VIRTUAL RESISTANCE: A GENEALOGY OF DIGITAL ABSTRACTION

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According to one narrative, an evolutionary trajectory for computer graphics begins at rudimentary figures and progresses towards visualizations of a world whose properties mirror our own. But there is a tradition of computational abstraction that renders visual equivalents of abstract mathematical calculations. This paper considers whether computational abstraction fits a modernist narrative or whether it envisions a new call to order.

According to one narrative, the history of computer graphic imaging has privileged verisimilitude, in which a virtual image imitates optical reality as faithfully as possible. This account posits an evolutionary trajectory for computer graphics beginning at pixel-based figures and progressing towards rich visualizations of a world whose properties mirror our own. This history may hide the fact that this virtual world is often visualized as if it were captured by a camera; the camera-based image is simulated by encoding a mathematical model of a picture as it would appear through a lens, with a specific field of view and focal length.[i] Computationally generated pictures often analogize the visual qualities of a world seen through a camera lens, and would seem to tend towards the particular qualities of virtuality, and the visual distortions, produced by a camera.

But there is a tradition of computational abstraction that revels in the facility of the computer to render visual equivalents of abstract mathematical calculations. Such screen-based abstractions generate imagery based on formulae for physical forces such as gravity. Painterly compositions emerge as a result of inputting random values into an algorithm encoding change over time. This paper assesses whether there are a set of principles with which computationally based abstractions are concerned, and what kind of "world" is imagined through this algorithmically generated visual model. Taking into account the history of abstraction in modern art, it considers whether computational abstraction fits into a modernist narrative or whether it envisions a new call to order distinct from that set forth by 20th century modernist movements.

The aesthetic of mimetic virtuality demonstrated by graphics imitating a camera can be distinguished from an aesthetic of computational abstraction by the latter's typical foregrounding of discrete values mirrored in the structure of the picture. A digital image is defined by its discrete composition out of distinct, interchangeable units. This is most easily recognized in the formal properties of the pixel, but can also be conceptualized in a more theoretical manner, as in Nelson Goodman's formulation, according to which "to be digital a system must not be merely discontinuous but *differentiated* throughout, syntactically and semantically."[ii] This formulation adds another dimension to the theory of picturing in general, one in which analog and digital aesthetics can be formulated and evaluated as distinct categories. There is also an aesthetic trajectory that bridges the gap between the two modes of analog and digital by examining the structural features underlying a given representational system through strategies of abstraction.

One exploration into the mechanics of recorded moving images occurs in the phenomenon of Structural film that emerges in the 1960's. Deploying such strategies as loop printing, rephotography off the screen, the flicker effect, and fixed camera position, structural film is "a cinema of structure in which the

shape of the whole film is predetermined and simplified….and what content it has is minimal and subsidiary to the outline."[iii] Structural film unfolds algorithmically, according to a predetermined system, which provides the rules according to which the film proceeds. Structural film is invested in uncovering the material infrastructure behind the continuous motion we come to associate with cinematic technology. It also, crucially, often favors abstraction, for example in the films of Paul Sharits, as a convenient mode of exploring film technology.

To understand what kind of images or objects will be most likely produced within a particular technological milieu, it is imperative to consider the facilities of that technology—the ways its affordances and constraints will, alongside creative decision-making on the part of the artist and other factors (such as cultural norms), dictate the types of forms that will be produced by that technology. While most traditional narrative film attempts to make the medium transparent through such techniques as suture, in which the editing and other elements of the cinematic apparatus are suppressed, structural film examines the material qualities of the filmic medium. Like conceptual art, in which the visual qualities of the final product are secondary to the idea underlying and driving its production, structural film reveals the mechanics of film, or the "idea" of film itself. Structural film is, therefore, "cinema of the mind rather than the eye."[iv] Often, for example, structural film will use rephotography to emphasize the graininess and flatness of the image, disrupting the reality effect or impression of virtuality that might otherwise occur.[v]

Alongside structural film, early computer animation utilized the particular visual characteristics of computationally generated imagery to reveal what I have called a digital aesthetic based on discreteness and the use of an interchangeable module as the fundamental unit or building block with which computational pictures are constructed. I suggested above that while the history of analog picturing privileges qualities such as smoothness, continuity, and indiscernability of internal parts, the "digital", recognized qualitatively as having its own particular visual characteristics, reveals its constitutive discreteness, its ability to calculate and generate patterns based on the computation of individual values. This often results in the production of an abstract visual field and the rejection of mimesis in favor of a direct interrogation of systemic principles.

Examples of early deployment of computational strategies for the production of "art" emerge in various media, including film. Stan Vanderbeek, Jordan Belson, and John and James Whitney are among the most important producers of abstract film that utilizes computation—a phenomenon that Gene Youngblood calls "cybernetic cinema."[vi] Cybernetic cinema, for Youngblood, is an approach to the production of moving images that privileges not merely a photographic capture of the external world, but situates itself in terms of the relationship between humans and technology, or more precisely, as Zabet Patterson has articulated, "under the auspices of the human-machine feedback loop."[vii]

The link between abstraction and technology is observable throughout the history of modernism. The rise of modernism is concomitant to the rise of industrial and reproductive technologies, and as such, technology itself becomes the subject of art. Modernism is also recognized as bringing about the advent of abstraction in the visual arts, and while technology and abstraction might seem at first glance to be unrelated, or to follow divergent principles, they are in fact inextricably entwined. Abstraction begins to turn toward the look of the technological in numerous instances, as in the proto-computational, pixilated forms of Victor Vasarely's Op-Art and in the synthesized mandalas of John and James Whitney.

Meditations on the expansive effects of technology on the horizons of visual representation in modernist art practice are nearly endemic. Futurism gives up "meat" (the representation of human figures,

especially the nude, in the history of Western art) in favor of creating a visual universe that celebrates the beauty of speed, simultaneity, and the clang of machinery, all phenomena directly attributable to the compressions of time and space wrought by new technologies.[viii] Futurism does not only depict machinery, but it also explores the way in which technology provides a new visual and perceptual experience of the world—it examines not only what technology can do, but also the ramifications of that technology on our consciousness, for example the shrinking of time and space that occurs with the invention of mechanisms for fast transit, such as the automobile.

But modernism has also been characterized by a concern with the spiritual, with purity, often achieved by the reduction of form to its most basic elements. Total abstraction, then, with its aims towards a spiritual universalism, would seem to be opposed to a technological worldview focused on functional forms. But as RL Rutsky has pointed out, a formalism oriented towards the *look* of technology in the end abstracts the technological from functionalism, so that the technological becomes a representational trope that speaks toward an overall word view rather than a direct portrait of specific technological devices. Heidegger has argued that "the essence of technology is by no means anything technological"—technology is not revealed in particular objects, but in a turn toward a technological way of thinking, in the way that new technologies reveal aspects of the world to us.[ix]

Ultimately, technology and spiritualism become deeply imbricated. The theosophic foundations of De Stijl, led by Mondrian and Van Doesburg, merge spiritualism and functionalism. Abstraction is posed as the antithesis of nature and the natural—it is "functional" and ordered as opposed to the disorder of the natural, and is of the spirit, which is also separate from nature. Universalism and abstraction are deeply imbricated with one another, united in their opposition to nature, as is evident visually in the precise geometrical angles and forms of Mondrian's and Van Doesburg's painting. These geometries are linked to modern urban life; the "genuinely Modern artist sees the metropolis as abstract living converted into form."[x] Moreover, modern living is characterized by the machine, and machines are, counterintuitively, connected with spirituality; "the machine is, par excellence, a phenomenon of spiritual discipline."[xi] Abstraction, now associated with the functionality of the machine, in turn becomes a function *of* the machine, as is visible in the films of Vanderbeek, the Whitneys, and later generative computational "drawing." (And it is notable that the Whitneys state an alliance with Mondrian and his view that abstraction attains a "truer" reality.[xii]) The images we see unfolding on the screen can be read, alternately, as simulacra of computational functions or as indexical traces of the same. This undoes the opposition between autonomous generative grammar and indexicality, given that generative grammar can be seen as leaving its own imprint in filmic form.

"Function" can have various meanings. Computers are functional in their ability to create a model of the world by numerically calculating and graphically representing calculable data. This utilitarian view of function can be set against the theory of abstraction, as proposed by De Stijl or the Suprematists, in which abstraction provides an indirect model for universal social freedom. Both approaches to abstraction have a distinctly utopian bent, the former imagining a perfect simulation of the world attainable through the powers of computational machines, the latter championing the capacity of abstraction to produce social harmony. The two poles of realism and abstraction, therefore, eventually converge in their utopian teleology.

Film and video are most often associated with principles of realism—they are technologies whose particular affordances lead toward mimesis. As a reproductive technology, film might be thought to have the capacity to reproduce the world in much of its fullness; film both reproduces the world and is itself reproducible. But cinematic trends toward abstraction have coexisted with traditional narrative film, as

we see in early experiments with abstraction such as Duchamp's *Anemic Cinema*. Abstract, generative computational video takes filmic abstraction even further, going beyond abstract cinema's exploitation of shape and line to offer a visualization of often *invisible* forces such as push and pull at various rates. Mark J. Stock's simulations, for example, combine individual elements exhibiting simple behaviors into "complex galaxies" of abstract, moving forms whose rules for development and change are governed by a mathematical system with distinct parameters. According to Stock, these fluid visual landscapes reveal "the natural origin of their rules. This is the way of computational science: to break complex, real problems up into many smaller and easily solvable problems such that the ensemble predicts the behavior of the real system."[xiii]

One can go one step further to claim not only that technology and abstraction have been linked from modernism forward, but that there is a particular view of technology and technological operations that foregrounds a computation and calculation. This computational order privileges systems that deploy numerical values or other non-numerical forms of calculation (any kind of "system") to produce its results, in this case the visual field of representation. The work of Frieder Nake and George Nees presented a mode of artmaking in which the artist's unique capacity to manifest the beautiful is supplanted by the computer, leading to a rationalization of beauty, a notion of beauty as emanating from programmatic schemas. Amongst early computer artists, including Nake and Nees, there was no small anxiety about this notion of programmed beauty—could the artificial generate an authentic work of art, or would the experience of beauty be authentic? Eventually, the most likely conclusion to be drawn is that what is being accomplished is not merely the imitation of pre-existing modes of artmaking, but that something new is being introduced: an art that foregrounds the abstract structures produced through programming. Machine-realized art moves us away from the virtuosity of the artist's hand, the grand designs of her mind. Computationally executed art comes as close as possible to completing this circuit. In so doing, it envisions a world of values and forces, understood better in terms of computational efficacy than mimetic reflection.

A brief look at the history of computing reveals the development of a philosophical trend in which mathematics and systems theory play an increasingly prominent role in theories of knowledge, human behavior, and even art. Researchers such as Turing, Von Neumann, Shannon and Weaver, and Wiener postulate that phenomena can be accounted for in terms of logical operations. "Rationalization" in representational terms consists of analyzing and reducing form to its most basic elements, whether this is the simplified form of the square or the breakdown of the world into data.[xiv] Likewise, abstraction is a process of stripping down worldly phenomena into its most elemental or essential forms. In this way, abstraction can be viewed in terms of rationalization, as a mode of quantification of form into a series of operations. Thus, abstraction can be both spiritual, in its search for essences, and procedural, in its breaking of matter into its constituent operative parts.

George David Birkhoff, the American mathematician, proposed that the beautiful is a function of order, so that something with the greatest amount of order and the least amount of complexity is the most beautiful.[xv] This parallels the theories of abstraction in the history of modern art that have attempted to systematize visual signs through the reduction of elements such as shape and color to their most basic forms. As I have suggested, abstraction, for visual artists including Malevich and Kandinsky, approaches spiritual purity.

Information aesthetics are often associated with generative art, which has been defined as art that deploys a system, such as a computer program, that is "set into motion with some degree of autonomy contributing to or resulting in a completed work of art."[xvi]A work that is designed and carried out

using a pre-determined system that unfolds with or without the intervention of the artist's hand does not necessarily but will often demonstrate the aesthetic or formal properties of that system in a self-reflexive manner. Thus, the visual world built by these systems is one that replaces mimesis with an exploration of repetition, transformation, and parametrization.

Looking at Mark J. Stock's 2009 *Rising*, it becomes apparent that because informatic and generative art is concerned primarily with the principles and system with which it is constructed, it will be more likely to remain unconcerned with verisimilitude. Viewed from one angle, generative art emerges from a lineage of proceduralist aesthetics, wherein "inanimate accuracy" is substituted for "human touch."[xvii] Generative graphics reveal a field of operations whose principles of change—growth and decay, for example—are given by certain encoded parameters that exist and unfold apart from the artist's decision-making process. Because it is computational, the system necessitates fragmentation, the existence of parts that can be set into motion by the program. As a visual form, generative art is certainly concerned with the aesthetic qualities of its product, but the aesthetics are defined by the interactions between parts and the emergent qualities that develop as a result of this interaction.

Lev Manovich has defined the aesthetic quality of computational art in terms of an aesthetics of complexity,[xviii] which exists in contradistinction to the simplified forms of earlier 20th century modernisms, such as the extremely reduced formal vocabulary and palette of the Russian avant-garde, and particularly Suprematism, in which Malevich "in 1913, trying desperately to liberate art from the ballast of the representational world…took refuge in the square form."[xix]

I would define computational aesthetics not so much in terms of complexity, but consider instead the aesthetic ramifications of the computer's ability to carry out rapid, repetitive calculation and to build structures out of discrete, interchangeable units. Looking at Gursky's *99 Cent* or Jennifer Steinkamp's 2008 *Daisy Bell*, we can observe instead an aesthetics of repetition, a sense of an indefinitely extendable universe of discrete elements arbitrarily cut off by the boundary of the screen, the mechanism by which this computational universe is made visible.

This repetitive calculation can be used either to mask or to highlight a picture's computational underpinnings, to build a dense, virtualized simulation or to emphasize the discrete, numerical infrastructure of the image. Artists such as Jim Campbell, who in his *Ambiguous Icons* series reduces moving figures to broad, highly unresolved silhouettes by filtering them through a grid of LEDs, choose to foreground the fact that what ultimately appears as a picture on a screen begins as a chain of abstract data. Campbell abstracts photographically captured imagery using discreteness and low resolution to interrogate the notion that computational imagery must always produce a seamless virtualization of a three dimensional world.

What I have shown in the preceding arguments is the way in which theories of abstraction have united with theories of modern technology, from the mechanical to the computational, to produce a particular mode of representation: technological abstraction. Technological abstraction has a lineage that extends beyond the advent of computers; after the invention of modern computers, it is evident in work produced using mechanical, analog computers and later, digital computers. These works deploy the same machines used to generate immersive virtual worlds, but utilize that technology towards very different ends. We should not suppose that computational abstraction emerges simply because computers were not yet able to construct virtual worlds, but rather that it arises alongside a fascination with a computa-

tional universe, governed by the same physical rules as the human body, but adhering to a different perceptual order, one which favors pure relations, patterns of data, and elemental forces, and into which we are ushered via the screen, with its array of points of pure light and proliferation of digital units.

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