gold™* and *Endorfun™* may actually create a kind of kinaesthetic interaction between objects and players which ignites discontinuity and
paradox between time, space and common-sense thinking. D’Amato (1996) explains that Tetris Gold™, re-released by Spectrum Holobyte (there have been many variations and mutations), moves like a serial “snow storm” as clusters of four squares (with seven possible permutations) drop from top to bottom. The player must guide the objects in their descent so they will fit neatly and compactly in the gaps below, avoiding the “unnatural” accumulation of incomplete rows. When a player completely fills in a row of squares, it disappears, unlike any natural or human-constructed topography in our actual universe. In Tetris Blast™, the intervention of alien, unearthly elements, and strangely uniform, self-contained “explosions” of disappearing columns of geometric elements may aid, interrupt, or intercede in the player’s attempts to control, stack and fit the clusters on certain game levels (“bombs” alter common Tetris™ strategies). Another variation, Welltris™ challenges players to remove columns as well as rows while the polygonal figures, the tetraminoes and multiminos, fall down the four sides of a 3D well. The multiminos break apart into smaller blocks and shapes after the player positions them. The Canadian software developer, H½O, created Tetrisphere™, another Tetris™ mutation that combines exploding combinations of rectangular forms with a new spherical environment. Players must manipulate multiple 3D shapes so that they are flush against each other, which sets off a blast that clears a strategic path into the center of the sphere.
Enumerating the possible combinations of a limited number of basic shapes, setting a few parameters and then playing out their permutations, *Tetris™* may seem to pose a conceptual or spatial-perceptual undertaking (D’Amato 1996, p. 25). Beyond this, D’Amato discloses that *Tetris™* also has a paradoxical nature that is very engaging to players: construction is linked inextricably to destruction in that the player builds only to demolish, a metaphor for war, architecture, social relations, the temporal and procedural relationships between objects and ideas, etc. The metastructural dynamics of the digital images integrates structure and control into a spatiotemporal continuum that defines an infinite, “virtual” space. The 3D images in new versions of *Tetris™* embrace space and time from all directions, rather than limiting the vantage point from one perspective.

Similarly, *Endorfun™*, from Onesong Partners/Time Warner Interactive, is an example of *irreal* artifice that involves the manipulation and maneuvering of six-color, throbbing energy cubes across psychedelic grid-like structures. The cubes move against the conventions of gravity and “real” feedback and reaction time, demanding concentrated thought from the player in her attempts to position to cubes to “kill” or “merge with” an increasing number of color-filled squares; the player must roll each cube like a ghost brush across the virtual grid patterns in a state of heightened acuity (D’Amato 1996, p. 26). The sensory-surrounding, multimedia backgrounds accompanied by driving “tribal” soundtracks create superfluous “bells and whistles” effects in the computer
game, D'Amato implies, remaining somewhat extrinsic to the otherwise relatively "deep" conceptual, responsive interface.

In their capacity to present multi-perspective, multi-sensorial interfaces and computer-generated virtual scenarios, computer games may serve as models for instructional media, meeting constructivist expectations that the 3D objects and avatars are viable in their instrumental fit and capacity to attain objectives, rather than any fixed, inflexible correspondence to any objective ontological reality or truth-claim. The participant engages in a universe of free variables floating in 3D spatially dynamic experiential constructions which interact with the participant and with one another (an ideal, utopian vision of future constructions). Although it never permits an exit from "real-time" interactivity, D'Amato (1996) suggests that Tetris™ encourages multiple approaches toward space-time phenomena and appears to upset or invert temporal and procedural relationships between objects and concepts (as already mentioned).

This seems to leave a crack in the door for the entry of new space-time regimes in virtual games, such as those that the twentieth century philosopher, Henri Bergson, predicts will ignore the limitations of Cartesian time and space and will lead to new kinds of thinking.¹⁰ Temporality is absolutely inherent in

¹⁰ In Duration and Simultaneity, Bergson (1965) demonstrates that Einstein's reciprocity of motion posits that there is no single, readymade time, but a number of durations, or multiple real times. His respect for Einstein and his conviction that he provides not only a new physics, but "new ways of thinking", inspired Bergson to attempt to make his concept of multiple durations compatible with Einstein's views on
the mind, whereas spatiality often depends on the particular features of a sensory framework. Anything that presupposes space-time, touches on the manifestation of the mind (but not the mind itself), a kind of internal ontological reality. From the way D'Amato (1996, p. 26) describes how some computer games create in players states of attentiveness verging on trance or fugue (of alleged interest to brain-chemistry researchers), its no great leap of faith to believe that variations/alternatives in spatial and temporal dimensions (as part of larger conceptual frameworks) may be possible in some future digital media.

3.8 Concluding remarks on conceptualist, technosensual aesthetics

Minimalist art objects are plastic: they fit purposive and descriptive contexts. Therefore, my brief archaeology of art critical writing shows that minimalist objects are close to instructional objects. Foster (1996) locates the minimalist break when Judd reads late modernism so literally that he answers its call for self-critical objectivity perversely with his specific objects. Morris seeks to reconcile this new literalism and penchant for everyday articles with the old modernist autonomy of objects, drawing on shape as the given property of objects that gives them their thingness and perceptual situatedness, their gestalt and their reflexiveness. In its interest in the body, minimalist work complicates the purity of conception with the contingency of perception (Foster 1996, p. 40). Its no great leap to imagine and create conceptual cyberforms, time and relativity.
abstract post-mechanical assemblages, and condensed neuromappings of the 
*posthuman* body in 1990's cyberspace. Stone (1995a), Weinbren (1995) and 
others show us how the erotic, technosensual, kinaesthetic interaction 
between objects and players in intuitive computer games (which use 3D 
animated cinematic sequences) can become a practical model for non-game 
instructional media. They also examine and delve into the profound 
technosensual aesthetic values which the blend of the organic, robotic and 
technological properties that occur in the *posthuman* entity. (Universal Studio's 
*T23D* exhibit is a poor but a recent example from the commercial entertainment 
industry of the mixed embodiment of robotics, 70mm 3D computer animated 
cinema, real-time visual effects and stage show with human performers.)

Stone (1995a) chooses erotics, grounded and authorized by multiple 
post-mechanical bodies, as her aesthetic problem: the body image, or sense of 
the "topological self", is mediated partially by both digital mechanisms and 
cultural contexts. Stone describes the post-mechanical body as constituent of 
these simultaneous multiple bodies: 1) the "neurobody", or the internal neural 
impression of an external physical form, 2) the body that acts as the translator 
between neural impression and physical sensation, and 3) the topological body 
of 3D, or 4D surfaces (including space-time dimensions). The technosensual 
aesthetics of the post-mechanical has imploded into a vast congeries of 
organs, surfaces and protuberances, enabling a myriad of somatic and 
aesthetic responses. The body possesses multi-dimensional tactile
extensionality, every extension of which is potentially an "attractor" and "grounder" for technosensual play (Stone 1995a, p. 136). Sadie Plant (1993) also reminds us that the human and the technological are locked in the embrace of prosthetic, transgenic love, the displacement, disjunction, and multiplication of diverse combinations of human and artifice. Similarly, Stone clearly targets technosensual aesthetics within and without virtual cyberspaces as the objective of post-mechanical bodily manipulations and remappings.

Following the same pursuit into the technosensual transmogrifications of the body in cyberspace, Haraway (1985, 1997) is consumed with the process of materialized refiguration, the project of technoscience and feminism that transforms subjects and objects into different types of knots. These are technoscientific incarnations, the collapse of the semantic and material, subject and object, the technical, textual and organic into bodies, or spatio-temporal figures. The discourses of genetics and information sciences are sites in which secularized refiguration operates. Objects like the fetus, computer chip, gene, race, brain, ecosystem, database, etc. are stem cells, Haraway suggests, of the technoscientific body (1997, p. 11). Clark (1995) foresees these technogenetic bodies as capable of "mating" by exchanging genetic and technical material, so that new configurations and patterns of behavior can emerge within the virtual arena. Virtual bodies and creatures in the 3D animated interface behave according to digitized instructions which determine their interactivity and visual appearance.
Mimetic practices and parodic clone matrices are the tools/strategies which gestate fusions of the technical and cultural. Crary (1990) shows us how 3D animation techniques, such as lofting, ray tracing, texture mapping and morphing bodily movement, maintain a mimetic component that holds the human gaze: digital images and objects share in the constructs of mimesis. Crary contends that post-photographic phenomena inherit and extend the capacity to reconfigure virtual worlds: the relocation of the generation of images and objects in the digital realm constitutes a radical decoupling (a blurring and decomposing) of the actual, phenomenal world and the realm of representations (1990, p. 2). Clark (1995) also delineates popular culture trends in which photorealistic, cinematic animations contribute to the aesthetization of the body and other object forms which are subject to continual (re)representation. He points out that many of these 3D animated bodies include among them both renditions of the steroid and silicon enhanced physiques of human actors who play cyborgs in conventional analogue media (celluloid film), as well as entirely virtual, or hyperreal bodies and objects which are proliferating in digital sequences of cinema and computer games, lacking or having lost any connections to "real world" referents except through the intervention of the imagination (Clark 1995, p. 125).

In closing, the conceptualist, technosensual aesthetics that permits or encourages paradoxical object behaviors, unknown topographies and unearthly realms, altered tempos and dubious space-time regimes, and
enigmatic and improbable narrative themes in computer game design can be traced to the rigorous conceptualism of the 1960's. The simple notion that we discover ideas intuitively "gives birth" to further possibilities for the acquisition of knowledge through the sensuous interaction with virtual 3D objects and surfaces in simulated computer worlds
CHAPTER 4

3D SIMULATIONIST AESTHETICS: DIGITAL EFFECTS. OBJECT BEHAVIOR AND INTERACTIVITY

Abstract of Chapter

This chapter explores the relevant aspects of simulation and “simulated realism” with an emphasis on 3D simulations in computer media. The aesthetical dimensions of simulation in mediascapes include five aspects: 1) the graphical rendering of objects in 3D space, 2) the mapping of images and textures on 3D forms, 3) the creation and use of semi-autonomous computer avatars, 4) paradigms of interactivity, and 5) cinematic approaches to interactivity.

Elements of new media aesthetics include simulationist effects, interactive cinematic strategies, animated worlds, 3D texture mapping, dynamic reversals and transitions in narrative, and semi-autonomous avatar behaviors. Simulation in an era of post-photographic technologies involves the reproduction and consumption of multiple visual surfaces and images in computer media that are oftentimes photorealistic but also somehow “unreal.” While Jameson defines such visual simulations as epitomes of artifice that arise and decay endlessly, Deleuze describes them as constructions devised through a sense of disparity or difference regarding meaningful referents on
the surface of the computer screen or projection. Baudrillard, going a step further, suggests that any material reality of simulated figures is erased by their sense of resemblance, imitation and third-order artifice. In general, both ideas and their effects are superficial in simulationist new media: "depth" is realized on the surface in the domain of visual, auditory and tactile representations.

In practice, the application of simulationist aesthetics in computer media expands on the 3D computer game aesthetic in part by pushing the limits of photorealism and "life-like" behaviors. In the creation of an apparent or alternative realism, the continuity of a nested hierarchy of perceptual cues that organize light, space, color, form, movement, texture, sound, and object behavior in 3D mediascapes correspond to our shared understanding of everyday events and things. As digital and analogue images are seamlessly woven together in a composite mesh these cues and transpositions can be transparently unreal or appear subtly "real". Embodying the formalist concern with modulating planar structures and surfaces, 3D texture image mapping produces the maximal amount of surface detail for the smallest expenditure of computer resources, such as RAM memory and file storage space. Complex, irregular 3D objects in motion are therefore comprised of image maps fitted to multivariate triangular or quadrilateral facets on object surfaces that have been specified to satisfy the demands of modes of camera position, camera angle, kinematic animation and artificial lighting. Recent advances in artificial intelligence research also create the possibility for partially autonomous
synthetic objects and avatars to engage in their own self-directed autofictions and intuitive behavioral strategies. They embody and extend the minimalist penchant for the tracking configurations of conceptual objects across perceptual and multisensorial domains.

Lastly, regarding interactivity, cinematic strategies that account for dynamic, random connectivity and behaviors in computer instructional media are well suited to new media. The more conventional network nodal structures associated with hypermedia seem too stilted and rigid in comparison. Cinematic strategies interrupt extreme forms of rationalism and linearity by creating fictional or false continuities between images: they utilize purely visual, auditory, tactile or mental devices (transitions) to simulate modulating durations of time in the mind and memory of the observer/player. This chapter examines 3D object visualization and the dynamic interaction of participants and synthetic agents within interactive simulations in the recent computer graphics literature. After introducing some theoretical observations about simulations in our commercial culture in the next section, I will briefly discuss the practice of fitting image maps to object surfaces that have been specified to satisfy the demands of photorealistic digital effects in film.

4.1 Theories of simulation

Simulation involves the serial reproduction and consumption of images in the arts and media. Mitchell (1994) has already mentioned the possibility of a contemporary turn toward the pictorial, of a culture dominated by both visual
simulations and mimetic images during an era of post-photographic
technologies on a global scale. Past examples of simulations in art include
Andy Warhol's serial silkscreens, including his *Marilyns* and *Death in America*
series, and Richard Prince's superrealistic rephotographs of magazine
advertisements. Simulation in the visual arts is sometimes taken to be
synonymous with this kind of photorealism in photographic and post-
photographic (computer) practices. It offers a certain measure of plasticity and
ductility of content and form: images can be attached to real world referents or
they can represent other images without any direct reference to any worldly
thing. Jameson, Baudrillard and Deleuze are leading cultural theorists who
provide differing definitions of simulation and its value as an effigy of
contemporary cultural consumption.

Jameson (1991) explains simulation in terms of a schizophrenic
breakdown of meaning and temporality that provokes compensatory
investments in the image and the instant. He describes the addiction to the
photographic image as a tangible symptom of the intensification of the
multitudinous photographic simulacra, or more exactly the appearance of
multiple simulated surfaces (or screens of projection) coming into view
simultaneously. Rather than finding meaning and value in a single image
sequence, a single screen, the contemporary viewer is called on to do the
impossible, namely, to see a number of screens at once, in their radical and
random difference (Jameson 1991, p. 31).
More recently, Jameson (1998) implies that both public and private spaces are completely saturated with the culture of the image and of heterotopias of unclassified and unclassifiable signs. Tangible portions of the experiential world (actual and virtual) are raised and dropped repeatedly in a permanent inconsistency of a mesmerizing sensorium of images. Exposed to the dynamic of commerce that now reorganizes space in terms of similitude (an identical value), the voluminous parade of visual signs are also divested of their multiple referents and reduced to equivalencies, through a process in which they are seized and flattened out into a grid of identical parcels (1998, p. 66). The pluralism of visual representation is reduced to a single, homogenous vision. Jameson depicts the present moment in visual media as a science-fiction stasis in which simulations arise and decay endlessly without any momentary wavering in its ontological prestige: a kind of illusion of slower permanence accompanies the lived like an optical projection. The triumphant artifice of new media and technologies simulate formerly natural effects and rhythms for commercial convenience and use value. Similarly, Vattimo (1992) suggests that the world of objects manipulated by technoscience has, by a perverse kind of internal logic, become the world of merchandise and images, the phantasmagoria of the mass media.

In the creation of a transparent society, the irreality of signs functions according to the nihilistic dynamic of simulation that hastens the implosion of dead or illusory values that find no sustainable or lasting meaning in surface
appearances. This idea of a transparent society is introduced with a question mark by Vattimo: he proposes that 1) the media play a decisive role in the passage between the modern and postmodern moments, 2) that they do not make culture more transparent, but more dynamic and chaotic, equating meaning with movement, and 3) that this relative chaos should not be dismissed too easily, for it holds possibilities for the expansion of human thought that no one can yet fathom. Jameson (1998) identifies technology and the media as true bearers of simulationist practices, which enact the epistemological function of blank appropriation and serial production. Experiments in hybrid high-tech media (such as computer art, digital photography and interactive cinema) begin to seep into and "colonize" the more traditional visual domains. Technologies of the expanded conception of media densely "crystallize" and then project the painterly past in the form of discrete gadgets, foregrounding the relationship between aesthetics and technology in the postmodern and unmasking the reciprocity between notions of beauty and the high-tech structure of late capitalism.

Jameson (1998) suggests that simulation augurs a new kind of spatial proliferation of artistic modes, as well as a collapse of the boundary between art and mass culture. He affirms that the nature of the reception and consumption of art has recently undergone a mutation that renders irrelevant older paradigms such as modernism. The broad-based return of aesthetics is not a wholesale revival of its former philosophical form. The preceding period
of modernist criticism had already undermined and canceled out Kantian aesthetics (e.g., Adorno). Jameson claims that the sphere of culture continues to expand to the point where everything becomes both *acculturated* and an object of everyday consumption in activities such as “shopping” (1998, p. 111). The traditional specificity of art aesthetics is lost or blurred as the postmodern attacks the autonomy of the art object and as aesthetics widens its concerns to include media and cybernetic technologies. Forms of perception that are “purely” sensory or “purely” aesthetic are no longer possible. These newer aesthetics of postmodern visual stimuli will nonetheless continue to coexist and overlap with localized revivals of older types of aesthetic effects and pleasures, Jameson says. We celebrate new media aesthetics as a heightening upwards or downwards of perceptual experience, including interesting speculations on the *sublime*, on the simulacrum and the strange, odd and *uncanny* (the Russian ostranenie), now interpreted less as specifically aesthetic modalities than as local intensities, accidents, breaks or gaps in the perceptual system of late capitalism (Jameson 1998, p. 112). In general, the return of aesthetics is accompanied by appropriation, satire, *pastiche* and the application of simulation in new media; Jameson identifies these four as markers of postmodern practice.

*Pastiche*, also called “black irony”, can therefore be seen as an instrument of both construction and deconstruction: it is important to distinguish pastiche as an instrument of critical practice from pastiche as a
symptom of the shallow appearance of routine mass media production
(although these may be understood as a continuum). Pastiche now eclipses
parody with its embrace of empty simulation, immense fragmentation and
stylistic diversity. Jameson (1998) posits that pastiche and simulation are
consonant with the transformation of “reality” into images and the
fragmentation of time into a series of perpetual presents; both simultaneously
reinforce and resist the logic of consumer capitalism through their mechanisms
of serial reproduction and retroparadox, the repeated inability to deal with time
and history (including the incapability of achieving the aesthetic representation
of our own current experience) while continuing to appropriate the elusive
styles of the past.

In his later work, Baudrillard turns toward delineating the age of
simulation that he believes characterizes our postindustrial culture, and which
begins with the liquidation of all referents by their artificial “resurrection” in a
system of signs. The hyperreal comes about through the operational
substitution of signs of the real for the real itself: signs prove themselves to be
more ductile material than any real meanings in that they lend themselves
more readily to imitation, duplication and parody. Baudrillard writes, “when the
real is no longer what it used to be, nostalgia assumes its full meaning. There
is a proliferation of myths of origin and signs of reality, of second-hand
objectivity and authenticity” (1988, p. 171). Such nostalgia is a futile effort to
rejuvenate a fiction of the real, an attempt to conceal the fact that the real is no
longer real with the awareness, also, that it is dangerous to unmask images
that have nothing behind them.

Baudrillard has become somewhat famous for his depiction of
Disneyland as both the perfect model of third-order simulation and a
deterrence machine: Disneyland is presented as imaginary in order to make us
believe that the rest of America is real, when in fact the Los Angeles of
shopping malls and endless, unreal circulation is hyperreal, a simulation
(1983, p. 25-26). Like a prefiguration of how “reality” could be, past and
present forms meet in “playfully promiscuous” Disney mosaics, where all
cultures, including the future, meld and recur in the bewildering perspective of
fairytale scenarios (it may be naive to think that these scenarios are harmless
or benign to the ethnic/cultural groups depicted). Just as “Hollywood Disney”
is continually reconstituted in “Florida Disney,” Baudrillard (1994) suggests
that the Disney-effect enables us to revisit the whole past and future as living
simulation.

In Simulations, Baudrillard (1983) describes the more general and
universal demise of meaning as it is enveloped in a culture of simulacra. The
effects of hyperreality surpass any effects of the real, because there is no
longer any sense of any mimesis or reproduction of some original reality.
Baudrillard insists on the impossibility of rediscovering any absolute level of
the real: it is lost forever, a desert of the real (1988, p. 166). He presents the
refraction of the serial form, as in the case of Warhols’ work, as an instance
where there is no formal "flection" or even internal reflection, but only
continuity of the same, flection and reflection zero (1983, p. 144). The
corporeal reality of the figures are erased by the resemblance: the real no
longer reflected, it feeds off its mirror image to the point of emaciation, sheer
transparency, or absolute vapidity. For Baudrillard, the omnipotence of
simulation is both productive and erasing in that contemporary "material"
production is itself hyperreal (computer simulations are part and parcel of this
semiotic production) and because none of us can escape our (dis)appearance
in the epiphany of representation completely erased all real objects of
representation. His metaphysical despair derives from the idea that images
conceal nothing at all, but are actually perfect simulacra forever radiant in their

The artificiality of simulation also masks over the technological
machinery that supports it: the underlying material reality is servile to
hyperreality and the advancement of simulation; digital technology is
incessantly reshaped to produce pure appearance. Although Baudrillard
(1983) repeatedly mentions the close ties between technology and simulation,
he gives no attention to the substructure itself, the undergirding technology.
Nevertheless, Baudrillard presents consistently, and in general, a view of
commodity culture by which marketing signs are the surface forms of third-
order hyperreal appearances that have.
In *The Illusion of the end*, Baudrillard (1994) no longer questions the transition to a culture of simulations, a fact he considers a done deal, but is concerned with the role simulations play in historical cycles and recursions, particularly in the impending turn of the century, or *fin de siècle*. The problem with discussing "ends" or "end points" as historical events, according to Baudrillard, is that you have to speak simultaneously of what lies beyond the end and of the impossibility of ending. The media suppresses and transfigures the cause-effect relation of all historical continuity, programming their occurrences and anticipating their effects in a kind of chaotic distortion of the sequence of events. Baudrillard writes,

> The distortion of causes and effects, the mysterious autonomy of effects, this cause-effect reversibility, engendering a disorder or chaotic order (precisely our current situation: a reversibility of reality [le réel] and information which gives rise to disorder in the realm of events and an extravagance of media effects), puts one in mind of chaos theory and the disproportion between the beating of a butterfly's wings and the hurricane that unleashes on the other side of the world (1994, p. 110).

The problem of the logic of events in terms of artificial production and media transfiguration is equivalent to searching for the virtual efficacy of absent molecules, Baudrillard says; a paradox where "ends" cannot be located in a nonlinear, non-Euclidean space of history. The sequencing of forms and retroversions of history are modulated in the "variable refraction media hyperspace", which we can interpret as a kind of turbulence, due to the hastening of events which reverse and swallow up their own course (the cat chasing his own tail, a virtual solipsism).
In this logic of perverse effects and spiral whirl of time and history, everything tends toward a zero point, itself also a strange attractor, moving exponentially towards a total entropy where all events have already taken place. Baudrillard explains that our simulated history moves in loops, tropes and inversions of meaning; events remain indefinite, unfinished and deprived of their ends (1994, p. 120). It's undeniably important to remember that the radical strangeness of the strange attractor, our innate virtual solipsism, is merely a metaphor for a world engulfed in simulation.

Baudrillard suggests that the historical fictions that we weave open onto a world that is more and more consumed with illusory representations and artificial ends. We put both our origins and ends into play as we satisfy our thirst for nostalgia and appease our utopian desires in situ and in vitro: we exhume our origins in archeology and engage our utopian visions through science and technology (1994, p. 120). The culture of simulation also requires periodic visits to the realm of the cyborgian carnavalesque. Regarding genetics, the material simulation of beings, Baudrillard recognizes that artificiality is no longer directed towards deferred ends, but extends itself through prosthesis, literal fetishism, and the reproduction of a timeless genetic code. Again, he returns to an earlier theme of the inversion of the material and semiotic, of an illusory and mechanical prosthesis whereby the play of appearances of the body are volatilized by genetic transcription (1994, p. 98). The inhuman domain implodes into the human: we are destined to share the
same clonal, metastatic eternity, a common life-extension created by simulation and artificial prosthetics.

As if Baudrillard's writings over the past few decades also run in circles and regressions, he returns to the themes of his Simulations, namely the resurrection and resuscitation of older images, signs and values in fluid, unstable simulacra and media consumption. He (re)interprets the revival of vanished or vanishing forms as an attempt to escape the "apocalypse of the virtual" and as the last of our futile utopian desires. Baudrillard reminds us that the more we seek to rediscover the referential, the more we sink into simulation (1994, p. 117). Earlier forms never resurface as they were, however, but as third-order or fourth-order hyperreal retro scenarios superimposed one on another without any historical significance. While Baudrillard contends that none of these trompe-l'oeil events and effects make any difference to the present melancholy of the fin de siècle, we can interpret them as examples of the creative aesthetic or spark occurring entirely on the surfaces of our age.

For Deleuze, the simulation is constructed on a disparity, or difference which rises to the surface, a phenomenon that operates entirely within the realm of representation. It matters little whether resemblance involves a great external or small internal difference, or vice versa, only that difference, great or small, always occupy the decentered locus of the simulation, or event.

Deleuze (1990) distinguishes the simulation from the copy in two ways: the
copy is endowed with resemblance, but the simulation need not be; the simulation is not a degraded copy in the Platonic sense, but harbors a positive power in denying the original and the copy, the model and the reproduction. Without doubt, it still produces an effect of resemblance, but this effect is completely external and produced by a different means than at work within the model; it internalizes a dissimilarity.

Deleuze affirms that the artificial and the simulated are not the same thing, they are even opposed to each other. The artificial is always a copy, which, Deleuze says, should be pushed to the point where it changes its nature, where it nourishes and internalizes disparities and is reversed into the simulacrum (the moment of pop art, for example). Deleuze (1990, p. 265) defines (post)modernity by the power of the simulacrum, by the simulation conceived at the edge of critical modernity, by the destruction of Platonism (the most innocent of all destructions) effective in the raising of phantasms.

Deleuze embraces the stoics as the first to try to reverse Platonism, to bring about the radical inversion of bodies and ideas: bodies, with their states, qualities and quantities, have substance and cause, while ideas are relegated inefficacious, inert, sterile and a shallow surface. Ideality, or incorporeality is stripped of its causal and spiritual efficacy and is rendered nothing more than a sonorous, optical, or linguistic effect on the surface. The Platonic idea is something never hidden completely, Deleuze suggests, although it is pushed into the depths of the body, like being drowned in an ocean (1990, p.7). The
stoic operation reverses this direction: everything now returns to the surface. Simulacra now become important in providing sense and meaning: they cease to be elusive, "subterranean rebels" and make the most out of their phatasmic effects. In attempting to create a new logos animated with paradox and inverted philosophical values, Deleuze discusses how the stoics and cynics regard the idea as event and superficial effect, rather than the highest cause or essence, reorienting all thought in something other than depths and heights. Unmasking the deceptive practices of Platonism, Deleuze comments, "the depth is a digestive illusion which complements the ideal optical illusion" (1990, p. 130). Once the idea is deprived of its height, it falls to the surface as a simple incorporeal effect. The stoics discovered the autonomy of the surface, its incorporeal events, meanings and effects, as irreducible to deep bodies and lofty ideas.

For Deleuze, meaning is simulation, a contradictory, paradoxical entity that defies "common sense": it seems to inhere in language, but also appears on the surfaces of things. If one seeks it in things, it appear as an event that is spatially and temporally there, yet always somewhere else, always past and future. Objects, things, corporeal bodies are rendered flat and depth-less in surface events. Depth is realized on the surface just as the three-dimensional space is represented in a two dimensional image or projection, which once flattened, can be mapped/morphed from object to object, surface to surface.
Simulations are manifestations of appropriation and serial production in photography, digital animated media and other technological forms. Jameson reminds us that they are symptoms of our addiction to a culture of image heterotopias which appropriates past styles in a perpetual present. Baudrillard defines simulations as the ever-present proliferation of artificial third-order signs, the results of a continual semiotic production that erases all traces of original referents. For Deleuze, simulations are the events in which both sense and the meaningful image appear on the liquid surfaces of representations. They are the optical effects/projections of both meaningful thought and paradox: they undermine rigid assumptions about rationalism and transparency in the visual domain. I believe that consumption in an age of post-photographic phenomena involves the relocation and reconfiguration of images and objects in the digital realm, and a radical decoupling (a blurring and decomposing) of the actual, physical world and the realm of representations. As Jameson (1998) reminds us, the “triumphant” artifice of new media and technology is really beginning to simulate “natural” effects and behaviors for the demands of consumption.

4.2 Photorealism and 3D digital effects in cinema and animated media

As apparatuses for the production of contemporary simulations, digital imaging technologies are rapidly transforming nearly all phases of contemporary cinema and photography. In the Transparency of spectacle, Wheeler Dixon (1998) concludes that the digital world is destined to become
seamlessly meshed with the mass-produced photograph/video-taped image. The digital cinema video space will become the zone of the eternal hyperreal (via Baudrillard), the "picture postcard vision" of existence for art, education and entertainment consumption. Presently, Dixon believes that viewers/observers are conscious of some degree of image manipulation in the films and photographs they witness when the visual juxtapositions are transparently unreal, but more subtle digital transpositions will continue to go unnoticed as the digital/analogue image mesh is woven tighter (1998, p. 34). Dixon identifies a growing industry of hyperreal image production that circulates around 3D animated effects and exists in an fictive zone of non-being or the phantom zone of signification. The new digital imaging spectacle invites continuous consumption, the fetishism of artificial perfection and substance, and an air-brushed world of synthetic serenity (Dixon 1998, p. 184).

Resembling Jameson's simulations, the present becomes eternal through its manipulation by pixels (through its digital representation) and the whims of market consumption. Assumptions about photorealism in the cinema and, more recently, interactive media are tied to concepts and relations of indexicality prevailing between the photographic image and its referent. Because computer graphics imaging (CGI) is so novel and the creative possibilities it offers are so unprecedented, its effects both on representation and on audience response are poorly understood. What are the implications of computer imaging for art, education and entertainment, particularly for
concepts of photographically-based realism and simulation in these venues?

For reasons that are both obvious in their transparency and subtle in their reality-creating effects, computer imaging challenges indexically based notions of photographic realism. The realist aesthetic, presented most famously by André Bazin (1967), is based on the allegedly objective nature of photography which bears the mechanical and chemical trace of its referents. Bazin stipulates that no matter how fuzzy, blurred, distorted or discolored the photograph, the image is the object freed from the constraints of time and space by its very process of becoming: the photographic image is a reflection of reality (in its reproduction of the referent). More recently, Nichols (1991) observes that a digitally designed or created image can be subject to infinite manipulation, its reality a function of complex algorithms stored in computer memory (rather than a necessary mechanical resemblance to its referent).

In an important article in *Film Quarterly*, Stephen Prince (1996) affirms that computer imaging operates according to a different ontology than do analogue photographs. It departs in obvious ways from photographically coded realism: multiple 3D objects can be co-present in digital space, though not in the actual, physical space which photography records. Computer environments have to be programmed to account for collision detection and response when simulating an interactive narrative; therefore 3D animators begin with transparent wireframe models which they can rotate to determine movement and intersection in simulated space (Prince 1996, p. 30). Prince
provides an example from Spielberg's *Jurassic Park*:

The animators who created the herd of gallimimus that chases actor Sam Neill and two children in *Jurassic Park* were careful to animate the twenty-four gallis so they might look like they might collide and were reacting to that possibility. First, they had to ensure that no gallis actually did pass into and through one another, and then they had to simulate the collision responses in the creatures' behaviors as if they were corporeal beings subject to Newtonian space (1996, p. 31).

In a second example from James Cameron's *The Abyss*, computer imaging anchors pictured objects, like the underwater creature, in seeming photographic reality by using simulated lighting (shadows, highlights, reflections) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (the creature's slimy, rippling responses) and surface texture detail (Prince 1996, p. 30). Of course, this is actually an *irreal* synthetic reality.

Prince points out that credible computer animation requires the addition of motion blur to simulate the look of a photographic image. Morphing exhibits part of this reality-effect, smoothing out the differently modeled and textured configurations of mouth and face. The ping-pong ball rallied between Tom Hanks and his opponents in *Forrest Gump* is a computer animation of a digitally scanned photographic model that was composited into the live-action footage of the game in post-production: the animators were careful to add motion blur to the digitally key-framed object (Prince 1996, p. 32). Computer imaging can bend, twist, stretch and contort virtual objects in surreal, cartoonlike ways that both parody and depart from "real-world" referents.

Prince concludes that computer imaging creates synthetic, virtual realities that resemble photographic realities. Its simulated realism is
presented as a discourse coded for transparency such that the indexicality of photographic realism is replaced by a reality-effect created by computer code and fictitious narrative (as described in passages below). Nichols (1991) suggests that documentary creates a realistic effect by means of its epistephilia, a pleasure in knowing, but also by a certain textual persuasion, aesthetic style, and a particular economy of logic in argumentation. The engagement stems from the rhetorical force of an argument about the external world, a vision or worldview. Narrative discourse is a rhetorical troping of the facts that gives them the form and content of argument. Rhetoric is therefore the logic of narrative figuration, or what Serge Doubrovsky (1988) has called “autofictions,” a type of narrative in which the audience is teased and cajoled into an understanding of the unfolding of events. Nonetheless, computer imaging has an inherent flexibility that distinguishes it from the indexicality of the photograph’s relationship with its referent, but does this mean that CGI creations should be grouped under the rubric of realist film theory? How do the capabilities behind CGI and 3D animation challenge the assumptions about realism embodied in conventional film theory?

Computer imaging provides new horizons and thresholds for cinematic theory, particularly in its pushing the limits of photorealism and its deliberations over the nature of pure simulation. As we can see, these two issues can be viewed as two sides of the same coin. Prince interprets CGI and 3D animation including hybrid media, such as the interactive cinema as attributions of
realism in film, because he believes that viewers adhere to specific
correspondences that are structured and/or transformed by the image. He
insists that even fictionalized realities in media correspond to visual and social
coordinates in our actual, material world, their focus need not reinstate
indexical referencing as grounds for realism, but can emphasize "falsified"
correspondences and the transformation of cues (1996, p. 34). Even unreal
images can be perceptually realistic, Prince says. Viewers add non-real or
hyperreal objects to their repertoire of everyday things because they recognize
something familiar in a film's semiotic correspondences and cues. Iconic and
non-iconic visual and structured cues are structured into cinematic images in
ways that facilitate, understanding, knowledge, interpretation and evaluation by
viewers/observers. In more detail, Prince continues,

At a visual level, these cues include the ways that photographic images and
edited sequences are isomorphic with their corresponding real-world
displays (e.g., through replication of edge and contour information and of
monocular distance codes; in the case of moving pictures, replication of
motion parallax; and in the case of continuity editing, the creation of a
screen geography with coordinates through the projective geometry of

Therefore, the continuity of a nested hierarchy of cues that organize light,
space, color, texture, form, movement, sound and object behavior in 3D media
"realities" in ways that correspond to the observer's own understanding of
everyday events and things. The speed and complexity of digitally rendered
3D cues, which are computationally expensive and exceed the limitations of
many computer systems, work to integrate synthetic objects and environments.
Prince believes that coherent sets of perceptual cues create an apparent realism in their synonymity with the properties of actual, physical space and the "natural" environments experienced in daily life (1996, p. 35).

Although Prince (1996) posits that unreal digitally-composed images and animated sequences invoke memory traces of perceptually valid experiences in the viewer/observer, these same images may actually be illusory constructions with their own spatio-temporal existence. Nichols (1991) suggests that computer imaging practices throw into question film theory's insistence on revealing the constructedness and artifice of media properties, but he reminds us that all media representations are in the end equally artificial, since they are all forms of construction. Film is no longer the transparent window on the real world that it promised to be, but is recognized instead as imposing an artificial coherence and constructed meaning on noncontiguous or completely fictional objects and events. In the future, interactive CD-ROM cinema may become a preferred medium for the construction of small interpretive pieces, for the creation of little fictionalized histories, because it draws on an inventory of camera techniques, multiple audio-track editing, and digital effects to simulate form and create the illusions of fullness, closure and truthfulness where there are only fragments and ephemera. As products of the culture of simulation, computer images operate according to a different ontology than do indexical photographs. As Crary (1990) suggests, computer graphics imaging and other techniques maintain a
photorealistic, or mimetic component, having the capacity to reconfigure and reconstitute the phenomenal world in a realm of "real appearing" cinematic representations.

4.3 Three films: breakthroughs in 3D synthetic character animation

The "post-Jurassic Park virtual cinematic effects are visual manifestations of the recent breakthroughs in computer graphics imagery that construct photorealistic creations and unreal, synthetic environments. The recent technowave of computer hardware and software (with expanded processing power and memory capacity) allows for unprecedented freedom in the digital compositing of computer graphic creations: the integration of live action film with artificial elements and 3D modeled creatures is accomplished through digital rotoscoping, which involves careful outlining and multiple matte blending techniques. The construction of the final photorealistic composite involves the separate manipulation of the model, its movement, its lighting and its surface detail. The imaging process, including the blurring of edges of all 2D mattes with 3D elements, is completed using image editing software (such as Adobe Photoshop® or Parallax Matador®). Many of the small imperfections are then corrected with the stroke of an artist's electronic paintbrush! A complete description of the kind of visual effects that appear in Akira Kurasawa's Dreams (1990), for example, including rainbows, rain elements, power plant meltdowns, artificial pyro effects, and radioactive fogs are beyond the scope of this paper. We are more concerned with the use of 3D animation
software (most often SoftImage®) for the construction of 3D virtual objects and actors. More particularly, we are interested in the use of 3D objects in mainstream film and their potential applications in game design, art and instructional media. Three films, The Abyss, Terminator 2, and The Mask are important precursors of advanced, life-like 3D animated character design in contemporary film and media.

The postproduction animation of the nonterrestrial watery pseudopod in The Abyss (1989) is the first significant application of 3D computer character creation technology in film. A "real" physical model of the pseudopod’s spatial and textural qualities was first sculpted from pure resin maquettes; then the effects team began work on the construction of the computer wireframe "pod spine" on which the basic tubular creature took shape. Animation software locked in the pseudopod’s fluid, part-serpentine, part-liquid movements. The simulation of wave motion was used to create a library of hand-adjusted ripple effects, which became the basis for the creature’s transparent, reflective surface. The computer then simulated the appearance of water through the use of refraction, reflection and shadow algorithms. The resulting texture was not perfectly photorealistic, because the effects team chose not to use time-consuming and memory expensive ray tracing techniques that more precisely simulate liquid surfaces. Regardless of the omission of ray tracing, the lengthy process of compositing the completed 3D element (animated form, watery rippling surface, light reflection and refraction) required four hours per frame.
for twenty separate shots and seventy-five seconds of film: this soon became the new standard for cinematic illusions (Vaz and Duigan 1996, pp. 193-200).

In order to construct digitally the T-1000 Cyborg Liquid Metal Prototype that appeared in Terminator 2 (1991), the effects team built a full-action chrome man with complete musculature from a computer wire-frame spine. The team painted a black grid on a live actor and recorded his motion characteristics photographically with multiple cameras. They then digitized the reference footage and constructed a frame-by-frame computer skeleton. The effects team wanted to simulate the laws of Newtonian physics and then move beyond them in their creation of fantasy effects. They succeeded at duplicating accurately human attributes, motion and affect. The team smoothed and blended the edges of a digitally modeled surface, the points in the 3D mapping where polygons and patches crease and/or overlap. They employed customized software to animate the various morphing shots of the chrome humanoid’s shape-changing actions and his movement in and out of liquid, molten form. After the team composited the 100 elements and approximately 8,000 frames of 3D illusory effects, they used image editing software to paint out flaws and repair tears and gaps in the cyborg’s chrome texture, completing the entirely digital film footage (Vaz and Duigan pp. 200-209).

The Mask (1994) reproduces all the histrionics of a classic Tex Avery animated cartoon with complete photorealism and 3D digital character design.
The film showcases the first partially computer animated cartoon human, setting the precedent for later films. The importance of *The Mask* also lies in its CGI effects that reproduce photorealistically all the distortions of material reality *de rigueur* in the world of cartoon animation. The effects team began with a background plate of the actor with live makeup effects, prepared an Avery riff with a wire-frame construction in 3D animation software (*Alias*® software), and then superimposed the wire-frame over the background plate (using *SoftImage*® software). Lastly, the team reanimated and rendered the final composite shots of the cartoon human experiencing fantastic physical contortions.

As a result, the film's 3D computer imaging work features classic cartoonesque riffs such as the synthetic character going through eye-popping and jaw-dropping convulsions, climaxing in a human to cartoon wolf transmogrification. The director, Charles Russell, attempted to avoid the extremely horrible contortions and grotesque, "ultraviolent" human refigurations that had circulated in earlier versions of the filmscript (Vaz and Duigan 1996, pp. 259-266). Such 3D cinematic effects are the inspiration for an expansion of the 3D game aesthetic and for recent experimentation in 70mm Imax film, where computer images fill the peripheral vision and permit the observer to explore virtual landscapes from a non-human perspective (from inside a synthetic creature, for example).
4.4 The Creation and use of semi-autonomous 3D synthetic objects and behaviors

The creation of believable synthetic characters and objects, simple but complete 3D situated agents who can do the “right things” inside a particular virtual scenario, is one cutting-edge intersection of entertainment and artificial intelligence (AI) research. The construction of such avatars, artificial agents for use in interactive virtual environments is on the rise in computer labs worldwide. Emphasizing form and function over the content of virtual narratives, it is possible to weave miniature stories and sub-genres, small narrative strategies with artificial players that are particularly suited to animated cinematic sequences. Narrative configuration is rooted in its application to the everyday world, but it is also an artificial and hybrid construction that makes connections between the past and present.

At MIT Media Lab, Blumberg and Galyean (1995) discuss new advances in the design of partially autonomous avatars capable of responding to internal (computer intelligent) and external (player) influences. They suggest a balance between pure object autonomy and external directability by the participant/player. There is a need to endow the synthetic avatar with the ability to perform some autonomous activity as the complexity of the object’s interactions with the environment and with other objects and creatures increases with the power of 3D computer animation. Blumberg and Galyean affirm that insights from research in autonomous robots strengthen the
possibilities for "intelligent" animated objects that merge real-time action with
dynamic and unpredictable environments (1995, p. 1). They propose a layered
architecture and a behavioral model of action selection that provides support
for dynamic, multi-level direction and player-object interaction. The design of
3D synthetic avatars should therefore include 1) an approach to participant
“control” that allows the player to direct a virtual object or character at a
number of different behavioral levels, 2) some kind of behavioral model for
object sensing and action selection in semi-autonomous animated objects that
also supports external control, and 3) a layered architecture that supports
repetitive goal-directed action (reusability) and multiple levels of direction
concerning object motor skills, navigation and activity (Blumberg and Galyean
1995, p. 2).

Interactive 3D simulations now include synthetic vision for navigation
and other actions which enables real-time object-object interaction, such as
that in computer game design. Blumberg and Galyean (1995) identify two
sources of input to the synthetic 3D object: 1) artificial perceptual sensors
enable both task level and autonomous avatar behavior and 2) the human
participant or player can adjust directly the object’s actions or motivations at
multiple levels. Sensors provide information to the synthetic avatar in three
possible forms: real-world physical sensing, synthetic sensing and direct
sensing. Physical devices like the temperature sensors in the motors of the
Cog robots (Brooks 1996) and the infrared sensors on other mobile robotic
systems are examples of real-time sensors. Such sensors are not yet available in other 3D interactive systems. Synthetic vision techniques attempt to derive salient information from the virtual scene rendered from the viewpoint of the 3D object, such as the artificial fish of Tu and Terzopolous (1994). 3D avatars also gain information about a virtual world or object within that world through direct sensing, such as that we experience in many computer games. Blumberg and Galyean (1995) suggest that the use of synthetic vision is gaining in popularity, because it is the simplest and fastest way to extract useful information from the environment using artificial vision for low-level obstacle avoidance and simple navigation. The scene is rendered from the perspective of the animated object and the resulting image generates a number of gradient fields for sensory perception within the 3D Cartesian grid system (1995, p. 4).

Regarding issues of participant control, Blumberg and Galyean (1995) believe that synthetic object autonomy and directability need not be mutually exclusive: the designer and/or participant can program weighted preferences for or against the execution of avatar behaviors or groups of behaviors. These weighted preferences can be implemented at the level of motor skills and inverse kinematics. The participant may choose to "shut off" behaviors and issue motor commands directly to the avatar, or the participant may issue persistent secondary or meta-commands that have the effect of keeping interaction running or of augmenting and modifying object behavior (1995, p. 149).
3). In this way, the synthetic 3D avatars may ultimately behave passively regarding the interactive narrative, but ideally the participant can construct her own goals, outcomes, or objectives while remaining within the parameters of some overarching narrative. The 3D avatar shows spontaneous and involuntary reactions toward other avatars, something which the human observer may not otherwise initiate explicitly. The designer may produce seamless animation by having the object carry out chosen behaviors and synchronize itself with its environment, therefore bridging the gap (time lags) between meaningful interactive events.

The choice of avatar actions and goals can therefore be a complex phenomenon: if the designer creates competing goals that cross purposes: dithering and obstructions may set in by which the object may vacillate between competing behaviors or may simply reach dead ends. On the other hand, the avatar may not be able to enable some constructivist or intuitive goals, which may be unattainable. Likewise, some actions may be unavailable, unreliable, or ineffective. Like game strategies, the participant must develop learning and/or observation strategies around priorities, possibilities and opportunities. Much of this decision-making must be made intuitively during run time and amidst player-object and object-object interaction, because external opportunities (participant) need to be weighed against internal demands (3D avatar, computer environment) in order to provide just the right level of opportunistic behavior (Blumberg and Galyean 1995, p. 2).
Some animators and programmers even attempt to anthropomorphize their avatars and creatures, drawing from literature in context analysis, discourse theory and autonomous communicating agents. In evaluating their own animation software, BodyChat™, that creates autonomous conversational avatars that appear human, Cassell and Vilhajmsson (1999) complain that most computational models appear relatively simplistic by constraining object behavior to a limited set of displays devoid of many “real world” nuances. They argue for embodied communicative behaviors that rely on psycholinguistic and ethno-methodological approaches and focus on the execution of the micro-steps involved in gesture and speech in varying virtual settings and interactive contexts (Cassell and Vilhajmsson 1999, p. 20).

Cassell and Vilhajmsson present an alternative approach to avatars serving as what they call “presence indicators,” avatars that stand motionless or repeat a selected animation sequence.

*Embodied* conversation is a form of player-object interaction that acknowledges and reflects the “natural” relationship between the body and the conversational context: although designers recognize that avatars need to be animated to “bring them to life,” their approaches often fail to take into account the number and kind of different communicative functions of the body during an encounter (within a *conversational envelope*) (Cassell and Vilhajmsson 1999,
In the BodyChat™ system\textsuperscript{11}, avatars automatically animate attention, salutations, turn-taking, back-channel feedback and facial expression. In their interest in creating interfaces that resemble the interaction between people, Cassell and Vilhajimsson examine communicative behaviors like eye gaze, head nods and eyebrow raises in conversations between humans and avatars that are mediated by machines (1999, p. 2). Object autonomy is limited to a range of communicative expressions of the “face and head,” leaving the player in direct control of navigation and speech content; therefore there is no need for the player to micromanage every aspect of animating the humanoid figure. The application of each communicative behavior starts an animation engine that manipulates the corresponding avatar geometry and changes its visual appearance. As Cassell and Vilhajimsson point out, reliance only on the explicit player or participant to mediate change does not fully exploit the function of \textit{embodiment} in the construction of animated 3D avatars, because of the deep resonance and nuance in involuntary behavior common to social situations between people (1999, p. 14,20). For example, Hilary McLellan (1993) mentions SimGraphics Engineering’s Waldo World™ VR application as an example of a computer-animated avatar interface in which objects are partially controlled by the player in real time. In this 2D simulation, wearing an

\textsuperscript{11} Cassell and Vilhajimsson (1999) mention a number of other commercial distributed virtual environments (DVEs) that implement 2D or 3D communicative avatars by placing avatar portraits on top of flat image backgrounds. These DVEs include Circle of Fire Studio’s Active World’s Browser\textsuperscript{TM}, Blaxxun Community Client\textsuperscript{TM}, Oz Interactive’s Oz Virtual\textsuperscript{TM}, and Fujitsu Business System’s Worlds Away\textsuperscript{TM}.
electronic mask and body armor equipped with sensors, the animated avatar makes subtle movements and gestures on a screen based on the real-time motion of the "puppeteer", but the screen appearance always resembles a somewhat static, pre-programmed and distant simulation. Already an expected and pre-given feature in recent computer game design, the interaction between player choices and autonomous communicative behaviors allows the player to concentrate on high level control and navigation, while depending on the animated avatar to convey visual signals and ideas that represent or simulate the player's intentions.

Artificial intelligence (AI) approaches are also being implemented in the construction of 3D object action selection and behavior models. Kline and Blumberg (1999) at MIT recognize the need for a shift away from cognitivist models of avatar behavior in favor of models that feature the dynamics of agent-environment interaction. AI researchers argue for the selection and use of collections of simple, competing behaviors that are tightly coupled with perceptual sensors and actuators (Kline and Blumberg 1999, p. 3). Velasquez (1998) presents a framework that models how emotional systems interact with motor skills, perception and other behaviors. "Emotional drives" provide a mechanism for achieving goal-directed behavior by biasing action selection toward satisfying the compelling internal needs of the synthetic avatar or object. Kline and Blumberg argue that most object-oriented approaches to synthetic character design include cyclical and homeostatic drives that allow
for positive and negative deviations in behavior over time. This is obviously an attempt to simulate human behavior in synthetic graphical avatars. The pursuit of desires above and over some base state of "satisfaction" can be attended to by the successful execution of attentive behaviors, or by changes in external stimuli, such as temperature fluctuations or interactions with other objects/actors (1999, p. 2). When unattended to, drives slowly increase in momentum over time, but the effect of attentive avatar actions shifts the drive back to its homeostatic base state. As an example, Breazeal (1998) created a system of drives that regulate interactions between a robot "infant" and its human caretaker with the objective of maintaining a suitable learning environment.

Adjusting the parameters across the space of emotions and drives functions to shape the "temperament" of the synthetic actor. Although drives may increase and decrease slowly over time, emotions typically exhibit large impulse responses followed by gradual decay back to a base state. Kline and Blumberg vary the dimensions of artificial emotions by adjusting the magnitude and slope of the impulse response, but since it is difficult for the participant to perceive visually more than one emotion at a time, the animator uses one dominant emotion to parameterize 3D object motion and expression (1999, p. 2). This gives the observer some insight into the internal desires and artificial values of the synthetic object and its behavior toward other graphical avatars within the simulated environment. 3D simulations now exhibit a high degree of
interdependence between perception, emotions and drives in their influence on internal object state, avatar actions, and the external conditions within the virtual world: for example, the changing value of emotions and drives affects internal object needs, perceptual elicitors determine the relevance of precepts, and action selection mechanisms help determine opportunistic behavior. Kline and Blumberg (1999) acknowledge that more value-based or value-dependent frameworks have the advantage of enabling more intuitive interaction between players and avatars at the level of computer interface by providing an intuitive way to think about emotions, drives and sensory input. Often going beyond conventional physical laws and behaviors, the intuitive computer interface nurtures informal ways of knowing and allows for the acquisition of knowledge through the exploration of surfaces. It allows the participant to surf unknown topographies, engage previously unknown digital domains, and survive encounters with unexpected characters, elements, behaviors and features.

Synthetic, embodied 3D avatars actualize the techno-sensual materiality of embodied objects and forms, but also transcend the corporeal nature of the body by rendering it immaterial. In both their simulation of the body and their deviance from the body in the non-human, or post-human 3D object, they reflect Stone’s (1995) post-mechanical body as constituent of the “neurobody”, the internal neural impression of an external physical form, and/or the body that acts as the translator between neural impression and physical sensation. As human/machine couplings, synthetic graphical avatars also envision
Haraway's (1995, 1997) hybrid *refigurations*, which appear and reside in quasi-topological, quasi-machinonic simulated visual forms. In this way, autonomous animated objects operate according to a functional and *liquid* architecture that permits multi-level, multi-directional interaction between participant input, avatar sensory perception, inverse-kinematic movement and behavior, and elaborate 3D geometry and texture mapping on the object's surface. Interaction with synthetic avatars also allows the observer to become a thinker in her reflection on how unseen, conceptual, interior facts or object-concepts precede 3D graphical representations, but are understood through the communicative behaviors of interactive avatars and the kinaesthetic relationship with those avatars. Simulations are the events in which both sense and the meaningful image appear on the liquid surfaces of representations. Depth is realized on the surface just as the three-dimensional space is represented in a two-dimensional image or projection, which once flattened, can be mapped/morphed from object to object, surface to surface.

4.5 Rendering 3D objects

In addition to the geometric modeling of the 3D object, I believe that rendering object surfaces is the final and most important facet of animation, because it endows essential visual content to the 3D image. Ofek, Shilat, Rappoport and Werman (1997) discuss the requirements of high quality rendering, which include an understanding of the object's material properties, the use of appropriate and good quality textures from photographs, video stills
or 2D paint systems, and complex algorithms that produce multiresolution representations with an appropriate level of detail needed for any location on the object's surface. Knowing the strengths and weaknesses of a rendering process is advantageous to the 3D creative process with computers, just as understanding modeling techniques and object topology may be crucial in satisfying rendering requirements.

Thalmann and Thalmann (1990) remind us that the geometrical representation of 3D objects usually involves describing the object as a collection of convex and non convex polygons, planar figures defined by a list of vertices (points) and linked by line segments (edges) in Cartesian coordinate space. The decomposition of object designs into polygonal faces (also called polygonal surface normals) is easiest for objects such as cubes and polyhedra, though large numbers of polygons are often needed even for "low-polygon" objects in game design. Thalmann and Thalmann explain that for elaborate, irregular 3D objects and models composed of prominences and depressions, the animator must choose and specify vertices and triangular or quadrilateral facets on object surfaces for effective rendering and shading. The animator must consider 1) camera location, because any curve (sequence of edges) that is shown in profile and/or close to the camera eye must have many vertices and 2) object or avatar motion, because the computer algorithm must increase the number of vertices for each curvature in motion (1990, p. 16). Kitagawa-Deleon (1999) cautions animators that many 3D animation
software packages subdivide non-planar (skew) polygons in ways that may not
be appealing in the rendering process (involving the animator's aesthetical
judgement). Non-planar polygons appear when some vertices of a polygon
don't fit in the object geometry; the software algorithms must therefore
necessarily (re)subdivide them.

4.6 Texture mapping 3D object surfaces

Object surface features that are salient in the rendering and animation
process include color, detailed surface texture or gradient texture, shininess,
reflectivity, refraction and transparency. Thalmann and Thalmann (1990)
describe the most usual process of deriving 3D models from flat photographs
or either 2D or 3D orthographical projections: 1) the animator draws important
vertices or grids on the object, 2) the computer calculates the coordinate
system (the x,y,z 3D coordinates) from a number of perspective views,
(vertices in wire-frame models and grids in facet-based planar models such as
those constructed of quadrilineal or trilineal patches), correcting partially for
errors in perspective and situating the object on a "turntable," pivot point or
other type of rotation and scaling mechanism. The animator can consequently
change the angle of the 3D object in conjunction with camera position (1990, p.
12). The computer then creates the edges of all facets in a wire-frame,
subdividing any non-planar polygons according to some specified algorithm; it
then colors each object using gradation that varies by the quality of artificial,
computer-generated light sources ("natural", uniform ambient lighting, distant

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unidirectional or omni-directional lighting, and/or intense spot lighting). The extraction and mapping of an image texture on an object's surface in the course of rendering is an even more complex and computationally expensive matter. Ofek et. al. (1997) posit that the simulation of artificial textures (texture generation) by computers is still in a novice phase of development and involves some unsolved difficulties. Although specific textures are being simulated successfully everyday, artificial textures often look too smooth and clean for many photorealistic applications, even when noise is added using statistical methods (Ofek et. al. 1997, p. 18). For animated simulations of either "real", surreal or unreal (unknown or fantasy) objects, the texture is usually extracted and digitally manipulated from a photograph and then mapped on the 3D object surface.

Ofek et. al. disclose that a texture's geometry as captured in a photographic image may not match the requirements of the renderer's texture mapping algorithm, causing perspective distortion. The photograph may also fall short of high multiresolution image requirements of most 3D animation packages, lacking spatial or color resolution or containing a high level of noise. Texture geometry and lighting may also be incompatible with the 3D object to be rendered (Ofek et. al. 1997, p. 19). By way of possible solution, Burt and Kolczynski (1993) present an algorithm to fuse several digitized photographic images into one image, and Irani and Peleg (1990) describe the creation of a super-resolution image from an image sequence when the relative translations
between the images are known by subpixel accuracy, but these approaches are exorbitantly expensive in computational time and intensity. Ofek et. al. (1997) describe more recent approaches that employ the following methods: 1) track at least five points along an image sequence and reconstruct the geometric display transformations of a 3D model using "well-known" epipolar geometry equations (from objects with planar or 3D geometric structures), 2) average all values mapped to a certain location in the texture space, creating averages of color as captured in the images, 3) choose the highest resolution for each texture pixel mapped into the image, and 4) calculate 2D affine transformations or 3D projective transformations (for 3D perspective) in the reconstruction of image textures using weighted averages that give priority to finer details, but do not ignore information contained in lower resolutions. Some problems continue to exist, because some approaches corrupt the quality of higher resolution images, some result in unwanted noise invariants, and some do not correct for highlights and reflections of a light source from the object's surface. The basic idea behind texture image mapping therefore consists of taking a 2D photographic image and projecting or wrapping it on the topological surface of a 3D object while effectively simulating surface

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12 Ofek et. al. (1997) describe the highlight disparity between two images as a function of the changes in viewing direction, the local curvature, and the distance of the light source and the observer from the surface. Consequently, motion of highlights in the images depends on the observer and increases when the angle between the viewing direction and the surface normal at the point increases, the distance to the observer decreases, the distance to the light source increases, and the local curvature increases (1997, p. 24).
attributes, such as reflectivity, transparency, color, bumpiness, roughness, smoothness, etc.

Surface textures can also be computer-generated to change the three-dimensionality of the object's surface normals in conjunction or in addition to 2D visual textures derived from 2D photographs. Visual textures are flat simulations of 3D textures that do not effect the topological surface of the object: they operate like a wallpaper. In contrast, spatial textures affect the 3D spatial integrity of the object surface, but require a detailed mesh of planar polygons, which is a time consuming and computationally costly process.

Kitagawa-Deleon (1999) suggests that bump maps provide a easier alternative technique for creating complex and realistic textures on the otherwise smooth surface of irregularly shaped objects that are not too close to the artificial camera. They do not alter the geometric complexity of the object in rendering.

Bump maps modify the appearance of a textured surface with patterns of modulations: the darkest values in the image represent valleys or silhouettes, the lightest values simulate the peaks in the simulated bumpy texture. Kerlow (1996) discusses an alternate method of creating bumpy visual textures that simulates imperfections on an object surface by changing the surface normals: these bump maps may be used in combination with parametric waves to represent the linear or concentric undulations of water when affected by wind or touch. Kitagawa-Deleon (1999) describes how displacement maps can create similar effects by modifying both the position
and shape of the surface normals at each point of a polygon, creating a 3D terrain with the rich color and nuances of 2D image mapping. The superrealistic visual effects of reflection can be used to render shiny, glossy materials such as glass, metals, plastics and varnished surfaces with the use of reflection maps and/or the application of ray tracing and radiosity rendering that simulates more precisely the amount of reflectivity on a 3D surface. Kerlow (1996) infers that reflection maps drive the simulation of reflectivity through brightness values to the detriment of color: they are usually monochromatic, chromatic information being irrelevant in the subtle specular highlights of a 3D reflection. Glassner (1989) describes how ray tracing computer algorithms create the photorealistic rendering of shadows, depth of field, motion blur, reflection and refraction by estimating the maximum number of times a ray of light can be absorbed by depth or bounce off each pixel in the image plane (the reflection or refraction of light in a scene with differing object surfaces). Kitagawa-Deleon (1999) also acknowledges that the use of ray-tracing in combination with radiosity algorithms that calculate the interplay of diffuse reflections between surfaces is capable of rendering very photorealistic images. Ultimately, every texture map must be fit, centered, deformed, projected, tiled, or shrink-wraped on the surfaces of each object, whether it be planar, cylindrical, spherical, tubular, or cubical in nature, or whether it is a unique, invariant topological structure.
The interplay between the complexity of object geometry and texture (image) mapping becomes pivotal in real-time and postproduction animation. Sturman (1998) instructs the animator to examine texture motion to watch for aliasing artifacts (distortions in pixel resolution) and make recommendations as to where to remove polygons for added speed or add polygons for better visual effect. Geometric deformations, dynamics and collision detection also influence the object's computational expense in animation. After making these observations, the animator modifies object geometry, reforms contours and remaps textures for optimal performance, parallelizing the per-frame computations as much as possible for smoothness of motion. In commercial game design, such as Medialab's production of the Donkey Kong Country™ cartoon series, higher resolution (more polygons), extra dynamics, shadows, textures and effects were added in postproduction rendering before marketing (Sturman 1998, p. 41). Uri Dotan (1996), computer artist, in homage to 1960's painter Frank Stella, summarizes the new synthetic possibilities of virtual space as the complex creative expression of expanded computer code in modeling, lighting, ray tracing and transparency. The complex geometry of

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13 Sturman (1998) explains that both performance models that use real-time keyframing and those that calculate differences in subtle motion in postproduction require careful object design to optimize polygons, since polygon counts affect rendering speed and the use of computer resources. He recognizes that more experienced designers know how to exploit polygon counts and texture mapping to produce maximal detail with minimal resources: texture mapping can add detail in place of geometric complexity, but the texture map's size and quantity must be matched by the computer's capabilities (Sturman 1998, p. 40).
curved abstract shapes elaborated in contrapuntal, liquid 3D forms, and in combination with heavy texture mapping, draws attention to surfaces that both reflect and distort the virtual reality around them.

These object-spatial constructs involve 3D abstract objects and concepts with the surface mapping of textures and ambient or directional lighting in a simulated environment. They are the simulacra of the unseen, reminiscent but unlike objects in nature. They belong to no "real" space but to hermetic, alternative worlds. Cécile Babiole’s Virtus (1992), for example, explores the kinaesthetic adventures of an interactive half-shrimp, half-armored humanoid knight in a futuristic labyrinth of tubular structures, corroding corridors and metallic-textured trap doors with tooth-like jaws and obstructions. While it functions as surreal fantasy art, Virtus also improves spatial understanding and hand-eye coordination. Similarly, Alon Wolf’s Slain 3D animated art series is inspired by robotic, cyborg and science fiction visions: his synthetic images contain more than 800 textures maps leading to tremendous memory requirements. A single frame took up to four hours to render. Wolf paints most of his textures by hand, because he believes that computer-generated procedural techniques fail to capture the infinite amount of detail found in photorealistic objects, the "dints, dents and dirt," for instance (Charles 1997, p. 5).

Yochiro Kawaguchi’s Mutation (1992, interactive CD-ROM) is a liquid, morphing 3D meditation on the endless repetition of "biocosmic" ideas in
action. Kawaguchi uses growth algorithms and elaborate, multi-layered textures to visualize the fluidity of the development and change of artificial, biomorphic shapes and creatures that exist at the interstices of microbiology and computer code. His interactive films speak to the collapsing boundaries between art and science. They invoke visual impressions of conceptual art, geometric abstraction and pattern painting, but their spatial structures reflect the recursion, repetition and randomness of computer growth algorithms in operation. As epitomized by Kawaguchi's work, the simulationist computer compositing and inflection of multi-layered texture (image) maps in 3D animation embodies the formalists' concern with enfolded, planar or other elastic topological surfaces in 3D cyberspace; the seamless, modulating, liquid architecture of complex topological forms in digital realms.

The fluid, seemingly part-serpentine, part-liquid undulations of Mutation's artificial forms resemble the movement of sand on the ocean's floor, the simulation of wave motion or lava flow, or the ripple effects of water after an object's touch. The radiating, shimmering texture surfaces on the abstract objects are the composites of animated form, watery rippling surface, manifold color, reflection and refraction. Like tangible, plastic, but less durable kinds of digital architecture and construction, modernist artists of the past also invented entire worlds without explicit reference to explicit reality. Like Malevich's architectones, Kawaguchi's 3D animations extend formalism's concern with form, surface and texture to include the language of abstract topology and
folding surfaces.

The use of texture mapping and motion can go only so far in simulating alternative realities, so animators also draw on aesthetic models of multisensorial interactivity that include vision, sound, touch and thought. Hypermedia or cinematic models of player-object and object-object interactivity in various 3D environments are making inroads into the creation of “life-like” virtual simulations. All interactive media exhibit the same disconnected phenomenological structure as cinema and video. In the next two sections, I will examine how recent cinematic strategies interrupt extreme forms of linear organization by creating fictional or false continuities between images: they use visual, auditory, tactile or mental transitions to simulate modulating expanses of time in the mind of the observer. Cinematic approaches to interactivity differ from conventional nodal structures in multimedia environments.

4.7 Paradigms of interactivity in computer media

A cursory examination of the computer literature on interactivity prompts the question, if new media makes more complex, dynamic interactive structures available, why do most commercial designers continually adopt the linear progression of hierarchical nodal structures? The discussion of nodal links and structures in interactive programming requires some explanation. Some conventional definitions are as follows: 1) The term “node” is a euphemism for an item (block, track, frame, shot, sequence) of visual, textual,
tactile, and/or auditory information on a computer screen or in a 3D projection or artistic cyberpiece. 2) Anchor points within each node, oftentimes taking the form of explicit or "hidden" buttons, form the starting point for structural (navigational) and associative (conceptual, referential or indexical) links to other nodes. 3) Navigation is a term for the process of moving within and between nodal structures, of "clicking" or "touching" an anchor point to leap to another node. 4) Key concepts are the nontextual equivalents of "keywords," used to search informational nodes by the use of abstract, referential and/or associative concepts and other logical patterns (Ginige, Lowe and Robertson 1995, p. 26). Hierarchical structures are often organized into sections and subsections, but retain the original linear structure contained in the informational database. In contrast, a network or associative nodal structure binds common or related concepts together within an informational space using semantic or pragmatic links that are non-sequential in nature (Ginige et. al. 1995, p. 28).

Issues of balance and composition, plot and structure, randomness and determinateness are important aesthetic considerations in interactive computer media. Reiser and Reiser (1995) insist that the designer must write a plot and structure wholly original to the interactive media adaptation, otherwise the outcome would resemble a sloppy "shoveling around" of informational material. They ask, what are the compositional and aesthetic effects of interactive computer media? Does a single, original and inspired node serve the purpose
of conveying the central message of the whole piece? Why not diagram the interactive art work as a structure of connected nodes on a page (1995, p. 24)? If you want to be more of an "artist" than a "noise generator," Reiser and Reiser advocate the application of a more or less modified deterministic structure of nodes in designing a multimedia piece. They suggest the use of some nodal structures, some simple and some more complex: a simple four-level binary tree starts with one node and eventually branches to eight nodes that are equivalent to eight different endings on the fourth level. As a simple "nonlinear" structure (its sense of "nonlinearity" is open for debate), Reiser and Reiser affirm that the feeling of expansive interaction comes more from the amount of choices made than from the actual number of choices available: a binary tree has more depth (more times to choose) per total number of nodes than any other tree structure (1995, p. 25). Reiser and Reiser caution the designer to keep the number of levels to a minimum (and consequently the number of endings), since the more levels you have, the more difficult it is to keep the early nodes from becoming vague while still providing a foundation that serves all the different ending nodes. They dictate that the designer must make each node serve as the sole parent node for no more than two branching nodes, to maximize participant interaction per amount of authoring effort (Reiser and Reiser 1995, p. 25). Binary trees and other such hierarchical branching structures operate according to a kind of forward moving predestination, because branchings do not allow players to move backwards to
reverse or correct a fateful decision.

Reiser and Reiser (1995) acknowledge that the application of looping structures solves the problem of irreversible decision points, increasing the aesthetic sense of participant power while providing a sense of the paradoxical in interactivity. There are no “wrong” choices, since loops expand the number of interactions without doubling geometrically the number of nodes before you reach an ending. Actually, the designer can avoid an ending or sense of closure using looping structures, because loops add environment and atmosphere to the interactive piece without providing a sense of plot progression (1995, p. 26). Participants click or touch on an icon or avatar and enter a loop that will eventually return them to a linking node where they can choose another loop; and so the participants can construct a circular and somewhat random journey. Randomness can add narrative layering, compositional “texture” and a sense of exploration to the interactive piece when it is used with the balance, dynamism and composition of the whole work in mind. Reiser and Reiser, however, are wary of both the casual use of loops and random linking, because such structures may leave participants feeling that they accomplished nothing of consequence. They claim that only a “vacuous” designer would expect a player to construct a unique meaning for a piece based on a random journey through it (1995, p. 27). Reiser and Reiser (1995) also caution against the use of randomly located or “hidden” representational avatars: when the participant encounters random graphical
objects on the premise that they might be useful (but they are not), then the
interactive work is communicating a lack of meaning. Conversely, they
suggest that some measure of narrative, exploration, structural complexity and
repetition can create a challenging interactive environment.

Multimedia and teleaction buttons, icons and avatars may be salient in
hypermedia type structures. Firstly, McClellan (1993) suggests that icons and
avatars hold affordances that provide strong clues to the operation of things in
a kind of harmony or synaesthesia. Objects afford grasping, tossing,
containment, shaping, molding, manufacture, stacking, building, etc. in the
context of perceptual and motor systems enable the player to orient himself in
cyberspace and to navigate and handle virtual worlds (McClellan 1993, p. 6,8).
Chang (1996) also discusses a formal framework for visual semantics based
on the notion of an icon algebra, a multidimensional grammar that captures the
dynamic nature of multimedia objects through icons (graphics), earcons
(sound), micons (motion) and vicons (video). Chang's visual semantics allows
participants to customize iconic sentences and access media dynamically,
while accommodating a variety of multimedia and teleaction objects. A visual
sentence is a spatial arrangement of object (conceptual entity) and/or
operation (context-dependent) icons and avatars that activate location-, time-
or content-sensitive information, and are useful in specifying the syntax,
knowledge structure and behavior of dynamic multimedia elements (Chang
innovations in pattern recognition strategies to detect and classify
characteristic gesture patterns used to determine the activation and
manipulation of objects, such as virtual buttons. The Z position of the
participant’s body and hands in 3D Cartesian coordinate space, together with a
combination of gestures and clues, ensures that the participant’s intentions are
translated into the actual manipulation of a 3D object, icon or avatar (Maes et.
al. 1995, p. 7). In the future, the use of unobtrusive, full-body sensing and the
presence of autonomous agents that respond to simple, natural gestures in
virtual environments will satisfy participant needs for object elasticity, cohesion
and conversational interaction.

4.8 Cinematic approaches to interactivity

Nonetheless, advances in DVD-based interactive cinema, 3D animation,
digital MPEG video, visual resolution and display, and web technologies may
render obsolete hypermedia and indexical models of interactivity. For
example, Davenport (1996) posits that keyword matching is a crude and
unproductive method for sampling the information content of complex sources
such as the Web; their truncated representations fail to encompass the larger
meaning embedded within the source, stripping away the quality and veracity
of contextual information. She suggests that “push-button,” superficial
structures and descriptions are not enough to design complex computer media
applications; rather, we must have meaningful glimpses into the internal
mechanisms, behaviors and connectivity of the individual medium (1996, p.
Davenport infers that interactive cinematic strategies may provide the best models for present and future 3D computer media, including computer games. She suggests that a good model should provide a 3D mapping structure to guide the author in story weaving and plot encoding. It should be able to incorporate both interactive and cinematic strategies and should provide a range of dynamic reversals that might be necessary in model-based, animated worlds, where we can dynamically modify narrative form and quickly call up transitions in settings and avatar behavior (Davenport 1996, p. 15). For Davenport, a good cinematic model is a universe in a teacup: it is a scaled down, codified representation of objects, processes and their interrelationships that presents a reusable formula. Davenport also expects the designer to associate theories of thinking with models of visual production and presentation: changing a point-of-view is not just a simple matter of changing cameras or camera positions, but requires transformations in thought and narrative (1996, p. 15). Making an effective link between the understanding of content and visual perception in the construction of knowledge is the key element to good interactive design for entertainment, training or teaching, but its not always so easy to accomplish.

As a possible solution to this problem, Régis Durand (1995) examines the differences between the vertical and horizontal effects of moving images, or between the *filmic flow* and the *materialization of objects* in the still image,
as a way of overcoming the disparity between visual presentation and thought. He asks, how can the same type of image carry values so radically opposed: viscosity and suture on the one hand, tremor, shifting and fragmentation on the other? (1995, p. 142). Regarding a vertical reading, the still frame is the ideal object, as it was for Barthes in Camera Lucida (1981), in the sense that it is free of the narrative and sequential imperative of film, while at the same time retaining its configuration of objects, the "armature of permutational unfolding" (Durand 1995, p. 143). Durand continues to explain that the still image, perceived vertically, attempts to capture a thought as it tries to image itself, to materialize itself in an object or scene. Following Deleuze (1989), Durand suggests that since the presence of objects and settings can be very compelling and forceful (including virtual 3D objects and settings in interactive cinema), then as a still frame searches for a novel image of a thought, it always reiterates its own inception and reveals its inchoative nature in an image-thought. The closed loop, image-relation/relation-image, is a simulation of the process of thinking itself (Durand 1995, p. 148).

Durand refers to vertical features that operate in the spatial field of the screen, including 1) the magnetism of frame and attraction of object mass, 2) figure and ground relationships, and 3) vectors of force and direction. Firstly, the magnetism of the frame is the kind of visual pull that the frame's borders exert on the objects, or configuration of objects contained within them. If an object, such as a spherically shaped avatar, is large and wedged into the
screen, it is subjected to the magnetism of all four edges, as if it wants to burst out of the frame’s confinement. Conversely, if the object is small and centered, far from the frame’s boundaries, it does not appear to be affected by their visiomagnetic pull, but surrounded and compressed by “heavy” space (cf. Zettl 1999, p. 93). Relatedly, all 3D objects within a configuration appear to engage and/or attract each other in terms of graphic mass: the larger objects with highly saturated colors appear more stable and dominate the smaller objects within the screen. Whereas screen width and height have definite spatial limits, depth in 3D cyberspace is virtually limitless: we therefore perceive object size in depth of field by the object’s position closer or farther along the z-axis in relation to the 3D camera. As Durand suggests, the essential dynamism of the vertical cinematic reading lies in its implosive quality: in any given modulation of scene, the gaze oscillates from the represented object to the edges of the frame and back to the object, collapsing it again into the shadows behind the curtain.

Secondly, with new 3D camera techniques, figure-ground relationships alter continually in animation and the changing field of view. The figure is usually less stable than the ground, because the figure is more usually more likely to move, but observation may oscillate between foreground and background structures and objects (as with Kawaguchi’s animations, for example). The cinematic animator can also reverse the figure-ground relationship with visual and auditory digital effects; superimposition, for
instance, renders figure-ground boundaries deliberately vague, having the
effect of making the objects transparent and flattening the 3D depth of field (cf.
Zettl 1999, p. 100). This effect creates overlapping planes that are dissolved
into a complex array of intersecting images. Thirdly, graphic, index, or motion
vectors present clues regarding the dynamics of object movement, object
interaction, and/or object “gaze”. Vectors of force may create coherence
through convergence, or discontinuity and dynamism through divergence (cf.
Zettl 1999, pp.109-110). In Durand’s understanding of the phenomena, the
combination of effects from these vertical features contributes to the
formulation of an image-thought within an instant, single still image, or frame.

However, Durand affirms that the referential correlations between the
image and identifiable objects cannot account for the forcefulness of the
image-thought: the relation between still images and objects cannot be
reduced to 1) an indexical relationship (not the referent or the fetish), 2) some
inherent process of “realism,” 3) the ontology of the digital image or
photograph, and 4) the production of part-objects into a whole. Rather, the
relation between still images and identifiable objects is unique in photography
because of the medium’s ability to make those objects disappear and return
within fractions of an instant, even though these instants can never be
captured and rendered without introducing some kind of artificial delay in the
photographic/cinematic process (Durand 1995, p. 147), a kind of photographic
paradox. Consequently and in general, the still image does entreat a taste for
fragments in conjunction with a vertical reading of articulations and

In the cinematic, moving image, Durand (1995) acknowledges that
tings are never so cut and dry, because the *filmic flow* transposes every
vision of the image into memory, even if it is a memory of something in the
making. Since the permanent quality of the still image depicts it as a pure
presence, that presence is fated to deceive and undermine the memory of a
scene that has already taken place and that now attempts its
(re)representation. Durand explains,

> When that happens, it is a real event, a moment of purely visual thought that
takes place. . . having to do with the ability to modulate distance infinitely, to
rely on the frame in order to extract significant blocks of space. Just how
this theater of signs and memory is constituted, whether it be through
contemplation, capture, or intensification, remains to be studied in detail

Durand believes that the cinematic process introduces the radical discontinuity
of the visual image into the thinking process, which operates contrary to the
homogenous operation of language and narrative. The insertion of this
opaque “foreign body” into the abstract or symbolic process of thought has the
effect of captivating the observer. The eye is more than willing to rest in the
unquiet mobility of the cinematic image, to “bask in the serene contemplation
of the represented object, in its indisputable presence” (1995, p. 148). In a
horizontal reading of the moving image, the cinematic process therefore lacks
the mobility necessary to represent the dynamism of a narrative passage,
transition, or transformation, but can at best only suggest a moment when the
observer shifts from an apparent image to something else, enacting a metaphoric or metonymic displacement. Deleuze (following Bergson) identifies these shifts or transitions as moments of modulating duration (see passages below), a complex of dynamic durations of time and sequence that can be attempted through various cinematic devices, such as sequencing, superimposition, blurring, digital special effects, and the composition of planes and volumes in the depth of field (Durand 1995, p. 150). In the play between narrative molding (moulage) and photographic modulation, the cinema realizes the simultaneous paradox of constructing itself on the time of the object and of taking the imprint of its duration (Deleuze 1989, p. 24). Bill Nichols (1991) also reminds us that still images are concrete, always of a particular time and place, but that combinations of images through editing and montage, intertitles and the their juxtaposition with sound can create a sense of narrative integrity or closure.

Although Deleuze (1989) suggests that a distinction between the vertical and horizontal reading of the moving image may be pointless, he may actually extend the horizontal reading regarding the virtual mental image created by cinematic flow. He points out that montage effects are already present in the modern cinematic image, or the components of the image already imply montage without or before its execution: in this way, montage is expressed in the depth or flatness of the direct-time image within the implicitly expressed durations of the cinematic flow, but no longer in the linking and
editing of shots and sequences (1989, p. 42). Here lies one of the principle premises of the horizontal reading: the alternative between montage and shot has become superfluous with the use of high-tech cinematic strategies, including 3D computer animation techniques. Deleuze writes, the contemporary electronic image either had to transform cinema or to replace it, to mark its death. He acknowledges that the a conceptual theory of digital effects in cinematic images remains to be determined (1989, p. 265,280). The moving image has entered the new domain of contemporary interactive cinema.

Deleuze contends that cinematic time ceases to be derived from linear movement alone, as it was in classic film through the mid-century. Cinematic time now gives rise to false movements and false continuities by the use of sound, image and digital effects. Images are no longer linked by rational cuts and logical continuity; rather there is a loosening of the sensory-motor linkage allowing time in its "pure state" (in multiple distinct and discontinuous durations) to fall to the surface of the screen as a simple incorporeal effect (Deleuze 1989, p. xi). The relations and disjunctions between the visual and sound endow cinematic production with new powers for capturing and expressing time and objects in time. The observer diverges into time rather than crossing space. All forms of what Deleuze recognizes as time-images in contemporary cinematic approaches break with direct representation and shatter the linear, empirical continuation of time, the chronological succession,
the empty and unfolded form of time, or the separation of the before and after (1989, p. 155). Durational time may be defined by the relative length of subjective or qualitative time and the involvement, intensity and density of an event. Common experience tells us that the more involved we are in the event, the shorter the event's duration seems to be and vice versa, but moments of intense awe, extreme beauty, or terror can also lead to longer, almost timeless durations. Deleuze believes it is necessary to combine image, sound and touch with the aggressive force of profound thought and vital intuition to construct durational time-images (1989, p. 22). In recent applications of interactive 3D animation, as an example, the effects of the time-image blur the differences between reality and non-reality, or documentary and fiction in their permutations of purely optical, auditory and tactile units and sequences, autofictions and “falsifying” narrations, and liquid simulations on the screen’s shifting surface of appearances.

Late modernist cinematic strategies, as Deleuze observes, cease to coordinate spaces or link together perceptions and actions. Contrary to the sensory-motor scheme of traditional film production, where perception is organized in obstacles and distances to be crossed, while action invents the means to surmount them, in new cinematic techniques movement is only important in its aberrations that depend on time. The classic cinema of the 1920s and 1930s that gave rise to the “great” Hollywood talkies depend on action and the supra-organic recomposition of absolute movement to attain its
sense of *sublime* narrative closure, whether in the supreme artifice of Vertov, or the dynamic, mathematical sublime of Gance (Deleuze 1989, p. 40); but contemporary cinematic strategies replace indirect images of time with direct *time-images*, with non-localized relations of pure optical, auditory and tactile situations. Deleuze suggests that the cinematic use of time now seems “out of joint” or “off the hinges,” as less coherent combinations and figurations of opsins (vision), sonsigns (sound), dectosigns (touch) and noosigns (thought) are direct presentations of time. As a way of collapsing the subject-object dichotomy that is the bane of conventional narrative, characters no longer “jump across” relations between shots and sequences, but are “swallowed up in them” as false continuity effects are now the sole source of non-localized relations (Deleuze 1989, p. 41).

Deleuze (1989) identifies the pre-war Japanese cinema of Ozu as a “primitive” precursor of contemporary cinematic strategies and direct-time cinema. He singles Ozu out as the inventor of opsins and sonsigns, pure optical and sound situations in a Japanese context. Ozu’s cinematic object is the everyday banality of family life in the Japanese house. Camera movements are infrequent, tracking shots are slow, and the always low camera is usually fixed frontally or at an unchanging angle. Ozu abandons dissolves in favor of the simple cut, a purely optical passage or punctuation between images. The linkages of the terms in a series are “naturally” weak: they are constantly upset and do not appear in order. An ordinary term goes out of sequence and
emerges in the middle of another sequence of ordinary things in relation to which it takes on the appearance of a remarkable moment or complex point. Deleuze writes, there are many similarities, shared functions and imperceptible transitions between Ozu's empty spaces and still lifes: while his empty spaces owe their importance to the absence of a possible content, the still lifes of his settings are defined by the presence and composition of objects that are wrapped up in themselves and become their own container. The false continuity of gaze, direction, and position of objects are constant and systematic. Time is the unalterable form filled by change. Deleuze depicts Ozu's still lifes as having a duration, a horizon that links the cosmic to the everyday, the durable to the changing, one single and identical time as the unchanging form of that which changes. They endure with minimal plot and without the empirical measure of time, without past-present-future (1989, pp. 13-18). Later, in Negotiations, Deleuze discusses further the possibility of temporalizing the cinematic image in moments of pure time as form rather than motion. He writes that the "cinematic revolution" of the use of these devices is foreshadowed in different contexts by Welles and, long before the war, by Ozu. In Welles there is a depth of time, or coexisting layers of time that the depth of field in camera view develops on a truly temporal scale (in Citizen Kane, for example); and Ozu's famous still lifes bring out the unchanging patterns of time in a new media world that has already lost its sensory-motor connections (Deleuze 1995, p. 59).
In *Cinema 2*, Deleuze writes, it took the contemporary cinema to re-read the whole of cinema as already made up of aberrant movements and false continuity devices and effects. Smooth cinematic spaces are mediated by discontinuities, *parataxis* and *bricolage*, propagating a matrix of jumps, ruptures, local coherences, and minimal sequences broken across gaps or synapses of transition. Consequently, all interactive media exhibit the same disconnected phenomenological structure as cinema and video (Moulthrop 1994, p.303). The participant in the interactive cinema finds herself prey to visual, auditory, tactile, cutaneous and *coenaesthetic* (synaesthetic) sensations that have lost their linear motor extensions. Deleuze believes that the very special extension of the opsign and other sensorial signs is to make time and thought perceptible, to bring the senses into direct relation with time and thought. In the work of Garrel and Kurasawa, for example, Deleuze writes that the "suspension of the world", rather than movement, gives the visible to thought, as an act that is constantly arising and revealed in thought. The visible is affected by the inchoate quality of the initial incoherence of thought. Little noosigns or suspensions of thought are made visible in Garrel's dancing grains, luminous dust, flakes of snow, and blankets of soot, or the grey mist of Kurasawa's *Cobweb Castle* (Deleuze 1989, p. 169).

For Deleuze, Godard and the *new wave* in French cinema are the masters of the direct time-image in the way they reconcile sequences of irrational points, snippets and transitions according to non-chronological time
relationships. In Godard's *Weekend*, for example, there are no longer any perfect or resolved "harmonies" between sequences of images in Eisenstein's musical conception of the continuous, but rather there are dissonant tunings, irrational cuts and unlinked "tones" that form a constructed series. Deleuze insists that all metaphor and figure disappear as the internal monologue gives way to sequences of images, each sequence being independent and standing for itself in relation to those that both precede or follow it (1989, p. 182). He writes, if the bankers are killers, schoolchildren prisoners, photographers pimps, and workers the victims of their bosses in *Weekend*, then this is shown in series of images that are never "metamorphized," but constructed in consequence as they might be in computer media. Deleuze suggests that Godard's method of the constitution of series, or "free vision," creates a new kind of synthesis between narrative passages and "intercalary," discontinuous genres through electronic procedures of recurrence, recursiveness and feedback (1989, p. 184). Godard's films are syllogisms with an Aristotelian style that concurrently integrate degrees of probability and paradoxes of logic/rational coherence. With Godard and the new wave, Deleuze says, the use of "interstices," transitions, and false continuities between frames exists everywhere; this method of mixing ousts montage and effects the allocation and distribution of different auditory and visual elements.

In their discontinuous configurations of "pure" elements of vision, touch and sound, contemporary cinematic strategies emulate a techno-sensual
aesthetics that emphasizes the sensual materiality of embodied objects and forms, but also transcends the corporeal nature of the body by rendering it immaterial in post-photographic digital media. Bodied objects are cast as plastic, ductile, conceptual cyberforms and are made visible, instrumental and valuable to the observer as digital-symbolic avatars and afterimages. The 3D interactive cinema also typifies what Deleuze calls the “aesthetic actualization of the event,” the exposition of the virtual that makes the event resonate and come alive in thought. Cinematic models for interactivity draw on the liquid nature of simulations in incoherent structures, on the differential, correlative distribution of singular events in topographic thought and on the surfaces of the screen.  

14 The simulationist aesthetic in interactive media is often limited by the range of applications of virtual environments of some cumbersome wired interfaces. Computer interfaces obviously differ by range of quality regarding the nature of human embeddedness in the system and by the amount of available interaction: these interfaces form a continuum from traditional screen and mouse-click based desktop systems to wireless, non-intrusive 3D graphical interface systems, such as MIT’s Artificial Life Interactive Video Environment (ALIVE) (Maes et. al, 1995) or the CAVE Automatic Virtual Environment (Cruz-Neira et. al, 1992) that use moveable sensors or batons. Falling somewhere in the middle, the more conventional virtual environments allow the participant to be embedded in a “wired” computer-generated environment with the use of gloves, vests, and headsets. Wireless computer interfaces permit the kind of interaction with semi-intelligent graphical avatars and the simulationist compositing of 3D surface textures that we have discussed above. Maes et. al. (1995) also suggest that these systems allow a rich and intuitive set of gestures to be used in controlling and navigating virtual worlds; they hold great potential as interface tools, especially as available computational and video processing power increases. The ALIVE interface, for example, uses vision techniques and routines for perceiving body actions and gestured that the participant performs with sensors, figure-ground processing, scene projection, hand tracking and gesture interpretation. Vision routines use a single, calibrated wide field-of-view camera to determine the 3D position of salient body features: the interface computes figure-ground segmentation by use of spatially-local
4.9 Aesthetic considerations for the design of interactive, instructional computer media

There is considerable overlap between new media aesthetics and notions of knowledge-building within and between 3D animated computer simulations. Since digital-symbolic material is plastic, ductile and easy to transform, aesthetic issues encompass the more conventional art aesthetics associated with form, shape, color, texture, lighting and the gestalten impressions of the embodied object. Computer aesthetics also embrace aspects that are unique to the computer medium; these issues include the "give and take" between photorealistic effects and transparent unreality, the artificial intelligence and programmable behavior of interactive, embodied, synthetic 3D avatars, the high quality rendering of polygonal surface normals on 3D objects, the algorithmic simulation of artificial texture maps, the choice between interactive structures, and the use of cinematic devices to create virtual moments and modulating durations of time. A summary of the aesthetic considerations and implications of interactive new media is as follows:

1) The designer should consider the degree of apparent or alternative realism in her use of 3D photorealism and digital effects. Even unreal images can be perceptually realistic in their use of structured cues and falsified pattern recognition techniques to characterize changes in the scene and morphological analysis to extract objects. The intuitive manipulation of objects, information and visual/spatial events in a virtual, projective digital interface requires a new kind of interactive aesthetics, one that is dynamic, balanced, non-linear, random, spatial and anti-hierarchical, and can incorporate multiple cinematic strategies.

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correspondences to "real-world" referents. The systems of representation
employed by computer graphics imaging (CGI) must be understood as
renditions of machine code in culturally and educationally specified forms.
Framing and composition are, to some extent, intrinsic to photography and film
and offer some sense that visual objects were present to the camera at the
moment of shooting. CGI is veering continually toward perspective and "real-
world" mapping, producing images as images and third-order simulacra for the
consumption of specific educational or entertainment audiences. The
perspective of the single virtual camera is capable of providing access to
virtual constructs in two dimensions; but unlike the "kinoeye" that preceded it,
the virtual camera now scopes in three dimensions. More surprisingly, 3D
representations are entirely Cartesian in orientation, despite the fact that what
is being given visual form in the interface is a matrix of binary digits, rather
than the object-analog world of conventional photography. As virtual culture
demands a return to the question of realism, we must also consider the
assertions of John Tagg (1988) and others that there can be no universal
concept of realism, and that we require a more diversified, plural recognition of
realisms in new media. The artificial existence of the virtual object therefore
signals an ontological shift to a full-fledged, aggressive surrogate reality
composed of digital symbols. Michael Heim (1993) explains that the
movement into a simulation is more than a paradigm shift, or a shift in
epistemological stance, but a shift in symbolic reality where the world or
context of the object becomes meaningful. This explains not only how the user is able to operate in a situation involving total sensory immersion, in a self-sufficient world within cyberspace, but also the confusion between actual and virtual created by a high degree of realism, by the synchronous use of sharp three-dimensional images, photorealistic "real-time" texture mapped worlds, and 3-D digital sound space.

2) The designer should fathom the tradeoffs between intuitive gaming/decision-making and constructivist learning outcomes when designing the behaviors and reactions of synthetic 3D objects. This involves some choices regarding the balance between player directability (the intuitive construction of goals) and autonomous avatar sensing, navigation, emotion, drives and behaviors.

Insights from research in autonomous robots and artificial intelligence strengthen the possibilities of post-human animated avatars that merge real-time action with dynamic and unpredictable settings. However, the designer of instructional media must be wary of a technicist, quasi-Heideggerian version of destiny that rests on the premise that we find salvation in the linear and perfectionist rise of the machine. Felix Guattari (1995) contends that the evolution of human thought (into something called post-human or trans-human) relies matter-of-factly on the mediation of technical machines, but that many people incorrectly characterize "thought" only in human terms. Among the venues of artificial intelligence research, the genesis/emergence of mneumotechnics in artificial entities continues to be driven and encompassed
by human thinking. Antithetically, a truly "machinic" conception of creative
evolution must embrace a radical pluralism of technical, semiotic, axiomatic
and other machines that avoids the positing of the "human" and the reified,
humanized notion of what constitutes autonomy on the machine (see my
concluding chapter).

The layered architecture in the design of "intelligent" 3D avatars
supports repetitive goal-directed action (reusability) and multiple levels of
direction concerning object motor skills, and a behavioral model of action
selection that provides support for dynamic, multi-level direction and player-
object interaction. "Emotional drives" provide a mechanism for achieving goal-
directed behavior by biasing action selection toward satisfying the compelling
internal needs of the synthetic avatar or object. Cyclical and "homeostatic"
drives also allow for positive and negative deviations in behavior over time.
Designers may program short-term constructivist goals regarding individual
learner outcomes and problem-solving into the narrative, but much of the
ultimate decision-making must be made intuitively during run time and amidst
player-object and object-object interaction. The needs of the learner must
engage the internal logical and "emotional" demands of the 3D avatars
themselves as the instructional scenario unfolds. The incomplete specification
of object states and behaviors, errors in graphics composition and animation,
or "bugs" in programmed subroutines can result in failure in the implementation
of artificially "intelligent" avatars.
3) The designer should assess the advantages and disadvantages of costly, memory-consuming, high quality rendering using multiple image layers on complex, multipolygonal object surfaces, verses more economical alternatives that may sacrifice detail and photorealistic effects. The demands of smooth animation and motion may require the reforming and remapping of geometric contours and textures in postproduction. A combination of ray-tracing and radiosity algorithms render photorealistic images most effectively. The designer may also weigh the pros and cons of using simulated artificial textures as opposed to those derived from photographs, including the use of computer generated bump maps or displacement maps that change the 3D appearance of object surfaces.

4) The designer should consider choices regarding models of interactivity, between linear hierarchical nodal structures that branch into subsections, associative or network nodal structures that bind related concepts together using semantic links, or non-hypermedia cinematic approaches to interactivity that attempt to simulate the inversions and paradoxes of meaning and events common to human thought. These paradigms of computer interactivity attempt to create a sense of artificial representation and connectivity, relatedness, circularity or randomness, narrative structure or cohesiveness, and/or variant trains of thought in very different ways. The use of one model of interactivity over another (and variations in the application of one particular model) will generate divergent outcomes.
Deleuze’s cinematic model follows Bergson by arguing against the experience of measurement, of spatial fixity, in favor of a number of durations, or multiple "real times" in the perception of 3D interactive motifs. Bergson (1965) believes that it is the function of physics to compose a world for us in which we can, for the convenience of action, ignore the limitations of classical time. Temporality is absolutely inherent in the mind, whereas spatiality oftentimes depends on the particular features of a sensory framework. Since objectified space-time must be experienced spatially and temporally as its content, it must not be used as an adequate explanation of the mind. Anything that presupposes space-time, touches on the manifestation of the mind, but not the mind itself. The application of such theoretical constructs directly to any post-sensory objects traps us repeatedly in paradox. Any third-person, cybernetic, neurophysiological approach to artificial intelligence, which discards the subjectivity of the mind, emphasizes only spatially identifiable objects, and disqualifies mental qualia, has no place in contemporary approaches to interactive cinema. Deleuze and other constructivists argue that complexity in the mind does not correspond to expanded cybernetic hardware in the brain, or to the idea of a "Cartesian theater of the brain" that operates from the third-person perspective of brain function (the complexity of the brain is not the reference base for an understanding of an alleged connection between abstract thought and consciousness). Deleuze’s analysis of durational time-images, of the cinematic use of transitions and anomalous
movements of sound, vision, touch and thought in the construction of cinematic
time fosters plural versions and frames of mind.

5) The designer should be aware of the power of photorealistic 3D simulations
that border on the illusory, or create what Baudrillard calls third-order or fourth-
order hyperreal retro scenarios and trompe-l'oeil effects. As the "inhuman"
domain implodes into the human in the construction of post-human "intelligent"
and autonomous avatars, the designer must be cautious of the coercive force
of 3D animated simulations artificial scenarios. As Baudrillard warns us, the
omnipotence of simulation is both productive and erasing because none of us
can escape the contemporary semio-material production of the "epiphany of
representation," of virtual mediascapes that are devoid of "real" objects. Jon
Dovey (1996) conversely points out that these same mediascapes can be
places where visionary utopias take shape and fuel the engine of social
transformation; where innovation is used to reinforce and amplify the interests
of emergent groups in a culture, interests represented by positive and utopian
social aspirations. Enmeshed in the production of aesthetic commodities,
many of the most creative inhabitants of simulations, who emphasize agency
and radical individuality, exist on the critical fringe of digital culture and in the
emerging realm of the post-human, a link, or a coupling between the
phantasmic technological space with quasi-Cartesian
concomitants/coordinates and the physical space of the human body. Deleuze
(1990) reminds us of the moment when simulations cease to be elusive,
“subterranean rebels” and make the most out of their phatasmic effects. At such times, radical and utopian difference is capable of rising to the surface of representations in new and intuitive ways.

In the interest of creating instructional media that plot narratives, build spatial and abstract skills, or allow for the construction of knowledge across various disciplines, the consideration of these aesthetics is crucial, particularly when choosing between the simulation of real-world phenomena according to conventional physical laws, or fictional, imaginary artificial phenomena that overstep the bounds of Newtonian physics. Following Weinbren, I suggest that the design of computer media involve managing unknown topographies, engaging the contours on unearthly terrains and domains, resolving imaginary or newly-constructed conceptual problems, and exploring the minds of others. The construction of unreal narratives and polyvalent interpretations potentially supports a multiplicity of cognitive styles.

4.10 Concluding remarks

As evidenced by an overview of the recent computer graphics literature, 3D multisensorial media simulations push the envelope of the “pictorial turn” and a culture saturated with images by inaugurating new kinds of interactive narrative structures embodied by juxtapositions and overarching temporal transitions of image, sound, touch and thought. Simulationist aesthetics expand minimalism’s concern with the plastic, embodied, material nature of 3D objects and the contextual conditions of everyday things. They also expand
formalism's interest with shape, texture, lighting, shadow, color, and
topological issues of curving, modulating 2D surfaces on 3D objects. The 3D animators love affair with ductile, material-semiotic cybersurfaces (incorporeal effects) involves more than just the reciprocal expression of aesthetical notions (taste, beauty, sublimity) and technical prowess in the construction of artificial realities; it is also the expression of artificial intelligence advances from computer media labs around the world, the fusion of invention and late capitalist financial structures. A prime example of this synthesis is the emergence of synthetic, neurosensing and navigating avatars that are capable of expressing autonomous behaviors and emotions.

The "triumphant" artifice of new media and technology is really beginning to simulate "natural" effects and behaviors for the demands of consumption, as Jameson (1998) reminds us. With the use of cinematic devices, media simulations can also transfigure the historical continuity of events and effect a fragmentation of time into a series of perpetual presents, or a reorganization of pasts and presents. Davenport (1996) shows us that cinematic models of player-object and object-object interactivity in artificial 3D settings, associated with temporal theories of thinking, are ideal for the construction of "real" looking, acting, sounding and feeling simulations. This
enables unlimited possibilities for the future of instructional media.
CHAPTER 5

CONCLUSION

One has to follow in Leibniz's footsteps but also in those of artists who echo his work, even unknowingly — Mallarmé, Proust, Michaux, Hantai, Boulez — anyone who fashions a world out of folding and unfolding. The whole thing is a crossroads, a multiple connectedness. We're still a long way from exhausting the potential of the fold; it's a good philosophical concept.

*Gilles Deleuze*

Like the evolution of the artificial 3D animated avatar in cyberspace, my archaeology of the writings on aesthetics and criticism surrounding the 3D object continues to undergo mutations and morphing, folding and unfolding, convergence and dispersion. In this chapter, I attempt to restate the archaeological object of my study and to identify common threads in my rewriting of the emerging simulationist aesthetics on 3D graphical objects in virtual cyberspace worlds. I identify four overlapping threads in my (re)construction of this dynamic and evolving body of aesthetic knowledge, but these threads continue to bend, weave, and fold into one another. Therefore, my concluding remarks necessarily remain open-ended. Baudrillard (1994) reminds us of the paradox in history where "ends" cannot be located in a nonlinear, non-Euclidean space.
In my attempts to demonstrate that the formalist and conceptual aesthetics of the 1960's have "ended" in some kind of uneasy synthesis, I am not attempting the dialectical reconciliation of two opposing antagonisms; but in the manner of what Deleuze (1989) calls, a "constructivist, Godardian pedagogy." I am trying to show relinkages and interstices between sets of ideas and concepts. In my view, my rewriting somewhat resembles a geotemporal cartography of historical analysis in which important concepts and precepts emerge in multiple and rhizomatic ways. In a "paradigm" of folding and unfolding, I intend to reemphasize the value of a creative aesthetic in the intuitive and nonlinear construction of knowledge and information in computer media.

5.1 Evaluative criticism as my archaeological object

The undertaking of an archeology involves the regressive and recursive contemplation of a corpora of discursive documents and tangible objects: its objective is to trace the interrelationships and discrepancies between those objects. In my introductory chapter, I identified the archaeological object of my study as the value-based and critically-determined art polemics surrounding 3D objects from the 1960's onwards. I began with the premise that the art aesthetics of 3D graphical forms are largely the academic enterprise of critics, curators, art historians and other academics vested in the production of evaluative and theoretical knowledges of graphical figures. My rewriting of late twentieth century aesthetic knowledge (as an ethical, practical and constructed
assemblage of statements and visible objects) demonstrates that my
archaeological object has multiple dimensions, strands and dispersions.

These strands can be (re)partitioned and fragmented in sundry ways,
but in my rewriting I try to (re)group them under four cardinal threads: 1) the
mapping and modulation of topological surfaces that form liquid architectures in
3D mediascapes, 2) the object-concept and the conceptual uses of intuitive,
constructivist computer interfaces, 3) the 3D object aesthetics of trans-human
graphical avatars, and 4) the interactive, cinematic mechanisms of knowledge
diffusion and cognition in computer media. Of course and rightly so, there is
extensive intersection between these threads. In this concluding chapter, I
make efforts to delimit and refine them. All four threads are part of the larger
tapestry that I call "the simulationist aesthetics of 3D surfaces, events and
effects." Throughout my dissertation, I attempt to locate the convergences and
divergences, the similarities and differences in evaluative agenda surrounding
3D object aesthetics and, conversely, to uncover the wholesale
aestheticization and "masking" of ethical discourse in the arts. My dissertation
traces and rewrites the critical trajectories in aesthetics that are themselves the
products of various and conflicting phasic-regimes and cultural practices.

Following Foucault (1972), my rewriting is part of the new history project
that attempts to describe the space around a series of themes, worldviews and
overall "shapes" in discursive material. However, rather than remove
discontinuity, the job of the conventional historian, the new historian makes
discontinuity and temporal dislocation the basic elements of historical analysis. "Description" itself becomes a deliberate operation, not something that should be eliminated or reduced to a linear schema. Foucault identifies "description" as the means to discover the limits of the historical process, the boundaries of an oscillation, the inversion of a regulatory movement, or the instant when a circulatory causality breaks down (1972, p. 9). Through the individuation of different series that overlap, intersect and are juxtaposed on one another, "description" questions the possibilities of convergence and culmination of discursive statements and critical practices; it also places in doubt the formation of totalities and inflexible, closed narratives.

As Lyotard (1993) asks, what is a discursive statement? How is it legitimated and situated? Who authorizes its writing? He infers that a theoretical text is an immobilized organic body that satisfies the formal properties of consistency, saturation and completeness regarding its domain of reference; but it is the discourse itself, not its domain of reference, that becomes a unity or totality. The realization of a narrative discourse that produces a **body-effect** is, for Lyotard, the outcome of an aestheticism and elitism that situates and affixes the events to the narrative as it unfolds. The events described in an art critical narrative thus become the attributes of an aestheticism that hides deeper political and ethical agendas. For example, Solomon-Godeau's work (1991) reveals how the modernist canon masks its own traces and presents itself as a natural, teleological phenomenon instead.
of making transparent the private interests that actively produce it. Aesthetic theories and perspectives, such as formalism, are never monolithic; rather they always derive from plural knowledges and values. The multiplication of discontinuities in the history of art critical ideas emerges from the archeology of its discursive terms.

5.2 Mapping curving and folding surfaces in 3D cyberspace

In reconstructing the first thread of my archaeology, I began with the possibility of folding and curving surfaces in non-Euclidean cyberspaces as an "object" and traced its derivation backwards to the formalist art criticism of the 1960's. Tomas (1991), Benedikt (1991), Eisenman (1993) and others conjecture that Cartesian algebraic geometry is only one of many possible, alternative paradigms emerging in explanation of spatio-temporal phenomena in cyberspace. The digital-symbolic spaces in computer displays are modulated information interfaces; they are settings for the interplay between pixel data visualizations and the inner structure of our minds. For Deleuze (1993) and Eisenman (1993), the point of the fold of a folding or pleated surface is the smallest element in the labyrinth of the continuous. It is also the place of departure for elastic, liquid cyberspace architectures, new configurations of space, light and postorganic sensoria.

My rewriting of the archaeology of folding cybersurfaces led to the metaphor of "mapping" out digitally coded territories for describing the computer interface. Serres (1983) warrants that the identity of a culture is to be
read on a map and differentiated by its appearance, its locus, its changes of
state, and its fluctuations in a plastic manner. Relatedly, in Digital Aesthetics,
Cubitt (1998) insists that twentieth century philosophers accept the map as a
model for logical thought and the spatialization of interlinked knowledge
architectures and information catalogues. Framing devices like photography
also follow the tack of perspective mapping in Cartesian coordinate space,
generating worlds that are built to viewer specificity. Beyond geotemporal
cartography, Cubitt suggests that maps fold into the nanospaces of "restricted
access" computer networks. The endlessly updatable maps of cyberspace
contain the past and mark out the future in a ceaseless series of binary
addresses in a potentially bottomless database (Cubitt 1998, p. 50).

Cubitt assumes that the fragmentary and incomplete worlds of
cyberspace are semiotic inventions rather than representations of "reality" that
would reflect "natural" spatial relations. However, Stone (1995a) sees the
human interface with cyberspace as something larger and beyond the expanse
of computer dimensions alone: the post-mechanical body includes the
cyborgian "neuromapping" of body figurations within and without non-
Euclidean spaces. She contends that the post-mechanical body is an abstract
assemblage that includes both an internal neurological state, perhaps
something that corresponds to a state of mind, and an external specular state:
It is both a "neurobody," or the internal neural impression of an external
physical form, and the topological body of space-time dimensions.
The surfaces of digital art constructions therefore correspond to modulating, neuromappings of fluid mind/body figurations that take on form, color and shape in the formalist sense. In three dimensions, the basic idea behind texture image mapping consists of taking a 2D photographic image and projecting or wrapping it on the topological surface of a 3D object while effectively simulating surface attributes (reflectivity, transparency, color, bumpiness, roughness, smoothness). The complex geometry of curved abstract shapes elaborated in contrapuntal, liquid 3D forms, and in combination with heavy, layered texture mapping, draws attention to the importance of surfaces in the simulation of objects, events, and narrative scenarios.

3D imaging and animation software are capable of visualizing surfaces and spaces as topological invariants in non-Euclidean cyberspace, and notions about the possibility of such manifestations have influenced Modernist art movements of the twentieth century, including formalist art criticism. Non-Euclidean geometries have influenced artistic visions in cubism, constructivism, orphism, neoplasticism and kinetic art (Shearer 1992, p. 146). While Poincaré wrote about the tactility of curved space, Picasso’s cubism enabled the radical materialization of this new space. Picasso indulged in and extended non-Euclidean paradigms of rounded or curved spaces in his collages of angular cut-outs and simplified, tactile forms. Cubism represents objects as a series of discontinuous, fractured planes, all equidistant from the
viewer, rather than using light and perspective to suggest solidity and pictorial depth. Victor Burgin (1982) suggests that cubism marks the advent of the full erasure of the sign from the surface in formalist art, but it is also a point of departure for the consideration of "weightlessness" and incorporeality in art.

In Modernist Painting, Greenberg (1958) explains how the early abstractionists and cubists flattened out the "3D illusionism" assumed in the tradition of Renaissance art. Weightlessness and modality are the basis of formalism's new illusionism where 3D form is understood cerebrally but not physically, and where matter is weightless and corresponds to some non-Euclidean algebraic geometric space not unlike cyberspace. In fact, if we perceive art objects in a merely phenomenal and logical manner, as Greenberg proscribes, then the inclusion in formalist aesthetics of "optical illusion" or "opticality," as a graphical effect of some 2D surface art that suggests some kind of "third dimension," paves the way for the emergence and acceptance by formalists of a 3D cyberspace visualization. Greenberg writes, formalist aesthetics renders substance entirely optical and recognizes form (whether graphical, sculptural, architectural, or digital) as an integral part of ambient space. As an example, Barbara Rose (1967) demonstrates that the "new illusionism" is purely graphical, functioning at the level of the surface. She attempts to reconcile abstractness with illusionism, the flatness of the surface of the medium with the illusion of 3D space. Although Greenberg's critical doctrine is exclusively narrow and prescriptive of what kind of "good art" should
be exhibited in galleries and museums, his choice of Olitski’s sculptures as epitomes of modality and weightlessness raises topological issues concerning the mathematical nature of 3D composite objects in cyberspace. Olitski’s colorful, hybrid pleated surfaces extend formalism’s concern with form, surface and texture to include the language of abstract topology and the curved spaces of non-Euclidean geometries.

The possibilities of other algebraic geometries in cyberspace outside of the conventional Cartesian coordinate space of Albertian perspective leads to the augmentation of the ontological definition of art into new domains. This opens up new spaces for hybrid forms. As post-1960’s reactions to formalism, pop and simulationism introduce the practice of appropriation as a distortion rather than a negation of prior objects and signs. Pop and simulationist appropriation of images disrupts the privileged autonomy of the art object, or at least puts that autonomy in suspicion as a subject of negotiation. Pop and simulationism introduce an instability in the correspondence between the object and concept, as meaning is producible in the unstable field of the relation of audience to work. The overall meaning of a work of art constantly undergoes reconfiguration in relation to audience and ambient environment; it is provisional, negotiated and (re)constructed. Minimalist artists also deliberately transgress the boundary where, according to Greenberg (1993), art becomes an arbitrary object: They then assume the quality of arbitrariness for themselves. The term "art" derives from the artificial, the unreal, unnatural,
constructed, invented, predetermined, objective and conceptual. Minimalist work also departs from the prescriptive two-dimensionality of abstract expressionism by adding the 3D element. It advances a conceptual paradigm shift that allows for the visual presentation of ideas and deliberately confuses, or abridges the art object with the arbitrary, everyday "object" that may hold perceptual or practical knowledge.

5.3 The Object-concept and intuitive computer interfaces

The conceptual 3D object is capable of conveying knowledge intuitively and interactively in the computer interface. It is a plastic form; it fits purposive and descriptive contexts in cyberspace learning environments and, in this way, resembles a practical, everyday commodity. From minimalist art, we learn that the acquisition of visual ideas is an intuitive process, one by which knowing and understanding derives from immediate engagement and the act of doing, rather than from abstract reasoning. Minimalism is crucial in reviving the intuitive creative process in computer design by providing elastic, malleable environments in which to work and think. The interaction between minimalist objects and observers, or between graphical avatars and players on the computer monitor may lead to the intuitive understanding of visual concepts. From radical constructivism, we learn that object permanence, or the retention of the idea of the object in the mind of the observer, follows the sensing of the object in the field of visual, auditory and tactile perception. Multimedia, graphical computer interfaces that rely on the quality of immediate usability
therefore present ideal environments for intuitive learning.

In positing the object-concept, the minimalist sculptor, Robert Morris (1966) recognizes that the presence of the object alters the total space: Every internal relationship of space and light, whether it is set up by some structural division or barrier, or enhanced by the richness of surface or light sources, creates a more intimate relationship with the objects in question. The presence of strong framing devices, such as empty space between objects, thick lines, grids, windows, and other structural borders or physical reference points mediates the degree of connection between observers and 3D objects. This process contributes to an intuitive perception and immediate understanding of the object-concept. Art critic, Rosiland Krauss (1996) writes that we no longer test abstract art by its ability to transcribe form and appearance, but by intuitively apprehending its concepts in the spaces of the mind. No Pythagorean dream is too exalted for conceptual art not to be able to reflect it as visual metaphor, or as the diagrammatic manifestation of the mind.

Minimalist design endows objects and elements with specific informational values in terms of movement, rhythm, foreground and background transitory relationships, processes of change in size, form and dimension, and their relationship with the center and margins of the screen. Morris (1967) insists that observers identify a number of factors that influence the creation of hierarchies of salience among objects that they believe are more or less worthy of their attention, which could include sound effects and auditory contrasts, the
graphical mass of objects, color contrasts between strongly saturated and “soft” colors, the placement of objects in the visual field, and depth of field.

Constructivists in the field of digital art perceive post-photographic practice as an open-ended horizon that involves radical change in the technology of image emergence, not only in how meaning is announced, but how the world is pictured and framed. New media has undoubtedly opened up unlimited possibilities for the processing, manipulation, storage and transmission of the “image-information product.” Roy Ascott (1996), digital artist, writes about the “love of construction” concerning the use of montage and the technologies of image-emergence in representation and in framing meaning. Papert (1993) discusses the unprecedented opportunities created by information technologies for action in improving the quality of learning environments. He heralds an “epistemological revolution” in the ways new media is enhancing the diffusion of knowledge and supporting a wide range of intellectual styles. Drawing on Levi-Strauss’ La Pensée sauvage (The Wild, untamed mind), Papert presents bricolage as a method of pragmatic utility and a “science” of the concrete that can be applied to the design of computer media. Papert defines bricolage as a kind of tinkering or play using computer media and the assorted mental tools that the learner has accumulated from everyday life and experiences. The use of these tools of pragmatic utility can be a rich source of ideas, a stepping stone to abstract concepts, and a means of fixing and improving knowledge-based mental constructions of all kinds.
Similarly, Weinbren (1995) alleges that pleasure that comes from mastery or expertise is essential in interactive computer media. This resembles Sherry Turkle’s (1993) notion that the computer encourages a soft, informal mastery of knowledge through play and *bricolage*, the process of tinkering around in computer simulations. Rather than tackling concepts through rules and abstractions, she suggests that the computer nurtures informal ways of knowing and allows for the acquisition of knowledge through the exploration of surfaces. This also draws on Piaget’s idea that knowledge is not passively received, but built up by the observer as a thinking subject, so consequently the observer’s reality is formed continually by means of *construction* rather than through the accumulation of readymade structures (von Glasersfeld 1995, p. 58). By visually or sensually tracking an object in the field of perception, the observer achieves an object permanence, the retention of the idea of the object in the mind. Radical constructivists contend that object permanence depends on the experience of the object before and after its disappearance from the observer’s perceptual domain and can lead to a deeper understanding of the conceptual object. Despite the radical constructivist requirement for thoughtful reflection after the experience of the object, Weinbren regrets the omission of the immediate interaction with avatars in the intuitive interfaces of non-game instructional media applications, a deficit that debases the expressive and communicative possibilities of interactivity.
Weinbren (1995) suggests that both authors and players can be "world builders" who enter computer simulations to construct and alter specific realities and to conceptualize products, spaces and events. These realities can be synthetic recreations of real-life situations, simulations of possible physical events or scenarios, or imagined constructions. Weinbren discusses new computer games that escape or transcend a localized spatial reality and move to a different tempo in cyberspace. They appear to transgress the conventional set of mechanical laws and approach the paradoxical behaviors of quantum phenomena. Players can engage intuitively in these knowledge or information-based scenarios through immediate hands-on experience and interaction with object behaviors. Recent advances in artificial intelligence (AI) suggest that value-based or value-dependent frameworks in computer media have the advantage of enabling more intuitive interaction between players and avatars at the level of computer interface by providing an intuitive way to think about emotions, drives and sensory input. Future advances in wireless interface design and projection systems, partially autonomous animated graphical avatars, and other applications of AI may even permit us some freedom from mechanical physical laws in terms the tempo, rhythm and elasticity of movement in cyberspace.

5.4 The Evolution of intelligent, trans-human avatars

From advances in AI and robotics engineering, computer designers can endow the synthetic avatar with the ability to perform some autonomous
activity and complex interactions with other objects and environments in 3D computer animations. Thus far, the limitations of AI and the needs of the instructional media and computer game industries demand a balance between internal avatar semi-autonomy and external player directability of behavior. Blumberg and Galyean (1995) affirm that authors of computer media for teaching, entertainment, and interface have focused up to now on implementing a limited set of perceptual, behavioral and motor systems in game-like environments. However, research in autonomous robots supports the need for more avatar autonomy in dynamic and unpredictable computer environments and scenarios. The emergence of autonomous avatars in cyberspace has consequences for the evolution of both the human and machinic minds. With greater organic and machinic intermixture and the creation of new organic to non-organic social relations, we may conclude, following Deleuze and Guattari (1987), that machinic or rhizomatic becomings do not so much take place in evolution as they create or invent evolution. Evolution in itself is now entering a biotechnological phase, in which biological life is becoming more technological and technological "life" becoming more biological. The human does not stand outside the machine, but affirms her involvement in the machinic conditions of existence and in evolving transhuman beings.

As the basis of evolving transhuman conditions of existence, computer designers are now situating AI elements in diverse biotechnological
cyberspace refigurations. Kline and Blumberg (1999) at MIT recognize the need for a shift away from cognitivist models of avatar behavior in favor of models that feature the dynamics of agent-environment interaction. They mention the advantages of hybrid AI systems that balance “competent” autonomous action with external directability and in which mutually-exclusive behaviors compete for dominance using mutual control arbitration. *Nouvelle AI* researchers argue for simple designs comprised of collections of simple competing behaviors coupled tightly with digital sensors and actuators. In value-based frameworks in which all semantic representations are converted to weighted values, intuitive, interactive ways to think about avatar emotions, drives and perception are emerging. Blumberg and Galyean (1995) explain that digital mechanisms responsible for controlling avatar behaviors support both prescriptive and proscriptive control and express weighted value preferences for or against the execution of a single behavior, or a group of behaviors directly at the motor level (the level of action).

Kline and Blumberg (1999) also discuss the biasing of action selection towards “goal-oriented” behaviors that satisfy the “internal needs” of the avatar. For example, attentive behaviors like eating can satisfy avatar “desires” or “drives” by changes in external stimuli, such as temperature fluctuations or interactions with objects or other avatars. When unattended, drives slowly increase over time until the effects of “attentive actions” shift the value of the drive back towards its homeostatic base state. In simulating
natural animal behaviors, adjusting homeostatic parameters across the space of "drives" and "emotions" shapes the mood, temperament, or emotional state of the avatar (Kline and Blumberg 1999, p. 2).

Whether an advantage or disadvantage over human behaviors, the transhuman avatar is capable of avoiding mixed or conflicting emotions, because its underlying emotional model is able to support dominant emotions and expressions over other lesser value-based ones. This kind of behavior necessitates synthetic perceptions (a method of sensing the environment) and a method for evaluating the salience of that sensory information. Semi-autonomous avatars now employ three types of sensing for navigation and obstacle avoidance and to provide data to emotions and drives. These types of sensing are 1) "real-world" noisy sensors, 2) direct sensing via direct interrogation of other objects and avatars, and 3) synthetic vision of an image rendered from a viewpoint (Blumberg and Galyean 1995, p. 4). Since it is difficult for human observers to visually perceive more than one emotion at a time, the benefits and disadvantages of multiple, value-weighted emotions in the intelligent avatar can only be demonstrated over time. Indeed, the effects of nouvelle AI advances in transhuman behavior are the elements of evolutionary change.

As we enter the new millennium, we also enter a biotechnological phase of evolution in and for itself. We need to be reflective about the meaning of "technics" and "technology" in evolution. It is difficult to deny as a matter of
fact that *humans* have been constituted at least partly by their technical evolution: Although "technics" is not particular to the evolution of the human form, it is both the sign or mark of human distinctive futurity and the source of the *artificial* character of inventions and "evolutions" in science. In past and present scientific writings, I surmise that "the machine" is typically construed as a deficient entity in contrast to organic life, which is regarded as owning a monopoly over formative power and all self-generative evolution. However, Deleuze and Guattari (1987) attempt an innovative and far-reaching revaluation of the machine/organism distinction in which the "machinic" is opposed to both the mechanical and organic to allow for complex, open-ended becomings within evolution.

Deleuze (1983) writes that the essential reactive person can transform her/himself by means of a synthesis of forces that affirms becoming, multiplicity, and chance, and through the transvaluation of values, a new active way to create values. Deleuze defines multiplicity itself as the product of diverse, non-localized, ideal connections and spatio-temporal relationships incarnated in a variety of terms and forms (Deleuze 1994, p.183). Similarly, Guattari (1995) argues that a truly "machinic" conception of creative evolution must embrace a radical pluralism of technical, semiotic, axiomatic and other machines that avoids the positing of the "human" and the reified, humanized notion of what constitutes autonomy on the machine.
Thus, it is no longer possible to conceive of evolution, whether of nature or of industry, in terms of isolated and individual dynamic regimes. Deleuze and Guattari (1987) envision a rhizomatic mapping of evolution that cuts across a linear historical time and enables an intricate interweaving of evolutionary regimes and adaptive systems. They also suggest that the rise of cybernetic and information machines in the last century implements a insidious form of subjection: The distinction between the organic composition of capital (the source of human surplus value) and the machinic composition of capital becomes blurred and breaks down as a tenable distinction. However, the very conditions that have created "human-machine systems" in information and engineering technologies also (re)create unexpected possibilities for "revolutionary, popular, and mutant machines" and organic to non-organic social relations in the biotechnological phase of evolution (Deleuze and Guattari 1987, p. 526).

In a complementary way, Haraway (1998) links biotechnological evolution to the processes of implosion, the heterogenous and continual construction through historically located practice where the actors are not all human. Implosion exposes the surface of events (the imprints of history) on the hybrid body. It liberates those who seek free political action, who are constructing a new molecular politics, or micropolitics of biology. It is now important that we affirm the evolutionary force of implosion and acknowledge our machinic conditions of existence in the intelligent computer avatar.
In support of this position, Baudrillard (1994) affirms that it is more a question of technology inventing the *human* than of the human inventing technology that delivers us from the Heideggerian vision of technology as pure immediacy and total transparency, as the final phase of metaphysical investigation. Baudrillard points out that having lost our metaphysical utopias we now build "prophylactic" ones with technology in which our immortality is guaranteed (you can always download your brain!). The artificiality of the biological and genetic is no longer that of a "deferred end," as in a teleological sense that leads to the end of history, but of a *prosthesis* and a reproduction of the literalness of the same (Baudrillard 1994, p. 98). Moreover, Baudrillard contends that the play of appearances of the body is destroyed in the "simulation" of the functions of life and volatized by genetic transscription. Similarly, thought processes, the very exercise of cognition, are abolished in the "instrumentalization" of mental faculties and the "fetishism" of artificial intelligence.

Baudrillard then suggests that the blurring of the boundaries between the *human* and *inhuman*, between the organic and inorganic, are not moving towards the *transhuman* per say, but toward the *subhuman* and the progressive reduction to genetic code, the lowest common denominator. For Baudrillard, biotechnical manipulation has become merely a "caricature" of the revaluation of values concerning evolution and what it means to be *human* (1994, p. 94). Genes no longer hold symbolic value, but only functional
purpose. In the transfiguration by excess of the human by the inhuman, algebraic and genetic formulas have supplanted the evolutionary play of forms; what's worse, the living beings generated by formula will also not outlive their own formulas. In a sense, we are all living on borrowed time. In the near future, genetic transcription and code may become the basis of cyclical and homeostatic "emotional drives" that provide a mechanism for achieving goal-directed behavior by biasing action selection toward satisfying the compelling internal needs of the synthetic avatar. Political action is consequently lost in the melancholy of homeopathic and homeostatic systems that spreads the virus of ecological micro-servitude, suggests Baudrillard.

Baudrillard recognizes intelligent 3D avatars as the fragmented, peripheral and retroviral forms that are the products of the re-creation of nature on the level of germs, bacteria and chaotic objects. The "real" planet, presumed condemned, is sacrificed to its miniaturized, air-conditioned clone that is designed to vanquish death by total simulation. For example, dystopic visions meet science fiction in a recent article in Wired, "Why the future does not need us: Our most powerful 21st century technologies — robotics, genetic engineering, and nanotech — are threatening to make humans an endangered species." The author, Bill Joy (2000) writes,

Some serious people are already suggesting that we (humans) simply move beyond Earth as quickly as possible. We could colonize the galaxy using von Neumann probes, which hop from star system to star system, replicating as they go. . . . What are the moral implications here? If we must move beyond Earth this quickly in order for the species to survive, who accepts the fate for those of us (most of us, after all) who are left behind? (2000, p. 254).
Baudrillard believes that synthetic avatars and other intelligent forms are the inhabitants of a micro-universe that seeks to exercise catastrophe (germs, viruses, bacteria) by making an artificial synthesis of all the elements of catastrophe (1994, p. 87). Baudrillard writes that catastrophic "systems" combine in effect "an inflation, a galloping acceleration, a dizzying whirl of mobility, an eccentricity of events and an excess of information with an exponential tendency toward total entropy" (1994, p. 112). For Baudrillard, then, biotechnological futures reside only in a maleficent ecology, or in the nihilism of entropy that surrounds the simple (but intelligent) avatar.

*Human* evolution has always been *unnatural*, and intelligent computer avatars and other technological forms pose a new force in the artificial evolution that all species now share. *Human* history cannot be modeled on natural history, since its mechanisms of selection have always been *unnatural*: We can forgive Baudrillard for lamenting the new forces of artificial evolution in which people endeavor to remove themselves from the Darwinian laws of natural selection. In *Speech and Gesture*, Leroi-Gourhan (1993) concludes that the whole of *human* evolution has been oriented toward placing ourselves outside species adaptation by transferring our memories to social and technological tools/organisms of our invention. Evolution has entered a biotechnological phase with the exteriorization of the noospheric brain in *transhuman* avatars within artificial, simulated cyberspace worlds. As Deleuze and Guattari (1987) suggest, we must avoid gross anthropomorphisms as we attempt to explain and
describe the mutations and morphing involved in this phase-space transition of intelligent, "machinic" evolution in biotechnological terms.

In their pursuit of AI, a wealth of knowledge is now available to computer designers about the human brain: its plasticity, elasticity, and recursiveness; the reversible sequencing of its operations. Deleuze and Guattari (1987) describe both the brain and thought as being organized like a rhizome, an uncertain and open system, more like "grass" than a tree, with probabilistic, semi-ambulatory mechanisms. In Negotiations, Deleuze (1995) explains that it's not that are thinking begins from what we know about the brain, but that any new thought traces uncharted channels directly through the twisting, folding, and fissuring of brain matter. He acknowledges that many cinematic forms of interactivity and transition are inspired by the neurobiology of the brain, as demonstrated by Bergson and the associationists. However, cerebral associations cannot be reduced to the intellectual or to pure brain function, because the brain is emotive and impassioned also. Deleuze concludes that the richness and complexity of cinematic connections, arrangements, disjunctions and synapses are the reflections of the mechanisms of thought and the multiple visions of the mind. Aesthetics cannot be divorced from the complementary questions of "cretinization" and "cerebralization" (Deleuze 1995, p. 60). Creating new connections in art means creating them in the mind too!
5.5 Cinematic approaches to interactivity and cognition in computer media

In *Cinema 2*, Deleuze (1989) contends that interactivity with (3D or photographic) cinematic forms comprised of image and sound is capable of revealing specific determinations of thought and deeper links with knowledge. He writes, it is the material automatism of images that imposes a thought from the outside, creating and constructing the “unthinkable” in thought, or new cerebral connections in thought. As I have discussed (see my chapter 4), associative nodal structures bind related concepts together within an interactive informational space using semantic or pragmatic links that are non-sequential in nature. Conventional looping structures in multimedia design also expand the number of interactions numerically but not geometrically, creating simpler, easier navigation; and *randomness* can add narrative layering, compositional “texture” and a sense of exploration to the interactive piece. However, Davenport (1996) suggests that “push-button,” superficial structures and descriptions are not enough to design complex 3D computer media applications; cinematic strategies and other experimental associative paradigms of cognition are more suitable for the design of interactive new media. Deleuze (1989) recognizes that in cinematic approaches of the direct *time-image*, relations and disjunctions between the images and sound endow cinematic production with new powers for capturing and expressing time and objects in time.
Recent cinematic strategies allow the interactive "observer" to perceive layers of time, modulating durations of time, as if the relation between movement and time in the filmic flow has been inverted. Montage does not vanish in cinematic application, but plays a different role now that movement follows time. In Negotiations, Deleuze (1995) also suggests that the image bears a new relation to its optical, aural and tactile elements in recent cinematic approaches, where the visionary aspect becomes more "legible" or "literal" than visible: Therefore, when identifying pure chronosigns, lectosigns, opsigns, and noosigns as matters of classification, cinematic devices allow the image to catch the mechanisms of thought (image becomes thought).

All forms of what Deleuze recognizes as time-images in contemporary cinematic approaches break with direct representation and shatter the linear, empirical continuation of time, the chronological succession, or the empty and unfolded form of time. Cinematic strategies combine image, sound and touch with the aggressive force of profound thought and vital intuition to construct durational, modulating time-images. Deleuze, following Andre Bazin (1967), explains that the cinema is constantly modulated where the parameters of the image are subjected to variations, repetitions, alternations, and recycling. In Cinema 2, Deleuze recognizes that the "new regime" of the image based on Godard's new wave is constructed on what Deleuze calls a "pedagogical base." Godard's cinematic approach is instructive for designers of new media in that he uses irrational cuts, interstices and intervals to make sequences of
anomalous images and sound tracks (Deleuze 1989, p. 248). Godard employs a “system” of cinematic devices that produce interruptions, disengagements, and micro-cuts in all directions; these transitions pass in and between visual and auditory elements that are purified, rendered disjunctive and freed from each other. Deleuze names Godard as one of the authors who has thought most about image-sound relationships and their multiplied connections: He expresses this relation as a new metaphor; the audio-visual image is not a whole, but a fusion of the tear.

In Negotiations, Deleuze (1995) explains that the sensory-motor scheme of classical cinema breaks down in contemporary cinematic schemas to leave discordant and disoriented movements, new patterns and “becomings” rather than stories. It is movement as false movement, as aberrant movement that now depends on time. Godardian pedagogy, like the human brain, creates spatio-temporal volumes in which you might see different links, continuities, and false continuities as cinematic synapses. Deleuze insists that Godardian pedagogy is not a debasement of information, but the temporalizing of image, sound and touch as pure time, or little bits of time in pure forms, rather than linear motion (1995, p. 59). In Negotiations, Deleuze also re-acknowledges his prior claim that contemporary cinematic strategies are foreshadowed by Welles and even earlier by Ozu: In Welles, there are profound, coexisting layers of time that the camera’s depth of field helps to develop; and Ozu’s still lifes are thoroughly cinematic because they bring out the unchanging patterns of time in
certain early twentieth century Japanese "realities." In the sense of the "unsummonable" in Welles and the "undecidable" in the French new wave, Deleuze says that the brain has lost its Euclidean coordinates and now emits noosigns in asymmetrically unlinked (but always re-linked) images.

In the interactive, noospheric cinema (a cinema of thought), the modulating, internal relations of time take on topological or quantic forms. In Cinema 2, Deleuze draws on the work of Changeaux and other neuroscientists to show that the discovery of synapses in the brain was enough to shatter the idea of a continuous cerebral system, because it supports the idea of irreducible points or cuts. In the case of chemical synapses, the point is irrational and belongs to neither of the two sets it separates. In fact, in the synaptic gap, vesicles release discontinuous amounts of transmitter substance, or "quanta" (Deleuze 1989, p. 318). In a similar way, Deleuze describes how the use of discontinuous and enveloping cinematic devices makes layers of reality as the past and present correspond in a topological and probabilistic space. Strategies where relinkages are subject to the cut and interstice, instead of cuts subject to the linkage, construct, according to Deleuze, "an organic process of integration and differentiation increasingly pointed to relative levels of interiority and exteriority and, through them, to an absolute outside and inside in contact topologically" (1989, p.211). Deleuze attributes this process to the discovery of a topological, probabilistic or semi-fortuitous cerebral space and the application of the "constructivist novel" as a cerebral game.
Following Bergson’s *Matter and Memory*, Deleuze (1989) explains that the process of association comes up against cuts or gaps in the continuous network of the brain; and elsewhere there are micro-fissures that are not merely voids to be crossed, but random mechanisms interrupting the sending and receiving of associational messages. Consequently, the three cerebral components of the contemporary cinema are the point-cut, the relinkage and the screen or monitor; and the three aspects of the cinematic approach to interactivity are the topological, probabilistic and irrational (Deleuze 1989, p. 215). Each of these constructs with the others a noospheric “circulation” and a cinema of thought. In its simplicity and concreteness, the interactive, cinematic computer medium is a space of topologically-constructed cognitive and informatic structures where form meets content in the aesthetics of acentered systems. Like philosophy, Deleuze insists that the interactive cinema is a conceptual practice: in its twisting, folding and fissuring of digital, informatic substance, it constructs and discovers new pathways, connections and concepts.

5.6 Concluding remarks

Deleuze shows us that the creation of philosophical concepts is very similar to the design of computer media: Neither the concept nor the design is ready-made or pre-existent; the philosopher must create concepts and this involves as much invention as required in art and design. It’s my premise that my rewriting of the value-based art polemics and criticism of 3D graphical
representations has “ended” in a detailed description of simulationist aesthetics in the computer graphics literature (chapters 4 and 5). The simulationist aesthetics of 3D objects are where form meets content in concrete cultural practices that include the design and use of interactive media. Both ideas and their effects are superficial in simulationist new media that express seriality and reproduction: The “depth” of meaning is realized on the surface in the domain of visual, auditory and tactile representations, just as the three-dimensional space is represented in a two dimensional image or projection, which once flattened, can be mapped/morphed from object to object in 3D rendering.

Regarding these aesthetics, I selected four threads of thought from sundry choices to sum up the presentation of ideas: They are 1) the modulation of topological surfaces in 3D media, 2) the object-concept and the conceptual uses of the constructivist computer interface, 3) the evolution of the intelligent 3D avatar, and 4) the cinematic, cerebral topological space of informatics and knowledge in computer media. These threads weave, fold, or interact like a diagram in different configurations of space and volume. As Deleuze (1995) writes, if we think of “lines of thought” as the basic components of things and events that weave through space in different directions, then everything has its geography, its cartography, its stratigraphy, its diagram.

In my geotemporal rewriting of formalist and conceptualist aesthetics, I agree that the fragmentary and incomplete worlds of cyberspace are semiotic inventions rather than representations of “reality” that would reflect “natural”
spatial relations, and that they involve new configurations of space and volume that resemble non-Euclidean, or "less Euclidean" geometries. I discuss how the idea of folding and curving spaces in cyberspace can be traced back to formalist art generally, and to cubism, constructivism and neoplasticism specifically. I suggest how the formalist notions of "weightlessness" and "modulation" as practiced in Olitski's hybrid, pleated sculptures resemble chiaroscuro effects in Baroque art, which in turn resemble folding and curving spaces in non-Euclidean geometries, such as Beltrami's hyperbolic geometry. I discuss in some detail how minimalism adds the 3D conceptual element to the visual representation of the arbitrary object, and how minimalists have contributed to our knowledge of the apprehension of objects and their concepts in the spaces of our mind. I also agree with Weinbren (1995) that both authors and players can be "world builders" in computer simulations; and new advances in partially autonomous animated graphical avatars and other applications of AI will allow us to construct conceptual, instructional 3D worlds according to a new tempo and elasticity in virtual, non-Euclidean cyberspaces.

Despite the balance between autonomous avatar action and player/learner directability now demanded by computer media publishers and designers, I believe that future "machinic" evolutionary mutations in the intelligent, 3D robotic avatar hold some potential for subversive political action and the liberation of all species, forbidding the possibility that the transhuman destroys all life through his/her bioethical choices. Deleuze and Guattari (1987)
envision a rhizomatic mapping of evolution that cuts across a linear historical
time and enables an intricate interweaving of evolutionary regimes and adaptive
systems. The only nature available to contemporary ontological discourse is
this artificial conception of nature, a hybrid nature, a infinitely plastic universe of
cyborgs.

_Nouvelle AI_ advances in _transhuman_ behavior are elements of this
evolutionary change, particularly as they concern value-weighted emotions and
drives in the intelligent 3D avatar. Evolution appears to have entered a
biotechnological phase with the exteriorization of the noospheric brain in the
cerebral, topological spaces of computer media and in artificial cyberspace
worlds. Cinematic strategies that produce interruptions, disengagements, and
micro-cuts in all directions enable new connections, _relinkages_ and rhizomatic
becomings in interactive computer media. _Deleuze_ (1989) suggests that the
cerebral, topological and probabilistic space of interactive media is where the
rhizome/brain/thought come alive! Image, sound and touch become thought!
He affirms that the complexity of interactive cinematic connections,
arrangements, disjunctions are the reflections of the active, semi-ambulatory
mechanisms of thought. I agree with Papert (1993) that the emergence of new
media signals an "epistemological revolution" in education and knowledge, in
the ways the computer is enhancing the construction of knowledge and
supporting a wide range of intellectual styles. Creating concepts in/with
computer media is both a kind of creative expressionism and a constructivism
whereby the extension and unfolding of lines of thought lead to the production of something new. I believe this perspective captures the potential of learning with computer media. In Negotiations, Deleuze summarizes it best.

Concepts are composites, amalgams of lines, curves. A concept's power comes from the way it's repeated, as one area links up with another. And this linkage is an essential, ceaseless activity: the world as a patchwork... there's a hidden image of thought that, as it unfolds, branches out, and mutates, inspires a need to keep on creating new concepts, not through any external determinism but through a becoming that carries the problems themselves along with it (1995, p. 149).
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