

From Point to Pixel:
A Genealogy of Digital Aesthetics

by

Meredith Anne Hoy

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Committee in charge:

Professor Whitney Davis, co-chair

Professor Jeffrey Skoller, co-chair

Professor Warren Sack

Professor Abigail DeKosnik

Professor Kristen Whissel

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Abstract

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Meredith Anne Hoy

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University of California, Berkeley

Professor Whitney Davis, Co-chair

Professor Jeffrey Skoller, Co-chair

When we say, in response to a still or moving picture, that it has a digital “look” about it, what exactly do we mean? How can the slick, color-saturated photographs of Jeff Wall and Andreas Gursky signal digitality, while the flattened, pixelated landscapes of video games such as Super Mario Brothers convey ostensibly the same characteristic of “being digital,” but in a completely different manner? In my dissertation, *From Point to Pixel: A Genealogy of Digital Aesthetics*, I argue for a definition of a “digital method” that can be articulated without reference to the technicalities of contemporary hardware and software. I allow, however, the possibility that this digital method can acquire new characteristics when it is performed by computational technology. I therefore treat the artworks covered in my dissertation as sensuous artifacts that are subject to change based on the constraints and affordances of the tools used in their making. But insofar as it describes a series of technological operations, the word digital often references the tool used to make the art but does not help a viewer/user relate to the art as a sensorially apprehensible artifact. Consequently, I gather together artworks that disclose visible evidence of their digital construction in order to identify the perceptible characteristics of digitally processed artifacts. I foreground not the hidden operations of computers—the intricacies of binary code and programming languages—but rather the surface qualities of digital graphics. While acknowledging that internal processes govern the aesthetic properties of these surfaces, I investigate the extent to which it is possible to encounter digitality at the level of the interface. Taking into account that the sensuous object will be informed by an underlying conceptual and technological framework or genotype, I set out to discover whether certain phenotypic aspects of digitality will be inherently accessible at a phenomenological level.

Much of the best scholarship in media studies has offered cogent analyses of the political, social, and economic formations that emerge alongside digital technologies. These readings of “networked culture” focus on the systems of power/knowledge that arise from the Web 2.0 and a globalized world economy. Although this research proves invaluable to the understanding of a culture shaped by ubiquitous computing, a well-developed methodology for interpreting the role of digital technology in art practice must

also situate digital artifacts in a specifically art historical and theoretical context. When do digital artifacts overcome their dubious status as mere demonstrations of technical novelty, and become artworks worthy of serious consideration? What is the importance of digital technology as an artistic medium, and how do affordances and constraints and technical parameters of digital processing influence the sensible configurations of computationally generated artifacts?

Despite its foundation in immaterial electronic pulses, digital technology produces material effects on culture and communication. The assessment of digital images is often based on their “reality quotient”—the degree to which they accurately reproduce the optical and haptic conditions of external world. The fascination in digital cultural studies with virtual reality, second life, and other such practices supports this view, and also leans dangerously towards the notion that progress in art is achieved by producing ever more sophisticated techniques for rendering illusions of spatial depth. This concentration on the immersive capacities of digital graphics runs the risk of assuming a teleological progression in art towards “accurate” spatialization and virtualization. But this is not a tenable model for art historical investigation, given that the evaluation of art objects based on culturally determined signifiers of naturalism is exclusionary of alternate visual models and historical traditions. It is therefore imperative to consider depictions that exhibit visible evidence of digital construction—digital aesthetic characteristics— independently of the virtualizing capability of computational technology. My dissertation examines a subset of digital image-making practices that suppress virtualization in order to examine the structural principles undergirding digital graphics. In parsing these often abstract, highly formalized pictorial strategies, I conclude that they convey a different aesthetic and architectonic sensibility than analog depictions.

Over the course of five chapters, my argument moves between theoretical analysis and case studies of artworks produced both with and without the aid of computers. Chapter One outlines the theoretical models used to differentiate digital and analog properties, and illustrates how and why art historical discourse has accorded value to artworks based on analog principles, such as fineness of color, texture, and line. It argues that discrete, particulate digital artifacts are constructed according to different principles than analog artifacts, which are relatively smooth and continuous with no absolute division between parts. My review of the formal characteristics of digital systems sets the stage for my argument that an observable model of digital facture—a digital method—preexists electronic, binary computers and that this digital process results in a digital aesthetic. Understanding this aesthetic is useful for theorizing the genealogy of contemporary computational graphics. Additionally, it provides for alternate theorizations of artifacts that have not traditionally found a secure place in the artistic canon, and it affords a new interpretive schema with which to examine artists and artworks whose position in the art historical demands renegotiation. In my second chapter, I support the claims of the preceding chapter by evaluating the extent to which the work of several modernist painters, including Paul Cezanne, Georges Seurat, and Paul Klee, exhibits constitutive features of a digital system. I use my findings to argue that understanding these artists’ roles as experimenters with a digital method adds a new dimension to the theoretical, aesthetic, and historical significance of their work.

The following two chapters provide comparisons between artists who apply a digital method without electronic computation and artists whose digital aesthetic is

computationally driven. Chapter 3 attempts to recuperate the value and relevance of Op-Artist Victor Vasarely. Through an inspection of his writings and his algorithmic painting practices, I trace Vasarely's lifelong goal to develop a programmable visual language, and demonstrate how, without ever touching a computer, he was attempting in his practice to adopt a visual model of a digital system. In the second half of the chapter, I introduce the example of Marius Watz's computationally-generated homage to Vasarely's work in order to ascertain whether the use of a computer alters the visible qualities of Vasarely's plastic language. In Chapter 4, I examine Casey Reas's fraught and often contradictory response to the legacy of conceptual art in programming-based practices. Through a comparison between Reas and Sol LeWitt, I maintain that Reas occupies an oscillatory position with respect to the values traditionally attached to analog aesthetics, such as immediacy and uniqueness/irreproducibility. By mobilizing algorithmically encoded instructions to automate artistic production, Reas reinforces the turn away from the cult of the artist achieved in conceptual art. But at the same time, Reas's fascination with handmadeness and organicism preserves a link to analog aesthetic principles. Finally, my conclusion shifts away from direct comparison between computationally and non-computationally digital art, and instead assays the discursive resonances between Jason Salavon's software-based computational "paintings" and the increasingly widespread use of information visualization as primary mode of mapping the vast amounts of data produced by the mechanisms of the "culture industry".

The works under consideration in my dissertation cohere around questions and problems related to painting. Part of the difficulty in defining "digital art" as a singular medium or genre is that the range of artifacts potentially contained under the rubric of digital art is massive and therefore resistant to canonization. A concentration on painting initially allowed me to refine my analytic method. However, the broader rationale behind this constraint grows out of the fact that the screen-based computational pictorialization analogizes painting. I contend that painting, despite, or perhaps due to its status as a two-dimensional mode of depiction, is deeply concerned with spatial and material architectonics. Painting is invested not only in the problem of how to graphically render volume and depth, but also the dynamic spatial relationship between bodies and concrete objects. Similarly, digital rendering must cope with the question of how to present the relationship between objects and spaces in two, three, or multiple dimensions. My goal is to discover whether the technical parameters of computation affect the way pictures are constructed, the kinds of subjects for which computers have the greatest representational facility, and by extension, the way digital pictures—the graphical index of digital technesis—will ultimately look.

Overall, my dissertation offers a methodology for speaking about and contextualizing digital practices within the history of art and visual culture. While programming literacy is important for many scholars, producers, and users of digital hardware and software, if artifacts made using computational technology remain inaccessible to all viewers except those with a background in programming or engineering, we are faced with an art practice that is technically dexterous but phenomenologically bankrupt. Unless the possibility of translation between two languages is realized, a communicative gap will continue to yawn between art history and "media studies," which makes more urgent than ever the need to grant digital artifacts

and processes the possibility of making a significant intervention into and contribution to the artistic canon.

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Introduction

The Digital: An Aesthetic Ontology

Picture a screen before you, roughly the size of a moviehouse projection. Then picture this screen divided into a 4x8 grid of perfectly regular squares, each pulsing with a pale monochromatic light. As you read the description of this work, you notice that it claims to present an encrypted version of the final scenes of Kubrick's *2001: A Space Odyssey* and Antonioni's *Zabriskie Point*. At this point, the installation begins to make sense, perhaps as cinema redux, or cinema remixed. As you gaze at the pared-down coloration of the grid structure before you, you may be reminded of the seriated photographs of Bernd and Hilla Becher or the houses on the Sunset Strip photographed by Ed Ruscha. Perhaps you even think of the rich tones of Jeff Wall's lightboxes. But, if you continue to wait for something like cinema to reveal itself to you, you soon realize that no image is about to shimmer into pictorial legibility. Instead, each square changes color with infinitesimal slowness and clings resolutely to purified abstraction of light and color; any pictorial content remains latent, hidden far below the human perceptual threshold. This is Angela Bulloch's *Horizontal Technicolor* (2002), not quite cinema, not quite sculpture, not quite sound installation, but possibly intelligible as something else altogether, as a playful union of high modernist abstraction and digital programming. Bulloch, a London and Berlin-based sculptor, installation and sound artist who has been counted among the Young British Artists, performs a "digital reduction" of selected scenes from Kubrick's and Antonioni's films and displays the results in a grid of colored "pixel boxes". These large "pixels" abrogate the possibility of image-resolution and force the viewer to reconsider the structural composition of the photographic pictorialization that usually accompanies the cinematic experience. These pixel boxes appear as luminous, individuated tiles, as screens that produce their own strange glow rather than as image-machines that reflect the familiar world back to the viewer. Here, the picture never supplants the technological apparatus, nor does it camouflage the grid of pixels, the very structure that engenders digital graphics at a cellular level.

Bulloch's work is best described as aesthetically digital; that is, it renders its visual data as a formal array of discrete elements that correlate to a definite informatic quantity. Because any kind of information, such as color, sound, words, or numbers, can be processed digitally once it is converted into machine-computable numeric data, the type of information conveyed may vary. But once the parameters of an element—its behavior within an overall system—are defined, it must reliably produce the same output with each iteration. Thus, if a pixel location is commanded to render a given numerical value corresponding to a particular shade of blue, the color will be the same each time it appears. Within a digital system, the range and complexity of the information that can be conveyed—the resolution, for example, or fineness of discrimination between color values—is dictated by systemic parameters. Binary systems process information through a series of commands that turn a simple switch to an "on" or "off" position, but increasing the number of possible switch positions dramatically increases the complexity of the tasks the computer is able to carry out.

More often than not, however, users/viewers attribute digital characteristics to digitally processed artifacts—video games, digital photographs, cinematic special effects—not due to observable traces of digital processing on their surface (which are

often registered instead as “glitches” in the system), but because their constitutive digitality is deduced associatively. If an image appears on a computer screen or monitor, I know, logically, that it is a digitally processed image. My awareness of technical parameters of digital computers tells me that the image that appears on it must be processed and rendered digitally, but I cannot necessarily discern evidence of digital processing embedded in the picture’s formal configuration. When the computational ability of computers-as-machines meets or exceeds the maximum fineness of resolution registered by the human sensorium, this associative logic replaces direct observation in the determination of digital ontology. But some digital artworks use the medium reflexively, to consider how both objects and knowledge are reconfigured within a digital epistemological framework. In this instance, the appearance of discrete units on the image surface is not attributable to technological failure, insufficiency, primitivism, or to a lack of technical dexterity on the part of the artist/programmer. An unfortunate peripheral effect of the expectation that technological development leads inexorably to seamless, transparent virtualization is the concomitant assumption that digital and analog modalities will converge and ultimately become indiscernible.¹ While this is certainly true in many cases, what I want to guard against is the blanket supposition that digital depiction always, or even in most cases tends toward immersive pictorial virtualization. Rather, I postulate that artworks, like Bulloch’s, that emphatically and obsessively explore the visible properties of digital discreteness are bound together in their profound investment in and investigation of the effects of the information revolution on patterns of seeing, thinking, and acting both individually and collectively. Bulloch formulates a visual (graphical) proposition in which the “digital” becomes a sensed and experiential, instead of a technological, category and identifies the perceptual properties of digitality as a valid analytic problem within contemporary epistemology that necessitates both perceptual and intellectual negotiation.

Horizontal Technicolor is a work of art made with a computer, but it is not simply its computational ontology—the invisible processing of binary code taking place prior to its graphical rendering—that lends it a digital aesthetic sensibility. In many examples of computationally generated works, such as the digitally manipulated photographs by Jeff Wall, their formal appearance is derived through the processing of binary digits but they do not bear the stamp of digital processing on the pictorial surface. In other words, while these depictions are technically digital, they adopt the look and feel of analog imaging; instead of foregrounding the piecemeal, additive processing of individuated pixels or even vector-based curves,² these depictions are computationally derived but bear the properties of analog pictures, such as continuity, density, repleteness, or what I will call irreducibility, ambiguity, and indeterminacy.³ I will explain these terms in further detail

¹ Transparency occurs when all signs of artifice and mediation “disappear” from a picture, leaving the viewer instead with an impression of a naturalistic, three-dimensional illusionism or “virtualization.” For more on transparency see Jay David Bolter and Diane Gromala, *Windows and Mirrors: Interaction Design, Digital Art, and the Myth of Transparency* (Cambridge: MIT Press, 2003).

² In vector graphics, the “digital depiction” becomes, in theory, infinitely expandable and compressible, because the appearance of a line is independent of the arrangement of pixels on a bitmap, instead derived from equations that are transposable to a screen of any size and/or resolution.

³ Nelson Goodman, *Languages of Art: An Approach to A Theory of Symbols* (Indianapolis: Hackett Publishing Co., 1976). See also Robert Pepperell, “Seeing Without Objects: Visual Indeterminacy and Art,”

in Chapter 1, but to illustrate the distinction I am drawing between digital and analog modalities more concretely, the following counterexample to *Horizontal Technicolor* exemplifies the ambiguity that lies at the center of analog aesthetics.

Edouard Manet's *Olympia* (1865) is an ubiquitous figure in university courses on the topic of modernity. As T.J. Clark has shown, paradigmatic work not only exhibits a complex and potentially irreducible series of meanings at a level of narrative and iconography—the symbolism of the black cat, the model's pose, a direct reference to Titian's *Venus of Urbino* (1538), the hovering presence of the African maidservant—but also reveals the way in which the appraisal, interpretation, and theorization of painting has thrived on, or even depended for sustained discourse upon, the indeterminacies, potential invisibilities, and discrepancies resulting from the application of colored pigment to canvas. The painting, first hung in the Paris *Salon* of 1865, immediately generated an aggressive critical response, in part due to what is taken to be latent aggression in the attitude of the painting, and its contents, towards the viewer. The overall *mien* of the reclining prostitute in the painting leads critics to read her posture, attitude, and her hygiene as base, vulgar, and even dirty.⁴ Overall, the instabilities of the painting, deriving at least in part from its painterly execution, define it in parallel to the poetry of Baudelaire, whose “meanings are so multiple and refractory, so unfixed, so unmanageable, in 1865.”⁵ But even more striking are the dramatic ramifications for the painting's formal, social and narrative “meaning” effected by a single feature that hovers just outside the range of visibility, at least for its viewers at the *Salon* of 1865. Signifiers of Olympia's distasteful brashness and unclean nudity were present in the grey of her skin, the impudent refusal implied by the clenched hand covering her pubic area, but also in her hair, which was to all appearances pulled back in a severe, “unfeminine” coif, made all the more ridiculous by the large flower pinned behind her ear. Caricatures of the painting conspicuously foregrounded this feature; in their satiric, performative reiteration of the painting, these drawings called attention to the sordid, off-kilter nature of the subject of the painting and of the visual encounter between viewer and object. However, as Clark reveals in the climactic moment of his essay, the subtlety of Manet's facture concealed for contemporary viewers, already unsure of how to classify the painting or its subject, a shock of loosened auburn hair, that, once revealed, “changes the whole disposition of head and shoulders...the head is softened, given a more familiar kind of sexuality.”⁶ It is this significance of detail, and of course its social reception, or lack thereof, that determines Olympia's placement as one of the great, discursively irreducible works of art of the 20th century. But this is also the kind of detail that must be coaxed into view, and it is precisely this coaxing that supports the idea that that the

Leonardo 39, no. 5 (2006): 394-400, and Timothy J. Clark, "Preliminaries to a Possible Treatment of 'Olympia' in 1865," *Screen* 21.1 (1980): 18-41. 39.5 (2006): 394-400.

⁴ Clark identifies in the writings on and caricatures of *Olympia* “the figures which indicate the ways in which the hand of Olympia—the one spread over her pubic hair—disobeys, crucially, the conventions of the nude. The hand is *shamelessly flexed*, it is *improper*, it is *in the form of a toad*, it is *dirty*, it is in a state of *contraction*. It comes to stand for the way Olympia's whole body is disobedient: the hand is the sign of the unyielding, the unrelaxed, the too-definite where indefiniteness is the rule...” Clark p. 25

⁵ Clark p. 29

⁶ Clark p. 36

density of facture and a subtle handling of materials demarcates analog modalities from discretized digital ones.

Whether precisely linear or carefully blended, the pictorial landscape of a painting will never possess the numerical exactness of a digitally constructed picture, in which each pixel is programmed to behave in a determinate way—with an exact color value or degree of illumination. There is of course a scientific mythology that develops from the fact that the digital-computational universe is, hypothetically, knowable in an absolute sense, where the “absolute” is co-extensive with knowledge of a quantized color value, location, or other species of data. A supporter of a computationalist model would suggest that “meaning” is more accessible when an object or situation is filtered or mediated computationally. It might be supposed that meaning is more available to analysis because the object is numericized, transformed into searchable, comparable, quantifiable data. Computationalism is rife with its own problems, first and foremost its tendency to collapse semantic content into statistically verifiable data. But the opposite position is also problematic insofar as it would insist that relatively “more” or “richer” layers of meaning result from a representational model that constitutively resists or refuses exactitude.

I am suggesting here that digital and analog modalities demonstrate their own particular semantic facilities; they tend to generate different types of meaning. But instead of valorizing one over the other, I contend that it is more useful to examine them in a dialectic exchange, in which the productive specificities and conditions of possibility, as well as the blind spots, in each model are clarified in their dialogic intersections and deviations.⁷ Moving back to *Olympia*, I do not want to suggest if the painting had been constructed digitally, the problem of the invisible hair would have been obviated. Rather, it is precisely these types of debates, whether in the tradition of Morellian connoisseurship, with the identification of the telltale signatory mark (the *Grundform*) made by every painter, or in the social history of art, as in the present example, that identify the aesthetic and intellectual interest of a painting precisely in the ambiguities and indeterminacies supported, or even, in the strongest case, necessitated by the properties of the medium.

Returning from the realm of oil on canvas to computational graphics, in contradistinction to *Horizontal Technicolor*, Andreas Gursky’s 1993 *Paris, Montparnasse* is a computationally assembled and retouched photograph that suppresses its constitutive digitality by rendering it imperceptible at the surface level of the picture. If there is a digital “look” to Gursky’s photographs either before or after 1992, when he began to use computers to manipulate his pictures, it is not because surfaces are discretized and fractured, revealing an infrastructure of digital components, but because his photographs throw into sharp focus the dizzying partitions of human-inhabited city- and landscapes. *Paris, Montparnasse*, one of his earliest deployments of computationally-aided montage, sutures two photographs of an apartment building in Paris and crops the ends of the building at the right and left edges of the picture so that

⁷ Paul Gordon has argued with respect to aesthetics in the literary and critical tradition that aesthetic discourse becomes distinct from other discursive models by virtue of its emphasis and performance of duality, or the “critical double.” Paul Gordon, *The Critical Double: Figurative Meaning in Aesthetic Discourse* (Tuscaloosa: University of Alabama Press, 1994).

the building seems to continue panoramically beyond the limits of the frame, leaving an impression of a flattened, potentially infinitely extended grid of colorful windows sectioned by regular concrete bands. The photograph gestures referentially in two directions, oscillating between a tip of the hat to Mondrian, the industrial/ modernist grids of Gursky's teachers Bernd and Hilla Becher, and the visibly bitmapped, pixelated landscapes of early computer graphics. Gursky makes nearly constant visual references in his photographic practice to his own historical situatedness within the digital age. His pictures contain ubiquitous reminders of the new cultural fascinations and pictorial conventions in the digital age, most evident in his attention to the replicability and multiplicity of digitally recorded data. Within the hyperbolically partitioned pictorial field of *Paris, Montparnasse*, people—sitting, standing, dancing—are visible through the windows, but they are subsumed by the overwhelming array of units, symbols *both* of the industrialized beehive of the modern lifeworld and the exponential replications of an informatic universe. Digital and modern worlds are thus seen in dialog, so that the digital presents an intensification and hyper-mediation, into the realm of “simulation,” of modern mechanical capabilities.

In a more dramatic instance of suppression of the digital, Jeff Wall's *Flooded Grave* (1998-2000) also mobilizes computational montage, but it erases the sublime multiplicity visualized by Gursky by concealing the units or digits that are the building blocks of its smooth, apparently continuous surface. As such, it completes a recursive loop back to traditional analog techniques of image-making through the processing of binary code. Wall's photographs, and many of Gursky's, revel in undecidability. They preserve the intense coloration, the highly-resolved crispness, the emptied-out or sparsely-populated visual landscapes of computationally generated environments, but they also play the capacities of computational photographic technology in a complex counterpoint against the endlessly replicated, often deeply artificial realities of industrialized, digitized spaces of capital in which flows and feedback loops between money, technology, and architecture collude in the fabrication of a vertiginous, intensified version of Jameson's postmodern pastiche, embodied by Los Angeles' Bonaventure hotel.⁸

These initial references ground my exploration of the intricacies of digitization by illustrating how the distinction between digitality and analogicity is easier to maintain in theory than in practical application. These categories have been debated most rigorously in the field of cybernetics and cognitive science, and perhaps most notably in Nelson Goodman's seminal text *Languages of Art*, but are infrequently addressed in relationship to specific works of art. While it might seem that the digitized quality of digital art can be taken at face value, it becomes difficult to take the term “digital” at face value if artworks do not present themselves *as* digital, or if these works do not possess a set of characteristics that reference the digital processes that construct an image, bit by bit. I contend that ultimately, “digitality” has no means to signify itself as such if the aesthetic properties of digitization remain untheorized. As a means of proposing a method for

⁸ For more on the extensions and distortions performed by digital spatial modeling and special effects, see Kristen Whissel, "Tales of Upward Mobility: The New Verticality and Digital Special Effects," *Film Quarterly* 59, no. 4 (2006): 23-34. For Jameson's account of the postmodern space of capital, see Frederic Jameson, *Postmodernism: Or, the Cultural Logic of Late Capitalism* (Durham: Duke University Press, 1991).

assessing these properties, I consider when, how, and why digital artifacts appear to be “digitized,” which is to say when they appear to be comprised of individuated units, pixels, or digits. Employing various theoretical rubrics and examples, I identify the surface qualities of digital works, and evaluate whether these qualities can be distinguished in any absolute way from analog traditions of depiction.

The complexities of this endeavor and the potential pitfalls of a programmatic assessment of digital artifacts come to light when we notice that even a very brief survey of the varieties of digitally-generated artifacts exposes a variety of trends in digital graphics.⁹ Some of these tend towards a seamless remediation of older technologies, such as photography and film, and work to preserve a sense of indexical correlation between picture and referent. Others exploit the capacity of digital graphics programs to build three dimensional worlds, but turn it towards the fabrication of fantastical, fairy-tale universes, essentially fusing the imaginative conventions of Disney and Warner Bros. cell animation with the reality effect of naturalistic digital modeling. Still others veer away from naturalism towards information displays that, in translating complex data sets and sequences into a visually legible graphical form (i.e. a data “map”) blend qualitative (aesthetic) and quantitative characteristics. And finally, a subset of artists working with computational technology mobilize the “glitch,” or faults in the system that register as a disruption or scrambling of the pictorial surface.

Not only is it in many cases increasingly difficult to recognize when an image is digital or analog, but it is also clear that being “digital” carries many potential meanings. The digitality of Pixar’s animated feature films (*Toy Story*, *Ratatouille*) does not map onto the scrambling of digital signals performed by glitch artists, such as the Barcelona-based duo Jodi. The theoretical parameters and evaluative methods applied to digital technology vary wildly, even amongst theorists who explicitly treat aesthetics as an analytic problem.¹⁰ My own approach is to determine how particular media—in this case, computer technology, including both processors and other hardware and the hugely varied array of software programs—not only determine the structural conditions of the depiction, but how the assemblage of marks, the method and process of inscription, affects the way in which the image signifies. In other words, I set out to characterize how the affordances and constraints of a given representational technique (such as one-point perspective) or technology (digital computers) tend to produce artifacts that are better at communicating one facet or horizon of “meaning” than another. To wit, the greatest communicative facility of sculptures might lie in their ability to speak to the relationship between objects in space. And, paintings might search for the best way to convey the essence of objects in the reduction from three to two dimensions. Computers, in contrast, are designed as engines of calculation—for the high-speed collection, collation, and

⁹ D.N. Rodowick has claimed that digital processes do not make images at all, in the sense of making a stable visual object that is “identical to itself.” Instead, digital graphics rendered on electronic displays have an elusive presence, and a notorious ephemerality. “Having disappeared into information, the image can be reborn or reconstituted only as an electronic signal.” D.N. Rodowick, *The Virtual Life of Film* (Cambridge: Harvard University Press, 2007), pp. 131, 134.

¹⁰ See, for example, Sean Cubitt, *Digital Aesthetics* (London: Sage Publishers, 1998). Anna Munster, *Materializing New Media: Embodiment in Information Aesthetics* (Hanover: University Press of New England, 2006). Johanna Drucker, *SpecLab: Digital Aesthetics and Projects in Speculative Computing* (Chicago: University of Chicago Press, 2009).

manipulation of data. This means that even in the stage of graphical rendering computers will be oriented towards the visual modeling of data patterns. My goal is to test the hypothesis that continuous, analog inscriptive modalities imbue depictions (whether pictorial or notational) with a different set of signifying characteristics than do discrete, digital methods of composition, which index a different set of ideological, epistemological, and representational norms.¹¹

Much of the best scholarship in media studies has offered cogent analyses of the political, social, and economic formations that emerge alongside digital technologies. These readings of “networked culture” focus on the systems of power/knowledge that arise from the Web 2.0 and a globalized world economy. Although this research proves invaluable to the understanding of a culture shaped by ubiquitous computing, a well-developed methodology for interpreting the role of digital technology in art practice must also situate digital artifacts in a specifically art-historical and theoretical context. When do digital artifacts overcome their dubious status as mere demonstrations of technical novelty and become artworks worthy of serious consideration? What is the importance of digital technology as an artistic medium, and how do affordances and constraints and technical parameters of digital processing influence the visible/sensorially appreciable configuration of computationally generated artifacts?

Despite its foundation in immaterial electronic pulses, digital technology produces material effects on culture and communication. The assessment of digital images is often based on their “reality quotient”—the degree to which they accurately reproduce the optical and haptic conditions of external world. The fascination in digital cultural studies with virtual reality, second life, and other such practices supports this view, and also leans dangerously towards the notion that progress in art is achieved by producing ever more sophisticated techniques for rendering illusions of spatial depth. This concentration on the immersive capacities of digital graphics runs the risk of assuming a teleological progression in art towards “accurate” spatialization and virtualization. But this is not a tenable model for art historical investigation, given that the evaluation of art objects based on culturally determined signifiers of naturalism excludes alternate visual models and historical traditions. It is therefore imperative to consider depictions that exhibit visible evidence of digital construction—digital aesthetic characteristics—independently of the virtualizing capability of computational technology. My dissertation examines a subset of digital image-making practices that suppress virtualization in order to examine the structural principles undergirding digital graphics. In parsing these often abstract, highly formalized pictorial strategies, I conclude that they convey a different aesthetic and architectonic sensibility than analog depictions.

¹¹ In a slightly different vein than Rodowick, Whitney Davis has also advanced a theory about how a series of marks comes to be recognized as a “picture” in his writings on Paleolithic art. Beginning with the question: “Many things resemble many other things without being images of them. How do we know how to distinguish an image from any chance resemblance?” Davis ultimately argues that images develop through strategies of context-driven and convention-dependent replication that perform the translation of physiological “seeing” into the cognitive symbolic register of “seeing-as”. However, Davis not only outlines a set of conditions an inscription must fulfill to become a picture, but also adapts Goodman’s analog-digital distinction to Paleolithic mark-making. This application of the analytic parameters of analog and digital becomes useful to my discussion of the deep history of digitality in Chapter 1. Whitney Davis, “Replication and Depiction in Paleolithic Art,” *Representations*, no. 19 (Summer 1987): 111-147, p. 117

If we assume the interdependence of concrete cultural artifacts and discursive epistemological structures, the omnipresence of digital images in both popular culture and high art would suggest a concomitant emergence of a digitally encoded representational modality and a generalized digital world view, both of which would be directly traceable to the advent of computational technology. However, even a cursory glance at the art historical register discloses evidence of discretized models of symbolic communication (including but not limited to pictorial representation) that pre-exist computational technology by decades or even centuries. These artifacts, without the use of computer, point to the ways in which the fabric of meaning is often patched together out of small, disjoint and highly articulated units. In addition, examples drawn from 19th and 20th century art offer an implicit critique of Romanticist (or vitalist) holism¹². Without the use of computers, these works show that the physical world is not a totalized, closed system. They set up a world picture that paves the way for computationalism, and they also trace a deep history of digital systems.

Theories of digitization and concrete instances of its appearance emerge from a wide array of disciplines, each of which construct their theoretical models in support of distinct teleological and ontological narratives. I will cover, in brief, several of these models, beginning with philosophical accounts of analogicity and digitality, followed by art historical and anthropological considerations of discretized artifacts and, of course, treatments of the digital within media studies. My plan is to proceed with my investigation of “digits” using, in addition to the disciplinary models above, a simple algorithmic schema according to which objects fall into property-driven sets. Computation and digitization occupy the highest tier of my hierarchical schema, and objects are categorized according to whether or not they can be identified as ontologically computational or digital. My definitions of computation and digitality operate independently of particular machines or technological formations. The digital is the fulcrum upon which my argument turns, and is not technologically determined. Granting that “computation” may also refer to a number of processes unbound to electronic digital computers, I am using it in contradistinction to the discrete, schematic facture I am associating with digital aesthetics. Because I argue that a digital constructive method, and by extension, a digital aesthetic, pre-exists, or is separable from, computational technology, I require the word “digital” to signify independently of its typical association with the technical specificities of computer hardware and software. While “digital” is for now a floating signifier which will acquire a broader semantic valence in the following chapters, I use the word computation—which of course possesses its own unique history and properties—as an abbreviation, or a metonymic stand-in, for electronic digital computing machines: what we recognize as contemporary computers.¹³

¹² For a thorough examination of strains of mysticism and transcendentalism that float through technoutopian narratives, see Richard Coyne’s study of technology and romanticism. “[F]or romantic narrative, which privileges the subjective, the one is presented as an issue of the unity, which is the unity of humankind with nature, beyond the individuation and classification considered necessary for objectivity. For romanticism, objectivity divides the world into many parts and is obsessed with individuation.” Richard Coyne, *Technoromanticism: Digital Narrative, Holism, and the Romance of the Real* (Cambridge: MIT Press, 1999), p. 90

¹³ Johanna Drucker provides a helpful series of distinctions between calculation, computation, digital processing, classification, and electronic communication. Most applicable here are calculation and

Over the course of five chapters, my argument moves between theoretical analysis and case studies of artworks produced both with and without the aid of computers. Chapter One outlines the theoretical models used to differentiate digital and analog properties, and illustrates how and why art historical discourse has accorded value to artworks based on analog principles, such as fineness of color, texture, and line. In Chapter 1, I argue that discrete, particulate digital artifacts are constructed according to different principles than those that apply to analog artifacts, which are relatively smooth and continuous with no absolute division between parts. My review of the formal characteristics of digital systems sets the stage for my argument that an observable model of digital facture—a digital method—preexists electronic, binary computers, and that this digital process produces a framework within which to articulate a digital aesthetic. Understanding this aesthetic is useful for theorizing the genealogy of contemporary computational graphics. Additionally, it provides for alternate theorizations of artifacts that have not traditionally found a secure place in the artistic canon, and it affords a new interpretive schema with which to examine artists and artworks whose position in the art historical world demands renegotiation. In my second chapter, I support my initial claims by evaluating the extent to which the work of several modernist painters, including Paul Cézanne, Georges Seurat, and Paul Klee, exhibits constitutive features of digital systems. I use my findings to argue that understanding these artists' roles as experimenters with a digital method adds a new dimension to the theoretical, aesthetic, and historical significance of their work.

The next two chapters provide comparisons between artists who apply a digital method independently of electronic computation and artists whose digital aesthetic is computationally driven. Chapter 3 attempts to recuperate the value and relevance of Op-Artist Victor Vasarely. Through an inspection of his writings and his algorithmic painting practices, I trace Vasarely's lifelong goal to develop a programmable visual language, and demonstrate how, without ever touching a computer, he was attempting in his practice to adopt a visual model of a digital system. In the second half of the chapter, I introduce the example of Marius Watz's computationally-generated homage to Vasarely's work in order to ascertain whether the use of a computer alters the visible qualities of Vasarely's plastic language. In Chapter 4, I examine Casey Reas's fraught and often contradictory response to the legacy of conceptual art in programming-based practices. Through a comparison between Reas and Sol LeWitt, I maintain that Reas occupies an oscillatory position with respect to the values traditionally attached to analog aesthetics, such as immediacy and uniqueness/irreproducibility. By mobilizing algorithmically encoded instructions to automate artistic production, Reas reinforces the turn away from the cult of the artist initiated by conceptual artists in the 1960s. But at the same time, Reas's fascination with "handmadeness" and organicism preserves a link to analog aesthetic principles. Finally, in Chapter 5 I conclude with an examination of the hybrid practices of Jason Salavon. In this chapter, I articulate explicitly the relationship between painting and digital media, an end towards which each of the preceding chapters progresses. Shifting away from direct comparison between computationally and non-

computation; while calculation entails the automated representation of numerical content, computation is more generalized in the sense that it can represent any type of information (not just numerical) as long as that information can be processed within the rules of formal logic. Drucker p. 23.

computationally digital art, the concluding chapter instead assays the discursive resonances between modernist painting, Salavon's software-based computational "paintings," and the increasingly widespread use of information visualization as primary mode of mapping the vast amounts of data produced by the mechanisms of the "culture industry."

While scholars and critics have approached the problem of digital aesthetics from a variety of vantage points,¹⁴ the artworks and texts under consideration in my dissertation cohere around questions and problems related to painting. Part of the difficulty in defining "digital art" as a singular medium or genre is that the range of artifacts potentially contained under the rubric of digital art is massive and therefore resistant to canonization. A concentration on painting initially allows me to refine my analytic method. However, the broader rationale behind this constraint grows out of the fact that the screen-based computational pictorialization analogizes painting. I contend that painting, despite, or perhaps due to its status as a two-dimensional mode of depiction, is deeply concerned with spatial and material architectonics. Painting is invested not only in the problem of how to graphically render volume and depth, but also the spatial dynamics between bodies and concrete objects. Similarly, digital rendering must cope with the question of how to depict objects and spaces in two, three, or multiple dimensions. My goal is to discover whether the technical parameters of computation affect the way pictures are constructed, the kinds of subjects for which computers have the greatest representational facility, and by extension, the way digital pictures—the graphical index of digital technesis—will ultimately look.

After outlining the terms and theoretical debates at hand in my particular formulation of the analytic parameters of digital construction and digital aesthetics in Chapter 1, subsequent chapters are oriented towards an appraisal of an array of objects whose technological underpinnings range from computational to handmade, and whose constructive logic ranges from digital to non-digital. However, each continuum is separate, so that computational does not necessarily correlate to digital, and vice versa. In other words, I examine objects that possess one quality or the other, computation or digitization, but that are not necessarily both computational and perceptibly "digital." My aim in proposing an interpretive methodology for and a language with which to

¹⁴ Beginning in the early 1990's, with the first theoretical forays into Cyberculture and Internet art, the most common tropes mobilized in the description of the "newness" of new/digital media focused on simulation. Simulation was associated with the virtualizing possibilities of computational media, so that the endgame of digital graphics seemed to be heading towards a perfected, fully immersive version of virtual reality. The emphasis on simulation also materialized in utopian dreams for artificial intelligence, and then artificial life, in which computers would not simply imitate intelligence, or biological behavior, but would perform the essence of each. Some accounts of digital aesthetics, such as Johanna Drucker's *SpecLab*, are focused on digital textuality, while others concentrate on time-based works (leading to a comparison, most prominently, with cinema), as is the case with Mark B.N. Hansen's *New Philosophy for New Media*. Others focus on distributed networks, in general, or the Internet, in particular, as in Julian Stallabrass's *Internet Art*, others on gaming, such as Alex Galloway's *Gaming: Essays on Algorithmic Culture*, and still others on the vast realm of popular culture, visible in Henry Jenkins' *Convergence Culture: Where Old Media and New Media Collide*. Mark B.N. Hansen, *New Philosophy for New Media* (Cambridge: MIT Press, 2004). Alex Galloway, *Gaming: Essays on Algorithmic Culture* (Minneapolis: University of Minnesota Press, 2006). Henry Jenkins, *Convergence Culture: Where Old Media and New Media Collide* (New York: New York University Press, 2008). Julian Stallabrass, *Internet Art: The Online Clash of Culture and Commerce* (London: Tate Publishing, 2003).

discuss digital objects by way of a digital aesthetics, then, is not merely to valorize the digital, but to discover the way the digital communicates, and by extension, the extent to which the range and type of meaning that digital artifacts communicate is determined, or at least inflected by, its affordances and constraints as a representational technology. The artifacts and artworks addressed in the following chapters fall within any of four categories: a) non-computational, non-digital: b) non-computational, digital: c) computational, non-digital, and: d) computational, digital. Examining artifacts that fall within each category, or exhibit characteristics of each will enable me to paint a clearer picture of exactly how these stakes change over time, and propose at least one solution for determining how images change with the advent of computational technology.

The broader stakes of this identification of systems and artifacts as analog or digital lie in discerning whether or not artifacts composed according to a digital method, logic, or aesthetic have been ignored, suppressed, misunderstood, or only partially understood because they fail to conform to the expectations, norms, and conventions for art objects that cohere within an analog-based framework of apprehension and interpretation. It matters whether an image is either digital or analog because, as I contend, digitally configured depictions have been cast into an interpretive limbo, where they can be interpreted neither as utilitarian objects, nor as art objects, nor even, in many cases, latter-day examples of anti-aesthetic conceptual art. Examining the archaeology of digital systems sheds light on the patterns, norms, and internal disruptions that occur within the parameters of digital architectonics, and paves the way for the genealogical account I present here.

To sum up, then, my dissertation works toward a definition of a "digital method" that can be articulated without reference to the technicalities of contemporary hardware and software. I allow, however, the possibility that this digital method can acquire new characteristics when it is performed by computational technology. I therefore treat the artworks covered in the following chapters as sensuous artifacts that are subject to change based on the constraints and affordances of the tools used in their making. But insofar as the word digital describes a series of technological operations, it often references the tool used to make the art but does not help a viewer/user relate to the art as a sensorially apprehensible artifact. Consequently, I gather together artworks that disclose visible evidence of their digital construction in order to identify the perceptible characteristics of digitally processed artifacts. I foreground not the hidden operations of computers—the intricacies of binary code and programming languages—but rather the surface qualities of digital graphics. While acknowledging that internal processes govern the aesthetic properties of these surfaces, I investigate the extent to which it is possible to encounter digitality at the level of the interface. Taking into account that the sensuous object will be informed by an underlying conceptual and technological framework or genotype, I set out to discover whether certain phenotypic aspects of digitality will be inherently accessible at a phenomenological level.

The examples under consideration in the following chapters all formulate a visual (graphical) proposition in which the "digital" becomes a sensed and experiential, instead of a technological category. Think of the patterns visible in knitting, for example, how the stitching might analogize a pixel, but in a "hand-made" instead of a highly technologized sense. In the field of media studies, theorists have often focused on the links between digital media and film, or on the sociological effects of the digital

production and distribution of information. However, fewer scholars have contextualized new media within art historical discourse. My specific contribution is to address how the digital makes itself available to sense perception, and whether a distinct digital aesthetic may inhere both in computationally generated graphics, as well as in pictorial and notational strategies that predate the invention of electronic computers. My argument for the digital has implications for the evaluative methods applied to both “new” and “old,” computational and non-computational media.

The series of examples that follow range from aesthetically digital artifacts made before the invention of electronic computational technology, to “smoothed,” non-digital works made using computers, to computational works that make visible the discrete, particulate and schematic nature of the computational processes that generate the graphical output. Often, they reveal an unstable discursive exchange between the aesthetic perception of the digital and the technological specificities of electronic computation. I am placing the digital in an expanded field, so that it is a mechanism, a process, and a constructive method that operates well beyond the boundaries of computational technology. Once digitality is disaggregated from contemporary electronic computers, it becomes a category that can be used to address works of art, techniques and technologies that may speak in a different language and thus require a different interpretive framework than pictures and artifacts configured through analog processes. In my research, the contemporary figure of the digital becomes an analytic tool with which to examine both contemporary and historical artifacts for qualities other than those that would be recognized within the norms attached to analog picture-making. Once these qualities are recognized, they can then be put into dialogic exchange with existing theories and methodologies.

What I call the digital, then, is a mode of visual understanding that has appeared at other times under other names. It speaks to the replicability of the pointillist dot, and to the simulated matrix of perspective. Here, the digital ceases to be a highly technical term relevant only in contemporary discourse, but becomes an art historical project about making connections. This is not to enforce congruence between all digital, proto-digital, and quasi-digital systems—I do not want to say that perspective, pointillism, Op Art, and contemporary computational artworks are reducible to historical, cultural, and formal equivalence. Instead, I want to bring out features of these works that interface with my notion of the digital in complex and potentially idiosyncratic ways. I seek to open digital representational technologies to renegotiation and renewed interpretation, and to create the possibility of a new conversation between contemporary art and that of both the recent and the deep past. My question of whether the “look and feel” of digital media is correlated to the appearance of individuated “digits” within pictorial structure is ultimately not merely a formal, but also a social, philosophical, and an art historical problem. My thesis thus seeks to discover how an evaluation of digital composition might add a new narrative layer to the long art-historical discussion about how and why pictures “mean,” and what they say about a given culture in a given historical moment.

Chapter 1: From Analog Pictures to Digital Notations

In attempting to survey the rocky terrain around the fault lines of the digital divide, it is difficult to negotiate the formations that are beginning to sediment around disciplinary centers. Thinking, and articulating, the nature of digitality seems to require polyglottal dexterity in negotiating the languages of philosophical thought experiments, mathematics-heavy engineering diagrams of complex circuitry, the procedural logic of programming languages, the slangs of gaming and ubiquitous computing, to name a few. That is to say, the most crucial aspects of what it means to be digital might vary according to the features that one particular scholar or researcher needs to emphasize in describing what digital media can do. Depending on whether we are interested in the aesthetic dimension of digital artifacts (the way digital artifacts look), their principles of operation (binary switches and circuits, for example), or the symbolic effects of digital technology on culture, the enumeration of primary features will vary. In 1987, media artist Frank Dietrich, for example, argued that computers are most valuable as “tools for thought experiments” in order to “venture beyond the surface criteria that seem to dominate much of contemporary discussion of computer art. The ‘look and feel’ of computer-generated imagery is less interesting to me than extrapolating from known basic digital-symbolic functions into the future potential of this new medium.”¹⁵

My own goal for this chapter is to discover whether the “look and feel” of digital media is dependent on the appearance of individuated units or “digits” within the formal structure of the artifact or image. I intend to ascertain first whether there exists a formally digital quality, visible on the surface rather than hidden from sensory perception in the black box of computational processes, that is unique to digital media. Second, I search the art historical record for the presence of digital or proto-digital artifacts prior to the inception of electronic digital computers. Within the overarching trajectory of the chapter, I examine the distinction between analog and digital systems as it has been theorized in philosophy, art history, information science, and anthropology to discover whether we can discern digital characteristics in non-computer generated artifacts, and conversely, whether computationally generated artifacts necessarily reveal their constitutive digitality. As a corollary, I determine whether the computational digit and the non-computational digit display different perceptual effects dependent on their computational or non-computational origin. I contend that identifying the visible (or otherwise sensorially apprehensible) characteristics of digitality, which pre-exists or exists independently of computational technology, will help to construe more accurately

¹⁵ Frank Dietrich, "The Computer: A Tool for Thought Experiments," *Leonardo* 20.4 (1987): 315-325, p. 317

Even if in 1987, the year this article was published in *Leonardo* (still among the most prominent journals cataloging the intersections of art, science and technology), “computer art” was still more often addressed through the lens of formalist art history, in recent years archaeologies of digital media have shown that the threshold between analog and digital media may prove to be indistinct at best. Examples of recent publications that adopt an archeological approach to “media” include Anne Friedberg, *The Virtual Window: From Alberti to Microsoft* (Cambridge: MIT Press, 2006). See also Siegfried Zielinski, *Deep Time of the Media: Toward an Archaeology of Hearing and Seeing by Technical Means* (Cambridge: MIT Press, 2006).

whether or not the digital is in fact a unique and constitutive aspect of the phenomenological (aesthetic, sensory) *experience* of contemporary computer graphics or “new media.”

Many of the categories of new media are easily explored in terms of their theoretical difference from analog media, an approach to new media that champions radical novelty or replaces criticism with the descriptions or explanations of the technical specificities of computational processes and processors. But this approach tends to ignore the fact that theoretical, and often even technical categories become complicated or even fractured when tested against sensory experience of concrete artifacts; in this case, a working comprehension of the operative principles of digital technology—the nitty-gritty of how the technology works—may deepen a viewer’s conceptual grasp of an artwork or artifact. However, I want to address the possible claims that a) the difference between analog and digital may have already become imperceptible and b) that if the work does not deliver any overt information about its status as analog or digital, the relevance of that distinction also disappears.¹⁶ While acknowledging that media practices and programs are every more vastly multiple, I want to consider whether, when faced with a pictorial schema that intuitively seems technological or artificial, the pictorial surface contains any particular elements that communicate its digital origins.

Media theorist Sean Cubitt has claimed that the *technical* distinction between digital and analog recording technologies becomes relatively minute when the rate at which data is digitally “sampled” and collated.¹⁷ To illustrate this more concretely, take for example digital and analog recordings of a symphony. While an analog recording is literally analogous (bears a direct relationship to) its referent, insofar as a phonographic recording device responds to physical vibrations in the air, a digital recording takes discrete “samples” of sound, between which there is a smaller or larger gap in which sound will resonate uncaptured. In early digital recordings, a slower sampling rate would mean larger gaps and would thus result in an inferior, artificially sutured sound quality in the recording. However, in principle, as the technology advances and sampling rates increase, the density of analog and digital recordings will become fully commensurate.¹⁸

But to rely too heavily on the decreasing technical gap between digital and analog leads, potentially, to a misprision of the broader cultural and epistemological effects of technology, and specifically, the ways that the technological imagination contributes to the formation of a particular world view, thought world, or lifeworld (depending on the preferred terminology), which necessarily tends to produce certain kinds of theoretical formations while passing over and/or suppressing others.¹⁹ In other words, even if the

¹⁶ Whitney Davis’s essay on this topic, “How to Make Analogies in a Digital Age,” poses these questions in order to address the hybridity found in many examples of contemporary art, in which the smoothness of the pictorial surface, which may or may not be combined with a visual emphasis on artificiality, renders the digital or analog ontology of the picture indiscernible. Whitney Davis, “How to Make Analogies in a Digital Age,” *October* 117 (2006): 71-98.

¹⁷ Sean Cubitt, “Analogous and Digital,” *Theory, Culture and Society* 23.2/3 (2006): 250-251.

¹⁸ Cubitt p. 250

¹⁹ This claim is clearly indebted both to Foucauldian epistemology and, most directly, to Thomas Kuhn’s theory of the changes in world view led by revolutions in scientific paradigms, in which, “led by a new paradigm, scientists adopt new instruments and look in new places. Even more important, during revolutions scientists see new and different things when looking with familiar instruments in places they have looked before.” Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of

technical specificities of digital technologies approach or surpass the fidelity of analog ones, and even if we live in an age of media convergence,²⁰ in which old and new media collide, presented through the same channels (over the Internet, for example), the distinction between analog and digital remains crucial for revealing the intricacies of pre-, post-, and proto-digital epistemology. The relationship between the two modalities may include both intersections and deviations; thus, I am not interested in claiming total continuity, nor complete rupture, but a theory of digitality and analogicity that attends to the dialogic, mutually informative relationship between them, which issues from their status as representational technologies, or at the very least architectonic strategies.

In ascertaining the extent to which a sensible quality of the digital is (or is not) co-extensive with a quality particular to computational media, I trace a history of representation that both permits historical specificity—the situatedness of a representational norm within an historical, cultural, and geographic nexus—but also constructs a view of the present, whose characteristics are notoriously difficult to qualify without the benefit of hindsight and the counterfactual ideal of critical distance. I do this both by finding past precedents, but more importantly, by evaluating which individual aspects of history become most prominent—most frequently cited, analyzed, and as such, become most visible as explanatory figures—in the contemporary imagination. To restate, insofar as it is concerned with explaining the present with reference to the past, the present work is modeled after a genealogical instead of an archaeological method. I am less interested in arguing that the past *determines* a present view than that certain features of the past become visible, or become available to direct analysis in a unique way within the conditions of knowledge and perception that emerge within a given epistemic or paradigmatic configuration. Making an argument that a digital method for the construction of visual representations (whether in service of pictorialization or other forms of depiction and notation) appears prior to computational technology requires a concomitant account of how a new language for the description and interpretation of non-computational digital aesthetics might change the “message” that these works deliver. And in addition, it necessitates a consideration of how computational digitization might communicate differently than proto-digitalizations, exemplified in the case of Seurat’s pointillist “dot.”

Within the humanities, which is to say outside of the technical fields of information theory and mathematics, the relationship between and identifying characteristics of analogicity and digitality have been most thoroughly covered in the analytic philosophical tradition. While I do not wish to contest the relevance or conceptual richness of this philosophical debate, I will cover only briefly the primary claims of the pertinent arguments. The *aporia* of these debates lies in their lack of application to specific test cases, such that analog and digital become conceptual game pieces greatly distanced from experience and sense perception. I aim to uncover how digitality reveals itself to sense perception—how objects offer up an experience of digitality and thus configure the digital as a perceptual phenomenon rather than conjuring

Chicago Press, 1962), p. 111. See also Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences* (New York: Vintage Books, 1994).

²⁰ Henry Jenkins, *Convergence Culture: Where Old Media and New Media Collide* (New York: New York University Press, 2008).

it as a purely theoretical notion or one type of technological system. Thus, I deploy the qualifying characteristics of analog and digital systems to explore how we *perceive* objects as analog or digital, and to ask whether maintaining this distinction is necessary to understand how we observe, interact with, and find pleasure or displeasure in our observations of digital, or digitally analogical art and artifacts.

I. Discursive Horizon(s) of Digits, Digitality, and Digitization

In the context of this analysis, then, digital aesthetics refers not simply to the look and shape of computer hardware or the products of electronic digital computation, such as the Internet, but rather to a much broader, non-technologically specific method of image and artifact construction that might be called “facture.”²¹ This section will cover some of the literature in philosophy and information science that attempts to construct a clear demarcation of the boundary between digital and analog. An important question to ask, however, is what the stakes are in mapping this territory. What do these scholars hope to gain by addressing this problem? What is the story they are trying to tell? Although the following discussions in this chapter will challenge the possibility of an easy distinction between analogicity and digitality, at first glance the difference between analog and digital remains quite intuitively straightforward; analog technologies (which can be electronic) process “signals or information represented by a continuously variable quantity, such as voltage, spatial position, etc, which in the case of measuring instruments can be displayed on a dial or other fixed scale,”²² while digital technologies operate “on data in the form of digits or similar discrete elements.”²³

As an illustration, take the example of “digitization,” a term that refers to the translation of analog media into digital form. In its technical application, then, digitization is a process by which a continuously variable analog signal, or stream of information, is converted into a string of discrete units, or bits, that can be processed individually or in multi-bit groups by a binary computer. When a scanner transfers a photograph of a painting from a book to your computer, for example, areas of the photograph are divided into units, such as pixels, and the information in that area is sampled and averaged. Low-resolution image files, like JPEGs, render highly pixilated results under certain conditions. In a low-resolution image file the color values of two adjacent pixels might differ dramatically, and the continuous, subtle gradations of hue and tone found in the analog photograph, or the painting of which an analog photograph is taken and subsequently digitized, give way to a jagged array of pixilated color. Moreover, blowing up the photograph to a larger size does not produce more pixels to fill the larger area. Instead, if the size of the image is increased by 300 percent, the pixels are

²¹ According to David Summers, “to consider an artifact in terms of its *facture* is to consider it as a record of its own having been made....[F]acture is *indexical* in semiotic terms, that is, it implies immediate relation to a prior cause, as a footprint implies the former immediate presence of a foot.” David Summers, *Real Spaces: World Art History and the Rise of Western Modernism* (London: Phaidon Press, 2003), p. 74.

²² “Analog, n.,” *Oxford English Dictionary Online*, 2 April 2010

http://dictionary.oed.com/cgi/entry/50007887?single=1&query_type=word&queryword=analog&first=1&max_to_show=10

²³ “Digital, n.,” *Oxford English Dictionary Online*, 2 April 2010

<http://dictionary.oed.com/entry/50063921?single=1&query_type=word&queryword=digital&first=1&max_to_show=10>.http://dictionary.oed.com/cgi/entry/50063921?single=1&query_type=word&queryword=digital&first=1&max_to_show=10.

scaled up proportionally, so you end up with a much larger pixel with the same amount and type of information (the color value of the pixel, in this case), as in the smaller, scaled down version of the image. Thus, the same lines of code processed by two different computers render two images that have the same informational content—the same amount of bits and bytes—but might appear very different (and appear at different speeds) due to the differing technical specifications of the two machines and the two interfaces.

Even viewed simply through the lens of technical practice, digitization provokes a host of questions and problems relating to analog-digital conversion. In audio conversion, the amplitudes of an analog waveform are sampled at discrete points. The computer-readable “data” are the numerical values derived from the sampling process. But when the basic structure of the signal itself is altered so drastically, can we still claim that the digital translation is the same creature we started with? Translation or conversion seems to transform the “essential” properties of the analog signal—the continuous waveform—into something more essentially digital—discrete numerical values. It might seem easy enough to argue, then, that the material disjuncture (where electronic materiality manifests as energized matter) between analog and digital signals nullifies any possibility of a successful, relatively lossless translation. Further, it would seem impossible that the material footprint (the index) of digitality or analogicity would not be left in the artifact itself.

But this is an argument that requires stubborn adherence to one polar extreme or the other of technological determinism; either digital technology will never become sophisticated enough to erase the perceptible differences between discrete, binary signal-processing, or the distinction between analog and digital will become irrelevant when technology overtakes the human-sensory capacity to distinguish analog continuousness from—albeit very finely and highly resolved—digital discreteness. Whitney Davis has argued that “there is often little practical difference between analog and digital modes of representation, despite the historical importance of the distinction. . . . If analog and digital cannot be perceptually or formally discriminated, they might have no informational or aesthetic status for observers.”²⁴ Lev Manovich has also questioned the viability of separating analog and digital representation based on discreteness or continuity; for Manovich, the most compelling case for the uniqueness of digital media is made from the standpoint that computational media are *numerical* first and foremost.²⁵ Analog media can be notionally distinguished from digital media insofar as analog representations contain an indefinite amount of information in contrast with the definite number of pixels in a digital image. For example, as an analog photograph is enlarged, the outlines and tones of the figures within become increasingly grainy or fuzzy.²⁶ However, continual enlargement does not eventually reveal a grid of pixels that comprise the image, as is the case when a pixel-based digital photograph is subject to the same enlargement.²⁷

²⁴ Davis p. 82.

²⁵ Lev Manovich, *The Language of New Media* (Cambridge: MIT Press, 2001), p. 52

²⁶ For more on pixels and noise in digital imaging, see William J. Mitchell, *The Reconfigured Eye: Visual Truth in the Post-Photographic Era* (Cambridge: MIT Press, 1992).

²⁷ Manovich reminds his readers that “even pixel-based representation, which appears to be the very essence of digital imaging, cannot be taken for granted”. Fixed-resolution image-editing programs convert pixels into a series of mathematical equations. By manipulating these equations, the user can effectively

Depending on the number of pixels comprising the whole image, a digital photograph may maintain an appearance of analog consistency and continuity up to a certain level of magnification. However, a 1000 by 1000 pixel image cannot create more pixels to make the jagged edges of magnified pixels less harsh. But in an analog photograph, even if the grain of the photograph becomes increasingly prominent, the photograph never yields a perfectly regular, gridded array of pixels. In a poetic account of the light, texture, and mood of digital versus analog photography, Bernard Stiegler evokes the indeterminacy of the analog grain. “Even if the grain can be massively enlarged or diminished, one doesn’t have differentiated access to the grains, one cannot separate *different types* of grains.”²⁸ The grain in analog photography is sensed qualitatively, as a textured fabric of some more or less distant past. Graininess in an unfocussed or greatly enlarged photograph indexes the slow dissolution of memory as sharp images and sense perceptions de-resolve into a fog of indistinct shapes and continuous tones. Whereas the particular way in which indistinct patterns and texture overtake precise, legible figures is unpredictable in analog photographs, the fragmentation of digital images into a planar geometry of pixels never bursts the rigid framework of the grid. Analog figuration seems thus to decay, to return, like flesh, to dust and ashes.

By contrast, if a digital photograph is created or stored as a low-resolution image, it may only require two or three successive enlargements for the image to fracture into a blocky checkerboard. Despite the fact that, as Manovich points out, even by the turn of the twenty-first century, many digital tools, in this instance scanners, were capable of producing images at resolutions high enough to allow great degrees of enlargement without blurring into a field of pixilated noise, the finite array of pixels in the former creates a threshold of resolution that, once crossed, causes the image to dissolve into illegibility.²⁹ While it is the pixel that enables the image to form at the outset, it is precisely the limitations of these infrastructural components—the definite quantity of information contained in the digital graphic as opposed to the indefinite amount contained in the analog photograph—that result in the very undoing of the picture, its transformation from an organized pattern back into an incommunicative mass of distinct but seemingly random, non-depictive digital pixels.

Ultimately, Davis’ claim that “analog and digital modes are now themselves wholly continuous”³⁰ is most applicable if we examine the digital as a *technological* category rather than an *aesthetic* category, one in which the digital is a particular configurative method that can be disaggregated from contemporary electronic computers. In this case, an artifact can have digital characteristics whether or not its underlying mechanisms are electronically computational, and an electronically computational picture

alter the resolution capabilities of the image, so that the threshold of visibility attains a new upper limit. Manovich p. 53.

Vector graphics offer another possibility for designing non-pixel-based images. I should point out at this juncture that although I have been referring to photographic technology, the same argument can be applied to drawing, painting, and even sculpture, all of which can be carried out through analog or digital means, for example using rapid prototyping in the case of sculpture.

²⁸ Bernard Stiegler, "The Discrete Image," Jacques Derrida and Bernard Stiegler, *Echographies of Television* (Malden: Blackwell, 2002), p. 154.

²⁹ Manovich p. 53.

³⁰ Davis p. 84

might not bear any aesthetic index of its digital composition. Thus, the “look and feel” of digital images is, for my purposes, not a function of an electronic-computational ontology. I contend that the expectation for digital artifacts should move beyond the question of whether they can achieve a perfect mimetic resemblance to analog representation. Instead, I want to put pressure on what forms of both sensory and intellectual knowledge and experience digital facture *can*, in a more positive sense, produce. The historical development—the pre-history to the inception of computational technology—of digital artifacts requires consideration in terms of both history of art and the history of depictive technologies that circulate outside of the realm of art, such as maps, diagrams, charts, and other graphic modes of information visualization. Given that digital graphics often operate themselves on the edge of art, it is essential to situate them in a broad context of visual culture, which considers the historical trajectory of imaging technologies whose dialog with high art is inextricable, but does not always correlate with it in a direct or obvious way.³¹

To remix the words of Martin Heidegger, the essence of the digital is “nothing technological.”³² Digital facture is observable within and across a range of representational technologies, both pictorial and notational, and is therefore not merely an *effect* of computational technology; it is “nothing of the order of a machine.”³³ Sensible digitality might appear to issue from the division of the picture plane into distinct units, such as dots, pixels, or other metric devices, such as the points on a graph or tick-marks on a clock face. But whereas division presupposes the primal existence of a unified whole which can be cut into smaller pieces, a truly digital universe relies on the principle that the world can be understood best as a quantized, metric system. This means that any section of the observable world can be computed and constructed from the ground up. Here, the whole is not merely subject to subtractive *division* into discrete parts; rather, the world is always already metric, always already composed of units that link together into an amalgamated individual object/form. If digitization were an epiphenomenon of a metricized conception of space, it would seem to be a theoretical more than a perceptual category. But what we want to begin to see, like the shape of sieve as it pushes up through sand, is not just the sieve as a shaping device, but rather the particular qualities and textures of the sand that are produced and made visible by the screen of the sieve.

³¹ Svetlana Alpers’s and Michael Baxandall’s research on the effects of non-art artifacts and practices provide seminal examples of an approach to art through visual culture. Alpers’s appraisal of the “mapping impulse” in 17th century Dutch art, and Baxandall’s study of the 15th century “period eye,” in which artists seduce their patrons’ eyes by engaging their ability to calculate volume, a skill necessary to merchants at that time for quickly and easily assessing the weight and value of goods, show how various models of visual computing factor into the aesthetic experience and interpretation of pictures. Svetlana Alpers, *The Art of Describing: Dutch Art in the Seventeenth Century* (Chicago: University of Chicago Press, 1984). Michael Baxandall, *Painting and Experience in Fifteenth-Century Italy: A Primer in the Social History of Pictorial Style* (Oxford: Oxford University Press, 1972).

³² Martin Heidegger, “The Question Concerning Technology,” in *The Question Concerning Technology and Other Essays*, trans. William Lovitt, 3-35 (New York: Harper Torchbooks, 1977), p. 23.

³³ Heidegger p. 23

II. Digital Analytics: Nelson Goodman's Language of Notation

Twenty years after the last of the Macy Conferences—the series of meetings that galvanized the interdisciplinary study of systems theory, cybernetics, and computationalism—was held in 1953, philosopher Nelson Goodman published a slim but dense volume entitled *Languages of Art*. In it, Goodman set out to identify the formal and logical structure of symbols and advances a conventionalist theory of how and to what end symbolic communication occurs. The ability of verbal, pictorial, and musical representational systems to successfully convey a particular meaning depends upon the transparent operation of cultural conventions that are maintained not through voluntary consensus but rather through consistent, iterative application of a set of terms to particular types of objects. Of primary importance in the analytic problem at hand—the distinction between analog and digital, and the relevance of this distinction to the evaluation and interpretation of artworks and non-art artifacts—is the fact that Goodman's argument aims to show, first, how pictures are differentiated from other types of descriptions, and from other types of symbolic communication such as diagrams and maps, which will be called “notations,” a distinction which requires explanation before I proceed further.

Goodman introduces several typological categories for the analysis of the symbolic structures not only of art, but of other symbolic modes of communication that operate outside the purely linguistic register, including maps, diagrams and measuring devices such as clocks. Several key terms in Goodman's system of dyadic relations prove useful in establishing the types of expression and figural communication facilitated by analog or digital expression. A significant proportion of *Languages of Art* is devoted to Goodman's theory of notation, developed to test the distinction between the symbol systems at work in the (nominal category) “art” apart from those at work in “notations”—symbol schemes in which an array of differentiated characters—the inscriptions defined as notes or letters—are arranged to stand for one particular correlating thing—the sound of the note or the letter denoted by its graphic symbol. Whereas in dense and replete pictorial schemes a mark or set of marks might have an infinite or indeterminable range of correlates, in a notational scheme one mark stands for one correlate in all, repeatable instances.³⁴

Representations utilized in information science are more often notational than depictive. If they do refer to analogical representational strategies, these analogical modulations would be, more often than not, ornamental rather than information bearing. Aesthetics, here, diverges from the Kantian principle that aesthetics are purposive without purpose, which is to say, in vastly simplified shorthand, that aesthetic experience is not teleological or utilitarian.³⁵ Unlike ethical forms of social organization, such as laws which are created with a specific outcome in the minds of lawmakers and thus exist as means to an end, the value of a work of art is ascertained independently of the viewers' desire for the content depicted in the picture plane to exist or their desire to possess the object itself or its symbolic content. For example, the aesthetic pleasure I feel when

³⁴ Nelson Goodman, *Languages of Art: An Approach to A Theory of Symbols* (Indianapolis: Hackett Publishing Co., 1976), p. 131.

³⁵ Emmanuel Kant, *Critique of Judgment*, trans. Werner S. Pluhar (Indianapolis: Hackett Publishing, 1987), p. 174.

viewing Cezanne's *Still Life with Compotier* (1879-1882) is independent of my desire to eat or possess the apples depicted therein. My pleasure in viewing David's *Oath of the Horatii* (1784) is independent of my political views. And my enjoyment of Vermeer's *View of Delft* (1659-60) should be the same regardless of my desire, or lack thereof, to move to the Netherlands.

Kant's schema has been criticized on the basis that aesthetic experience is always political, always tied to ethical principles and epistemological frameworks. Nevertheless, the tenacity of Kant's separation of art and everyday life is never more apparent than in the art-science wars. "Aesthetics" in science are oriented towards functionality. A "good" example of information visualization is one that communicates its data immediately and effortlessly. It uses what it calls "aesthetic principles"—although these undergo a major semiotic shift as they move from a Kantian to a systems-theory framework—such as color, line, and shape, to erase indicators of its own selective construction of meaning. If the markers of a picture's status as representation, such as framing, disappear, the information contained within can seem to communicate transparently, without the distortions and filtrations that inevitably result from any process of mediation.³⁶

While the conventions of depiction valorize its constitutive ambiguity and indeterminacy, notational schemes support the fantasy of flawless, transparent information transmission. As analog continuity obviates pinpoint precision, notational schemas are built on the dream of it. In her critique of the implicitly Neo-Kantian (anti-functional) tendency to dismiss the aesthetic value of notational, point-based representational practices, Maureen Turim offers a compelling description of what we would usually think of as "analogical" inscription. "We usually think of [the] artisanal process not as a setting of points, but as a continuum. I draw a line, descriptive, expressive, gestural, fluid. If I am drawing from nature, then the line may be somewhat analogous to the referent."³⁷ In contrast, Nelson Goodman claims that "plainly, a digital system has nothing special to do with digits, or an analog system with analogy," and develops his terminology along different lines, on the basis of syntactic and semantic density versus disjunctness, repleteness versus attenuation, and so on, as elucidated in earlier sections of *Languages of Art*. Especially given Goodman's focus on disjunctness and differentiation, it is not in fact obvious that digital systems have nothing to do with digits or analog systems with analogy. It is quite common for analog systems to be

³⁶ In a recent book investigating the "myth of transparency" nearly endemic to interface design, Jay David Bolter and Diane Gromala draw on the legend of Zeuxis, whose flawless painterly technique caused birds to try in vain to pluck grapes from the bunches painted in his murals. Bolter and Gromala use this myth to demonstrate the ways in which interface designers attempt to naturalize their work, to make the surface, the appearance of constructedness and mediation, disappear. "Before there were computers," the myth goes, "people saw things as they really were: there were no pixels, no aliasing, and no need for Web-safe colors. Objects were present to people; the rays of light reflected by objects entered their eyes undistorted by any intervening medium (other than the air itself). Today, a good computer interface gets the user as close to that original experience as possible." According to Bolter and Gromala, this uncritical validation of transparency becomes subject to play and critique in digital art. Jay David Bolter and Diane Gromala, *Windows and Mirrors: Interaction Design, Digital Art, and the Myth of Transparency* (Cambridge: MIT Press, 2003), p. 49

³⁷ Maureen Turim, "Artisanal Prefigurations of the Digital: Animating Realities, Collage Effects, and Theories of Image Manipulation," *Wide Angle* (Ohio University School of Film) 21, no. 1 (January 1999): 48-62, p. 49

identified as such because they demonstrate a direct relationship to what is being measured, or because physical magnitudes produce changes in the system that can be approximated numerically, as in the case of analog computers that operate on resistors, which open or shut according to the amount of electricity coursing through them.

The relationship between digital and notational representation is only cursorily addressed in the section of Goodman's text devoted to analog and digital schemes and systems. The digital is ranked as a subcategory within Goodman's general theory of notation. As is the case for all notational schemes, digital systems are required to be discontinuous, but also syntactically and semantically differentiated, disjoint, and unambiguous, such that each character complies with a distinct correlate, and can be used interchangeably in all situations and are always "true copies of each other."³⁸ If all digital systems are notational, and must conform to an even more stringent set of rules to fulfill the categorical requirements of digitality, we must assume that every digital system, and probably also every product of a digital system, is incontrovertibly unambiguous both in its formal construction and its denotative range. But this claim underscores one of the primary complications in evaluating digital artifacts under the same criteria applied to pictorial schemes. Namely, artistic/aesthetic value traditionally increases proportionally to the interpretive ambiguity, the irreducibility of meaning to one determinate thread that is a product of the formal ambiguity of pictorial schemes. In addition to the formal density and repleteness of pictorialization, it has been generally assumed that meaning in a good artwork is not easily reducible to a set of clearly articulated propositions. Stated in terms of Kantian aesthetics, the pleasure we derive from the contemplation of aesthetic objects is in the free play of the imagination. Free play is non-propositional, non-teleological, and anti-reductive. Disambiguity and precision, which occur both hermeneutically and at a formal, configurative level in terms of syntactic and semantic differentiation, appear from the outset to exclude digital systems from a canonized view of aesthetics that embraces ambiguity, indeterminacy, and open-endedness.

Goodman's demarcation of notation and depiction and digital and analog allocates a set of terms that illustrate how the symbolic mechanisms of digital systems produce aesthetic criteria that operate independently of those typically used to evaluate analog representation. Because, for Goodman, what "counts as" representation has little to do with the internal content of an image, but is rather a matter of how representation is encoded conventionally, by reiteration and comparison between internal iconographic similarities.³⁹ Although Goodman's text contains analyses of notational features of dance, literary arts, music, and painting, digital systems are exemplified chiefly by scientific instruments of measure. For Goodman, the differences between digital and analog are primarily operational—he treats digital systems as functional but not as incorporated into codes of artistic representation. Although he takes great pains to define the parameters of disjointness and differentiation at both a syntactic and semantic level, he includes little discussion of how digital images and artifacts would manifest their constitutive difference at the level of the interface or image surface. While his

³⁸ Goodman p. 134

³⁹ "Nothing is intrinsically a representation; status as representation is relative to symbol system. A picture in one system may be a description in another; and whether a denoting symbol is representational depends not upon whether it resembles what it denotes but upon its own relationships to other symbols in a given system." Goodman p. 226.

conventionalist viewpoint explicitly provides for the expansion of artistic codes, in the context of *Languages of Art* he regards digital systems as notational, and thus resistant to codes of depiction and representation that have traditionally relied on the presence of density and ambiguity in the mode of inscription. The central point I want to make with this brief exegesis is that digital pictures—those that are fabricated according to a digital method—hover in between Goodman’s categories, and as such become an unstable, oscillatory representational type *because* they enfold what are for Goodman two different symbol schemes—dense, replete pictorialization vs. disjoint, articulate (digital) notations—into a single instance of depiction.

Goodman’s theory of pictures as independent from other descriptions depends on their correspondence to analog schemes, in which the inscription is both syntactically and semantically dense. Pictures are also dissociated from maps and diagrams because they are “replete”; or, in other words, are capable of communicating an indefinite amount of meaning because every perceived modulation of the inscription potentially yields a new layer of signification.⁴⁰ In replete schemes, every observable property of the picture, whether formal or material—such as thickness of line, color, and texture—is relevant and conceivably multiply relevant. And, moreover, it is difficult to pinpoint, in a pictorial scheme as opposed to a digital or notational one, what *exactly* is being “represented” or denoted—to determine to what in the object-world the inscription correlates—because there is a potentially interminable number of overlapping possibilities—a horse, the horse rearing, the sun reflecting of the horse’s flank as it rears, and so forth. Syntactic density obtains when the mark is unarticulated, or non-differentiable into constitutive elements whose boundaries can be precisely demarcated. According to Goodman, “a scheme is syntactically dense if it provides for infinitely many characters so ordered that between each two there is a third.”⁴¹ For example, a continuous line made by ink on paper cannot be broken into grammatical parts or discrete units, as a sentence can be parsed into words and then into letters. Until one arrives at the subatomic composition of ink and paper, there is no limit to the fineness of modulation within the line. Syntactic density, then, is the “fundamental technical-logical feature of analog representation.”⁴²

Semantic density occurs when there is overlapping or ambiguity with respect to the correlation between symbol and referent; for example, if are presented with a collection of objects and asked to assign fractional values to describe the weight of each, there is an unlimited degree of fineness with which each weight could be discriminated, because no lower limit has been set to determine “significant difference.” As such, the fractional assignation of weights, while numerical, is not digital (nor notational), and is semantically dense. A system can be neither notational, nor, as a notational subset,

⁴⁰ Goodman defines repleteness in opposition to attenuation. Repleteness signifies which features are salient in a given symbol scheme. Here, he deploys his now-classic distinction between the electrocardiogram and a painting of a mountain by Hokusai. In the former, only the ordinates and abscissas through which the lines passes are significant, and the thickness or thinness, color, or other visible features of the symbol scheme infect the information given. In the latter, on the other hand, any fluctuation in the line, any detail down to the darkness of the ink or texture of the paper is potentially significant. Thus, while the two cases are morphologically similar, their capacity for meaning and the kind of information they convey is radically different. The aesthetic manifestation of this difference obtains in that the diagrammatic symbol scheme is attenuated while the pictorial scheme is replete. Goodman p. 229.

⁴¹ Goodman p. 136

⁴² Davis p. 76

digital, if a referent can be named by multiple characters, or if a single character can apply to multiple referents.⁴³

Philosopher David Lewis offers the following summation of Goodman's differentiation between analog and digital inscription (and by extension, representation):

Digital representation is differentiated. Given a number-representing "mark"—an inscription, vocal utterance, pointer position, electrical impulse, or whatever—it is theoretically possible, despite our inability to make infinitely precise measurements, to determine exactly which other marks are copies of the given mark and to determine exactly which number (or numbers) the given mark and its copies represent. Analog representation, on the other hand, fails to be differentiated because it is dense.⁴⁴

As opposed to the density and repleteness that have become the standards by which analog depictions are evaluated, notational schemes can only be classified as such if there is no ambiguity either at the level of inscription or reference. That is to say, only one, distinct mark can correlate to a particular referent; by extension, one mark cannot stand for two referents nor can there be two different marks referring to a single referent.

Given that the features associated with pictorial depiction have been more prominently allied with the fine arts, it is curious that Goodman marshals notation, and by extension, digitality in a book that attempts to systematize and catalog the symbolic structures that make meaning in art. Overall, the technical specificities of these terms is ultimately less important than the initial claim, that *pictures are distinguished from other symbolic kinds by virtue of their analogicity*—their density, repleteness, and so forth. Maps and diagrams are quasi-pictorial, but do not fulfill the parameters for pictures insofar as they are notational rather than pictorial. The problem that arises here, then, is what to do when an artifact that we would normally classify as a picture conforms more strongly to a digital schema, either perceptually, where digital characters are visible on its surface, or technically, as in the case of a digital photograph that appears to be analog but is constructed by digital-notational means. According to Goodman's typology, and his argument for the incommensurability between pictorial (analog) and other (notational) symbol systems, a digital picture would contain essential ontological contradictions that would frustrate any attempt to interpret them using the evaluative criteria assigned to (fundamentally analog) pictures.

In appropriating Goodman's text towards a reading of digital art and artifacts, it is important to assess not only what analog and digital mean for Goodman, but what functions each category express, and how these functions become perceptible in the structure of artifacts. In a helpful contextualization and exposition of Goodman's project, Whitney Davis argues that while many scholars of information theory and computation had encountered obstacles in the attempt to define the supposedly "primal categories" of analog and digital systems, Goodman's application of terminology allows an "independent and precise characterization of analog and digital modes of representation."⁴⁵ Even these primal and purportedly oppositional terms are subject to etiolation. Despite Goodman's claim the "the difference between analog and digital

⁴³ Goodman p. 153

⁴⁴ David Lewis, "Analog and Digital," *Noûs* 5, no. 3 (September 1971): 321-327, p. 321

⁴⁵ Davis p. 72

machines or systems is easier to illustrate than to define,” both digital and analog artifacts often reveal elements of both categories deeply embedded within their basic structure.⁴⁶ It is finally quite tempting to conclude that the categories slip all too often from their oppositional seats into “analogical” indiscernability. Indeed, Davis claims that “one of Goodman’s most radical conclusions about analog and digital was simple: ‘many [symbol] systems are of neither type,’ including natural language. But this insight has been almost entirely forgotten in current discussions of media.”⁴⁷ My own hypothesis is that popular terms such as convergence, hybridity, transvergence, are, in fact, attempts to account for media artifacts that demonstrate characteristics of both analog and digital or “neither” analog nor digital, though what this last category would look like remains to be seen. Subsequent chapters are devoted to testing Goodman’s terms against a selection of media artifacts, in order to determine whether his classificatory approach accounts sufficiently for traits found within these objects themselves, or where nuances within the objects problematize, or require an expansion of, Goodman’s appraisal of the ontological and aesthetic character of digital and analog schemes.

One issue in particular with respect to analogicity, digitality, and notation is the idea, raised as an objection to Goodman’s enigmatic claim that “almost any picture may represent almost anything,”⁴⁸ that pictures, even if not overtly representational, are “object-presenting experiences.”⁴⁹ To gloss this statement, first, Goodman avows the denotative or referential function of pictures but declares resemblance inconsequential. What is denoted in a picture is determined by a conventionally determined “system of representation” or “plan of correlation under which the picture represents the object.”⁵⁰ Goodman’s effort to specify the difference between denotation and resemblance can be interpreted as a gesture of resistance to universalism; thus, while he concurs that pictures must refer to some thing, he refuses to assign a universally applicable trajectory—a logic of transformation—by which an object in the world is rendered pictorially in such a way that all or most viewers would concur that the depiction “looks like” or resembles a particular object by indirect (reflexive, automatic) consensus. Dominic Lopes has written that pictorialization, both within and outside of familiar systems of depiction (in which a viewer’s adjustment to and operation within a conventional schema ensures communicative efficacy) generates “object-presenting experiences.”⁵¹ This is less metaphysical than Heidegger’s notion of the world-disclosive power of art; pictures provoke a consideration the object world. They confront us with their object-ness and encourage us to think about both how and why they are configured in the way they are and how and why we represent them (pictorially or cognitively) back to ourselves in a particular way.

Looking forward to subsequent chapters, it is simple enough to say what is being represented, and not just due to resemblance, in the case of many of the proto-digital examples, such as Georges Seurat’s pointillist and Paul Klee’s divisionist paintings. But

⁴⁶ Goodman p.160

⁴⁷ Davis p. 73

⁴⁸ Goodman p. 38

⁴⁹ Dominic M. McIver Lopes, "From *Languages of Art* to Art in Mind," *The Journal of Aesthetics and Art Criticism* 58, no. 3 (Summer 2000): 227-231, p. 228

⁵⁰ Goodman p. 38

⁵¹ Lopes p. 229

when we move into the realm of digital-computational works, the class of objects to which the depiction refers is radically expanded, requiring a new correlative system for a viewer to recognize and sort the depiction into a range of objects potentially (re)presented by the visual schema at hand. For instance, the abstract permutations given by Victor Vasarely's experiments with a visual, plastic alphabet yield an abstract field of individuated elements (circles, ellipses) arranged in a multiple, combinatory array of possible patterns of color and shape, given by a pre-determined system and the morphogenetic properties of a single shape-element. In keeping with their status as pictorializations using an imagined visual grammar, Vasarely's paintings bear a greater morphological similarity to typographic charts, such as that of Adobe's master font, in which visual permutations of each letter, such as elongation (stretching) and line thickness are arranged in gridded rows and columns.⁵²

If Vasarely is exploring the combinatory logic of a computable visual language, he is still operating to a certain extent within the parameters of 20th century abstraction. A more pronounced shift occurs in Mark Hansen and Ben Rubin's *Listening Post*. This work prompts questions not only about what object is denoted by the piece, but also to what extent it reflects a change in possibility conditions for depiction—the range of objects that can be both presented and recognized by a given community of viewers. A large-scale installation that sorts, by statistical means, conversational patterns in Internet chat-rooms, *Listening Post* translates data into a multimedia installation that is accessed and experienced through multiple—visual, aural, spatial—perceptual and phenomenological channels. By statistically analyzing the collected data, sonifying it, and choreographing “scenes” in which particular word and sentence combinations, narrated by a generic electronic voice-over, will scroll with distinct cadences across more than 200 small LED screens, the software running the installation infuses it with the character of a technological polyphonic composition. But the piece is not simply a meditation on technology itself, but is instead pre-eminently about the relationship between human emotion, human communication, and the technological platforms that provide the framework for mediated intersubjective exchange. The piece gives a new significance to ephemeral, seemingly spontaneous expressive gestures typed in at least semi-isolation. It unearths the pathos of electronic telecommunication, creating from a digitized infoscape an emotionally charged experience of the human longing for relationality, but also underscoring the concomitant alienation that is so famously a product of modernity, and is arguably even more prominent in the digital age, in which constant electronic exchange is the norm.⁵³ Paradoxically, the expressionless electronic

⁵² The history and aesthetics of letters, alphabets, and typography present another theoretical model, and another, parallel historical trajectory within which to consider digital media. See, for example, Johanna Drucker's sweeping account of the design of alphabets and letters from the classical age to the 20th century. A reproduction of Adobe's master font for the letter “O” and other electronically manipulated letter-forms is given in her chapter on the 20th century typographic imagination. Johanna Drucker, *The Alphabetic Labyrinth: The Letters in History and Imagination* (London: Thames and Hudson, 1995), p. 284.

⁵³ I say this in full awareness that the fashion in the second half of the first decade of the 21st century has been to champion the community-building function of telecommunication and social networking. This trend has partly developed in as a rejoinder to early theories of Cyberculture, which proclaimed the end of “meatspace” (William Gibson) and the disembodied effects of online exchange. Currently, the more popular aspect of computing technology to highlight is its effects in real space, so that there is no longer an insurmountable divide between online and embodied communities. My own contention is that there is still

(male) voice “reading” the scrolling words and sentences imbues them with a sense of loneliness, of a desperate need for recognition, empathy, and dialogic exchange.

At the same time, however, *Listening Post* subverts the fantasy that thought, expression, and dialog produce an infinitely fine-grained world of expression from a limited range of symbols (letters, words). The software that mines text fragments from thousands of chat rooms, bulletin boards, and public forums does not present its data unfiltered on the suspended grid of screens. For disorganized data to become legible “information,” it must be filtered, mined for regularities, repetitions, or other patterns. Information sorting, as well as information sonification or visualization is inherently oriented towards similitude. Human conversations operate similarly; dialog is only possible if speakers stay on topic, finding points of intersection and departure that develop from a common idea. However, part of the effectiveness of *Listening Post* derives from its overt digitization of human expression. The aesthetic of the piece is pronouncedly digital, from the suspended grid of screens, to the discretized typographic style, in which letters are formed by illumination of individual bulbs, to the symphonic arrangement of text fragments whose surprising poetic impact may be due in part to the copresence of subjectivity (the initial act of writing) and automaticity (their statistical sorting and organization by the software program).

But there are also examples of analog systems that use digits; they are thus discretized and differentiated, but, similarly to the case in which fractional numbers are assigned to describe the weight of a set of objects, they employ analog representation. Electrical analog computers, for instance, receive input through resistors. The input is numerical, but the “representation of numbers by electrical resistances is analog representation.”⁵⁴ Another example is spring-loaded valves that mete fluid. Analog computation is possible using this method based on amounts of fluid passing between valves proportional to an amount of time. The fluid could also be comprised of pellets, which adds a degree of syntactic differentiation but the device still operates analogically. In all but the most technical definition, which might be assessed philosophically and is of course indispensable in practical application (engineering and construction), David Lewis says the use of physical magnitudes to identify analog properties partly misses the mark. Although technically digital systems also represent physical magnitudes, where “we may regard a physical magnitude as a function which assigns numbers to physical systems at all times,” the relationship between the physical magnitude in analog systems is more direct than that of digital ones, as in the case of resistors (analog) versus scanning/sampling (digital).⁵⁵

Thus, while the complex disjunctures and affinities between digital and analog systems remain important to address, not least because they in turn reveal sites of tension in digital, analog, and hybrid artifacts, it is also crucial to regard these artifacts through a macroscopic lens, to see how these distinctions manifest not only mathematically (Lewis) or within hidden computational operations (the hermetically sealed “black box”

a sense of loneliness or pathos underlying “virtual” communication, and that it is precisely this facet of that experience that is activated by *Listening Post*. For more on Cyberculture and meatspace, see William Gibson, *Neuromancer* (New York: Ace Books, 1984).

⁵⁴ Lewis p. 322

⁵⁵ Lewis p. 323

accessible only to a technocratic literati), but also the level of interface, which is the “aesthetic surface” of computational processes.⁵⁶

III. Cybernetics and the Macy Conferences

Although heated debates pertaining to the definitional boundary lines of digital and analog arose in the Macy Conferences, held from 1946 to 1953, documentation of these discussions has focused more prominently on the signals, noise, and feedback loops of cybernetics than on the relationship between digital and analog information processing. Participants in these meetings congregated from a range of disciplines, including electronics, psychology, and anthropology with the common goal of outlining the primary principles of a new, almost universally applicable epistemological model called cybernetics. This term has of course become emblematic of the age of information systems and personal computing, and has circulated widely in the history and theory of digital media. Notably, Katherine Hayles’s book *How We Became Posthuman* was one of the first attempts by a humanities scholar to situate these debates in a detailed map of a cultural landscape and a set of epistemological conditions which give rise to a computationalist theory of mind, behavior, interaction, and representation.⁵⁷ Hayles’s text quickly achieved recognition as the authoritative project on the legacy of cybernetics in the age of personal computing. However, for all the documentation and critique of cybernetics, in Hayles’s book and elsewhere, very little writing has been devoted to the vehement disputes that circulated around the problem of analog and digital. Not only did disagreements about the nature of digital and analog systems dominate conversations between such central players as John von Neumann, Warren McCulloch, Norbert Weiner and Claude Shannon, the implications of defining the parameters of these systems were significant and potentially threatening to the integrity of the very notion of cybernetics.

At the first conference, held in New York City in 1946, John von Neumann delivered the first talk concerning the problem of analog and digital.⁵⁸ In it, he argued that all “computing automata,” defined simply as an automatically and independently functioning machine used for the purpose of fast computing, are divisible into two classes—that of analogy and that of digital machines—and that these classes of machines can also be transposed onto living organisms. These classifications thus function as powerful and consequential analytic tools, which, in conjunction with technological experimentation, aid in the scientific exploration of living systems.⁵⁹ But Von Neumann’s emphasis on the *efficiency* of digital machines in computing, in expanding the range of

⁵⁶ “The interface is the basic aesthetic form of digital art. Just as literature has predominantly taken place in and around books, and painting has explored the canvas, the interface is now a central aesthetic form conveying digital information of all kinds.” Soren Pøld, “Interface Realisms: The Interface as Aesthetic Form,” *Postmodern Culture* 15, no. 2 (2005), np.

⁵⁷ Katherine N. Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago: University of Chicago Press, 1999).

⁵⁸ The documentation of these first three conferences, compiled by Warren McCulloch, is held in a private collection. I am using an account given by Claus Pias, a historian of cybernetics and technology, as my primary reference here. Claus Pias, “Analog, Digital and the Cybernetic Illusion,” *Kybernetes* 34, no. 3/4 (2005): 543-550.

⁵⁹ John von Neumann, *General and Logical Theory of Automata*, Vol. V, in *Collected Works, Volume V: Design of Computers, Theory of Automata and Numerical Analysis*, ed. A.H. Taub, 288-328 (New York, NY: Pergamon Press, 1963).

computable numbers, and in problem-solving betrays a stronger interest in building computers for warfare and military strategy than in the intellectual development of cybernetics per se.⁶⁰ According to Von Neumann, analog and digital machines are differentiated chiefly by signal-to-noise ratios. Because analogy machines are based on the numerical representation of *physical* quantities, such as an electrical current, they are necessarily subject to incursions of random noise into the “signal” that expresses the operation of the machine in a non-random, significant pattern. Random noise results unavoidably from the “uncontrollable fluctuations” that are part of any physical system. Whereas a digital system works *solely* by “representing numbers as aggregates of digits,” where digits are all-or-none switches that are either on or off, without any intermediate state between them, “no analogy machine exists which will really form the product of two numbers. What it will form is this product, plus a small but unknown quantity which represents the random noise of the mechanism and the physical processes involved.”⁶¹ The advantage of digital systems, then, is that each computed result carries a maximum accuracy with a minimum amount of noise.⁶²

However, what quickly became evident in the discussions of analog and digital in the first Macy conference was that under close inspection the two systems tend to overlap, so that an absolute distinction between them becomes untenable. Norbert Wiener’s claim that “every digital device is really an analogical device” would seem to contradict von Neumann’s portioning of digital and analog systems based on signal-to-noise ratios.⁶³ However, a further look at von Neumann’s “Theory of Automata” indicates that von Neumann himself accepted a certain degree of ambiguity and crossover between the two systemic types. Specifically, for Von Neumann the nervous system cannot be considered either digital or analogical—both systems are present in physiological function. “The nerve impulse seems in the main to be an all or none affair, comparable to a binary digit. Thus a digital element is evidently present, but it is equally evident that this is not the entire story.”⁶⁴ Functions dependent on chemical composition, such as the blood stream, von Neumann calls humoral. Humoral processes are analogical. But generally, “feedback chains” in the body are mixed. If living organisms are part digital and part analogical, and these parts are often interdependent and thus neither fully one nor the other, the same can be said of many computers. Similarly, Wiener also argues that systems may have digital or analog aspects that overlap or even transform from one type to the other. In a contemporary instance of this analog-digital symbiosis, Timothy Binkley has pointed out that through the end of the 1990’s most interface design relied on analog (CRT and then, later semi-digital LCD) monitors to

⁶⁰ Claus Pias, *Cybernetics/Kybernetik: The Macy Conferences 1946-1953* (Zurich: Diaphanes, 2003).

⁶¹ von Neumann p. 293

⁶² von Neumann does acknowledge that even digital machines do not produce absolutely accurate results; there is some degree of error in a digital machine. von Neumann explains: “this error is, or course, not a random variable like the noise in an analogy machine. It is, arithmetically, completely determined in every particular instance. Yet its mode of determination is so complicated, and its variations throughout the number of instances of its occurrence in a problem so irregular, that it usually can be treated to a high degree of approximation as a random variable” p. 295

⁶³ Pias, *Cybernetics/Kybernetik*, p. 158.

⁶⁴ von Neumann p. 296

deliver information to the user graphically.⁶⁵ The development of newer, sleeker interfaces with higher resolution capabilities has changed human-computer interaction at the level of the interface, but nevertheless, this example shows that even in what we take to be digital systems, the incursion of the analog disrupts the apparently closed circuit of the digital system.

It mattered to cyberneticians to define analog and digital because their theory was supposed to be all-encompassing—to apply to all organic and physical structures and phenomena. But for their theory to work, the world needed to undergo a radical reconceptualization, to be re-envisioned in terms of digitality and computational systems. Claus Pias has categorized this new shift as one similar to the historical ruptures tracked by Foucault; similar to the break in the 18th century, in which an “anthropological illusion” supplanted the preceding “metaphysical illusion,” in the mid-20th century we begin to see the emergence of a new “cybernetic illusion.”⁶⁶ As the birth of Enlightenment replaced metaphysics with the human sciences, epistemology converged around the figure of “Man,” who instead of being defined as a reflection of God’s will, becomes simultaneously the object and producer of knowledge.⁶⁷ A new epistemological rift begins to yawn in the 20th century, when the participants in the Macy conferences saw in the new interdisciplinary study of cybernetics an overarching epistemological umbrella, under which all knowledge could be reformulated, not, this time, in terms of Man or humanism, but rather in terms of systems, feedback loops, signals and noise, of which the human is only one instantiation in a total systemic ecology. However, running up against the indeterminacy latent in the analog/digital dyad threatened the stability of this new formation insofar as it undercut the possibility of an absolute differentiation between a world constructed according to calculable (statistically and probabilistically knowable) digital processes vs. an infinitely fine-grained, aggravatingly flexible analog world.⁶⁸

However, Pias also suggests that the very kind of thinking that proposes this typological distinction is dependent on the preexistence of a digital epistemology—a digital logic and terminology that activates a desire to see a system “as” digital or analog. Moreover, since many cyberneticians saw in digital machines the greatest potential for information processing, and cybernetics as a discourse is heavily invested in the trope of information, they stand to gain the greatest benefit from attaining a thoroughgoing knowledge of the types of information transmission and feedback loops generated by digital machines or living organisms interpreted through a digital lens. In Pias’ selection of quotes from notable participants in the meeting, we begin to notice the persistent, shadowy presence of “continuity” well in advance of Nelson Goodman’s typological study of analog and digital systems in the 1970s. Pias channels the anxious mood in the

⁶⁵ Timothy Binkley, "Digital Dilemmas," *Leonardo* 3, no. Supplemental Issue. Digital Image, Digital Cinema: SIGGRAPH '90 Art Show Catalog (1990): 13-19.

⁶⁶ Claus Pias, "Analog, Digital and the Cybernetic Illusion," *Kybernetes* 34, no. 3/4 (2005): 543-550, p. 548

⁶⁷ Pias p. 548. See also man as the empirico-transcendental doublet, the new trope of the 18th century, as discussed in Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences* (New York: Vintage Books, 1994).

⁶⁸ Pias avers that “Shannon’s information theory and McCulloch’s logical calculus are completely dependant on digital notions, and that means that the whole new universal cybernetic epistemology would not work if it is not based on digital terms.” Pias p. 546.

1946 conference surrounding the persistence of analogy in the following synthesis of participants' commentary: "Not only for building effective computers, but also for building an effective discourse of experimental epistemology one has to be 'ignorant' (as Walter Pitts called it)—ignorant 'of the actual continuity' in all things that virtually might be digital."⁶⁹ "'Treat them as if these transition states did not exist. It is quite a good way of treating them,' said John Stroud."⁷⁰ An inconvenient preponderance of analogical continuity subsists even in ostensibly digital systems; John Stroud, Walter Pitts, and McCulloch himself all acknowledge the possibility that digitality will always be haunted by shades of the forbidden ground of analogy: intermediate states, in-betweenness, and continuousness. Analogy in all its messy physicality is forbidden because it allows randomness and noise to muck up the hygienic, arithmetical precision of numerically driven digital systems. Permitting the analog to extend its reach into the digital threatens to destabilize digital epistemology, the very thing that cyberneticians suspect will be their most effective tool for finding points of comparison between, or even rendering equivalent, machines and living organisms.

Theories of analog and digital have been imported from the cybernetic theories of the 1950s into cognitive science and the philosophy of mind in the 21st century. Here, digital systems are conjured not merely as *models* of consciousness, in which the model is a secondary representation, serving as a descriptive shorthand or approximation of its referent; rather, consciousness is itself a digital system. According to a strong, pancomputationalist view, then, digital systems do not *simulate* consciousness; pancomputationalists believe that consciousness, as well as other physical, chemical and biological systems exhibit digital states, and that consequently, these systems function computationally, and can be most accurately replicated using electronic digital computing technology. In philosophy of mind, debates surrounding the degree to which natural systems, and by extension, human consciousness can be interpreted as computers coheres around whether consciousness processes information through computational operations or by building representations. In his article on representation in digital systems, Vincent Müller takes on the legacy of von Neumann and the Macy Conferences to assess the importation of definitions of digital and analog given by Goodman and the cyberneticists into contemporary computationalist viewpoints in the philosophy of mind.⁷¹ The mode of inquiry and description mobilized by cybernetics treats both organisms and machines as feedback mechanisms, and thus provides a backdrop against which living and technological systems can be made equivalent.

IV. Indeterminacy, Hybridity, and Impossibility

One of the most compelling aspects, for the purposes of my argument, of the philosophical debates surrounding the possibility or impossibility of maintaining a distinction between analog and digital is that these debates uncover the unstable ontology of digital states. Critical responses in analytic philosophy to the claim that digital states are constitutively discrete have pointed to the various indiscernabilities that arise between

⁶⁹ Pias, p. 546

⁷⁰ Pias, p. 546.

⁷¹ Vincent Müller, "Representations in Digital Systems," *Interdisciplines*, June 25, 2007, http://www.interdisciplines.org/adaptation/papers/7/6#_6 (accessed March 24, 2008).

digital and analog mechanisms. For example, even if the hand of an analog clock moves in discrete steps, its calculations are governed by an underlying analog system. One response has been that analog devices may exhibit discreteness but that they lack true differentiation because they proceed serially.⁷² Similarly, David Lewis has attested to the many cases of “representation that is as differentiated and non-dense as any digital representation and yet is analog rather than digital representation.”⁷³ In the preponderance of circumstances, attempts to narrow the demarcation of digital and analog states is that they tend to gravitate back towards one another, so that just as one distinction is posed, it is problematized by a further instance of the constitutive hybridity of digital and analog systems. Clarifying an absolute distinction between digital and analog states becomes an ongoing process of iteration, feedback, and reformulation, such that there is a temptation to declare that digital states are relative and fully description-dependent: that the boundary between digital and analog is vulnerable to permutation given the apparent flexibility and range of parameters that can be applied to define a system as either analog or digital.⁷⁴

The difficulty of assessing whether a system is truly analog or truly digital suspends their relationship in a perpetual state of open-endedness; even the conclusions drawn within the strict constraints of philosophical logic maintain their viability only in a narrowly controlled range of circumstances. To return to the problem of time, or more precisely the digital or analog operations at work in instruments for measuring it, a number of possible tests for determining a clock’s analog or digital status compete, ultimately leaving the solution indeterminate. In Müller’s “first approximation, being digital means being in a discrete state,” a simple enough statement.⁷⁵ But, the situation becomes more complicated when we discover that analog movements and markings can also occur in steps. To state confidently that a system is analog, must it simply demonstrate continuousness? This cannot be sufficient, for “an analog watch does not cease to be analog even if its hands move in discrete steps.”⁷⁶ One possible solution, that analog representations can contain differentiated marks or parts as long as those differentiated positions progress serially, is also suspect on the grounds that some systems, such as natural numbers are seriated but nonetheless digital. Although Müller eventually concludes this section of his argument by restating his initial premise that a digital state is necessarily and identifiably discrete, the most pertinent finding also appears so mundane at a first pass that it easily escapes a casual reader’s attention. To paraphrase, many systems require conversion between signal types (analog to digital and vice versa), and thus contain analog and digital parts.

But why then insist, if this is so obvious, on reiterating the distinction between digital and analog media in the construction of art (or art-approximate) artifacts? If

⁷² James Blachowitz, "Analog Representation Beyond Mental Imagery," *The Journal of Philosophy* 94, no. 2 (February 1997): 55-84, p. 71

⁷³ Lewis p. 322

⁷⁴ Citing Nicolas Negroponte’s definition of a bit, which “has no color size or weight, It is a state of being: on or off, true or false, up or down, black or white,” Müller rejoins, “Which of the black things are bits? What determines whether something is a bit?” Müller, np. See also Nicolas Negroponte, *Being Digital* (New York: Vintage Books, 1995), p. 14

⁷⁵ Müller, np

⁷⁶ Zenon Pylyshyn, *Computation and Cognition* (Cambridge: MIT Press, 1984), cited in Müller, np.

systems are bound to be so inconclusively both/and, what do we have to gain from identifying one from the other at the outset? While one possible response to these questions is that the persistent relativity and shifting lines of demarcation between digital and analog either obviates the necessity to categorically separate them, I contend that alongside the technical definitions for these terms there exists a set of perceptual conditions (or a process of perceptual conditioning) that prompts us to recognize, if through purely imaginative exercise or direct observation, sensory and formal criteria that arbitrate bindingly which side of a binary division (yes-no, digital-analog) the artifact will occupy. In other words, just as the cybernetic, and now the pancomputationalist philosophical standpoint creates a world view in which all phenomena are interpreted in terms of computational processes (if all the world is a computer, then all its systems must also function computationally), I argue that we will have different expectations for the kinds of knowledge and experience upon which an artifact comments and/or reflects depending on whether we see it *as* analog or digital. If an artifact generates a perceptual effect of “being digital,” not only are the truth-claims and indexicality of the picture called into question (if we are concerned with the matter of the waning of the index in digital photography, an issue that extends beyond the scope of the present discussion), but that artifact falls into a different epistemological framework or “way of seeing” than does an analog precursor. A viewer is, for example, expected to engage differently with a mosaic than with a painting by Poussin, or with a heavily pixilated, digitized portrait of Abraham Lincoln than with the original photographic print that was the source of the digitization.

One important point to note is that “not all systems that have digital states are digital *systems*.”⁷⁷ In colloquial speech, an implied equivalence exists between digital and computational machines. If computational machines exist to compute—i.e. to generate an output (a result) from input (a data set)—we must assume that their value issues from their functionality. In contrast with art, according to a Kantian aesthetic legacy, whose purpose may be to give pleasure, to revivify experience, or to provide a culturally sanctioned space for contemplation, the purpose of machines in general, and computers in particular, is to produce a controlled causal chain resulting in a specific, predictable and repeatable effect. But digital states may exist in non-machinic systems that lack a prescribed chain of causality. The fact that computers compute, that they process information, defines them as tokens of a typology of functionalist systems. But their characteristic of being digital is separate from that. This means, then, that while it is easy to assume that digital states are notational indicators or symbolic representations of information-bearing values (i.e., the peaks and valleys on an EKG printout that “represent” numbers which in turn “represent” the range of systolic and diastolic pressures in the cardiac system), a system *need not* be computational, nor need they demonstrate a chain of cause and effect to fulfill the conditions of being digital. In other words, we can gather evidence of digital states in non-computational, non-mechanically generated works of art, such as the abstract painted mosaics by Paul Klee in the 1920s

⁷⁷ Müller, np. Likewise, Goodman differentiates between schemes and systems, so that for a symbol scheme, defined as a label that sorts objects/symbols into classes (e.g. sorts blue objects from other colors of objects) to be analog it requires only syntactic density, an analog system is both syntactically and semantically dense. Goodman p. 160.

and '30s that will be discussed in detail in Chapter 2. These works have digital states but are not digital systems, but without distinguishing between digital mechanisms and observable digital properties of non-digital systems, it becomes all too easy to retreat into hard and fast functionalist distinctions between analog and digital and thus to become blind to the subtle network of relationships between and within each category.

At the same time, however, we must also preserve the separation between state and system if we are to understand how computational digital systems produce different types of output than artifacts that display digital states without necessarily being a part of a digital system. Klee produces digital effects in his painting without creating a self-contained digital system. Pointillism contains enough digital elements from the beginning to the end of production to warrant consideration as a digital system, but it is not computational. And then there are examples of digital systems that, without attempting to conceal their underlying digital functionality, also digitally simulate analog processes, such as brushstrokes or drips of paint, in order to give an impression of contingency, spontaneity, or imprecision.

Camille Utterback's artworks, for instance, are generated within the technical, programmatic constraints of a digital, computational system, but also incorporate analog elements to preserve a sense of "messiness" and handmadeness. This allows her work to be both technological—screen-based, software-driven, interactive—while at the same time appealing to an analog aesthetic sensibility, in which density and repleteness, manifested in the formal construction of the work, actively produce the indeterminacy, ambiguity, and open-endedness that occur at the level of signification. Specifically, her *External Measures* series, comprised of six individual interactive "paintings," explores the aesthetic and experiential possibilities that emerge at the intersection of computational systems, bodily movement, and abstract, painterly composition. Utterback's software responds to viewers' movements by creating animated swaths of color and texture that bloom at the origin of a gesture, and decay and eventually fade over time. In *Untitled 6*, honeycombs of fine lines gather around the silhouette of the viewers'/users' bodies, and their path of travel is marked by black and white forms, indexing their movement, themselves ceasing to move and coagulating in colored blots when they collide with the bodily presence of another viewer/user.

In this work, the digital is visible in its functionality—the fluid movements tracked and converted by the software into visible, textural patterns is evidently digital in the sense that the unfolding of the visual narrative in the work seems to be an effect of individual components acting on their neighbors, so that discrete elements create effects and disturbances in the overall system. In digital-computational systems, individual binary digital states are discrete, but their combined function is to work in tandem to support the entire system.⁷⁸ In a true digital system, each element in the system must be of the same type, such that each binary state will prompt an effect in another binary switching mechanism. Lev Manovich describes this relationship of part to whole in

⁷⁸ Müller emphasizes the role of function in digital modularity. "If someone would fail to recognize that my laptop computer has binary digital states, they would have failed to recognize the proper function of these states for the purpose of the whole system—namely what it was made for. . . . (And the fact that it computes is crucial to its function, but not to that of, say, my shaving brush—so pancomputationalism seems misleading here)." Müller, np.

terms of “modularity.”⁷⁹ In its visualization of modular chain reactions, the digital systematicity of Utterback’s work is intuitively palpable, though not directly mapped or indexed on the visual surface of the interface. While the slightly jerky movement of the visual configurations (lines, shapes, and overall patterns) conveys a certain flavor of articulated digitality, overall Utterback works to obscure discreteness and disjunctness, not in service of a fully spatialized virtualization (as in “naturalistic,” perspectival CGI), but rather to create a sense of continuity with the analog.

Utterback’s choice to activate the analog in her creation of “interactive painting” links her work historically to analog practices including Abstract Expressionist painting, in which gesture and movement are mapped or “frozen” onto the canvas by skeins and drips of paint, and kinetic sculpture, in which moving parts and light effects create a dynamic and often immersive experience of plane, volume, light, and motion. In addition, her work generates a new instance of a (clearly purposeful) hybridity, in which the affordances and constraints of analog properties and the aesthetics of computational systems react to and interact with one another in a discursive game of cat and mouse. As we have seen, the parameters of digitality become muddled due to the prevalence of description-dependent characterization of digital states. That is, if we have an interest in discovering digital features of an artifact, for example a lamp that exhibits binary characteristics in its ability to be turned on or off, but is not productively defined as digital in any other sense, we will find those characteristics where they suit us. Müller attempts to circumvent this problem by relying on the distinction between type and token. “Every digital state is also on a continuum: the digital speedometer might change quickly from one number to another, but it does have intermediate states—just that these are not states of numbers, not states of these types, of these descriptions. What is crucial here, therefore, is that a digital state is *of a type*.”⁸⁰ Defining types narrows the range of description, and thus the range of tokens that will fall into that type by setting up the terms in advance by which the digitality or analogicity will be assessed. Functional descriptions using type/token clarifications entail that one must examine whether the state, e.g. the lamp’s state of being on or off in question is functional in both sides of the binary. Thus, being “off” must be capable of imparting information just as being “on” does, as is the case in a machine with a low-battery light, which when in the “off” state communicates the full functionality of the system.

If Goodman’s conclusions about digital and analog systems circulate around notions of discreteness, continuity, density and disjointness, Manovich’s own analysis focuses on programmability and numerical manipulation. Contrary to Goodman, who treats the relationship between analog and digital systems as a subset of the larger issue of notation and depiction, Manovich emphasizes technological operations by embedding his discussion of “digits” in “numerical representation,” one of what he considers the five

⁷⁹ “Just as a fractal has the same structure on different scales, a new media object has the same modular structure throughout.” Manovich goes on to write that “structural computer programming, which became standard in the 1970’s, involves writing small and self-sufficient modules (called in different computer languages *subroutines, functions, procedures, scripts*), which are then assembled into larger programs.” Lev Manovich, *The Language of New Media* (Cambridge, MA: MIT Press, 2001), pp. 30, 31.

⁸⁰ Müller np.

principles of new media.⁸¹ My own schematization of the primary characteristics of digital media deviates from Manovich; perhaps the most crucial deviation is in my disaggregation of digital from both numericization and computation. The separability of these two categories can be illustrated by examples of what Manovich calls “modern” media such as photography and film. These media forms emerge in the mechanical age and use analog technology to produce results that are partially digitized but not technologically (computationally) digital. Celluloid, moving-picture film generates the illusion of movement by stringing together individual frames of still photographs. The rapid shutter speed exposes seriated frames that, when projected at 24 frames per second, appears as a span of continuous movement. In a chart of digital and analog technologies, photographs fall on the analog side—they are continuous, not comprised of discrete units, or to use Goodman’s language, non-disjoint and non-articulate. Film falls towards the midline—it is syntactically, but not semantically differentiated.

So while on the one hand Goodman’s schema seems to provide a precise formula for ascertaining the digitality or analogicity of various objects, on the other hand it also permits indefinite and inconclusive analysis of many if not most representational technologies or systems. Manovich simplifies the distinction between analog and digital by placing greater emphasis on quantization than discreteness. Thus, “while modern media contain levels of discrete representation, the samples are never quantified.”⁸² His initial explanation for the prevalence of discrete-but-not-quantified recording techniques of modern media tests the semiotic hypothesis that “communication requires discrete units.”⁸³ If we refine this statement to engage more actively with Goodman, we would say that communication relies on symbolic systems, and symbol systems are built of discrete units, such as linguistic theory’s phonemes and morphemes. However, Manovich quite deftly deflects a push into infinite regress when he calls attention to the fact that most “media” can be broken into discrete parts—drawings into lines, film into frames, paint into brushstrokes. He also points out that a strict semiotic reading proves untenable because “the discrete units of modern media are not usually units of meaning in the way morphemes are.”⁸⁴ Thus, Manovich discards semiotics but ultimately marshals the phenomenon of nineteenth century industrialization and the “separation of the production process into a set of simply, repetitive, and sequential activities that could be executed by workers who did not have to master the entire process and could be easily replaced.”⁸⁵ Industrialization, mechanization, and assembly lines seem somewhat “digital” on the basis of an interchangeability of parts and actions. Mechanical reproduction, mass production, and standardization and repetition in factories and on assembly lines characterize the ethos of modernity.⁸⁶

⁸¹ The five principles include numerical representation, modularity, automation, variability, and transcoding. See the chapter “Principles of New Media” in Manovich, pp. 27-48.

⁸² Manovich p. 28

⁸³ Manovich p. 28

⁸⁴ Manovich p. 29

⁸⁵ Manovich p. 29. See also Michel Foucault, *Discipline and Punish: The Birth of the Prison*, trans. Alan Sheridan (New York: Random House, 1979).

⁸⁶ Walter Benjamin’s essays on modernity, Siegfried Kracauer’s *Mass Ornament* and Martin Heidegger’s later writings on science and technology offer some of the most compelling illustrations of modernity, its iconic figures and paradigmatic structures. Walter Benjamin, *The Arcades Project*, trans. Howard Eiland and Kevin McLaughlin (Cambridge: Harvard University Press, 1999). Martin Heidegger, *The Question*

V. Functional Aesthetics: Measurement and Notation

The problem of analog versus digital is a systemic one. In other words, figures such as Von Neumann and, more recently David Lewis, have addressed the problem at a systemic level; both thinkers, the former an engineer, the latter a philosopher, are concerned with defining the parameters according to which a whole series of operations belonging to one organism or machine describe the computing function of that machine, where the computing function is the processing of a particular kind of signal to generate an output distinct from the original input quantities. Keep in mind that I am separating digital systems from phenomenally accessible—sensorially apprehensible—evidence of digitization in artifacts. Thus, I am proposing that the digital should be examined for its notional/theoretical valence, which is an unusual way of approaching the problem. Typically, the digital and the computational will be collapsed, because digitality is most obviously, especially for information scientists, a technological and functional rather than a perceptual category. Arguments concerning digital and analog systems usually assume that these systems are computing devices, so that even the term “representation” is imbued with a computational *telos*. Representation, here, has to do with the way the mind organizes and processes “information,” which encompasses all the kinds of stimuli—signals, symbols, images—that we absorb, collect, and manipulate to make sense of the world and our relation to it. As understood in the disciplinary contexts of art history, visual studies, film studies, and so forth, representation enacts a selective interpretation and an “enframing” of the world to communicate a particular kind of knowledge or experience.⁸⁷ However, information and computer science attend more to the invisible operations of the nervous system or computer than to the way in which these operations become inscribed on a surface and thus are made available to the sensorial register.

According to an etymological interpretation of the origin and scope of digital and analog, analog movement analogizes that which the instrument measures—the movement of the analog clock correlates to the passing of time, which, as Henri Bergson has argued, does not unfold in a series of jumps between steady states, as in a digital clock, but consists, rather, of a continuous durational flow.⁸⁸ But this begs the question: “which of the two characteristics is crucial for an analog state, the analogy to the represented, or the continuous movement?”⁸⁹ The digital in these cases is a way of thinking about measurement, the representation of information that can be measured using physical quantities (analog) versus purely numerical representations, or mechanisms that process information by translating data into numerical values. This suggests that digitality is a mechanistic tool, and that defining the digital is a matter of evaluating the operating principles of computing machines. If this is the case, it is easy to see why the focus in digital media has been either on human-computer interaction (or on intrapersonal human relationships vis-à-vis the computer—for example, the formation of online communities) or on the technology itself. In the latter scenario, evaluators of digitally generated artifacts would tend to focus on how the machine works—how it numericizes information

Concerning Technology and Other Essays (New York: Harper Torchbooks, 1977). Siegfried Kracauer, *The Mass Ornament: Weimar Essays*, trans. Thomas Y. Levin (Cambridge: Harvard University Press, 1995).

⁸⁷ Heidegger pp. 115-141

⁸⁸ Henri Bergson, *Creative Evolution*, trans. Arthur Mitchell (Mineola: Dover Publications, 1998).

⁸⁹ Müller np

and how its numericizing functions and information processing support the idea of a computable universe. How computing machines work, and the kinds of output facilitated by the specific way in which they process data, leads to a mystification of the machine, whereby it is assumed we cannot properly appreciate computer-generated artifacts unless we know exactly how they work. This implicit demand for computational literacy can be dangerous, however, because it suggests that less technologically savvy viewers/users simply lack the education to understand works that would otherwise impart wisdom or produce a genuine aesthetic experience. But this instantly forecloses arguments for the potential of distributed digital media to induce political activism and to increase democracy. It also contributes to a technological elitism that returns digital art to a state similar to pre-print culture, in which only the educated intelligentsia (usually clergy) could read, circulate, and make illuminated manuscripts.

Goodman deviates from his predecessors at the Macy Conferences and proleptically from the language of his respondents by contending that “plainly, a digital system has nothing special to do with digits, or an analog system with analogy. . . . Since the misleading traditional terms ‘analog’ and ‘digital’ are unlikely to be discarded, perhaps the best course is to try to dissociate them from analogy and digits and a good deal of loose talk, and distinguish them in terms of density and differentiation.”⁹⁰ Most efforts to define these terms presuppose the presence of analogy in analog systems, as well as digits in the digital, insofar as individuated metric units are constitutive of digital systems. Goodman’s dismissal of analogy does not result in a vastly different view of analog and digital, but it does offer a set of evaluative terms that allow one both to determine the status of given system or schema with greater specificity *and* to apply the terms to a greater range of objects and artifacts.

Analog and digital characteristics are more often ascribed to technologies, organisms (or living systems), numerical systems and the philosophy of mind than to art itself. And while the title of Goodman’s text would lead one to believe that his methodology was devised in order to assay the aesthetic properties of artworks, his test cases are not artworks at all but rather instruments--clocks, counters, and other measuring devices. However, while the breadth (applicability) of Lewis’s and von Neumann’s definitions seem limited to the particular domains from which they gather their evidentiary examples, Goodman’s introduction of density and differentiation expands the scope of his argument beyond the instrumental tools he uses to demonstrate the distinction between analog and digital into the realm of artifacts produced for sensory apprehension alone, rather than for utilitarian ends.

The conceptual architecture of Goodman’s argument is useful to tease out the deviations in how different symbolic systems make meaning, or in how we imbue them with meaning (how we make them mean rather than what they mean inherently), and what kind of signification is facilitated by each system. But when we turn our attention to artifacts themselves, the successful parsing of these objects, or the successful application of these terms to objects, their utility as explanatory and/or exploratory devices becomes somewhat muddled. Upon further examination of philosophical debates surrounding digital and analog systems, we discover that it may be digital and analog states themselves, not simply the terms in which they are theorized, that are susceptible to

⁹⁰ Goodman p. 161

breakdown.⁹¹ As Von Neumann, Stroud, McCulloch et al suspected in the 1940's, hybridity is built into most systems, such that careful examination of their operations reveal a fundamental indeterminacy in their status as *either* digital *or* analog. If a sweeping second hand on an analog clock seems to identify it as analog, the underlying system of marking time is already at least partly digital.⁹² Questioning the nature of time in terms of analogicity and digitality is a philosophical abstraction of a problem that manifests itself much more locally and more concretely in the time-keeping instrument. Clocks are in essence measuring tools that can perform their task according to either an analog or a digital logic. In either case, the primary function of the device is to measure an abstract quantity that is otherwise unavailable to direct perception; we cannot touch or see time, and therefore cannot use our own observational faculties to measure time in itself, but only its effects (the sun climbing higher on the horizon, the temperature of the air growing warmer and colder as the day waxes and wanes). Although we may experience the passage of time phenomenally as a perpetual flow, the symbolic representation of time divides it into discrete elements. The digital representation of time is functionally oriented—hours and minutes transform time from an a priori condition of being into a quantitative informatic tool, so that to experience oneself as a temporal being is now equated with one's ability to process the information-bearing symbols that stand in for time. Clocks can be understood as transcoding devices that “digitize” time in the technical sense by translating an analog “signal” into digital information-bearing quantities.⁹³

VI. Digital Gestures

I want to conclude this chapter by briefly introducing another constellation of thought about the digital, one which mobilizes etymological associations but also repositions the term, according it a strongly cardinal (bodily) orientation. My emphasis on the classical/etymological derivation of aesthetics from *aisthetikos/aisthesis*—sense perception—such that aesthetics is defined as knowledge produced from sense experience, rather than as an evaluative philosophical method, has implicitly signaled another manner of thinking about the digital that avers the connection between the body—specifically the “digits” or fingers of the hand—and calculating or counting

⁹¹ See Whitney Davis's arguments about how, due to the increasing indiscernability of digital and analog systems, it becomes more interesting to consider both digital and analog artworks and artifacts in terms of how they “analogize” or “look like”—bear certain aesthetic characteristics of—digital and analog systems. Davis p. 89

⁹² In his discussion of analog and/or digital representations of time, Müller postulates that Pylyshyn would argue that regardless of whether a hand advances one click forward or if a digit changes on the screen, if the “underlying mechanism” of the device is digital, the clock will necessarily be digital. I take issue with this on several levels; at the most general level, if the underlying mechanism is not perceivably digital, the relevance of its digitality may be negligible. This, of course, is the issue at the crux of my entire project. But even at a more particular level, the tendency toward regress manifests when we realize the “underlying mechanism” of time-keeping, or more applicably, time-measuring, instruments is precisely the discretization or *punctuation* (Bergson) of time itself.

⁹³ For an extensive analysis of the disciplinary forms that arose to organize bodies, both individual and in group formations, to subdivide both bodily movements and time itself, see Michel Foucault, “Docile Bodies,” in *Discipline and Punish: the Birth of the Prison*, trans. Alan Sheridan, 135-169 (New York: Random House, 1979). See also, on the invention of clock time, Lewis Mumford, *Technics and Civilization* (New York: Harcourt, Brace and Company, 1934), pp. 12-18.

functions. The digital becomes refamiliarized then, or re-envisioned in terms of intimate bodily practices that (seemingly paradoxically) yield abstract numericizing/counting techniques. Recent texts on new media practices have launched rejoinders against dystopic narratives presented in the 1990s about the disembodiment and alienating effects of computational technology.⁹⁴ Authors such as Mark Hansen and Anna Munster have strongly advocated for incorporating phenomenology into assessments of new media artworks and artifacts.⁹⁵

But another applicable model, which has not yet received adequate attention in Anglo-American media studies, reveals new points of intersection between the body and digital technology. What is most important to my work is the way in which this configuration allows digital, computational, numerical processes and epistemological formations to be integrated with aesthesis—sensing, perceiving, and feeling—and bodily practice. This theoretical account emerges not from the school of phenomenology, but rather from paleoanthropologist André Leroi-Gourhan's writing on tool use and hominization. According to Leroi-Gourhan, technics are always-already enfolded into the process of hominization; whereas it might be supposed that the brain enables the development of tool-use, Leroi-Gourhan argues in contradistinction that it is the tool itself that drives the evolutionary process.⁹⁶

Leroi-Gourhan's hypotheses have extended into some critical theorizations of "technics," notably in Derrida's *Grammatology* and French philosopher Bernard Stiegler's three-volume work *Technics and Time*, which argues for the central role of technics in shaping the historical and temporal horizons of the "human."⁹⁷ For Stiegler, humans are not the acting subjects of history while technology is the inert object; instead, humanity (and the human) and technology reciprocally/mutually constitute each other. While Stiegler's proposals work transhistorically, insofar as his theories address processes and relations—between humans, technics, and time—rather than a particular technological/historical period, Leroi-Gourhan speaks only indirectly to modern and contemporary regimes, taking prehistoric depiction as his primary technical milieu, which has been preserved chiefly in the form of cave drawing.

Using this method, then, it is possible both to see how digitality and computation have threaded through the deep history of artifact production, generally, and depiction, specifically. Whitney Davis has devised a research program around the "replication" of the ancient arts in the modern world, but more importantly, around identifying research methods that, while, as with any investigative project, are always culturally and

⁹⁴ For example, see Arthur Kroker and Marilouise Kroker, "Code Warriors: Bunkering in and Dumbing Down," in *The Cybercultures Reader*, 96-106 (New York: Routledge, 2000). See also Gibson, op. cit.

⁹⁵ Mark B.N. Hansen, *Bodies in Code: Interfaces With Digital Media* (New York: Routledge, 2006). Anna Munster, *Materializing New Media: Embodiment in Information Aesthetics* (Hanover: University Press of New England, 2006).

⁹⁶ André Leroi-Gourhan, *Gesture and Speech*, trans. Anna Bostock Barger (Cambridge: MIT Press, 1993).

⁹⁷ Jacques Derrida, *Of Grammatology*, trans. Gayatri Chakravorty Spivak (Baltimore: Johns Hopkins University Press, 1998). Bernard Stiegler, *Technics and Time: Volume I: The Fault of Epimetheus*, trans. Richard Beardsworth and George Collins (Stanford: Stanford University Press, 1998). Bernard Stiegler, *Technics and Time: Volume 2: Disorientation*, trans. Stephen Barker (Stanford: Stanford University Press, 2009). For more on the relationship between Stiegler, Leroi-Gourhan, as well as Jacques Derrida and Georges Bataille, see Charlie Gere, *Art, Time, and Technology* (Oxford: Berg Publications, 2006), pp. 13-34

historically situated, may yield pertinent information about an extensive field of cross-cultural and trans-historical practices.⁹⁸ Consequently, according to this model Paleolithic notations warrant consideration as digital practices, as do the examples I address in the following chapter.

While Paleolithic “art”—which seems to range in type between depiction and notation, or may hybridize or not distinguish between the two types of symbolization—might seem an odd point of reference for a theory of digital aesthetics, it is highly apposite to the overall goal of the current project. Namely, I want to highlight that the digital is less about a particular and highly specific technical configuration—in this case, the electronic digital computer—than about a *method*. Indubitably, computationalism, cybernetics, and the technological reality of the hardware and software at work in computational machines supply the possibility condition to renegotiate objects that appear as early in the artifactual record as the Paleolithic. Thus, it should be stressed that it is the particular epistemic horizon of the current contemporary moment out of which the digital practices under consideration here become visible. Nevertheless, re-evaluating the past through the epistemic lens of the present allows digital and computational practices to come to light across a broad span of historical periods and geographical locations. The greater significance of this comes from the fact that evaluating artifacts in terms of a digital method will allow them to signify in new ways, effectively opening the interpretive field within which artifacts both produce and reflect cultural knowledge systems.

⁹⁸ Whitney Davis, *Replications: Archaeology, Art History, Psychoanalysis* (University Park: Pennsylvania State University Press, 1996).

Chapter 2: Points, Divisions, and Pixels: From Modern to Contemporary Digitality

A quick look into the literature on digital and analog illustrates the degree to which the distinction between these two categories is more theoretical than actual. Recall that both Weiner and Von Neumann acknowledged that analog and digital systems tend to overlap, so that most systems are neither wholly analog or wholly digital, but contain elements of both. The difficulty of applying these categories not just notionally, but also in the object-world, bears out in the fact that many analog measuring instruments, such as analog clocks, have digital elements—namely, the tick-marks on the face of the clock—and that digital instruments often approach the analog by representing numbers in physical magnitudes.⁹⁹ Most treatments of analog and digital emerge in a context of information theory or philosophy, and as such deploy only notional examples as demonstrations of theoretical models, and thus do not examine whether or not the theoretical distinction obtains across a range of object-models. Lewis, Haugeland, von Neumann and the other cyberneticians discussed in Chapter 1, for example, are not discussing “art” at all. In fact, formal evaluation of a work’s perceptible “digitality” will often more easily identify moments of blending, partiality, or indeterminacy between the two modes. But additionally, when addressing works of art, and pictures specifically, the disentanglement of digital and analog becomes more complex, especially when the works in question are constructed by traditionally analog means—by hand—and when, because they were produced in a context in which analog and digital pictoriality had not yet been conceptualized as such, their digital communication must be evaluated retrodictively.

The series of artworks I will discuss in this chapter fall into two categories—those that precede the invention of electronic computers but still evince a digital aesthetic, and those that use computers to emphatically and obsessively explore the properties of digital discreteness. In the former case, exemplified here by the paintings of Georges Seurat and Paul Klee, despite the lack of electronically computational processing, the presence of the digit is resolutely surfacial, available for all to see. The digital here is an aesthetic, rather than a technological category. Instead of thinking of the digital as a term that describes the technology used in its making, wherein an object is “digital” if it is a product of electronic computational processing, I marshal both works that use computers and those that do not to define the digital as an aesthetic category, where “aesthetic” is deployed etymologically, to refer to the apprehension of features of an artifact that are available to sense perception. The digital then becomes a configurative and aesthetic modality rather than a technological one. Consequently, just because a picture is created using an electronic computer, whose underlying processes are computed digitally, it might not necessarily exhibit perceptibly digital features. And, contrastingly, an artifact that is made without computational processing might have digital features. Surfacial digitality does not automatically indicate that under the surface of the piece binary computational processes are hard at work. After examining Neo-Impressionist divisionism, Klee’s attempts to transcribe musical notation into a pictorial language, and his own divisionist period, we might assume that digitization emerges out of industrialization or that it is the visual-cultural offspring of the advent of mass production. But numerous classes of

⁹⁹ See David Lewis, “Analog and Digital,” *Noûs* 5, no. 3 (September 1971): 321-327.

artifacts, such as mosaics, chronophotography, and even Paleolithic cave drawings trump this claim. Mosaics, in particular, resist the smoothing effect of line drawing (analog continuousness), the gestural index of the negative handprint, the line drawing, or the painted brushstroke (digital “fingery”), and the messiness of paint splattered, splotched, or brushed onto canvas (analog ambiguity, irreducibility). The digital is a quality that either is or is not sensorially apprehensible via direct observation, irrespective of the technical particularities used to achieve it. This is not to say that the technology then becomes irrelevant, but disentangling the digital as an aesthetic quality from the constraints of electronic computational processing allows an assessment of the specific ways in which it appears over a broad span of historical and technological milieus.

Embedded in the term “digital” is its etymological connection to the hand, to the fingers or “digits” which become discrete units for tallying and counting. Fingers are not only tools for gestural communication, but can also function as calculating devices, or at least placeholders to aid in calculation. They are articulated at the joints, and seem to facilitate the development of schematic, iterable inscription, as well as patterned, informatic notation. Information is, of course, processed digitally in today’s electronic computers, but the digital as an analytic and perceptual category can be disaggregated from the technical specificities of today’s hardware and software. Rather, the digital refers to a particular configurative schema—to a state in which materials or signals operate and are operated upon as discrete states, as distinct from the continuous variation of the analog. Digital symbol systems may appear in the form of pixels, but may also manifest in a variety of other mark-making practices, such as points on a graph, in which a unit of measure has been assigned and outside of which no indeterminate state can be registered.

As we saw at the end of Chapter 1, Stiegler’s theory of technics, influenced by the paleoanthropology of André Leroi-Gourhan, links the development and definition of “the human,” as distinct from the animal, and all else that is not-human, with innovations in tools. But more particularly, Leroi-Gourhan posits that the making of marks is a materialization of the coordination of hand and eye, so that the process of inscription actualizes bodily rhythms, externalizes them, for example, on stone or other surfaces, and becomes an imprint, or what Derrida would call a trace, of the human organization of its own sensorimotor apparatus. Mark-making, or inscription, is thus intrinsically “digital,” an externalization of the handedness of human communication. Derrida, Stiegler, and Bataille, for example, refer frequently to the digital quality of writing, or in the latter case, of “grammaticalization of the visible.”¹⁰⁰ Grammaticalization relates both the institution of individuated rules that are said to regulate and govern verbal communication, and to the structuralist manner of parting out of channels of signification (speech, music, art, etc) into grammatical “units” in effort to isolate and identify the most elemental unit of these systems out of which more elaborate formations can develop.

And moreover, according to Leroi-Gourhan, technologies of inscription from hand-tools forward operate within the logic of “hand-operated machine”—the digital machine, so that “punched cards and electronic memory,” the endpoint of Leroi-Gourhan’s technological appraisal, and the computational binary systems of the 21st

¹⁰⁰ Bernard Stiegler, “The Discrete Image,” in *Echographies of Television* (Malden: Blackwell, 2002), p 149.

century, take over the comparative, memory-collecting function of the human brain.¹⁰¹ Punched cards and computers radicalize the process of externalization, which started with the feet and the shift to uprightiness, and then moved through many stages of evolution, until ultimately the hand achieved sensorimotor coordination in the act of inscription. Whereas “books in their raw state are comparable to hand tools: However sophisticated their presentation, the reader’s full technical participation is still required,” later machines will, for Leroi-Gourhan, complete the total exteriorization of processes once originally located in the body, thus guaranteeing its eventual obsolescence.¹⁰²

The Jacquard loom is “digital” because it uses discretely punched cards to produce a replicable pattern, but as Walter Seitter reminds us, weaving itself is digital, just like the grammatically, phonetically discretized practice of writing, insofar as fingers “which can be formed into a concentric fist, places in parallel rows, spread out and hooked into each other, provide the proto-types for the tools and products of these activities.”¹⁰³ Fingers are perhaps our most direct and intimate examples of discontinuous, repeated units, which mimic the interchangeability of fully externalized digital technologies in the similarity between the fingers or digits. “That which applies to the pianist and to the precision engineer is also true for the activities of drawing or writing, and equally so of plaiting or weaving. It is not only that all these activities require the dexterity of the fingers, but that fingers...provide the prototypes for the tools and products of these activities....The fingers of one hand are the original pencils; the fingers of the other are the original graphs or letters.”¹⁰⁴ But in the information age, digitality has come to signify something else than an application of mnemonics or metrics to bodily configurations. Despite the fact that electronic-computational systems bear metaphorical traces of these connections, as in our description of information-storage as “memory, the production of pictures and other forms of depiction is more often than not assumed to be rendered through code rather than by hand. Thus, traditionally gestural, indexically bodily modes of artificing such as painting, must speak, in some way, about technology; they now must either adapt or reject computational technology, which increasingly enframes all forms of cultural production, so that, as Knut Ebeling has written, “in the age of digital media, painting is less about making references than about encoding.”¹⁰⁵

When we begin to refer to the technological category of digitality, which finds its origins in the fingers but gradually supercedes the body, and even the calculating capacity of the mind, the “digits” in digitality are recognizable as such because they are switching elements: they can only occupy an on or off state, without any intermediary states between them. In her article outlining possible theoretical intersections between “aniconic” Islamic and computer art, Laura Marks’ discussion of Basrian Mu’tazili atomism offers an elegant and intuitively accessible explication of the theory of binary

¹⁰¹ André Leroi-Gourhan, *Gesture and Speech*, trans. Anna Bostock Barger (Cambridge: MIT Press, 1993), p 264.

¹⁰² Leroi-Gourhan p 264.

¹⁰³ Walter Seitter, "Painting Has Always Been a Digital Affair," Kunstmuseum Wolfsburg, *Painting Pictures: Painting and Media in the Digital Age* (Bielefeld: Kerber Verlag, 2003) 30-35.

¹⁰⁴ Seitter p. 30

¹⁰⁵ Knut Ebeling, "The Painting of the Men from Mars," Kunstmuseum Wolfsburg, *Painting Pictures: Painting and Media in the Digital Age* (Bielefeld: Kerber Verlag, 2003) 36-40.

digitality over which our analytic philosophers have labored so heavily. “According to the Basrian Mu’tazili, atoms occupy space, form larger units additively, measure space by occupying it, and prevent other atoms from occupying the same space.”¹⁰⁶ Marks captures several of the crucial elements of digital signals and systems: their fundamental role as measuring devices (although as we have seen, the same can be said, if contentiously, about analog signals), their singular, exclusionary occupation of one state or another, and their modular, fractallic structure in which the whole is not only an aggregate composite of smaller parts, but also mirrors the structural form of the smaller parts.¹⁰⁷

Thus far, the word “digital” has acquired several meanings—it can be used to refer to technological, bodily, or aesthetic milieus, all of which converge around the way discretization affords particular kinds of knowledge and experience. Digital tools can be seen to trace the process of externalization by which the tallying, counting, and ordering system afforded by the physiological structure of the hand is gradually distanced from the body and refigured in symbolic and depictive inscription and memory storage devices from books to portraits to computers.¹⁰⁸ Given their inability to handle ambiguity, their determinate, causal execution along a precise chain of encoded commands, not to mention their processing speeds and capacity for memory storage alone, digital tools have become associated in various documents of the post-cybernetic, Western cultural imagination, from Stanley Kubrick’s *2001: A Space Odyssey* to James Cameron’s *Terminator* series, with a profound sense of the *inhuman*. But when considering the Walter Seitter’s disimbrication of digital meaning and digital structure painting is also instructive. “If two applications of red paint are placed next to each other, and if these two applications of red are mixed or smudged together to produce a uniform red mark, then the digital or discreet method of painting is trying to disguise its own *digitality* in order to create the effect of having come from, perhaps even, of having developed from the same source.”¹⁰⁹ An application of paint to canvas in individual brushstrokes or marks is “digital” in the sense that it deploys a tool as an extension, and externalization, of the hand and the fingers. But even if the marks are applied digitally, or, even if a computer generates a screen-based picture using binary code, this does not mean it will exhibit a digital aesthetic. In other words, a picture can be technologically digital, constructed of syntactically disjoint units but this does not necessarily imply that this structure will be sensorially apprehended because those units can be highly resolved, smoothed over, and occluded. A painting whose digital structure is visible on the surface

¹⁰⁶ Laura U. Marks, “Infinity and Accident: Strategies of Enfoldment in Islamic Art and Computer Art,” *Leonardo* 39.1 (2006): 37-42, p. 40.

¹⁰⁷ For Lev Manovich, the modular structure of new media is one of its fundamental characteristics. His definition of the module analogizes the structure of fractals, in which the form of the constituent parts of the fractal is replicated at every scale, so that if we are confronted with a star-shaped fractal, when we “zoom in” to the figure, we will see that the macroscopically visible star is composed of many smaller stars. This definition deviates from, for example, David Summers’s, which emphasizes not the part-whole relationship but rather the metric function of the module, as the smallest part according to which “the notional surface is infinitely multipliable or divisible, and is reconcilable with any other measure.” See Lev Manovich, *The Language of New Media* (Cambridge: MIT Press, 2001), p. 30. See also David Summers, *Real Spaces: World Art History and the Rise of Western Modernism* (London: Phaidon Press, 2003), p. 411.

¹⁰⁸ See André Leroi-Gourhan’s chapter “The Expanding Memory” in *Gesture and Speech* pp. 258-266.

¹⁰⁹ Seitter p. 31.

is not only composed digitally but also communicates *about* digitality; it speaks, in a visual language with its own distinct syntax, about the relationship between surface and infrastructure, representation and technology, about the fact that all composition originates, to a greater or lesser extent, in a piecing together of disjoint units. A “whole” image, seamless, continuous, and dense, is the result of a careful process of suturing and smoothing, and when a painting uses a digital syntax to communicate a digital meaning, this in turns shows that a totalized, coherent image-surface is inherently illusory.

I. Seurat and Klee: Modeling Digitality

a. Pointillism: Discerning the Digital

Pointillism, the method of applying small dots of paint to canvas most notably embodied in the paintings of Seurat, appears almost too conveniently as a morphological precursor to the pixilated architecture of bitmapped computer graphics. But is there indeed any productive comparison to be made between pointillist dots and pixels beyond a quick observation of their morphological similarity? To insist on a *causal* technological lineage from 19th century pointillism to 20th century computer-generated imagery would be not only strained but also somewhat farfetched; thus, I do not want to force a perfect similitude between Seurat’s dots and the pixel of the electronically-computational Graphical User Interface, nor to suggest that pointillism predicts the technological and cultural milieu associated with the emergence of electronic computers. However, what is notable and worth examination is the fact that pointillism (also known as divisionism or chromoluminarism) emerges as a technologized method that produces its particular effects, its pictorial architectonics, and its aesthetic sensibility by envisioning and deploying a systematic, digital configurative method: a *program* designed to produce a particular range of affect and sensation that made these paintings stand out from stylistic models that both preceded it and were contemporary to it.¹¹⁰

William Innes Homer’s 1964 *Seurat and the Science of Painting* has been largely acknowledged, both by supporters and critics, as the most circulated, and most exhaustively detailed, scholarly book on Seurat’s application of scientific principles, specifically the physics of light and the psychology of perception, to painting.¹¹¹ Homer’s account reads Seurat’s technique as an attempt to perform the final transformation of Impressionist naturalism into a rigorous scientific study method that has less to do with any specific pictorial aims (any theory of representation that would align his practice with, say, figuration or abstraction) but, rather, specifically perceptual ones. Subsequent attempts to re-evaluate Seurat’s work have taken issue with Homer’s large-scale acceptance of Seurat’s grasp of the scientific theories in question, by which the adjacent application of pointillist dots was supposed to produce heightened, shimmering luminosity and brighter color effects than those achieved by color-mixing techniques, because the color would be blended optically (by the eye itself) rather than on the palette. Alan Lee, for example, shows that already in 1886, Seurat’s contemporaries (in this case,

¹¹⁰ For example, Neo-Impressionism can be read as an informed response to the Impressionists’ experimental method of immediately capturing and rendering on canvas a direct, unfiltered recording of imperfect, ephemeral human sensory perception. For more on “the impression” of impressionism, see Paul Smith, “Defining Impressionism,” Paul Smith, *Impressionism: Beneath the Surface* (New York: Harry N. Abrams, 1995) 7-32.

¹¹¹ William Innes Homer, *Seurat and the Science of Painting* (Cambridge: MIT Press, 1964).

Émile Hennequin) simultaneously and contradictorily noted the failure of the technique in practice, but adhered unquestioningly to the perceived scientific validity of Ogden Rood's arguments, presented in *Modern Chromatics*,¹¹² that greater luminosity is achieved by optical, rather than material blending.¹¹³ Directly subsequent to endorsing Rood, Hennequin avers of the *Grand Jatte* that "you cannot imagine anything more dusty or lustreless."¹¹⁴ The debates, then, over Seurat's work, extending from supporter Félix Fénéon, to Homer, and to respondents such as Lee and Martin Kemp, have centered largely on Seurat's degree of success in applying late 19th century theories of the science of optical color blending to his canvases.¹¹⁵ But I am less interested in his understanding or misprision of color theory than in another aspect of his technique, one that is largely taken for granted in these scholarly debates in the face of numerous and rich opportunities for evaluation.

This is of course Seurat's technique of applying paint in adjacent "dots," the digital *method* that underlies the theories of color blending outlined in Rood's *Modern Chromatics*, the book that not only informed Seurat's goals toward optical blending, but was also reported by Rood's son Roland to be the "bible" for the Impressionist painters as well. As Martin Kemp has argued, it was not only the Neo-Impressionists who would have adopted theories of optical color blending, but also the Impressionists, who participated in a less systematic divisionism by employing highly individuated, visibly unblended brushstrokes.¹¹⁶ These brushstrokes were more gestural, aimed at the impression of instantaneity or spontaneity rather than a regular, mechanistic array of dots that becomes the trademark of Pointillism. Recall Walter Seitter's claim that the side-by-side application of painted marks is "digital" whether or not it attempts to disguise its digitality through blending. For Seitter, blending functions as a disguise; the analog is no more genuine, no more natural (in the sense of lacking artifice) than the digital, and in fact is always "simulated."¹¹⁷ Seurat's technique, on the other hand, reveals its discreteness, its function as a kind of "tally," a record of each finitely countable touch of paint to the canvas through the digital extension that is the brush. Each dot is a single, unblended, and thus disjunct, point of color. To be sure, if we move back into a technical (instead of etymological and physiological) definition of the digital, these points show themselves to be at least partially analog; they are *not* mechanically applied, nor are they truly regularized and thus interchangeable. As such, their limits are not quantitatively bounded, and thus each "point" contains ambiguity and indeterminacy. Pointillism thus cannot be fully or perfectly discrete, disjunct, and therefore technically digital. However, we find again that in practice, when we are looking at materials and products of material processes, it becomes difficult to adhere to notionally "pure" definitions of digital and analog, because pointillism tends toward digitality in numerous ways; it is chromatically

¹¹² Rood's text, originally published in 1879, was familiar to Seurat through its 1881 translation into French, under the title *Théorie scientifique des couleurs*. For the English edition, see Ogden Rood, *Modern Chromatics, with applications to art and industry* (New York: D. Appleton and Company, 1879).

¹¹³ Alan Lee, "Seurat and Science," *Art History* 10.2 (1987): 203-224.

¹¹⁴ Norma Broude, *Seurat in Perspective* (Englewood Cliffs: Prentice-Hall, 1978), p. 42.

¹¹⁵ Martin Kemp, *The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat* (New Haven: Yale University Press, 1990).

¹¹⁶ Martin Kemp, "The Impressionists' Bible," *Nature* 1 May 2008: 37.

¹¹⁷ Seitter p. 31

discrete, in its unblendedness, and also syntactically and semantically verges toward the disjunct. And moreover, as I will illustrate, the inexactitude of the size and spacing of the dots is an important, and intentional, analog aspect of this technique that is ultimately deployed to enhance the perceptual digitality—the appearance of individuated units—of the paintings.

In pointillism, the dot as the unit of measure hovers on the surface of the picture, creating a directly perceptible digital aesthetic. Whereas in analog pictorialism, direct indices of metric armatures are usually suppressed, in pointillism, the “dot” asserts itself, mischievously and uncomfortably, bringing the metric to the foreground. What we begin to see in Seurat’s method is technique as program, a program for creating affect and sensation. This act of making visible the “unit of measure,” even if it turns out to be one that is, in Seurat’s case, imprecise relative to a bitmapped pixel, provokes a consideration of the long history of utilizing metric systems as the framework supporting pictorial depiction. Perspective paintings, for example, are constructed according to precise, quantitative rules; the numerical values that structure the spatial arrangement and proportion of objects to one another on a picture plane are computed manually instead of automatically by an electronic machine, but it is nevertheless a computational system. And while viewers see the *effects* of this system—what we are seeing when we gaze at a perspectival construction are the visually apprehensible results of a quantitative system at work—direct indices of that system, the scaffolding of orthogonals and transversals supporting the structure to which I gesture above, are, by and large, painted over. Thus, the pictorial illusion of space in perspective is governed by a notional matrix.

Perspective is not only a technique but is one aspect of a philosophical conception of matter, space, and world, in which quantitative values are increasingly viewed as the most accurate and viable means with which to describe, annotate, and depict our physical surroundings. But perspective is seen not only as a “symbolic form,” but also as an ideological structure in part because the technical apparatus, including, for example, orthogonals and transversals, and the famously monocular viewpoint, are occluded.¹¹⁸ The science of perspective has been critiqued for advancing an illusion of transparency, for announcing itself as the closest approximation to “natural” vision while in truth it involves a high level of artifice to be carried out properly. My goal is not to engage the complex debate surrounding the cultural and symbolic implications of perspective, but rather to show how in many cases, Western, analog pictoriality might often configure its depictions metrically, but that the artistic decision to reveal or conceal any indices of the undergirding metric system is highly significant, and must be viewed as responding directly to the Western conventions of spatial representation and pictorial artifice.

In the existing literature on Seurat’s pointillist technique, the presence of the “dot” is generally de-emphasized because it is seen as the vessel, medium, or vehicle—the syntactical unit—that communicates Seurat’s more *semantically* complex ideas about color theory. In other words, the dot is seen as less significant than the fact that it is employed in service of producing the sensation of luminosity in the viewer. However, if one reads this literature with attention to what *is* said about the dot, it becomes clear that

¹¹⁸ See, for example, Erwin Panofsky, *Perspective as Symbolic Form*, trans. Christopher S. Wood (New York: Zone Books, 1997). See also Hubert Damisch, *The Origin of Perspective*, trans. John Goodman (Cambridge: MIT Press, 1994).

there is an analytic subtext that warrants attention. I am reading, here, against the grain, by looking at the structural foundations—the technical means—that become the conditions of possibility for color, brightness, luminosity, or the lack of all of these, to be delivered to the viewer. For, in fact, it is argued more often than not that Seurat *failed* when it came to color. What is celebrated more, or is more consistently remarked upon, whether with approbation, disdain, or even fear, is Seurat's delicacy, his strangely immobile, quite geometric shapes and volumes, the sense of insubstantiality that, oddly, accompanies the stillness of his compositions. Both Meyer Schapiro and Turner scholar John Gage have preceded me in their attention to the dots themselves, Gage adopting the view that "Seurat was not so much interested in the optically-mixed tone as in the lively texture created by the separated dots themselves," Schapiro remarking that the dots are "a refined device" and that "this artificial micro-pattern serves the painter as a means of ordering, proportioning and nuancing sensation beyond the familiar qualities of the objects that the colors evoke."¹¹⁹

Thus, I am reading the literature on Seurat's method not to ascertain whether he succeeded or failed to achieve his chromoluminarist ideals, or whether he understood or misunderstood the finer points of Chevreul, Zunnul-Zadé, or Helmholtz, Ruskin, and Maxwell as ventriloquized by Rood.¹²⁰ Instead, I am interested in the particular ways in which the dot emerges rhetorically and descriptively as a digital, metric unit that allows Seurat's pictorial architecture and his digital aesthetic sensibility to develop. Despite Seurat's, and many of his interlocutors', primary interest in color, I am examining the rhetorical slips of the tongue, and the inconsistencies in the writings about his work, which hint that there was something else happening in Pointillism—a concern for the dot itself, not as a vessel for vibrant sensations of color but as Seurat's approximation of a metric, digital unit. To attend to the semantic valence of the dot and the pointillist method of facture, which allows the digital, systematically applied touches of paint to remain visible as disjunct units, instead of "simulating" the analog by blending the marks, is not to claim the insignificance of color. Rather, it calls attention to other facets of Seurat's work that are less distinct when color is the central focus of analysis.

This transposition of the metric unit from the invisible background to a highly visible foreground is one aspect of the digitality of Seurat's pointillist technique. Digital signals and systems have a fundamental role as measuring devices. Digital units are also metric units, but they are metric units that are singular, interchangeable, and binary insofar as they occupy one state or another exclusively, without overlap or intermediate positions between states. Digital units are modular, composite, and digitally configured structures are aggregate, composed of many smaller parts. In a true digital system, the elements comprising the system are all interchangeable and perfectly regularized, even if this proves to be only a notional possibility.

As I have intimated already, much of the historiographic record of Seurat's scientism accords pride of place to his use of color theory, and relegates his dotted brushstrokes—the "digital unit"—to a secondary position, in which it performs merely as

¹¹⁹ John Gage, "The Technique of Seurat: A Reappraisal," *The Art Bulletin* 69.3 (1987): 448-454. Gage, John. "The Technique of Seurat: A Reappraisal." *The Art Bulletin*, Vol. 69, No. 3, September 1987, pp. 448-454, p. 452. Meyer Schapiro, "Seurat," Meyer Schapiro, *Modern Art 19th and 20th Centuries: Selected Papers* (New York: George Braziller, 1978) 101-109, p. 102.

¹²⁰ For more on Seurat's scientific and theoretical sources, see Homer pp. 129-131.

a vehicle for the juxtaposition of complementary and contrasting color values. Viewing Seurat's technique from this standpoint, the dot serves as one effective tool to apply points of color adjacent to one another, rather than blending them in the traditional manner. The hypothesis, the accuracy of which has been debated from Seurat's first painterly experiments with it, is that the adjacent, disjoint placement of colors stimulates the viewer's visual cortex in such a way as to produce a shimmering luminosity, hence the adoption of the alternate term "chromoluminarism" to this method of painting. But Gage asserts that is not color but texture that shimmers and shifts in our visual field as a result of pointillist technique.

The argument according primacy to the dot itself, instead of color, to which I ascribe here, centers around the issue of fusion. If, as Meyer Schapiro has averred, the dot emerges at Seurat's "tangible and ever-present unit of measure,"¹²¹ and if, as Seurat himself wrote to his friend Fénéon in 1894, technique is the "soul and body" of his art, the field of individuated dots brings the metric apparatus to the pictorial surface.¹²² Proponents of the color theory model look for the degree to which Seurat was successful in producing optical mixing, which depends upon the fusion of the dots into a relatively smooth surface. In his discussion of viewing distance, Homer cites two passages, one by Fénéon, the other by Pissarro, to support the claim that the paintings should be viewed at a distance at which optical fusion can be achieved. Fénéon notes that as a viewer retreats from the painting, "all the multicolored specks melt into undulant, luminous masses. *The technique, one might say, vanishes*: the eye is no longer attracted to anything but that which is essentially painting."¹²³ Here, Fénéon clearly ascribes to the conventional expectation that the paintings should be viewed at a distance at which they appear analog, at a distance at which the digital technique is no longer perceptible, and the painting can present itself as reassuringly continuous, smooth, ambiguous, and aesthetically analog. Likewise, in an interview, cited again by Homer, with George Sheldon, Camille Pissarro was reported to have instructed pointillist paintings to be seen "as Nature is seen, at a distance sufficient to allow its colors to blend; or generally speaking, at a distance as long as three times its diagonal."¹²⁴ Nevertheless, Homer also dictates that the distance of three times the length of the diagonal (six feet in the case of the small canvas of *Les Poseuses*, 1888) prescribed by Pissarro is also the distance at which the eye will register the greatest degree of shimmering luminosity, or what Rood calls "luster." But luster is most evident when only partial fusion is achieved. Here, at this fixed distance, an oscillatory effect occurs, between fusion and separation, so that, "as hard as one tries, at a distance of six feet most of the colors can neither be make to fuse completely nor can they be seen individually. One's eye is simply caught between the horns of a visual dilemma."¹²⁵

Gage, following but pressing further than Homer, has attested that the standpoint from which Seurat's, and fellow Neo-Impressionist Paul Signac's paintings would have

¹²¹ Schapiro, "Seurat" p. 102

¹²² Seurat quoted in Gage, p. 448, n. 1.

¹²³ Félix Fénéon, "Le Néo-Impressionnisme," *L'art moderne*, May 1877: 139. Cited in Homer, p. 170. Italics added.

¹²⁴ George Sheldon, *Recent Ideals of American Art* (New York, 1890), p. 160. Cited in Homer, p. 294 n. 103.

¹²⁵ Homer p. 173.

been viewed was *not* at a distance at which the viewer could have achieved optical fusion. Instead, the dots would have remained visible as discrete points. As such, the makers of these paintings would not have used a digital technique to produce an analog aesthetic experience, but would have used a digital technique towards digital aesthetic ends. The pointillist method did, finally, parade its digitality, and by extension, implicitly rejected the occlusion, as in perspective painting, of the technical, metric scaffolding underlying the pictorial structure.

Homer nudges towards this conclusion by asserting that the ideal viewing position of a pointillist painting is not the point at which the discrete dots fuse into a smooth contoured shape or plane of color, but rather the standpoint from which the eye cannot quite resolve the dots into an integrated whole. And despite evidence that both Signac, in his early pointillist works, and Pissarro, as indicated above, designed their canvases to be viewed from a distance at which the dotted brushstrokes would blend into an even mixture of color, Gage notes Seurat's variation in the size of the dots, emphasizing in particular the areas in which Seurat reworks the canvas, but to increase rather than decrease the size of the dots, thus rendering perceptual fusion impossible unless the painting was to be situated at a great distance from the observer. Gage speculates that In *La Grande Jatte* and *Les Poseuses*, this variation in size and shape of the dots may be due to the fact that the two paintings "were painted in a studio too confined to allow the artist to stand back very far, with the result that he found the dots too small for the size of the canvas."¹²⁶ It is also striking that despite Signac's recommendation in a journal entry from November 22, 1894 that the observer situate himself in a favorable condition for fusion of the dots, after this date Signac himself enlarged the dots "so that by the end of the 1890's fusion can no longer be in question."¹²⁷

According to Schapiro, already in 1958 too much had been made of the scientific basis of Seurat's artistic methodology. Unlike Homer and later respondents, such as Alan Lee, Schapiro distantiates Seurat's scientific interest and intention from the paintings themselves, placing his focus on technique, in particular, to show the perceptual and aesthetic affordances given by Seurat's technique (which is digital), which combines precision and austerity with a sensitivity to variation, a richness and complexity that counters accusations that Seurat's painting were so riddled by his programmatic, technical theorizations that they balanced on the edge of failure.¹²⁸ Roger Fry reports that as Seurat's practice developed until his untimely end, brought by diphtheria, in 1891, his great passion for his method overtook the "sensibility"—the sensitivity to minute gradations and variations in tone and value (analog traits, as I have defined them)—that was visible in his earlier paintings, such as his *Bathers* of 1883-4, made a year before Seurat's adoption of the pointillist method was unveiled to the world in the form of the *Grand Jatte*. According to Fry, during the course of Seurat's life, "demonstration would replace inspiration and theory passion."¹²⁹ Whatever Seurat's scientific and theoretical influences may have been, Schapiro counters (in 1958 to Fry's essay of 1924), they matter little when faced with the paintings themselves, which exhibit a virtuosity that

¹²⁶ Gage p. 452

¹²⁷ Gage p. 452 n.34

¹²⁸ Schapiro p. 103

¹²⁹ Roger Fry, *Seurat* (London: Phaidon, 1965), p. 14

make them more than mere demonstrations of the validity of his method. Numerous scholarly studies have emerged on pointillism and optics, pointillism and color theory, pointillism and industrial technology, and pointillism and the printing press, to name a few. These treatises attempt to identify the ways in which this rather short-lived moment in the history of art reflects the massive cultural and technological changes coinciding with and resulting from the industrialization and the rise of mass culture. Schapiro's critical response to these scientifically inflected readings of pointillism appears to be a way to recuperate the autographic uniqueness of Seurat's practice. It is a way of reframing Seurat, of viewing his painting not simply as a series of weak dabblings in popular science by a late 19th century dilettante, but rather as complex, ambiguous, and artistically ambitious meditations on the effects of culture and technology on human perception.

While Schapiro, unlike Homer and his later respondents, such as Lee, maintains that Seurat's interest in color theory, optics, and the science of perception doesn't significantly affect the aesthetic import of his paintings, Lee's approach illustrates what I am trying to avoid here. Lee sets about to contradict the view that Seurat was a great pioneer, in the manner of da Vinci, in the conjoining of art and science, claiming instead that it was Seurat's blundering with and fundamental misunderstanding of optical principles that led to the development of chromoluminarism.¹³⁰ However, there are many "sciences" of painting, and many scientific and mathematical discoveries have exerted influence on norms and conventions of depiction for centuries. Whether Seurat's grasp of science was virtuostic or naïve, accurate or false, his method makes visible a particular *technology* of depiction and a correspondingly technological worldview.

Seurat's technologized application of paint to canvas in grains or dots introduces a form of handmade or gesturally implemented digitality. Although it is systematized and algorithmic, and in its systematization often evokes mechanical and industrial metaphors in the critical literature on his work,¹³¹ it is, seen in one way, precisely the fact that it is handmade and not mechanically produced that preserves its palpably digital aesthetic, even it is also this very handmadeness that prevents the dots from exhibiting a digitality in a strict sense, insofar as they are not interchangeable, their limits not quantitatively defined and thus not perfectly syntactically disjunct. Not only is optical blending *not* necessarily Seurat's goal, a conclusion that can be reached by considering the conditions under which the work would have been viewed, a point I will elaborate further, but it is the analog inconsistency of size and placement of the dots that prevent perfect fusion.

Alan Lee has conjectured that

the technique of pointillism *cannot* give perfectly uninflected areas of colour, even when the surface is viewed from a distance sufficient to ensure optical blending. This is so simply because it is not possible manually to apply spots of paint with perfect regularity. If, by some mechanical means this had been

¹³⁰ Lee p. 222

¹³¹ See for example Norma Broude's essay tracing the possible influences on Seurat's technique and worldview of the invention of photo-mechanical color printing in the 1880's. Norma Broude, "New Light on Seurat's 'Dot': Its Relation to Photo-Mechanical Color Printing in France in the 1880's," *The Art Bulletin* 56, no. 4 (December 1974): 581-589.

possible, then completely blended and uniformly flat colour surfaces could have been produced.¹³²

But to suppose, as Lee seems to do, that Seurat *would* have chosen a perfectly digital system if he could, or that he would have increased the resolution to the point of perfect uninflected fusion seems to run contrary to the fact that the ideal viewing position is one at which fusion is impossible. Lee's presupposition that Seurat imagined a teleological progression towards analog smoothness is precisely the argument I want to avoid. What is far more interesting to me, as we will see in the case of Daniel Rozin's 1999 installation *Wooden Mirror*, is to what end artists work against smoothness and resolution, choosing instead to foreground discrete, disjunct, digital or semi-digital systems of depiction.

In concurrence with Schapiro's claim that pointillist technique contains a significant aesthetic and political import in calling attention to "its own mode of operation," I contend that Seurat, and later, Signac's greatest contributions to modern aesthetics lie in their ability to render (connotatively) equivalent their painterly mode of operation with technology itself.¹³³ Operational modalities can be interpretively defined as encompassing the material and symbolic tools marshaled for the act of representation. Seurat and Signac both refuse to smooth over the mediating nature of media. But whereas the Impressionists employ a similar self-reflexivity to capture the transience and subjective contingency of vision, Seurat and his compatriots use a regularized system to conjure an image of a highly mechanized, mass-produced modernity. As Stephen Eisenman has written, "[p]ainted in discrete dots of color, applied according to a preconceived system, Neoimpressionist pictures are a kind of exaggeration or parody of the very type of industrial and alienated labor then expanding in France" with the rise of industrialization.¹³⁴ Consequently, while the origin of Seurat's technique in science and optics may have been overwritten,¹³⁵ the notion of technologically mediated vision embedded in the texture of their painting speaks volumes without having to embody conclusively any optical scientific theories of the day.

Although Schapiro minimizes the scientific aspect of Seurat's practice, the multiple references to mechanical production in the historiography of pointillism cannot escape notice. Mechanical image-making technologies are not of course automatically digital, so it is not this facet of chromoluminarist painting that lends it comparative value to computationally generated digitized images. In fact, while he contrasts the atmospheric haze of Pissarro and Monet's painting with Seurat's "sympathetic vision of the mechanical in the constructed environment," Schapiro most emphatic statements emphatically refute accusations that Seurat's painting tries so hard to be scientific that it ends up being overly mechanistic, devoid of the luster and vital liveliness that Seurat sought to achieve through this new technique.¹³⁶ Later, after the turn of the 20th century, pared down and geometrical strains of modernist art such as Futurism and Suprematism

¹³² Lee p. 208

¹³³ Gage p. 452.

¹³⁴ Stephen F. Eisenman, "Mass Culture and Utopia: Seurat and Neoimpressionism," in *Nineteenth Century Art: A Critical History* (London: Thames and Hudson, 1994), p. 281

¹³⁵ As Schapiro has admonished proponents of scientifically-inflected interpretations of Seurat's work, "how to paint brightly is no secret requiring a special knowledge of science." Schapiro p. 101

¹³⁶ Schapiro p. 108

elevated the mechanical to new heights by incorporating mechanistic elements into the form and content of painting. But after the seeming ease with which Impressionists injected a sense of immediacy and dynamism into scenes of industrial and urban life, Seurat's apparently "rigid" systematicity fails to conform to the traditional aesthetic standard that art be allographic: that it must bear the unique mark of the artist's hand.¹³⁷ Pointillism, according to this line of thought, is too scientific to achieve full aesthetic potential; art is made possible by the invention and repetition of technique, but if that technique appears to impinge upon or even override the harmonious realization of form itself, then it detracts from instead of contributing to the aesthetic value of the artwork. Thus, the accusation that Seurat's painting is mechanical is implicitly perjorative. In order to valorize Seurat, Schapiro is careful to frame his "virtuosity" in opposition to his alleged mechanicity. And though Schapiro concedes that Seurat's method confers a quasi-metric order upon his paintings, he is also quick to rejoin that "I cannot believe that an observer who finds Seurat's touch mechanical has looked closely at the pictures."¹³⁸ For Schapiro, the variety in size and shape of the dots confirms the allographic nature of Seurat's painting, and reasserts his conformation to a properly allographic/auratic aesthetic sensibility, but as I have suggested above, it is precisely this choice to enlarge the dots that preserves the visibility of his digital pictorial architecture.

Nevertheless, pointillist technique undeniably imposes a deliberate, ordered structure to the paintings that stands in opposition to the looser, intuitively applied daubs of paint exemplary of Impressionism. Schapiro himself, despite his argument for Seurat's non-mechanical virtuosity, proclaims that "the world is not perceived as a mosaic of colored points, but this artificial micro-pattern serves the painter as a means of ordering, proportioning, and nuancing sensation."¹³⁹ Order and nuance coexist in this painterly dimension, which preserves the allographic quality of these paintings. But this is not just any type of order; in fact, Seurat's dots, according to Schapiro, "are his tangible and ever-present units of measure."¹⁴⁰ Here we are faced with another possible contradiction—is pointillism a technique of nuance, luster, and sensation? Or is it an ordered, metric system—the kind of system that compels interpreters to remark upon its calculated, quantified, and mechanistic style?

One way around this interpretive polarity is to propose that Seurat's method is *digital* rather than mechanistic. The antecedent form of the mosaic is almost universally marshaled in descriptions of pointillism. And as Walter Seitter has noted as a point of proof for his argument that painting has always been digital, the mosaic "has clearly stood up for and demonstrably displayed the inevitably digital quality of painting.... If the mosaic can be described as an archaic form of the picture that stubbornly insists on its constitutive digitality, then the ruin would be the late form of the picture, which... would finally admit that it was built from strokes, blotches and spots."¹⁴¹ And further, "one of

¹³⁷ For further consideration of the dominance of allographic arts in traditional aesthetics, and of the challenges posed by the introduction of autographic technologies and movements, see chapter 3 on algorithmic art and the aesthetics of code. See also Kirk Pillow. "Did Goodman's Distinction Survive LeWitt?" *The Journal of Aesthetics and Art Criticism*, Vol. 61, No. 4 (Autumn, 2003), pp. 365-380.

¹³⁸ Schapiro p. 103

¹³⁹ Schapiro p. 102

¹⁴⁰ Schapiro p. 102

¹⁴¹ Seitter p. 31

the directions adopted by the painting of the nineteenth century was the path to voluntary ruin, that is, the mosaic: first in Impressionism, which constructs the painting from a multitude of small dots of paint without smoothing out the resulting *coarse* structure; and then Cezanne, who applies dabs of paint on top of previous dabs of paint.”¹⁴² Neither Impressionism nor the uncategorizable modernism of Cezanne bear sufficient evidence that they fulfill the requirements for true digitality. The perception of shared “points”—the atomic building blocks of pointillist figures—is manifested quite differently in pointillism than in impressionism. Neither Impressionists nor Cezanne assert both syntactic and semantic disjointness in their inscriptive practices. However, pointillism marks a point of departure precisely because it is syntactically and semantically disjoint, and even leaves traces of this aggregate character when viewed at a distance from which fusion is possible.

Impressionism is a method of capturing fleeting impressions and sensory ephemera. In fact, it was exactly the Impressionists’ desire to capture “fugitive appearances” that led to the rejection of this painterly model by the Neo-Impressionists.¹⁴³ By contrast, Seurat has been accused of being “rigid and systematic in his method,”¹⁴⁴ which has led to comparisons between his figures and the Pan-Athenaïc Frieze of Phidias on Parthenon.¹⁴⁵ The frieze-like character of Neo-Impressionist painting has been attributed partially to the positioning of the figures and their appearance of frozen statuesque immobility, but also to the dots themselves: to the particular organization of shape, volume, surface and depth imposed by the constraints of pointillist technique. Modernism has often been characterized by the ubiquitous incorporation of technical or industrial model into art production. Recall Seurat’s comment to Fénéon that writers and critics “see poetry in what I do. No. I apply my method and that is all.”¹⁴⁶ Schapiro writes that Seurat has a “taste for the mechanical” and appears as an “engineer of his paintings, analyzing the whole into standard elements...and exposing in the final form, without embellishment, the working structural members.”¹⁴⁷ Fry surmises that Seurat “proceeded perpetually by analysis and classification” and that his synthetic analysis “appeared to him to be a mere logical deduction from the classified data of sensation—a deduction which could be stated by perfectly ascertained and preconceived methods.”¹⁴⁸ By articulating his subjects as the outcome of a logical process of deducing and organizing raw data, Seurat demonstrates how to render pictorially the rigorous, programmatic logic that emerges with such force in the Enlightenment, is applied to technologies of mass production, reproduction, and mechanization in the industrial era, all the way to the computationally automated algorithms of the digital age.

Let us take another look at Seurat from a different angle: his relationship to the traditional aesthetic model of *disegno*. For Ingres, drawing not only facilitated recognition of the object at hand. Skilled draughtsmanship was tantamount to poetic expression; without drawing, the artist could not manifest the complex relationship

¹⁴² Seitter p. 31

¹⁴³ Eisenman p. 278

¹⁴⁴ Eisenman p. 277

¹⁴⁵ Roger Fry, *Seurat* (London: Phaidon, 1965), p. 7. See also Eisenman p. 277.

¹⁴⁶ Seurat cited in Gage, p. 448, n. 2

¹⁴⁷ Schapiro, “Seurat” p 108.

¹⁴⁸ Fry p. 9

between inner feeling and the external world. However, in the latter years of the nineteenth century, the ascendance of a “light-dark continuum,” charted by Linda Nochlin and others, ends the reign of *disegno*. Whereas lines individuate objects by designating their limit with a sharply contoured edge, a regularized application of dots both alters the appearance of volume and depth in the object, but also challenges the notion of the “edge” as the limit of the body, the point at which one object ends abruptly and another begins. Lines preclude the commingling of matter or the indiscernability of limits. The emphasis on line instituted by proponents of *disegno* discourages or even precludes an indeterminate “sharing” of particles between depicted objects. Under the regime of *disegno*, the edges of a body cannot remain indistinct, so that a mass reveals itself slowly and coyly, without the sharp decisiveness of the draughtsman’s pen.

The use of dots to produce shapes and contours generally lends Seurat’s paintings sense of indistinctness, a slight haze and dispersion of figure into ground. His technique, despite its airs of precision and its vulnerability to criticism on the basis of the wooden frozenness of his figures,¹⁴⁹ dismantles the notion that individual bodies are distinct, self-contained, and autonomous, suggesting instead that bodies, objects, foreground and background bleed into one another, and maybe are not so absolutely differentiated after all. However, while this is a perceptual effect of Seurat’s paintings, it is unequivocally part of Seurat’s artistic or philosophical program. In fact, there is evidence in the paintings that Seurat was concerned with contour, as well as object distinction, and in order to stay within his self-imposed algorithmic program (applying paint in dots rather than lines) he dealt with this problem not just by deploying the contrast of light and dark regions, by turning to the specifically digital issue of *resolution*. Seurat’s dots in one sense fail to conform to a true digital system—they are not interchangeable, varying in size to greater and lesser degrees in different areas of the picture. But Seurat makes his dots smaller when he is defining a contour; as such, the variation in size of Seurat’s dots correlates to the tradition of *disegno*, but uses dense, highly-resolved chains of dots to produce a linear effect. Where contours require solidification the dots become smaller, and therefore tend towards continuity. Decreasing the size of the dots effectively increases resolution; in shrinking the granulated dots and placing them more proximately to one another, Seurat mimics linear contours and dissimulates analogicity by creating the effect of “the large, smooth curves that respond to Ingres’ norm of good drawing.”¹⁵⁰ Whether or not this smoothing of the digitized surface and the creation of an illusion of continuity is necessary for Seurat’s ostensibly naturalist program, it does suggest a certain anxiety in his practice, or even provokes anxiety in his viewers setting up a contradiction in terms. Seurat’s greatest aesthetic innovation—his contribution to the expansion of received aesthetic parameters—is that his pointillist method manages to produce a strong aesthetic effect from its own refusal to smooth over the constitutive digitality of painting. In contrast with the sometimes grotesque immobility of his figures, his method redefines, potentially, the very definition of images. His strongly programmatic method, paradoxically, creates painterly surfaces and objects whose

¹⁴⁹ “And yet, for all this close adherence to observation, how unlike anything natural these pictures are! How utterly fixed and immovable everything is! His pictures are alive, indeed, but not with the life of nature.” Fry p. 10

¹⁵⁰ Schapiro p. 106

shimmering insubstantiality reveal the images as fundamentally evanescent, always-already on the edge of fragmentation and disaggregation. As Schapiro has shown, without Seurat's "peculiar means" we would not have "his surprising image-world where the continuous form is built up from the discrete, and the solid masses emerge from an endless scattering of fine points—a mystery of the coming-into-being for the eye."¹⁵¹

In 1889, Seurat painted *Eiffel Tower*, a heavily discretized canvas whose insistent digitality—its enlarged touches of color and a preponderance of high-contrast and primary colors—destabilizes the opposition between figure, ground, void and volume by allowing matter and ether to bleed together due to the juddering placement of the dots. Painted before the tower had reached completion, Seurat's method creates a digital screen. His rejection of decisive linear strokes causes the top of the tower to, instead of ending abruptly, simply dissolve into the blue of the sky, rendering indiscernible the exact moment in which iron lattice gives way to its enveloping atmosphere. Especially because it is painted by Seurat, the most technical of painters, this work can be read as a convenient testament to the changes, whether viewed as advancements or abominations, in the Parisian landscape wrought by the spectacular forms of industrial technology and similarly radical ruptures occurring in the theory and technique of pictorial representation. What is most compelling for me about this work—the punctum or perceptual fulcrum that then inflects my reading of the composition as a whole—is the zone of indiscernability at the juncture of tower and sky. Seurat chosen to paint a construction zone rather than a ruin, a monument to the imagined future rather than a nostalgic view onto the classical architecture of a distant past. But it is, oddly, the modernity of his technique—its almost industrial systematicity—that confers a sense of the pastoral onto this structure, interpreted variously as monstrous or elegant. In other words, it is precisely the ability of the highly articulated dots to construct a dispersed, low-resolution pictorial architecture that de-emphasizes the incompleteness of the structure itself, instead causing it to blend organically and harmoniously with its surroundings. The lack of distinction between figure and atmosphere lends this painting a sense of abstraction that is a specifically *digital* rather than geometric abstraction. It is an abstraction that feeds not simply on the flattening or simplifying of shapes, but plays with the possibilities for perceptual surprise that emerges with the early consideration of a digital, or notational system for composing on a canvas.

b. Paul Klee's Pictorial Notations

By 1931, Paul Klee had applied his own theory of divisionism to an even greater level of abstraction, painting works such as *In Copula* (1931), *Fermata* (1932) and *Tendril* (1932), in which a delicate tiling effect produces an impression of an ethereal, light-and fog-mottled atmosphere onto which curling or swirling lines, arrows, and circular suns are superimposed. These dark, continuous strokes punctuate the textural surface and function as a reminder of the canvas's flatness instead of implying the recession of objects into space. These paintings, a series that also includes his masterpiece *Ad Parnassum* of 1932, share a link with Klee's strategy, developed around 1920, of arranging rectangles of color in grid patterns on the canvas. While his earlier "magic squares" experiment with visually conveying musical harmony and counterpoint

¹⁵¹ Schapiro p. 101

through the juxtaposition of tones and colors in a rectangular grid, his divisionist phase intensifies the digitality of his compositions. By reducing the size of the individual unit, he turns the focus away from the geometric quality of the module, shifting attention instead to the aggregative function of the module and placing emphasis on the notionally extended world created by this metric or quasi-metric configuration. Klee's deep concern for structure, for the building blocks of the material world, and the relationship between spatial and musical structure (where each rectangle is conceived dually as a physical block and a distinct musical note), is evident in paintings such as *Static-Dynamic Gradation* of 1923, and later paintings, such as *New Harmony* of 1936, which employ the earlier technique. But viewing the products of both of these artistic phases, in conjunction with a consideration of his interest in graphical notation, specifically the possibility of visually annotating rhythm, calls attention to the conceptual and visual digitality of his artistic practice.

Working between the first decade of the 20th century and 1940, a year in which, before his death in June, he had already completed 366 works in various media, Paul Klee during the course of his lifetime produced a massive and stylistically diverse oeuvre. Alongside his approximately 10,000 etchings, drawings, prints, and paintings, which, to date, fill a weighty nine volume catalog raisonné, he also meticulously documented his practice in a compendium of notebooks. In addition to painting and writing, Klee was a practicing musician. This multimedia approach to art—one that comprises writing, pictorialization, and music, resulted in a practice that brought each of these branches of the arts closer to a common source, and was deeply invested in the notational systems that enable musical, verbal, and pictorial composition. Just as other early 20th century artists, such as Wassily Kandinsky, Klee was fascinated with the possibility of creating a visual language that could build a synesthetic bridge between music and painting. Klee was a musician, it is true, but as Ileana Marcoulesco, among other modernist historians, has put it succinctly,

in that period, the kinship of music and painting was in the air. Ravel had launched the notion that the laws of harmony were the same for music as for painting. Since Rimbaud and Baudelaire, artists had been on the lookout for correspondences between colors and vowels, and colors and moods... Colors were first of all qualities; secondly, they had weights, thirdly, they could be measured, and so forth.¹⁵²

In 1849, Richard Wagner envisioned grandiose stage productions that would incorporate a multitude of artistic media into a “total work of art” (*Gesamtkunstwerk*).¹⁵³ In his 1911 treatise *On the Spiritual in Art*, Wassily Kandinsky proposed an aesthetic theory heavily dependent on synesthesia, a condition in which neural pathways cross, producing sensory responses that do not necessarily correspond to the kind of stimulus applied. A synesthete, then, might taste colors, or hear musical tones when viewing certain shapes, or, as Kandinsky gleefully insisted, “our hearing of colors is so definite that it would be hard to find anyone who would try to express bright yellow in the bass notes, or dark lake

¹⁵² Ileana Marcoulesco, "Unclassifiable Klee," in *A Piece of the Moon World*, 13-27 (Houston: Menil Collection, 1995), p. 16

¹⁵³ Richard Wagner, "Outlines of the Artwork of the Future, The Artwork of the Future 1849," in *Multimedia: From Wagner to Virtual Reality*, 3-9 (New York: Norton Publishers, 2001).

in the treble.”¹⁵⁴ Whether actual or metaphorical, the implications for synesthetic perception were clear to Kandinsky, who believed that as painting approached the condition of musical composition through its unfettering from naturalistic representation, it would achieve an ever-greater level of purity.¹⁵⁵

Klee’s point of entry, the term that illustrates for him the most productive point of intersection between the visual arts and music, is *rhythm*. Rhythm, like writing or other digital modes of inscription, is articulated, metric, and algorithmic. And as Goodman shows at length in *Languages of Art*, scoring, the method of graphically notating musical compositions, is notational; as such, it is an inscriptive modality that is classified alongside digital systems.¹⁵⁶ Notational systems share different rules that those typically associated with pictorialization, which, as I have discussed at length in Chapter 1, is most often conceptualized as a fundamentally analog system in its density, richness, and continuity. His “creative credo” of 1920 reads like a formula for a notational painting practice, or more precisely a notational system, as in music, that can be used to “compose” a painting. Painting, as a system of depiction rather than notation, deviates from musical composition in that there exists no regularized set of notational marks. If a painter adopts a notational “system,” as in the case of Seurat, it will be unique to his or her own practice, and thus not fully replicable in the manner of a true notational system. The semantic content generated by that painter’s syntactical system will not extend unambiguously into other artists’ practice, so that we cannot “read” a painting by Barnett Newman according to the system advanced by Klee. True notational systems, such as musical notation, must contain what Manovich calls “transcodability,” or what I will provisionally call transmedial legibility.

Riddled with references to elementary units, dots, centers, points, elements, bits, and planes, this early text describes a quasi-notational schema: Klee narrates the movements he will take with his reader, namely a “little trip into the land of deeper insight,” instructing about how to achieve graphic purity, which we will navigate “following a topographic plan.” When we “stop to catch our breath,” the topographical mark will be “the broken line, or the line *articulated* by several stops.”¹⁵⁷ Distance traveled is a “sheaf of lines”, a boat is a “wavy line”, and a bridge is a “series of curves.” When we “travel joyfully together” lines converge, but when we inevitably disagree, the lines are drawn “independently of each other.” We cross an unplowed field that is a “plane traversed by lines.” A cart becomes a wheel, a child with curly hair “corkscrew movement”. Lightning flashing on the horizon is a “zigzag line,” and stars are “scattered dots” At some points, however, Klee’s desire to convey the potential vivacious dynamism even in his “notational” or hieroglyphic system begins to break through his rhetoric. His description of static graphic elements is replaced by reference to dynamic, expressive movements, catalyzed, we can only assume, performatively by the marks themselves—the child’s hair is not just a corkscrew but a corkscrew movement, our excitement as we

¹⁵⁴ Wassily Kandinsky, *Concerning the Spiritual in Art*, trans. M.T.H. Sadler (New York: Dover, 1977), p. 25

¹⁵⁵ Kandinsky p. 20.

¹⁵⁶ Goodman p. 178.

¹⁵⁷ All quotations from Paul Klee, “Creative Credo,” in *Theories of Modern Art: A Source Book by Artists and Critics*, 182-186 (Berkeley: University of California Press, 1968). Emphasis added.

travel is manifested in vibratory qualities within the marks: “expression, dynamism, emotional quality of the line.”

The notational aspects of Klee’s work have been recognized frequently, usually with respect to his attempts to translate both quantitative and qualitative aspects of music into a pictorial form of graphic depiction. In other words, musical scores and alphabets, as notational systems, use inscriptive systems that communicate a field of “meaning” (a melody, a sentence) irrespective of certain aesthetic elements of the configuration.¹⁵⁸ Thus, it does not affect the content of a written sentence, or a bar of music, if it is printed in red or blue ink, or if it is typed in one font or another. As long as the system is truly notational—if each symbol is, for example, discrete and replicable, the message can be transmitted within a range of media. Klee’s paintings and drawings acquired either digital or notational characteristics because he was interested in conveying meanings that are, arguably, more reliably communicated through precise notational systems rather than pictorial ones, which, we recall, are generally understood to thrive on ambiguity. Klee’s paintings then, can be read not simply as hybridizations of pictorial and notational systems, but rather as experiments that test what kinds of meanings can be transmitted *both* notationally and pictorially, or how different facets or valences of meaning might be exposed depending on whether they are notated or pictorialized.

For example, while teaching at the Bauhaus in the 1920s, Klee worked directly with musical scores to develop graphic methods of annotating and depicting the wide range of media in which music can be said to exist—from the notational score to the sonorous event—and the many ways in which it is experienced—as a text, as a rhythmic composition, as a continuously variant tapestry of pitch and timbre. In the pages of his notebooks, Klee attempted to annotate several layers of musical structure that escape the boundaries of the traditional score, with its measures, notes, and time signals. In one sketch, Klee places two bars from Bach’s sonata no. IV in G major for violin and piano. Below the score he sets up a grid, on which, arrayed along the vertical axis, each row stands for one note. The grid covers all the notes in three octaves. Along the horizontal axis, Klee divides each row into columns and uses these rows and columns to notate the pitch of each note by drawing lines that increase or decrease in thickness as the pitch changes. The resulting graphic impression is of a partially grid based, partially continuous line of varying thickness that extends across the page. Underneath this grid, he “set out schematically the qualitative (rhythmic groupings and dynamics) and the quantitative (the measured rhythm) structure of the bar, whereby the former varies as the dynamics change and the latter marks the regular structure (metre) of the piece.”¹⁵⁹

Klee’s practice, then, oscillated between graphically articulating measurable quantities, which can be represented notationally and digitally, and qualities that would

¹⁵⁸ I am not treating here Klee’s engagement with alphabets and writing, not because this aspect of his work is less important or less notational. In fact, I am addressing his engagement with music as one possible notational form among many, and as such it functions as an example rather than the single authoritative case for Klee’s deep, career-long explorations of the possible intersections and deviations between pictorial and notational depiction. For more on Klee’s incorporation of language and alphabetic notation into his depictive schemas, cf. K. Porter Aichele, *Paul Klee's Pictorial Writing* (Cambridge: Cambridge University Press, 2002). Also see Rainer Crone and Joseph Leo Koerner, *Paul Klee: Legends of the Sign* (New York: Columbia University Press, 1991).

¹⁵⁹ Haro Düchtung, *Paul Klee: Painting and Music* (New York: Prestel, 1997), pp. 35-36.

seem to escape quantification, those which are ambiguous, continuously variable, and thus perhaps solely available to analog inscription. As Hajo Düchting has underscored, while Klee was deeply interested in discovering what aspects of pictoriality could, like musical notation, be quantified and reliably replicated, color was for him “the ‘imponderable’ and thus individual element in the picture. While it is possible to quantify line and light/dark—as it is pitch and duration of note—the coloring of the image is not quantifiable; it corresponds to the expressive content of the musical tone.”¹⁶⁰ Klee himself wrote that color is “secretive” and “hard to grasp,” that colors are “the most irrational elements in painting” and possess “a suggestive power.”¹⁶¹ Thus, Klee used the digital form of individuated, discrete and articulated modules as the architectural system in which “imponderables” could be contained and set off to their greatest expressive advantage. Again, similarly to the example of Seurat’s *Eiffel Tower*, the digital here does not foreclose or narrow the range of aesthetic impressions, but rather becomes the structure, the condition of possibility for analog intuitions to be experienced.

In 1953, Vasarely wrote: “all true art is artificial, as opposed to natural.”¹⁶² Paul Klee’s distinction between “natural” and “artificial” does not conform perfectly to the digital/analog distinction, which is based on discreteness and disjunctness as opposed to continuous correlation, but it is related to showing, rather than masking, the necessarily (partially) disjunct, definite acts of delineation that comprise the act of pictorial composition. In his notebooks, Klee wrote that natural order is “the concept of illumination in nature (light form).”¹⁶³ It is the “natural unorganized crescendo or diminuendo. The innumerable subtle tones between white and black.”¹⁶⁴ Artificial order, on the other hand, is an “analytical sub-division to make light and dark measurable.”¹⁶⁵ The middle steps of the scale must become “perceptible and measurable” and the division of light and dark occurs on a “scale of regulated tonal mixture.”¹⁶⁶ Artificial order is characterized by articulation, and is fixed in a definite scale. Klee, however, does not champion this depictive mode, writing first that “to obtain greater precision you must become the poorer,” and again later that it is “impoverished, but clearer and more comprehensible.”¹⁶⁷ While experimenting with fixative, notational or quasi-notational strategies, Klee sets out not to fully digitize his visual alphabet in the manner of Vasarely, as we will see in Chapter 3. Instead, Klee argues that an understanding of natural laws, and its subsequent laws of depiction, must achieve a compensatory balance between the precise but impoverished artificial order, and the “richness” of natural order, where richness is identifiable in movement, illumination, and, most importantly, infinite gradation. Klee’s verbal description is accompanied by diagrams that arrange, for example, the gradation between black and white, and the “concept” of black and white, in

¹⁶⁰ Düchting p. 45.

¹⁶¹ Klee cited in Petra Petitpierre, *Aus der Malklasse von Paul Klee* (Berne, 1957), p. 19. Cited in Düchting p. 45

¹⁶² Victor Vasarely, *Vasarely*, trans. I. Mark Paris (New York: Fine Arts Books, 1979), p. 8

¹⁶³ Paul Klee, *The Thinking Eye: The Notebooks of Paul Klee*, ed. Jürg Spiller, trans. Ralph Mannheim (London: Percy Lund, Humphries and Co. Ltd., 1961), p. 8

¹⁶⁴ Klee, *Thinking Eye* p. 8

¹⁶⁵ Klee, *Thinking Eye* p. 8

¹⁶⁶ Klee, *Thinking Eye* p. 8

¹⁶⁷ Klee, *Thinking Eye* p. 8, 10.

a stepped chart, whose “x”-axis—the gradation from top to bottom—is evenly divided into strips, labeled not numerically but alphanumerically, with letters ranging from a to l. The “y” or left-right axis gives little indication of metric division; two adjacent stepped pyramids extend down from the “a” line—from left to right extending from white (left) to the “concept of white” (right) and a mirror-image of these pyramids reaches upward from the “l” line—black/concept of black. While the top “block” of each pyramid suggests a modular unit, there is no key—no numeric or corresponding alphanumeric register running from left to right that would define

In the subsequent section of his notebooks, Klee moves from the concept of “order” to the graphic visualization of what he names “natural and artificial measurement.” In natural movement, increase and decrease are represented as continuous—a pen-and-ink curve, as narrow as the width of a stylus at each end thickens as it reaches its indeterminate midpoint, smoothly, with no visible means of assessing regular “steps” in its expansion and diminution. This, for Klee, is natural measurement. Artificial measurement, as a function of the imposition of artificial order, “attaches exact numerical values to the steps and so gives us a synthetic method of representing the scale of tone values.”¹⁶⁸ The graphical index of these “exact numerical values,” however, appears not in Arabic numerals, but rather in series of tallying marks, also pyramidal in form. Numeric exactitude, then, is not of the order of abstract computational function, but tabulation. This tallying method deploys the accumulation of marks for the construction of recognizable, geometric forms, such as a row of cathedral-like architectural configurations in his 1927 pen-and-ink drawing *City of Cathedrals*, displayed in his notebooks in the section on natural and artificial measurement.¹⁶⁹ For Klee, form in its most “natural” or numerical/modular/notational manifestation exists in service of “function”—where function is a force of production and creation, the proliferation of vitality and life itself.

Paul Klee’s magic squares actualize the properties of mosaics—their disjoint, articulate surface—without relying on individuated brushstrokes (as in pointillism) or “bits” of tile to create the disjunction between the smoothness and continuity of the image and the disjoint, aggregate surface of the piecemeal construction. Just as a painting is distinct from the image and the picture, the status of the mosaic as artifact must be considered separately from the existence of the picture or image communicated through the constructed surface of the mosaic. But whereas mosaic tiles or Klee’s magic squares become part of the visible structure of the image-object, pixels are generally intended to be hidden from view. The visibility of pixels typically indicates technological failure—the inability of the computer program to effectively *re-construct* in its continuous density the digitized image translated into computer code from its original analog state. As William Mitchell has written, “usually we try to produce images that are of sufficient resolution to render the individual pixels imperceptible, but seeing pixels is not *necessarily* a bad thing. Prominent pixels call attention to the process by which a digital

¹⁶⁸ Klee, *Thinking Eye* p. 10

¹⁶⁹ Chapter 4 will introduce Casey Reas, an artist whose work involves a strong pedagogical aspect. While Klee used his notebooks, and many of his drawings and paintings, as pedagogical tools for his students at the Bauhaus, Reas, also, produces a handbook for his own, fully computational programmatic language, *Processing*, in 2008. Similarly, Victor Vasarely, the primary subject of Chapter 3, envisioned a fully programmatic visual alphabet that could be taught to and replicated by future generations of artists.

image is actually put together, in the same way that photographic grain or painters' brushstrokes can, and this may be an important part of an image's point"¹⁷⁰ Klee's magic squares prefigure Mitchell's assertion here, one that might seem most readily applicable to the digital formalism of Angela Bulloch, Jodi, and other artists who, in the legacy of high modernism and conceptual art (two systems not altogether opposed in their propensity to interrogate the limits of the artistic medium) use electronic computers increase the visibility of the discrete structural elements of digital artifacts rather than simulating analog density and continuity.

Even more than divisionism, which at least notionally resolves the digital application of "points" or dots into a smooth, almost foglike texture, Klee's technique places the tiling effect at the forefront of the viewing experience. The units or tiles themselves, then, are more than a byproduct of a digital painterly technique; the centrality of these tiles imbues these paintings with a semantic, not just a structural, digitality. Klee's obsession with units—the building blocks of science, plastic arts, music, and nature—manifests itself sensibly in his paintings, but is also outlined programmatically in his writings. His notebooks contain not only his musings on translating musical notation to pictorial depiction, but also numerous formulae for textural effects achieved through tiling that experiment with black and white checkerboard patterns, assigning numeric values to white and black and thus imparting a calculating function to the pattern of blacks and whites.¹⁷¹ This schema is explicitly numerical, tending even towards binary representation, highlighting the digital aspect of his work, identifiable in his assignation of a specific structural, rhythmic and numerical value to his symbol systems that can be reiterated throughout his practice. Later in the notebooks, he evaluated rhythm again from the perspective of a black to white variation in tonality, but here, the description itself of white—the quality of white—approaches the digital in an even more explicit manner than we have seen thus far. For Klee, "scales, whether divided into small intervals or large, of equal size or sub-divided, all belong to the sphere of structural articulation."¹⁷² His intervals as described as distinct units with a distinct color standard from which there are degrees of variation.

In both Klee's "magic squares" and his divisionist works such as *Ad Parnassum*, the structural, textural, and color-based harmonic effects of the picture all derive from his adoption of a modular schema. Modularity, according to Manovich, can be called the "fractal structure of new media."¹⁷³ Manovich writes: "Media elements, be they images, sounds, shapes, or behaviors, are represented as collections of discrete samples (pixels, polygons, voxels, characters, scripts). These elements are assembled into larger-scale objects but continue to maintain their separate identities....[T]modular structure of new media makes...deletion and substitution of parts particularly easy."¹⁷⁴ The module, in Manovich's description, exhibits digital qualities of discontinuity and interchangeability. In Klee's painting, which generates a digital, modular schema from a traditionally analog

¹⁷⁰ William J. Mitchell, *The Reconfigured Eye: Visual Truth in the Post-Photographic Era* (Cambridge: MIT Press, 1992), p. 69

¹⁷¹ Paul Klee, *Notebooks Volume 2: The Nature of Nature*, ed. Jürg Spiller, trans. Heinz Norden (New York: George Wittenborn, 1973), p 231.

¹⁷² Klee, *Nature of Nature* p. 377

¹⁷³ Manovich, *Language of New Media* p. 30

¹⁷⁴ Manovich. *Language of New Media*, pp. 30, 31

medium, any colored module could notionally be substituted for any other, creating different perceptual effects without changing the overall structure of the composition. Both Klee and Seurat could be said to have worked against Impressionism by becoming more formally “algorithmic.” Indeed, moments of collusion between art and science, from antiquity forward, seems to have facilitated or to have prompted the adaptation of scientific-experimental models to image-making practices. But the primary difference between Klee and Seurat is that while Seurat created a digital system, a technique that could be used to reliably generate aesthetic and perceptual effects based on scientific principles, Klee’s notational system, his charts and metric scales, are eminently concerned with the dynamic exchange between the module/particle and its capacity to activate, to catalyze movement. In his notebooks, he wrote that “a particle... must be shaped in such a way as to lend itself to movement and conduction.”¹⁷⁵ Particles “mediate—they are the middle links that receive and transmit.”¹⁷⁶ Nevertheless, he seeks, atomistically, to reduce his schemas to the level of the particle, to identify the smallest structural unit in a grid so that “any reduction or abstraction is barely possible. Each structural particle has the same value.”¹⁷⁷ The activating capacity of the notational scheme is analogized in the relationship between music as a sonorous event and the notational function of the musical score.

Klee’s charts and metric scales track, quantify, and make graphically legible the relationships between light and dark, dynamic and static, nature and artifice, opacity and transparency. Instead of creating a deep division between a dynamic, Romantic or vitalist conception of nature and its systematic quantification in a metric, notational system, Klee attempts to find, precisely by imposing a digital veil over the visible world, aspects of reality that would otherwise remain hidden. Marcoulesco describes his process of dividing and digitizing the world, described in his courses at the Bauhaus, as follows: “take the fish as a whole; find a principle of dividing it—for instance, its own scales; make a grid of it; spread this grid over the whole surface of the painting. The fish and its environment will still be visible through the grid, but the whole will be completely and differently ‘illuminated’ by the grid.”¹⁷⁸ Seurat’s division of matter into digital units, which are subsequently utilized as the building blocks for his pictorial compositions are viewed with suspicion for freezing the rhythms of life in to static, frieze-like geometries. Klee, on the other hand, adopts a notational vocabulary that references music, a time-based phenomenon. System, then, for Klee does not foreclose movement and dynamism, but rather catalyzes it. Consequently, he uses the “particle” and the notational symbol to inject his pictorial surfaces with the rhythmic dynamism of music.¹⁷⁹ Klee then, in a

¹⁷⁵ Klee, *Nature of Nature* p. 53

¹⁷⁶ Klee, *Nature of Nature* p. 53

¹⁷⁷ Klee, *Nature of Nature* p. 183

¹⁷⁸ Marcoulesco p. 26

¹⁷⁹ Considering Klee’s work in terms of a dynamism activated by particles conjures Henri Bergson’s profoundly anti-digital theory of duration and movement. Bergson calls up Zeno’s paradox, in which a flying arrow must be conceived as being motionless if at every moment it occupies a single position. For, in this estimation, the arrow occupies each separate, distinct, disjunct and therefore digital position successively, leaving no room for movement between positions. Bergson, then, would most likely determine that a fully digital system would result in stultification, where movement and duration become, impossibly, a series of immobilities. Henri Bergson, *Creative Evolution*, trans. Arthur Mitchell (Mineola: Dover Publications, 1998), pp. 308-309.

different way than Seurat (as described above) uses systematization against rigidity, deploying a notational symbol system to express the dynamic, vital energies of the natural world.¹⁸⁰

Klee indirectly sets himself against the impressionist quest to capture the effluvium of immediate optical perception and transfer (rather than translate) it onto the canvas. In his 1923 essay “Ways of Nature Study,” Klee encapsulates, with some irony, the impressionist agenda; “In this way excellent pictures were obtained of the object’s surface filtered by the air; the art of optical sight was developed, while the art of contemplating unoptical impressions and representations and making them visible was neglected.”¹⁸¹ Klee’s own ideas about what art should do are encapsulated most concisely in his earlier “Creative Credo” of 1920: “Art does not reproduce the visible; rather, it makes visible.”¹⁸² Contemporary, electronically-computational practices of information visualization echoes Klee’s credo in attempting to graphically render large data sets, effectively setting about to “visualize the invisible.” If digital devices are measuring machines, then Paul Klee’s praxis—his technique and its supporting theoretical armature—fulfills the characteristics of an analogico-digital representational model. To provide a point of reference and contrast, Paul Cézanne has been cited as a painter whose system might initially appear to have digital tendencies. He is read a precursor of cubism due to the incorporation of juxtaposed shards or facets into his color-blocked compositions, so that even “surfaceless” or atmospheric spatial fields resemble the tessellated surface of mosaics.¹⁸³ Cézanne, like Klee, employs basic geometrical elements—most famously the sphere, cone, and cylinder—in his image-constructions in order to emphasize the constructedness of paintings, their status not as imitations of the natural world but as structures that “parallel nature” by revealing the most essential forms of nature in relationship to one another.

Klee, like Cézanne, works toward an understanding of essential forms, but while Cézanne’s concerns remain more prominently pictorial, Klee conducts robust analyses, in a pictorial context, of notational, non-pictorial elements. Thus, not only does he expose the ontology of painting as a constructed amalgamation of parts, but he explores a range of symbol systems that extend beyond pictorial representation. Klee is less easily remarked as a painter of industrialization than his precursors, the Impressionists and Neo-Impressionists, because his references are not the nuts and bolts of industrialized, factory-stamped mass production. Rather, he sets out to conduct an interrogation of the limits of much older notational, (non-electronically) computational, digital systems. Neither Cézanne’s practice, nor that of the cubists after him, is digital, or proto-digital in the manner of Klee or Seurat. The use of pared-down geometrical form is endemic to

¹⁸⁰ K. Porter Aichele has argued that a series of early illustrations by Klee to Voltaire’s *Candide*, examined in conjunction with concurrent diary entries, can be viewed as experiments in the visual modeling of the conceptus of kinetic energy and “nervous energy” set forth by Jean Perrin and Wilhelm Ostwald, respectively. This suggests that Klee’s concept of nature, which was a primary subject of his artistic writings, teachings, and practice, would have been informed by scientific models, and specifically turn-of-the-century energetic and atomic theories.

K. Porter Aichele, “Paul Klee and the Energetics-Atomistics Controversy,” *Leonardo* 26, no. 4 (1993): 309-315.

¹⁸¹ Klee, *The Thinking Eye* pp. 63-66.

¹⁸² Klee in Chipp, p. 182

¹⁸³ Norbert Lynton, *The Story of Modern Art* (London: Phaidon Press Ltd., 1989), p. 23

modernism, but I would not want to argue that all of modernism is inherently digital. Cubism, constructivism, suprematism, even futurism mobilize geometrical abstraction to interrogate traditional representational strategies and to push the limits of painting, but their geometrical units are only very loosely modular, and too invested in exploring specific properties of form (shape, volume, depth) to be identified as notational, discrete, or aggregative (where the aggregate refers not just to the characteristics of the individual “digit” or unit but to the performative *act* of construction as a combinatory, tessellated practice). Thus, cubists seek to rectify the shortcomings of depicting three-dimensional objects on a two-dimensional surface by presenting all faces, angles, and possible points of view of their object simultaneously; the cubist painting “opens up” its object and projects it on the canvas just as a Mercator projection renders the globe on a planar surface, but its facets are not metric, and they are far from regular.

In Cezanne’s painting “the process of deliberation surrounding the application of every single dot of paint seems to postpone the picture’s completion indefinitely.”¹⁸⁴ But this is an application of “dots” that is not digital—when set alongside the notion of time as a series of fixed, crystallized instants, figured in the immobile “points” on the path of travel of Zeno’s arrow, we see that Bergson’s interest in the richness, density, and plenitude of duration works even against the concept of analog signal processing—there is no “measurement” possible in duration, because it contains the potential for compression and extension—an infinity of intermediary steps—to develop *within* moments or measured temporal units. Ultimately, the presence of the “dot” does not necessarily connote digitality nor does it indicate the cultural-historical presence of a digital unconscious or a digital world-imagination. Cézanne’s “vibration of painted flecks and areas of colour distributed over the whole surface of the canvas” do not correlate to Seurat’s procedural, systematic and eminently *technological* divisionist program, not least because Cézanne’s approach to “the empty canvas onto which nature is gradually and fragmentarily brought to light”¹⁸⁵ registers a deep desire to reveal the vital harmony of natural form. Thus, Cézanne’s painting seems markedly *antitechnological* in comparison to Seurat’s own practice, which eschews poetry in favor of technique, and if it is about nature, it is a nature that can be expressed within a verifiable, repeatable scientific system.

II. Digital Structure and Computer Art

With the advent of bitmapping, *Pong*, *Tetris*, and *Tron*, the grid of pixels became an easy trope by which to identify the “digital”. Early digital images resembled the notational characteristics of the EKG, in which only the apex and base represent the significant, information-bearing points on the graphic schema. Whereas in classical *disegno* every subtle modulation of a line adds layers of phenomenological and symbolic valence to the figure, highly pixilated images function similarly to the EKG insofar as each pixel contains a finite amount of undifferentiated information, such as brightness or color, and is demarcated by a precise boundary. The pixel meets Nelson Goodman’s definition of a notational, digital scheme because it is syntactically and semantically

¹⁸⁴ Frank Reijnders, “Painting? A State of Utter Idiocy,” in *Painting Pictures: Painting and Media in the Digital Age*, 20-29 (Wolfsburg: Kerber Verlag, 2003), p. 24

¹⁸⁵ Reijnders p. 24

differentiated or “disjoint.” Much like in Goodman’s notational pressure gauge, each pixel in a bitmapped screen is internally uniform and is recognizably separated from adjacent pixels due to the highly articulated “edge” of each square given by the structure of the grid. In an analog, non-notational system, there is no upper limit to the fineness with which we can read the position of a pointer, or for that matter the fineness of modulation in a line. While the analog pressure gauge the position of the pointer is variable and subject to the discriminatory ability of a reader/observer, because a digital or notational pressure gauge contains a finite amount of information, there is an upper limit past which a greater degree of discrimination on will become meaningless. The gauge counts as a digital system if “each dot [is] taken as marking the center of a region such that any appearance of the pointer within that region counts as an inscription of the same character,” which means that there is no variable information within the character and there exists a definite line demarcating the “inside” and “outside” of the character.¹⁸⁶

If we replace the pressure gauge with the grid of pixels as our digital exemplar, it becomes easy to see how digital systems seem to fall outside the parameters of artistic media; the technological limitations of early bitmapping precluded the richness, repleteness, and ambiguity (at least as they have been recognized in the classical tradition, not just in the West but perhaps even more pronouncedly in Eastern graphesis¹⁸⁷) that confer aesthetic value on classical art objects. This meant that computer-generated art was either relegated to a position of technological primitivism, where judgment of the computer’s potential to produce fine art is to be withheld until a later date, when the density of pixels in a grid becomes great enough to yield an impression of indeterminate fineness, or digital artmaking is deemed a “conceptual” practice insofar as it uses a technological tool to critique traditional aesthetic values and ideologies.¹⁸⁸

Jodi, for example, an artist duo formed by Joan Hemskeerk and Dirk Paesmans in the mid-1990s, became a pioneering figure in the critical/activist practice that became known as net.art. Jodi is the first of a number of artists whose work I will discuss briefly here, who foreground the primary graphical elements of digital structure, most recognizably the pixel. Though their motivation for performatively engaging this digital aesthetic varies widely, and foreground a number of issues ranging from tactical assaults on political and ideological formations, to a cooler meditation on the computer as artistic medium, each of these artists chooses not to obfuscate but to place at a premium the viewer/user’s sensory relationship to the building blocks of digital depiction.

From the inception of their collective, Jodi’s artworks have focused on dismantling the illusion of transparency that occupies the forefront of mainstream interface design. They, with other net.artists including Vuk Cosic, Olia Lialina, Alexei

¹⁸⁶ Goodman p. 158

¹⁸⁷ Masters of calligraphy claim such acute control of their brushes that even the finest, seemingly microscopic traces of ink spidering off the path of the primary brushstroke and the most subtle variations in tone due to shifts in pressure of brush to paper, speed of application of ink, and amount of ink contained on the brush are the result of intention, not accident.

¹⁸⁸ This distrust of the capacity of technology to aid in the production of fine art is observable also in the history of cinema and photography. See, for example, Maxim Gorky, “The Lumière Cinematograph,” in *The Film Factory: Russian and Soviet Cinema in Documents 1896-1939*, 25-26 (New York: Routledge, 1994).

Shulgin, Jon Ippolito, and Heath Bunting launched conceptual investigations into the structure of interface design, turning the interface inside out by replacing pictures with code. These seemingly impenetrable landscapes, comprised of scrolling lines of text, rough-hewn, heavily pixilated geometric shapes, or blocky ASCII graphics, often contain elements of interactivity, but it is an interactivity turned against itself, so that the primary function of the Internet, geared towards information access, is confounded. Embedded links lead to dead-end, empty web pages, leaving the user with a sense of futility, as if waiting for a stubbornly evasive informatic Godot. *g33con.com*, for example, allows the user to select a text box containing a series of URLs flashing in the top left section of the browser window. But when text box is selected, the screen goes “blank” white. All that is visible are the webpage titles—you-talking-to-me-you-talking-to-me-you-talking-to-me.com, then-who-the-hell-else-are-you-talking-to.com, you-talking-to-me.com, well-i-am-the-only-one here.com, and who-the-fuck-do-you-think-you-are-talking-to.com—that bounce from one to the other in an absurd exchange of aggressive commentary, looping in an endless cycle.

The conceptual armature of Jodi’s projects, critical of the slick, numbing spectacle of corporatized information transmission, lends itself to a highly digitized, lo-tech aesthetic often associated with “Glitch” art, which exploits systemic flaws in order to create jittery, stuttering visual and sonic landscapes. As Julian Stallabrass has written of net.art, it reverses the teleology of computer graphics, which have themselves been playing “modernism in reverse” by laying bare the operational principles of the Net and the mystifications at work at the level of interface.¹⁸⁹ Technical operations are mystified by the application of a glossy layer of illusionistic pictorialization. Code is obscured, thus veiling the fact that, as a language, code is shot through with ideology; by extension, the net is an ideological apparatus. Net.artists set out to dismantle or at least destabilize this false naturalization, often by revealing source code or other aspects of the information structures supporting the Net, or by rupturing the thin shell of spectacle by injecting glitches into the system.

In many cases, glitch art transforms virtualized, naturalistic and immersive environments into flattened abstractions. A notable example of this is Jodi’s *SOD*, one of several game modifications the duo has produced that strip down the figurative and representational structure of the interface to abstract, geometrical components. By refusing the spectacular virtualization that seems to be the imagined teleology of the gaming industry, *SOD* illustrates the possible alliance between a “critical digital aesthetics” and the technological/cultural critique initiated by net.art. Soren Pøld has argued that “net.art can be regarded as a reaction to the iconophilia of the computer industry—as some sort of digital iconoclasm.”¹⁹⁰ Instead of framing this work in terms of iconoclasm, I prefer to conceptualize it in terms of interrogation of visibility or regimes of visibility. By foregrounding an aesthetics of digital structure in the terms in which I have been describing them in this chapter, heavily digitized works like *SOD* reveal how

¹⁸⁹ “In modernism, the sign of the contemporary was a geometrical simplicity that mirrored mechanical forms, both being manifestations of a Platonic ideal; in the age of simulation, the sign of the contemporary is the completeness of naturalistic illusion.” Julian Stallabrass, *Internet Art: The Online Clash of Culture and Commerce* (London: Tate Publishing, 2003), p. 34

¹⁹⁰ Pøld, Soren. “Interface Realisms: The Interface as Aesthetic Form.” *Postmodern Culture*. Vol. 15, Issue 2, 2005. np.

computational processing affects what and how we see; it gives a particular shape to and sets new possibilities and limitations for what is included in the realm of the visible.

In the non-computational digital systems developed by Seurat and Klee, there has been no obvious presence of numbers or quantitative informational values to muddy the distinction between digits and computed numerical values. For example, pointillism assembles the image out of discrete points of color. However, the categorical disaggregation of information, numericization, digitization, and algorithm becomes a somewhat tricky business when we begin to examine the qualities of computationally generated images. All too easily and all too often, these four categories collapse into a monolithic notion of “the digital” or “the information age,” described as follows by the Friedrich Kittler. “In computers everything becomes number: imageless, soundless, and wordless quantity. And if the optical fiber network reduces all formerly separate data flows to one standardized digital series of numbers, any medium can be translated into another.”¹⁹¹ Echoes of Kittler’s prophetic intonations about an age in which all forms of communication will be reduced to standardized and optimized channels of frequency and bit rate have resonated in many of the texts in the still-forming canon of digital media studies. In particular, one aspect of Kittler’s rhetoric that has been seized upon most emphatically is the reduction to equivalence that seems to result from the quantitative notion of information derived from cybernetics.

According to the cybernetic view, information can be expressed in quantitative, probabilistic terms. But the problem with the enthusiastic embrace of cybernetics and information theory is that that all kinds of quantities, units, metric divisions, and so forth, are not examined for potential differences but are themselves reduced to equivalence. As I see it, not all artists, theorists, programmers, and users/consumers of our highly mediated economy performatively engage with a potentially or actually quantitatively mediated cybernetic universe in the same way. Not all numbers, universal metrics, and units of information are necessarily perceived as belonging to the notional system of equivalences imagined by cyberneticists. In other words, even *if* ubiquitous digital technology produces an ideal digital subject that processes the world as if it is one giant computer program or algorithm, a glance at recent artifactual history reveal that all quantities are not created equal, and that digits, numbers, code, and information can be taken as individuated phenomena with their own particular qualities. Jodi’s aggressive exposure of the pixel and the bitmapped screen provokes a meditation on the perceptual effects of digitization, but their work does not automatically read as a critical interrogation of a numerical universe. In contrast, the generative, heavily conceptual art influenced forms by Casey Reas is dependent of algorithmic processes, but does not perform an aggressively digitized fracturing of “interface”—the sensuously apprehended image-surface—into digital components in the manner of Jodi.

a. Daniel Rozin: *Wooden Mirror*

In 1999, Jerusalem-born, New York based artist Daniel Rozin constructed a *Wooden Mirror*. In it, a heavy, octagonal wooden frame encases a grid of 830 square wooden lozenges, each of which is mounted on a small servomechanism. When a viewer approaches the mirror, each servomotor receives information relayed through a computer

¹⁹¹ Friedrich Kittler, "Gramophone, Film, Typewriter," *October* 41 (Summer 1987): 101-118, p. 102

program from a hidden video camera, and mechanically angles the square toward or away from the overhead gallery lights. The degree to which each square is illuminated by or shaded from the external light source determines that square's visible gradation from light to dark. As each servomotor receives its real-time information about the figure standing before it, a grossly pixilated impression of the viewer's body coheres into visibility, accompanied by the faint clicking sounds of hundreds of scrabble pieces spilling over and against each other in a continuous loop.

Wooden Mirror is the first in a series of interactive installations fabricated from a variety of opaque, usually non-reflective materials, including wooden pegs, circles of laminated paper, woven fabric, and trash collected from the streets of New York City. In this series Rozin announces that his aim is to explore the relationship between the analog and the digital to "inflict digital order on a material that is as organic as it gets."¹⁹² But, this opens the question: in what features does the digital reveal itself? Why should we think of this piece as digital? Does it use digital technology to create an analog aesthetic experience? Or, does it employ analog technology to leave us with an aesthetic impression of the digital?

What we would expect to see in approaching a mirror, even a "fun-house" mirror, is a detailed if insubstantial image of ourselves generated by the refraction of light, no matter how distorted the results. When confronting *Wooden Mirror*, however, we cannot say the pixilated impression hovering before us is a "reflection," in the same manner as the reflections that appear in the silvered, glass mirrors to which we are so accustomed. Glass mirrors, of course, are mediating surfaces, just like the surface of *Wooden Mirror*, and there exists a long artistic tradition dealing precisely with the mediating effects of mirrors, of which Parmigianino's *Self-Portrait in a Convex Mirror* of 1524 reminds us. But, as Lewis Carroll's tale *Alice Through the Looking Glass* illustrates, it is also easy enough to think of the mirror as offering a visual extension *through* the seemingly transparent surface into a virtual world coextensive with our own. Glass mirrors, in other words, create a sense of continuity between the reflected world and the physical world in which the viewer stands.

Rozin's *Wooden Mirror*, in contrast, compels us to gaze *at* instead of attempting to look *through* the wooden pixels as they sweep towards and away from the light. The opaque, and non-reflective lozenges render a granular likeness of the viewer, but in such a way that calls attention to the modular composition of the interface—the grid of wooden pixels—instead of effacing them in favor of an illusion of transparency. The particulate discreteness of the "mirror image" renders an indistinct, discontinuous impression, dismantling the possibility of a perfect virtualization by foregrounding the digital elements that give rise to the overall pattern. To more concretely illustrate what I'm saying, think, here, of each wooden square in *Wooden Mirror* as a "digit"—a discrete unit that, when combined into a schematic array, constitutes a digital screen. While this schema is comprised of physical, tactile materials, instead of electronic impulses, it is similar to a bit- or pixmapped computer screen, in which the pixels are spatially mapped, arranged in a regular pattern. The surface of Rozin's so-called mirror is configured

¹⁹² Video from Bitforms Gallery, NYC. <http://www.bitforms.com/downloads/129-danielrozin20022008compilation.html>. Accessed April 6, 2010

digitally, then, insofar as it is constructed of discrete, interchangeable, and articulate modules.

A frequent and often unspoken presumption about digital media is that as their technical capabilities expand, so too will the immersive and mimetically naturalistic qualities of their virtual constructions. In the 1980s and 1990s digital graphics could be conventionally recognized by their jagged, pixilated or geometrically simplified forms. But as digital imaging and recording tools have increased their capacity for fineness of resolution, digital pictures have in many cases begun to achieve a smooth illusionism that meets or even exceeds the resolution threshold of the human eye, and as such have become indiscernible from their analog counterparts. Jeff Wall's *Flooded Grave* (1998-2000), for example, bears no indexical relationship to a particular place at a particular time, but is rather a collage of 75 different views taken at different locations over a two-year period.

However, even if it is a technological possibility that the pixel-like "modules" in Rozin's mirrors could be further and further refined, to the point at which they could no longer be perceived by the human eye as individual units, and even if it is feasible that the materials deployed in these mirrors could mimic the color and texture of the person or object facing it, the more interesting question to me is why artists like Rozin choose not to pursue that technological teleology, and instead choose to foreground digital discreteness. Digital technology may be capable, notionally, of virtualizations that appear perfectly coextensive with the physical world. The number of calculations and speed at which they can be carried out by computers is potentially infinite, the upper limit determined only by the limitations of existing, and as we know, always dynamically changing memory storage and processing speeds. Nevertheless, it is important to ask what is achieved by making the digital sensorially apprehensible, by keeping it open as an aesthetic and analytic category worthy of conceptual and perceptual consideration.

Rozin's mirror, finally, despite its initial appearance of a thoroughgoing digitality, ultimately displays an instability in its adherence, or lack thereof, to the categories of analog and digital. Here, although the array of lozenges defines the aesthetic experience as one of discreteness and articulation, the motion of the servomotors is perceptually analog. In other words, their movements and adjustments register as continuously correlated to the position of the viewer, just as a needle in a pressure gauge rises and falls smoothly, as a direct effect of the modulations in the physical quantity of pressure in the gauge. It is only the outermost layer of the interface—the array of discrete, modular wooden lozenges—that defines Rozin's mirror as *aesthetically* digital. Rozin, then, seems in some ways a perfect exemplar of Whitney Davis' category of analogical (rather than analog) art, although his work is more resolutely digital than many of the artists invoked by Davis.¹⁹³ In Davis's account, because works made without computers often analogize digital computation, and works made with them analogize the smoothness and ambiguity of the analog with equal frequency (though not in the examples I have analyzed here), we should no longer privilege their technological ontology but rather observe how the analog

¹⁹³ Davis includes works by Jeff Wall, Ingrid Calame, Massimo Vitali, and Benjamin Edwards, all of whom are artists who participated in *Painting Pictures*, a show held in 2003 at the Kunstmuseum Wolfsburg, Austria, about the state of painting in the digital age. Kunstmuseum Wolfsburg, *Painting Pictures: Painting and Media in the Digital Age* (Wolfsburg: Kerber Verlag, 2003).

and digital are invoked, rhetorically and aesthetically, in works that might be considered *both analog and digital*.¹⁹⁴

b. Jim Campbell: *Ambiguous Icons, Home Movies*

A quick glance through the literature of the 1990s will reveal a heavily polarized set of projections and proclamations concerning the effects of computational technology on culture. Scholars from a disparate range of fields, including literature, cultural studies, history, engineering, and computer science projected either intensely utopian and dystopian views about, for example, the liberatory, democratizing potential of the web, or, alternatively, the demise of embodied, phenomenal experience that accompany the emergence of computational technologies. It is now a truism that the flexibility and mutability of computational graphics technologies shattered the possibility of visual authenticity—the forensic “truth” ostensibly afforded by, specifically, analog photography and film. Both in the world of advertising and in the world of fine arts it becomes increasingly difficult to discern when photography simulated, dissimulated, or indexically documented the world presented in its pictorial frame.¹⁹⁵ Undoubtedly, this dream of visual truth in analog photographic technologies is itself illusory, but it is an ever-present issue in digital works that engage the history of film and photography. By way of conclusion, I will now introduce the work of Jim Campbell, an artist who puts digital and analog aesthetic modalities—and particularly digital graphics, photography and film—into dialog in order to engage questions of visual clarity, resolution, memory and knowledge. In the examples I will discuss here, Campbell overlays analogically recorded moving images and low-resolution, computationally programmed arrays, which are both aesthetically and technologically digital, creating a perceptual and conceptual gap between the analog and the digital. However, this gap does not hierarchize one modality over the other, but rather sets out to reveal how both technical approaches to depiction can be mobilized to de-resolve the image, creating more opacity than transparency, more indices of technological mediation than an illusion of immediacy and clarity.

Campbell’s *Ambiguous Icons—Running Falling* (2000-2004) and *Home Movies* (2006-2008) series translate analogically recorded moving pictures, of single figures running, walking, and falling, or of family events captured by home movie cameras, into shadows that flicker across low-resolution arrays of LED nodes. Campbell’s rejection of graphical resolution exceeds even Rozin’s; his LED grids obscure the particularity of bodies and objects, instead conveying gestures and movements that are intuitively recognizable despite their lack of figural detail. By using digital schemata in this way, Campbell’s work directly challenges Paul Virilio’s estimation that “the demise of the relative and analogical character of photographic shots and sound samples in favour of

¹⁹⁴ “Analogy—like a picture and like an art work—is neither analog nor digital; thus analogy in new media contexts tends to be *both analog and digital*. For my purposes, analogy can be defined as a looking-like that is continuous in some respects with its correlate.” Davis, Whitney. “How to Make Analogies in a Digital Age,” p. 88. Here the correlate includes “looking like” a mirror, looking like a digital array, but also moving with a fluidity that indicates analogicity.

¹⁹⁵ Andreas Gursky has become the exemplar of uncannily and often invisibly manipulated photographs. See also William J. Mitchell, *The Reconfigured Eye: Visual Truth in the Post-Photographic Era* (Cambridge: MIT Press, 1992).

the absolute, digital character of the computer, following the synthesizer, is thus also the loss of the poetics of the ephemeral. For one brief moment Impressionism—in painting and in music—was able to retrieve the flavour of the ephemeral before the nihilism of contemporary technology wiped it out once and for all.”¹⁹⁶ What Campbell’s artworks demonstrate, as have all of the works in this chapter—both those that use computers and those that don’t—is that what might be thought to be the “absolute character” of digital systems—their discrete, articulate, locatable position in a metrically configured universe, often raise issues about ephemerality, perceptual instability, and even semantic ambiguity.

In his *Ambiguous Icons* series, Campbell creates LED “sculptures” in which matrices of red LED nodes subject video footage of human figures moving across the frame to an overt, dedifferentiating pixilation. The number of LED nodes in the matrix varies, the intervals between each node determining the degree of resolution and the immediacy with which a viewer can identify the shapes and cadences of a running (and then falling) human figure through the digitally processed sequence. In some works, Campbell installs a sheet of treated plexiglass over the LED grid, which causes the discreteness of the individuated points to diffuse, returning to a more continuous, analog visual state. In *Home Movies*, Campbell makes the conversation between analog and digital aesthetics implicit in *Ambiguous Icons* directly visible by stringing a veil of wires and LED nodes directly in front of soft-focus, black-and white projections of found home movie footage. These home movies are the source materials for the digitally processed semi-abstractions that flicker across the grid of hundreds of LED nodes. But unlike the *Ambiguous Icons* series, which occludes the analog origins of its moving-image sources, *Home Movies* layers digital over analog picturing technologies, asserting their dialogic entanglement as the formal, aesthetic, technological and associative center of the piece. Home movies, for a certain generation of Americans, are an immediately recognizable form that might provoke a range of responses, from sentimental nostalgia to amusement to horror at these documents of the American suburban dream. Home movies are unabashedly about memory, but memory of a different sort than the electronically stored “memory” of digital computers. In addition to subjecting the nostalgia of captured fragments of everyday life to an *unheimlich*, abstracted digital dispersal over a heavily pixilated LED landscape, the formal construction of these layered “screens” refuse to allow the digital screen to become emblematic of an overly simplified, poetically barren quantized world view. Instead, Campbell seeks to show how different experiences of complexity are afforded by the analog and digital systems, both separately and in conversation with one another.

The beauty of the LED screen does not emerge from its likeness or proximity to an analog system—from its imitation of analog aesthetic properties. While the brightness of the lights seems to intensify and wane continuously, closer inspection reveals that the increase and decrease in brightness does not mirror the smooth ebb and flow of the projected analog film. Campbell’s digits might seem to flow through intermediate states to reach the extreme points of the switching device (on-brightest and off-dark). But the variation in light intensity only indicates the presence of a multi-level device in which the intermediate levels of brightness are binary switches themselves. Thus, the variations in

¹⁹⁶ Paul Virilio, *Art and Fear*, trans. Julie Rose (New York: Continuum, 2003), p. 48

each light occur in distinct steps or states of intensity, so that a graph of light activity would resemble the jagged patterns of Goodman's EKG rather than a continuous line with an even, wavelike curvature. To return to Virilio, again, Campbell's LED works are about technological, perceptual, social, emotional, and biological ephemerality; here, the "absolute" systematization of the digital reveals the presence of ephemerality in both systems, but a qualitative difference in each system in the way that ephemerality is manifested and defined. The analog films are about a way of life, a personal memory that may have been lost, or may have never existed, while the other is about the insubstantiality of the object, its deresolution into a grid of lights that flicker into illumination or fall into darkness. As the shadows sweep across the digitized surface of the LED nodes, it produces a different experience than do the films of swinging children or passing cars—one that is more rhythmic and musical than pictorial, more about the delicacy of this highly technological configuration than about its ability to capture the (out-of-focus) detail in the filmic projection behind it.

This process of paring down figures and gestures to the broadest, most abstracted outlines subjects the world to a metric quantization but preserves the haunting presence of analog properties of ambiguity, a possibility of semantic density and open-endedness achieved precisely in the act of syntactic articulation/discretization. Campbell's insistently digital aesthetic sensibility is instantly perceptible in his foregrounding of the grid of pixels, performed by either superimposing the grid over analog photographic material or by filtering and processing the analog image through the digital matrix without revealing its analog source. His works are clearly invested in the question of visual recognition, in the ways in which patterns emerge through fields of noise. In their investigation of the properties of the grid, of legibility and illegibility of form, of abstraction and figuration, individuality and collectivity, registered in the universally readable movements of non-individuated figures, and of the cybernetic feedback loop between signal and noise, Campbell's installations extend considerations about depiction, form, and the art object that have concerned art practitioners, critics and theorists since well before the advent of modernism. Like Rozin, whose heavily digitized mirrors call up the spectre of continuous, analog modalities of viewership, Campbell's installations use digital processing and digital aesthetics in a way that both embraces technology but also inserts it into larger historical and aesthetic discourses concerning the role of technology in depiction and the limits within which something can be recognized or understood as a picture.

Campbell's recombinatory "media-mixing" serves, at a semantic level, to emphasize the ephemerality and instability of both analog and digital media, but even if analog and digital media bear their own distinct syntax (their own syntactical "signature"), the layering of analog film and digital LED switches disrupts, complicates, or folds onto itself the syntactical signature of each signal, making them not only mutually referential but also interdependent. Stephen Eisenman has described Seurat's method as a "proclamation that beauty arises from a continuous process of opposition and resolution among contrasting colors, values, and lines."¹⁹⁷ In the 21st century, Jim Campbell accesses this compelling oscillation between opposition and resolution by experimenting with the pixilation of continuous, analog images. Often, he quite literally

¹⁹⁷ Eisenman p. 279

overlays the highly discrete, pixilated surfaces of LED panels with light- or line-diffusing materials like rice paper or smoked Plexiglas. One layer does not obscure the other—neither the “continuous”, almost entropic surface of rice paper, in his nor the low-resolution, highly discrete array of bulbs on the LED panel lend themselves to instant recognition. “Digitality,” or at least “pixilation,” in the case of Campbell, refuses a metaphorical or actual correlation between technological precision, at the level of commands—on/off—and immediate sensual apprehension. Resolution emerges slowly, or fades in and out of perceptibility. This slowness, which at once presents an obstacle to understanding and also enriches the work with precisely the kind of ambiguity and irreducibility that is posed *against* discreteness and digitality, is dependent on the lack of resolution imposed by the discrete LED nodes.

While the digital realism evident in video games and cinematic special effects extends a hand to the simulacral virtuality depicted so darkly by Jameson and Baudrillard, the experiments in electronically computational digital abstraction launched by Jodi, Campbell, and Rozin work prophylactically against the end of artwork that, even if it is not painting, continues to analogize and reference painterly practice. Using Gerhard Richter as his case in point, Frank Reijnders has claimed that, in the age of technology, painting “is today *impossible*.”¹⁹⁸ Richter’s project is to show that both photography, the realist medium par excellence, and painting, do not hold up a vision-enhancing, corrective lens through which to take in the truth of nature, but rather, both media “give the appearance of something they are not.”¹⁹⁹ Reijnders writes: “Painting is in a position to shatter all evidence and make all essence impossible. Painting directly confronts us with our elementary state: *nothingness*.”²⁰⁰

Gerhard Richter’s painting, blurred or peeled away in layers from the canvas, seems insistently analog at the same time that it reflects upon technology and the nature of mediation. His use of transmediality operates differently than Campbell’s on many levels, but most importantly here, he provides a counterpoint to Campbell by engaging the relationship between technology and the handmade (specifically painting and photography), resolution and blur, depth and surface without ever activating the digital. In general, photorealism plays between analogy and metonymy; photorealistic painting prompts the question of whether painting is “more analog” than photography and what aesthetic or conceptual qualities are to be gained by the translation between media. Photorealism also allows issues of seriality and repetition, of which conceptual artists are so fond, to be introjected into a multi-media framework; the iteration and reiteration of morphological doubles across media boundaries calls into question the ontology of the image and its subsequent layers of pictorialization. His painstaking erasure of brushstrokes (the mark of “fingery” or gestural digitality) and his technique of blending outlines in a way that mimics out-of-focus photographs confounds the distinction between the ideal of perfected, flawless photographic indexicality and the approximating function of painterly naturalism.

Richter’s photographic paintings, perhaps most famously, or at least controversially demonstrated the fifteen canvases comprising his *October 18, 1977* series,

¹⁹⁸ Reijnders p. 25

¹⁹⁹ Reijnders p. 25

²⁰⁰ Reijnders p. 25

appear blurred, out of focus. These paintings take as their sources the newspaper and police photographs of the young German radicals known as the Red Army Faction (RAF) or Baader-Meinhof group, three of whom were found dead while in custody in a German prison on October 18, 1977. Although the deaths were attributed officially to suicide, speculation abounded that the young peoples' deaths had been engineered by prison workers. While the "blur" in Richter's painting has become, in and of itself, the topic of many critical and theoretical exegeses, I bring the notion of being "out of focus" into consideration here because it provokes questions about the relationship between painting and technologies of mechanical reproduction, but does so in a different way than Campbell's LED works. Richter's painting gestures towards relationship between technology and depiction, but remains both technically and aesthetically analog. Conversely, Campbell's LED grids reduce of analog plenitude into a discrete, regular array, strangely rendering the data more precise and yet more indeterminate. The blur in Richter's paintings show the contingency and instability involved in "capturing" a moment of time, either with the instantaneous click of the shutter in an analog camera or within the extended, durational act of painting. Because it has undergone a technical transformation, and now exists as a painting, Richter's blur cannot be ascribed directly the low-resolution capacity or a mechanical defect in the device, in contradistinction to both the home movies collected by Campbell and the photographs appropriated by Richter. These artists' source material becomes subject to a migration across media, which ultimately underscores rather than occluding the technical specificities these media are expected to demonstrate—for example, flatness in a painting or the indexical trace in a photograph. But in Campbell's case, it is precisely the filtering of the already "blurred" moving pictures through a computational system that makes it less precise, more ambiguous. In Campbell's pieces, a struggle ensues between the two layers of media: between the picture projected on the wall and the shadowy impressions crossing the LED grid. In reference to Richter's painted photographs, Reijnders writes: "a painting can never be out of focus because: in comparison to what would it be out of focus? The blurred effect is achieved through painterly means: strokes carried out with a dry brush remove the definition from the depicted subjects. As paintings, these photographs no longer compete with *reality*. They exist only by the grace of their own reality and are therefore, strictly speaking, abstract."²⁰¹

Looking at Richter's painted photographs next to Campbell's *Home Movies*, we can immediately see how different media contain different possibilities for interrogating the notion of being "in-focus," how this is a distinctly technological category that whose standard of "clarity" becomes more uncertain—less clear—in each multi-media iteration. One cannot say that a painting is out of focus; there is no optical or technological standard to which a picture either adheres or from which it deviates. Painters have more and less precise, fine-grained technique, but technologies of mechanical and digital reproduction have different expectations attached to them. The home movies from which Campbell's LED curtains sample their constantly fluctuating degrees of luminosity are blurred, clearly recorded with lo-fi, probably, we can gather, obsolete technology. But instead of sharpening them, restoring them or giving them a technologically updated appearance, the addition of computational technology interposed between the viewer and

²⁰¹ Reijnders p. 24

the filmic projection fractures the picture even further, so that we are no longer looking at a blurred variety of indeterminacy, but instead, at a more fragmented, fully discrete and disjunct digital screen whose resolution is too low to give us anything more than a vague impression of movement. This “impression” is even less like a portrait, much less a mirrored reflection.

Each of these examples examines the conditions of representation, and the limits of representation, by foregrounding digital processes and composition, thus introducing the dynamic relationship between technology, structure, and representation as a philosophical, aesthetic, and material problem. In his discussion of the state of painting as it has advanced (temporally, not evolutionarily) through modernism into the present moment, Frank Reijnders claims that the Western, modernist tendency toward the flattening and “abstraction” of the picture plane, reaches its apotheosis and decay in the mid-20th century with Greenburgian “pure opticality,” and that at this time artists push up against, or collide with, the inevitability and unavoidability of “the surface,” the ultimate condition of painting and the absolute barrier past which it cannot progress and still retain its identity as a medium. As such, “due to the exclusive emphasis on the inescapability of the surface, from Manet onwards the focus shifted from representation to what made representation possible in the first place.”²⁰² Reijnders’ claim indirectly emphasizes the continuing legacy of modernist reflexivity. Moreover, placed in the context of the state of painting in the contemporary technical milieu, it provokes a consideration of the ways in which digital art responds to and thus activates the foundational tenets of modernist art practice and criticism in the present.

In this chapter I have placed the theoretical distinctions between analog and digital in an dialog with a series of artifacts extending from the two decades preceding the turn of the 20th century to the first decade of the 21st century. The artifacts in question have included paintings, installations, photographs and screen-based computer graphics, but they all engage with the problem of the digital in individual, sometimes idiosyncratic ways. Seurat, Klee, Jodi, Rozin, Campbell each import the modernist concern with surface and support into their meditations on the materiality of the computational interface, or the material effects that result from electronic computational processes. Consequently, high modernism continues to influence some strains of digital art. If the interface is conceived as a surface, and the picture plane (now, most often, the screen) is a medium through which to visualize computational processes, digital art in this vein signifies in terms of its permutations and explorations of how this technology reshapes, or fails to reshape, the norms and limits of representation.

²⁰² Reijnders p. 27

Chapter 3: Watz, Vasarely, and the New Abstraction: From Op Art to Generative Art

As the technical capabilities of digital media expand, it is frequently assumed that so too will immersive and mimetically naturalistic qualities in digital graphics. The “conventions” of digital imagery have transmuted from the highly pixelated, discrete bitmapped graphics emblemized by Super Mario Brothers and Jodi into a smooth, perspectival illusionism that meets or even exceeds the resolution threshold of the human eye. This trend towards illusionism has resulted in a tendency to obscure the architectonic properties of digital images, which begin life as a series of illuminated pixels, or as mathematical descriptions of one of a few basic shapes—circles, squares, and lines. But as the frenzy for digital naturalism licenses the concealment of the undergirdings of digital figures, a competing form of code-based, generative abstraction has emerged to succeed the proto-computational formalisms of artists such as Victor Vasarely and Sol LeWitt. This chapter will take the work of two artists as its primary case studies. First, I will discuss Victor Vasarely’s experimentation with a procedural visual language that closely approximates computational programming. I will use Vasarely’s own writings—his treatises and manifestos—to reframe his contribution to the artistic canon, and Op Art specifically. I argue that Vasarely’s approach to pictorial construction does create novel optical-kinetic experiences through carefully engineered, abstract visual stimuli, but instead figures a proto-digital visual language circulates within and expands a burgeoning digital epistemological horizon. Second, generative artist Marius Watz’s 2005 homage to Victor Vasarely, entitled *ElectroPlastique #1*, translates Vasarely’s algorithmic visual language into computational generative code. Well in advance of bitmapping technology Vasarely infused his works with a distinct computational “look” by conceptualizing the image as a field of discrete values arranged within and conditioned upon their relational position within an optically activating matrix. However, little has been done in the disciplines of art history or media studies to evaluate the extent to which Vasarely’s method predicts the possibilities and limitations of encoded computational plasticity.

Vasarely, who reportedly never touched a computer in his life, produced images that bear a morphological resemblance to computer art because his creative process set into motion an exploration of the possibilities generated and limitations imposed by the application of procedural logic (what might be known now as the logic of programming) to image-making. Despite the fact that they are not themselves produced with the technological aid of a computer, Vasarely’s optical paintings rehearse presciently the graphical indexes of computation that become common in the early years of computer art, for example in the films of Stan Van Der Beek, Larry Cuba, and John Whitney in the 60s and 70s.²⁰³ But these graphics also do more than merely metaphorize computation; Vasarely articulates a theory of plasticity distinct from the “already known” in its imagination of matter, form, and structure in digital terms. “As I work, I reduce all the data of my creations to invariables, so that I might retrieve identical values at the moment of re-creation.”²⁰⁴ For Vasarely, expressing the possible relationships between discrete

²⁰³ See, for example, Larry Cuba’s *3/78 (Objects and Transformations)* (1978), John Whitney’s *Arabesque* (1975), and Stan Van Der Beek’s *Poem Field 2* (1978)

²⁰⁴ Victor Vasarely, *Vasarely*, trans. I. Mark Paris (New York: Publishers of Fine Arts Books, 1978), p. 11

elements or units unlocks the possibility of seeing through new eyes the architectonic configuration of world, universe, and even social organization. His obsession with a cybernetics-influenced pancomputationalism manifests in his formulation of a series of notational schemata, including a decimal-based scale of color-form permutation²⁰⁵ and several instantiations of a plastic alphabet. This alphabet notates discrete, articulate, and interchangeable elements out of which, often through algorithmic processes, an image or a visual field is constructed.

Although it is not electronically computational, Vasarely's experimentation with the basic units of form facilitates understanding of why digital images look the way they do. By exposing the architectonic construction of modular forms that both reference grid-structures and expand beyond the static limitations of the grid, his work reveals the steps of digital construction. It shows how digital graphic output—the characteristics of the image made visible on a screen, on a continuum from mimetic lifelikeness to geometric abstraction—will vary dramatically as the image moves through various levels of processing, from raster and bitmapped graphics all the way to three-dimensional modeling. Vasarely envisioned his art as a program that, due to its notational characteristics, could be universally “computed” by both uninitiated viewers and future artists who would choose to adapt his algorithms. Those who learned the grammar of Vasarely's alphabet could either use it to produce their own works or to generate a new instance of an existing work. These new instances would not be mere reproductions or copies of Vasarely's paintings; rather, because his alphabet provides for permutations and reordering of constitutive elements, future iterations of his alphabet could precipitate sometimes minute, sometimes macroscopic changes to Vasarely's ordinary frameworks and motivating concepts. In this sense, then, Vasarely builds into his practice at the outset the possibility of appropriation and refiguration that we see realized in Watz's *ElectroPlastique*.

In the last third of the chapter, I will consider the effects of adding generative, temporal computation to the static digital schemas of Vasarely's paintings. Here, I will place Vasarely's “digital,” procedural aesthetic in conversation with a *ElectroPlastique*, Norwegian generative artist Marius Watz's 2005 homage to Vasarely, and discuss how and why Watz's cinematic narrative of the birth, development, and eventual fragmentation of a digital landscape appropriates and intensifies the model of digital visuality announced by his predecessor. I will show how Vasarely has been taken up in the context of contemporary digital practice, and how Vasarely's theory of abstraction can be applied to digital abstract formalism, a trend in digital art that is often marginalized, due in part to its basis in design and its concomitant affirmation of visual pleasure, and in part to the lack of a sufficiently theorized aesthetic and theoretical position from which to view it.

Vasarely's images make visible the differences between digital forms and the way pictures are presumed to be in most cases not only produced by analog means, but also to signify and communicate in an analog fashion. Pictures, as opposed to diagrams or other symbol systems thrive on indeterminacy and ambiguity, as we see in Goodman's

²⁰⁵ Each element, discrete unit, or “pixel” on his raster grid is delimited by its uniform coloration. In other words, there is no color gradation within the unit—instead, form and color, usually held to be distinct, are collapsed together so that the unity of color and form defines the discrete alphabetic particle.

example of the EKG vs. Hokusai's painting of Mt. Fuji. If Vasarely's painting practice offers a model of depiction that looks computational without using computers, I want to see how Watz's appropriation or "remix" of Vasarely's aesthetic either expands upon, affirms, or challenges Vasarely's ideas through the introduction of computational processing and generative code. In one sense, it would be easy to see *ElectroPlastique* as a translation of Vasarely's system into digital code, and thus as a digitization of an analog work. In point of technological fact, Watz does enact a re-mediation or a translation between media, but what new information or phenomenal experience is yielded by the appropriation of Vasarely's aesthetic into a computationally coded medium? In other words, conceptualizing *ElectroPlastique* as a translation requires a determination of what "languages," or what aspects of each respective visual world, are not only translated successfully, but which ones are available or more susceptible to translation at the outset.

While both Watz and Vasarely mobilize elemental modular structures in their art, what makes them particularly exemplary of a digital ethos, instead of the geometrical but non-digital abstraction of, for example, the Suprematists, is their subjection of these structures to the activating effects of code and algorithm. The dialog imaginatively enacted between Vasarely and Watz—the former employing analog tools to explore the still-gestating notion of digital systems, the latter pushing digital visual language further into the domain of self-generating computational abstraction—lays bare the conceptual and visual qualities of digital materiality and initiates the question of what we might learn by bringing the underlying structural principles of digital images back to a visible surface. If Vasarely, and Watz after him, are attempting to reveal the basic structural components of the natural/material world, what is different or new about the way each artist accomplishes this? Generally, what are the conditions of possibility for a new, digital abstraction to arise, and what might it communicate about the world? In this chapter, I will peel back the structural and historical layers back from Watz's computational generative abstraction to Vasarely's vision of a plastic alphabet in order to assess whether the construction of digital abstract landscapes affords either a new method of exposing old structures or a new method that lays bare the structural components of a new digital epistemology. Ultimately, I argue that the novelty of generative art extends Vasarely's artistic successes and failures, first in its affirmation of the aesthetic and social possibilities latent in the notion of a programmable visual language, and second, in its obfuscation of that possibility by way of its simultaneously hedonistic and hermetic, aggressively surfacial opticality.

I. Op Art, Computation and the Inhuman

Known as the father of Op Art, Vasarely developed over the course of his artistic career (beginning in 1929 and continuing until his death in 1997) an optical aesthetic deeply influenced by scientific and technological innovations of the 20th century. Trained in early adulthood as a scientist, Vasarely dropped out of medical school in Budapest to pursue a career in fine art and graphic design but continued to investigate the natural and physical sciences as well as cybernetics and technology. His ongoing amateur fascination with scientific development parallels his effort in his professional career to achieve an artistic realization of the structural principles of materiality itself. His artistic aims were driven in part by his aspiration to understand relativity and quantum mechanics, and through his reading of Einstein, Bohr, Heisenberg, and Wiener he determined that it

could be possible to make “scientific models [which are complex, abstract, and not necessarily given visual form] visually comprehensible” by offering these models “plastic equivalents.”²⁰⁶

In 1965, the Museum of Modern Art in New York mounted an exhibition entitled *The Responsive Eye* under the curatorial expertise of William Seitz. This exhibition, initially masterminded as a grand tour of the great optical experiments in art from Impressionism forward, was ultimately narrowed in scope to showcase only contemporary art, and a very particular version of contemporary art at that. *The Responsive Eye* gathered together examples of the profusion of painterly and sculptural work focusing on “perceptual effects” that exploded onto the art scene in the 1960s.²⁰⁷ Artists featured in the exhibition included Guido Molinari, Frank Stella, Larry Bell, Agam, and, of course Vasarely, among many others. Seitz’s historical vision became a window onto the concerns of artists in the early 1960s about the relationship between technology, abstraction, and depiction. This fact in and of itself begs the question of why and how Op Art rushed with tidal wave force into the art scene and then just as quickly receded. Of course, art has always been about, among other things, perceptual effects; such an observation on its own comes as no surprise. However, the particular form of perceptual abstraction—one that activated a vertiginous sense of the physiological nature of vision²⁰⁸—that proliferated in the mid-twentieth century gave pride of place to stricter, more simplified and schematic mode of discrete inscription than did Impressionism or even the more systematized Neo-Impressionism after it. The regularized, hard-edged illusionism of Op Art, similar to the art made with early computer graphics, lacks the “look” of fine art—the ambiguity and density, or even the negation of these qualities, visible in the aggressively purified, pared down abstraction embraced within purist avant-garde movements such as Suprematism. Op Art seems, in its subjection of the viewer to a new *trompe l’oeil*—this time not a mimetic illusion but a vertiginous, physiological trick—to fall to the wrong side of the distinction between high and low art, the popular and the refined. It lacks the immediately legible indices of political, economic and social critique that belong to the most vigorously applauded art of the 21st century. As such, designated as an (implicitly distasteful) “optical” or “retinal” stylistic flash-in-the-pan, Op Art’s reputation has been mostly relegated to a niche market of tricky, gimmicky poster art.²⁰⁹

An evaluation of Op Art that focuses primarily on its manipulation of the connective pathways between opticality/retinality and the physiological sense of disorientation deviates from my own reasons for addressing it here. I am less interested in whether Op Art’s mode of illusionism generates universal bodily and perceptual experiences of vertigo or kinesis, than in the intersection between an emerging computational world view, Vasarely’s own verbally articulated response to and innovations within this world view, and the digital world that emerges in his depictive

²⁰⁶ Robert Morgan, *Vasarely* (New York: George Braziller, 2004), p. 18

²⁰⁷ For the seminal account of Op Art in America, see the exhibition catalog for *The Responsive Eye*. William C. Seitz, *The Responsive Eye* (New York: The Museum of Modern Art, 1965), p. 5

²⁰⁸ Jonathan Crary has traced the history of artistic transpositions of scientific discoveries in optics and physiological basis of vision in the communication between eye and brain. See Jonathan Crary, *Techniques of the Observer: On Vision and Modernity in the Nineteenth Century* (Cambridge: MIT Press, 1990).

²⁰⁹ Seitz p. 3

strategies and the resulting pictorial field. So although Op Art has been typically framed in terms of its capacity for kinetic or three-dimensional illusionism, I demonstrate how Vasarely's artistic, theoretical, and social pursuits were only partially about vision itself, and were in fact equally invested the possibilities for a populist visual language manifested in the creation of computable structures. Although his work does in fact give rise to vertiginous optical effects, what is more interesting is the digital aesthetic engendered by his implementation his plastic alphabet. Whereas one approach to thinking about Op-Art focuses on optics as a dimension of human biology, physiology and perception (and is thus not about the human in a humanistic sense), Vasarely's research program gives visual and textual form to an inhuman system (computation) in order to meditate on the limits of human communication, as well as on the conditions under which communication can be performed and replicated successfully. Moreover, he uses computation to consider how communicative innovations—scientific, artistic, and social—occur, and identify the conditions that provoke epistemological change.

In spite of the summary dismissal of Op Art in America, even after MOMA's *Responsive Eye* exhibition (countered by the success of a few exceptions such as Bridget Riley), some limited attempts to recuperate Vasarely's reputation and his grand artistic vision have been launched in the later 20th century. Although these efforts have not resulted in a wide-ranging valorization of Op Art, in general, or Vasarely, in particular, what is perhaps most notable about the commentary surrounding his work is the marked morphological similarity of Vasarely's imagery to early computer graphics. The question is whether or not there is anything at stake in making this morphological comparison. It is my contention that Vasarely produced pictorial constructions that look like computer art because his creative process set into motion an exploration of the possibilities generated and limitations imposed by the application of procedural logic to depiction. Despite the fact that they are not themselves produced with the technological aid of a computer, Vasarely's graphics rehearse presciently the graphical indexes of computation that become common in the 1980s—blocky, Manhattan-skyline pixilation and simplified outlines of basic geometrical forms. But they also do more than merely metaphorize computation. They seem to perform a computational creative process but skip the essential step of numerical calculation without which computation cannot take place.²¹⁰

In 1959 Vasarely linked art and the applied technical sciences, pointing to the fact that as scientists are building electronic chess-playing "brains," artists are also engaging in their own assays with the possibility of a new visuality governed by binary code. "For quite a long time now, one branch of the plastic arts has been working on plastic language that can be encoded as a binary system."²¹¹ Although his disposition towards

²¹⁰ In making a distinction between the closed loop of the digital humanities, which employ digital tools to the data-mining of humanistic—primarily textual—artifacts, and her open-ended experiments in speculative computing, which thrives on rather than disavowing irregularities, indeterminacies, and inconsistencies in a text, Johanna Drucker lists the principles that generally define the expectations for and constraints of electronic computing technology. These principles are 1) calculation, 2) computation, 3) digital processing, 4) classification, and 5) electronic communication. Johanna Drucker, *SpecLab: Digital Aesthetics and Projects in Speculative Computing* (Chicago: University of Chicago Press, 2009), pp. 23-24.

²¹¹ Vasarely p. 15

technology is sometimes ambivalent,²¹² Vasarely's insight about the preoccupations of the electronic age is prescient and far ranging; alongside artistic attempts to produce an encodable, binary, electronically-storable plastic language comes a frenzy for totality, for the accelerated production of an exhaustive archive of all plastic possibilities discoverable within the breakneck computations of the electronic brain. "There are groups of young artists among whom everything happens as if they were feverishly taking inventory of all of plasticity's possibilities. This is a matter for an electronic brain, for a future plastic bank."²¹³

What is notable here is not only that Vasarely envisions a stored-memory archive, but also that he begins to see the profoundly *inhuman* quality of electronic processing and the explosion of human scale in the vastness of the electronic archive. Electronic computation is devised as a tool to aid in the constitution of new, human knowledge systems. At the most basic level it is a human construct, despite deterministic computationalist claims that such descriptions do not simulate nature, but actually replicate and execute the laws of nature, as in the case of complexity theory.²¹⁴ However, automated computational technologies are designed to carry out calculations, find patterns, organize data, and store information at a rate and in a volume impossible to match by the human mind. This fear is articulated in popular cultural artifacts such as James Cameron's *Terminator* Series (1984, 2001, and 2009) and the Wachowski Brothers' *The Matrix* (1999). According to the computationalist model of consciousness, if the brain is a biological computer ("wetware" to the "hardware" and "software" of the machines we call, nonspecifically, computers),²¹⁵ operating systems and hard drives become most terrifying when they surpass their function as tools—as stand-ins that ostensibly permit humans to engage themselves with higher-level problems than basic calculations by taking over menial, number-crunching tasks. They threaten not our physical strength, as in the case of industrial machines, but the aspect of humans that in

²¹² While Vasarely's supporters have remarked with great frequency the fact that he seems to mimic the technics of computer graphics long before the invention of the GUI, he does not take his interest in physics and the physical construction of matter as a fascination with "newness" or novel scientific theorizations of world and nature. In fact, in 1947 he wrote that "the overvaluation of the bizarre, the extraordinary and the novel ultimately sinks into boredom... The wondrous discoveries of the accidental, like the excessive love of technology, are leading towards superficiality." Gaston Diehl, *Vasarely*, trans. Eileen Hennessey (New York: Crown Publishers, 1972), p. 15

²¹³ Vasarely p. 15

²¹⁴ Simulation produces a copy of an existing system, but there is an associated implication that the copy, while it perhaps ultimately replaces and obscures any memory of an original, per Baudrillard, produces a weak version, an insufficient or distorted replica that lack certain elements of the real while overamplifying others. For the classic humanistic text outlining simulation and hyperreality, see Jean Baudrillard, *Simulations*, trans. Paul Foss, Paul Patton and Philip Beitherman (New York: Semiotext[e], 1983). Extreme proponents of complexity theory and producers of Artificial Life (A-Life) systems would claim that the behaviors of A-Life programs do not simply *imitate* biological and physical patterns and behavior in nature, but that the complexity visible in computer programs is coextensive with nature—that A-Life is not merely a metaphor but rather puts into action natural laws. See Stepfan Helmreich, *Silicon Second Nature: Culturing Artificial Life in a Digital World* (Berkeley: University of California Press, 1998).

²¹⁵ For a more in depth discussion of the term "wetware," see Richard Doyle, *Wetwares: Experiments in Postvital Living* (Cambridge: MIT Press, 2003).

the great literary and philosophical traditions has set them apart from other animals—the human capacity for intellection and consciousness.²¹⁶

The frenzy to compute and store multiple possibilities is related to the desire for total knowledge, but this also leads to an incalculable informatic sublime, in which the very quantity of data renders its territory too great to be conceived as a mappable, navigable world. As Lyotard has written, “the system... has the consequence of causing the forgetting of what escapes it.”²¹⁷ But, correlatively, the system also, through its absolute calculability by machine and its utter incalculability by the limited processing speed of the human mind, causes the human forgetting of what is inside it as well. It is to this end that Vasarely’s art is valuable to humanism: in its very exposure of the inhuman qualities of a machine-computable informatic universe. He reminds us of the rules by which the map of this universe is constructed, and that we have come to see the map *as* the territory.²¹⁸ In other words, Vasarely’s abstract landscapes graphically render one possible manifestation of a cyberneticist’s utopia, in which the universe and all the organic and inorganic bodies and systems within it can be explained in computational terms. Over the course of the 20th century and into the beginning of the 21st, this descriptive model becomes naturalized as the central epistemological paradigm of the 21st century, and as such begins to demand a new modality of interpreting the architectonics of form, or even a new definition of the beautiful. If for Kant the judgments of beauty obtain from the recognition of nature in art, if a shift occurs in our estimation of the structure and constitutive elements of nature—to a computationalist world view—then it would stand to reason that the definition of the beautiful requires extension if not a comprehensive revision. Moreover, if that which the viewer recognizes in a work of art as a constitutive aspect of nature will likely be judged as beautiful by rational consensus, an artwork that demonstrates or participates in the transition to a cyberneticist or computationalist worldview should become the new mirror of nature, and thus the new standard for judgments about artistic beauty.²¹⁹

Despite the highly contentious status of Kant’s theory of aesthetic judgment, I introduce this example to emphasize my claim that art connoisseurship and evaluative standards within the art world have, with respect to painting, resisted, if not computational determinism, then the effects on art theory such an epistemological shift

²¹⁶ I use this example in the broadest illustrative sense, leaving aside the myriad and complex distinctions that arise with respect to questions about intellection and consciousness, the degree to which other sentient creatures experience consciousness, and of course the role of intuition, emotion, and other pre-propositional forms of knowledge that might be considered inextricable from intellectual activity, and thus the reasons that computers cannot, ultimately, *think*. See Hubert Dreyfus, *What Computers Still Can't Do: A Critique of Artificial Reason* (Minneapolis: University of Minnesota Press, 1992).

²¹⁷ Jean-François Lyotard, *The Inhuman: Reflections on Time*, trans. Geoffrey Bennington (Stanford: Stanford University Press, 1992), p.2

²¹⁸ This equivalence of map and territory is the famous illustration of the simulacrum presented by Jean Baudrillard, which is itself a citation of Borges. See Baudrillard p. 1

²¹⁹ In his “Notes for a Manifesto,” Vasarely wrote of his “plastic unit,” comprised of an inextricable bond of form and color, that, “through its material structure is comprehended; the mathematics of the universe, everything in its intellectual superstructure. The unit is the abstract essence of the beautiful, the basic form of sensibility. Conceived with art, it makes a work, a poetic equivalent of the world it signifies.” Victor Vasarely, “Notes for a Manifesto,” in *Data: Directions in Art, Theory and Aesthetics*, 101-103 (Greenwich: New York Graphic Society, LTD, 1968), p. 101

would be expected to have. Specifically, in this case, the notion that Vasarely's painting graphically depicts a new digital/computational view of nature permits a greater range of interpretative richness and significant breadth than has been generally accorded to his work, to cybernetic art, and Op Art in general. His painting actualizes the vision of the creative mind at work, the kinds of structures it will build, the fictive imagination of the world it will have, as it envisions a universe constructed on computational principles that give way to a digital notion of discontinuous, constitutively discrete objects, bodies, and even knowledges. Jasia Reichardt, the curator of the *Cybernetic Serendipity* show²²⁰ held at the Institute for Contemporary Arts in London from August 2 to October 20, 1968, writes that "the processes involved in making computer art are best suited to those who follow an analytical approach in their work, who are concerned with permutational procedures, serial techniques or the transformations of images from one finite state to another."²²¹ However, while celebrating the potential in digital approaches to artistic production, she also makes the concession, still common in evaluations of computationally-generated art in 2009, that artistic masterpieces had, in the late 1960s, yet to be realized, despite the creativity and innovation generated by cross-fertilizations between art, science and technology.²²² Seitz's articulation of the interpretive dimension of Op Art deviates from my own in its deterministic overprivileging of innate visual response²²³ and in its concentration on the physiological impact—the "perceptual effects" that occur in the "incompletely explored region area [sic] between the cornea and the brain"²²⁴—of Op Art's depictive strategies and visual characteristics. My own interpretation steers clear of attributing success or failure to Op Art on the basis of its ability to stimulate neural responses, emphasizing instead its embeddedness within and experimentation with a burgeoning computational/informatic epistemology. Seitz acknowledges that the work presented in *The Responsive Eye* occupies a tenuous position with respect to art, aligning it more strongly with design and technical practices such as scientific diagrams.²²⁵ Vasarely is most favorably received by artists, curators, and

²²⁰ See Jasia Reichardt, *Cybernetic Serendipity* (New York: Frederick A. Praeger, Inc Publishers, 1969).

²²¹ Jasia Reichardt, "Cybernetics, Art and Ideas," in *Cybernetics, Art and Ideas*, 11-17 (London: Studio Vista, 1971), p. 14

²²² Reichardt wrote that "intellect has its own pleasures but these are not a substitute for direct emotional response. The central core of a work of art, which is the transformation of the material which makes up the sum of its parts, has so far defeated all analytical attempts." Presciently to the problems that persist in generative art today, she goes on to write: "Both Max Bense and Abraham Moles approach such an analysis from the peripheries of the structure of the work, but to this day there isn't a single masterpiece that has been made according to the principles of generative aesthetics." In an odd conclusion to her statement she adds: "This essential core of a work of art remains still to be fragmented, rationalized and reconstructed." This last sentence is particularly odd in its prescription for discovering art in the very action it is claiming that has not been yet reconciled with the aims of art: the digitization or transformation of matter into an endlessly reconfigurable, replicable, and additive series of ones and zeros. She suggests here that the intellectual act of rationalization will solve the problem of an approach to art practice that fails to catalyze the emotional response necessary to classify a work as art. Reichardt, "Cybernetics, Art, and Ideas" p. 14.

²²³ "Stripped of conceptual association, habits, and references to previous experience, perceptual responses would appear to follow innate laws, limited though our understanding of them might be." Seitz p. 7

²²⁴ Seitz p. 8

²²⁵ In the acknowledgements section of the catalog, Seitz says that the roots of "optical" or "ophthalmic" painting stretch "beyond what we call 'art' into graphic design, technology, psychology, and other

theorists who go to the edge of what is most broadly accepted as art, to the cross-over domain of art-science, to design and computer graphics, to esoteric mid-twentieth century theories, propounded in artistic manifestos, of a new abstraction suffused with a cybernetic spiritual idealism.

A consequence of the rise of the information society and the ever-increasing preponderance of computationalist models (for instance, of the control of computable neural activity over perception, and consciousness in cognitive science)²²⁶ in both scientific, social-scientific, and even humanistic modes of inquiry, has been ostensibly to narrow the divide between C.P. Snow's "two cultures."²²⁷ But in actuality the determinism often found in these models relegates humanistic approaches to knowledge and the lifeworld to an ever-more marginal position, both within and outside of the academy. While for some this may represent a welcome shift towards verifiable scientism within disciplines traditionally unbounded by the tenets of scientific methodologies, this also introduces a greater urgency to questions surrounding the role of humanism, and specifically the problems open to humanism that are less accessible to deterministic models.²²⁸

Vasarely's computationalist utopia, presented in both his writings and his visual art, proves chilling to some viewers. However, Vasarely imagined his art as a universally accessible, populist form. He viewed his plastic alphabet as a system built to encourage artistic literacy, and the formation of social communities around art reception and art practice. But if we look *only* with eyes accustomed to interpreting painting by virtue of what is contained within the frame (a habit of looking that becomes impossible later in the 20th century with the advent of critical practices including conceptual art, installation, performance, and land art), Vasarely's work remains visually compelling but interpretively hermetic. Rather, the locus of significance within his work is distributed; the frame must be dismantled, allowing his work to signify as a more open-ended process, so that the "open work"²²⁹ encompasses painting, sculptural artifacts, and sometimes film, but also Vasarely's theoretical, cybernetically-infused narrative of a society whose eyes might be collectively opened by a computational program, a new

sciences," and then later in the text concedes that of the works selected for the exhibition, certain of them bear "a stronger family resemblance to mechanical patterns, scientific diagrams, and even to screens and textured surfaces than to relational abstract art." Seitz, pp. 3, 8

²²⁶ See, for further discussion of this topic in philosophy, see Alva Noë, *Out of Our Heads: Why You Are Not Your Brain, and Other Lessons From the Biology of Consciousness* (New York: Hill and Wang, 2009). In vision science ("visual studies") see David Marr, *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information* (San Francisco: W.H. Freeman, 1982). For a neuroscientific approach to Art History, see John Onians, *Neuroarthistory: From Aristotle and Pliny to Baxandall and Zeki* (New Haven: Yale University Press, 2008).

²²⁷ C.P. Snow, "The Two Cultures," in *The Two Cultures*, 1-41 (New York: Cambridge University Press, 1998).

²²⁸ Regardless of its use value for the humanities, digital technology is grounded in formal logic and as such is subject both to the advantages and constraints of working within the strict parameters of a formal-logical system. See Johanna Drucker, *SpecLab: Digital Aesthetics and Projects in Speculative Computing* (Chicago: University of Chicago Press, 2009).

²²⁹ This is a reference to Eco's *Opera Aperta*, the Open Work, which is a model that applies not only to Vasarely's multi-media practice but also to the generative software systems authored by Casey Reas, the subject of the following chapter. Umberto Eco, *The Open Work*, trans. Anna Cancogni (Cambridge: Harvard University Press, 1989).

mode of visual literacy. And in turn, this narrative is enabled by the context in which his project was conceived, Vasarely's coming of age in Budapest in the 1920s, his continuous fascination for and study of cybernetics, quantum physics, and the scientific models that promulgated a world view characterized by dynamic systems and provided the contemporary, contingent assessment of what is human about humans.²³⁰

II. From Grid to Matrix

If so much has been made of the centrality of the grid, the enframing structure and the possibility condition for discrete, digital pixels to appear on the screen, in computational imaging, should we then suppose that the grid is a subsidiary property of, or co-extensive with digitization? David Summers' massive study of the development of metric, "metaoptical" spatial constructions in a broad and pangeographical history of image-making tracks the rise of the particular ethos of form that has come to dominate Western theories and practices of representation.²³¹ Instead of approaching the notion of form from what he calls the "pictorial imagination," or the "aesthetic-expressive definition" of art, Summers considers how the particular shapes of cultural artifacts—images, objects, tools, architectural constructions, and even "notational" devices such as maps—come into being as situated and purposeful objects with a complex relationship to their embodied human creators and their "real spatial" contexts. Summers not only identifies emblematic features of "universal metric space of Western physics and technology," but also attempts to work out the visual, phenomenological, and social conditions that contribute to and result from the mathematical, rationalized, and metaoptical world order.

Paramount among the phenomena he analyzes is the production of metric space and the co-ordinate plane, and the embedded, corollary properties of "homogeneity, divisibility, and infinity" that stand in contrast to the "qualitative, continuous, and unified" spaces associated with the natural, primordial world. One of the primary characteristics of the transition between qualitative and quantitative systems of measurement is that while qualitative systems retain some reference to the specific qualities of the particular, situated, and enworlded object subject to measurement, purely quantitative systems are notional, abstract, and separable from the format (the size, shape, volume, and texture of the surface of inscription) on which an image is presented. A logical extension of the shift from qualitative, relational systems, such as proportion and surface, to the abstract units of measure found in quantitative, notional systems such as ration and planarity, the true grid is independent of format. That is, it is not derived from the division of an existing surface into halves, quarters, and so on; instead, it not only pre-exists the format but also actually provides the infrastructure around which the picture can be constructed. The grid is an abstract measuring system that defines the relationships between objects in any image-construction, pictorial or notational. The same

²³⁰ "If humans are born human, as cats are born cats (within a few hours), it would not be...I don't even say desirable, which is another question, but simply possible, to educate them. That children have to be educated is a circumstance which only proceeds from the fact that they are not completely led by nature, not programmed. The institutions which constitute culture supplement this native lack." Lyotard, *The Inhuman* p. 3

²³¹ David Summers, *Real Spaces: World Art History and the Rise of Western Modernism* (London: Phaidon Press, 2003).

grid can be used to generate multiple “pictures,” each of which will be a generative infrastructural system of measurement.

Units or measurement that additively constitute the grid exist and function independently of any particular image. Like ratio, which selects its units of measure by isolating and excising one recognizable feature already present in the image or object to be depicted, a gridlike structure can appear through the division of the format into regular units. However, a “true grid” is independent of both the format and the image. In other words, a grid is not formed from the repeated division of a pre-existing format into smaller and smaller components but rather from the notional extension of a metric plane or cube infinitely into space. When subjected to the logic of the grid, space itself becomes a notional metric extension independent of objects that occupy it. The metaoptical cube allows any point in space to be plotted or mapped in relation to any other point. Thus, qualitative features are subsumed under the metric, quantitative structure of the grid, and no longer function to define “place” as a qualitative realm imbued with meaning through the operations of memory and symbolic communication.²³²

Vasarely’s digital world develops out of early experiments with the grid, a figure endemic to modernist art history and theory that often overlaps with a digital worldview but whose ontology is separable from digital systems. Criticism of modernist art has frequently engaged the figure of the grid, often concluding that the grid figures the reductive ideologies of science and capitalism. It is perhaps for this reason that the visual results of Vasarely’s method have led to some resistance on the part of art historians to the incorporation of his artwork into a fine arts canon. Visually, Vasarely’s oeuvre unfolds as a parade of checkerboard abstractions regulated by the logic of the grid. As his career progressed, Vasarely’s style of painting moved towards a rigorous exploration of the anamorphic properties of the grid that could be exposed by exploiting simultaneously the grid, known as an apparatus of a totalizing logic, and his grammar of highly discrete, modular and segmented plastic units.

Although Vasarely is remembered primarily as a painter (though a painter who suppresses the markers of handmadeness such as impasto and visible brushstrokes), his practice integrates architectural and sculptural elements into an illusionistic space of two-dimensional depiction. His works take on a three-dimensional solidity achieved through a skillful manipulation of optical illusion and the construction of intricate volumetric forms built from a latticework of isometrically supported “beams.” The grid, always in the midst of struggling to burst out of its flattened confines into a three-dimensional matrix, is the supporting mechanism of Vasarely’s abstract pictorial structures. In this section, I will use Vasarely’s painting to address the relationship between the grid—commonly understood as a tool that aids in the schematic conversion of the two-dimensional support into an illusionistic three-dimensional picture—and the matrix—the ostensibly more flexible, open and indeterminate array that signifies the expansion of machinic, modernist schemas into complex digital operations.

In the 2006 exhibition *Grid/Matrix*, mounted at the Mildred Lane Kemper Museum in Saint Louis, Sabine Eckmann and Lutz Koepnick paired works of modernist

²³² For more about the distinctions between space and place, see Edward S. Casey, *The Fate of Place: A Philosophical History* (Berkeley: University of California Press, 1997).

abstraction with contemporary artistic experiments using digital technologies.²³³ Their curatorial selections highlight comparisons and contrast between high modernism and the composite structure and nearly infinite malleability that comes from reducing one's referent to binary data (or at the most fundamental level, those most famous of metonyms for the digital—ones and zeros). Paintings by Piet Mondrian, Agnes Martin, Laszlo Moholy-Nagy, and Theo Van Doesburg, whose work visually engages the modernist grid, is set alongside contemporary, computationally-driven installations that challenge the static form of the grid. For example, Julius Popp's *Bit.Fall* deploys a series of valves, a water pump and custom electronics to create a screen of falling drops of water that mimic the grid of pixels in a bitmapped screen. The electronics that control the valves, and thus the frequency with which drops of water are released, are connected to a computer. This computer scans web pages and selects series of words that will be "printed" in falling water droplets, illuminated by overhead lights that, as they fall, are visible to the viewer. Popp's installation transmutes the grid from a stable form into one that is radically ephemeral, and so delicate that its structure will be destroyed with a single touch.

The number of works in the *Grid/Matrix* exhibition is small, but places a sharp focus on the effects of modularity on pictorial structure. The world view advanced by the collection of artworks is one in which matter is built digitally—from discrete parts forming a delicate physical structure, always threatening to decompose into an undifferentiated cloud of constituent units. The underlying argument of the exhibition is that whereas the grid mechanistically imposes order, regularity, and predictability upon the material world, the matrix becomes "emancipates" the repressive regime of the grid by opening up to spatial, rather than planar, and temporal dimensions. The matrix here is conceived as an open system in contrast to the closed system of the grid.

However, the grid and the matrix have a mutually constitutive relationship, in terms of both digital graphics and pictorial structure. Although the grid is a perfectly regularized system, it allows for a greater potentiality for permutation and instability than a strong claim about the totalizing, self-referential quality of grids would acknowledge.²³⁴ And, while the matrix is defined in the broadest terms as a precondition of materiality, and etymologically as a womb, a place of creation, gestation, and genesis, it is in itself without particular form or is indeterminate in form. It is a common place out of which worlds may be birthed, but unlike a grid, with its modular, latticed divisions, the matrix is unbound by immediately recognizable structural laws.²³⁵ Consequently, it becomes difficult to describe concretely the originary underlying framework or figural characteristics of a matrix, which would in turn give digital depiction its specific

²³³ Sabine Eckmann and Lutz Koepnick, *Grid/Matrix* (St. Louis: Mildred Lane Kemper Museum, 2006).

²³⁴ "Insofar as its order is that of pure relationship, the grid is a way of abrogating the claims of natural objects to have an order particular to themselves; the relationships in the aesthetic field are shown by the grid to be in a world apart and, with respect to natural objects, to be both prior and final. The grid declares the space of art to be at once autonomous and autotelic." Rosalind Krauss, "Grids," *October* 9 (Summer 1979): 50-64, pp 50, 52.

²³⁵ I am here referring to the etymological and philosophical roots of the term matrix, specifically the account of it given by Plato in the *Timaeus*, as explicated Edward Casey in his remarkable study of space and place, *The Fate of Place*. In his chapter on the *Enuma Elish* and the *Timaeus*, Casey discusses the philosophical valences of the matrix as the generative source of matter, energy, and the ordering force, which precipitates the architectural formation of world and universe. Casey pp. 23-49.

graphical appearance. In colloquial, contemporary usage, the matrix is often conflated with a modular cube that extends the generalizing and predictive capacity inaugurated by the grid into three dimensions.²³⁶ In 1999, the popular film *The Matrix* added a metaphorical dimension of temporal flux to this cube by portraying the “matrix”—the fictional world digitally created to entertain the minds of human bodies as they are farmed for their energy: “plugged in” but otherwise inert, kept alive by tubes and fluids in small, womblike pods.

What the *Grid/Matrix* exhibition reveals, ultimately, is a correspondence, instead of a rupture, between the grid and the digital matrix that simply extends the two-dimensional, planar grid into a three-dimensional cube, a pictorial strategy—and an epistemological paradigm—that was under continual negotiation in Western art from the Middle Ages forward.²³⁷ Until the 20th century, conventions of Western pictorialization dictated that any trace of the grid as an underlying technical support should be hidden from the viewer, leaving only an impression of seamless recession into depth. Of course this is an idealization, and paintings can offer a distinct sense of spatiality without conforming perfectly to perspectival rules. Moreover, indices of a fully rationalized or a rudimentary perspectival configuration are often visible in the inclusion of painted floor tiles in the image, which conform to the diegetic world of the picture but also reveal the modular construction of space, the structural framework the conditions that possibility for that world to appear. But in Vasarely’s painting, the grid is not a tool that aids in the production of an alternate pictorially-realized universe, as in the case of the Cartesian perspectival grid. Instead, the grid is itself the subject—the visible content—of his work. However, whereas in modernist painting the grid is often adamantly flat, self-referential, and submits the painting’s visible world to a strict, orderly regime, as in Mondrian’s black and white grids punctuated by primary color, Vasarely’s grids deploy order against flatness. Rather than exploiting the flattening power of the planar grid towards a polemic refusal of depth or spatial illusionism, Vasarely’s compositions swell and distort their modular array. They turn the structural regularity of the grid against itself, and produce a visual and kinetic sense of form struggling beneath its configurative parameters.

In part, Vasarely’s oeuvre is dedicated to exploring the possibilities of the *unifying* metric system of the grid—its capacity to create an overall fabric within whose regular patterns distortions become that much more visible. As we will see later in Watz’s *ElectroPlastique*, if one imagines the grid as a delicate web overlaying a terrain (marked with topographical features) beneath it, the web, which would be composed of perfectly regular squares if viewed as a plane from a direct, frontal perspective, will lose its appearance of regularity as underlying shapes distort (appear to stretch and compress) its otherwise perfect flatness. In Vasarely’s 1935 painting *Harlequin*, he has begun to explore how distortions of a grid would appear when that grid was subjected to pressure of forms swelling beneath it. The regularized grid of floor tiles ubiquitous in perspective

²³⁶ David Summers calls this the metaoptical cube, in which a modular division of space along x, y, and z axes creates an infinitely extended cube, measured in the regular intervals provided by the module. Any point might be feasibly mapped in relation to any other point within this cube, which “might in fact be extended in thought (if not in imagination) to be coextensive with the universe itself. This would be the universe conceived as an infinite, isometric matrix preceding any object that might appear in it.” Summers p. 560

²³⁷ Summers p. 550

paintings transforms into drapery, and becomes subject to quite a different set of laws—they do not lead the eye to perceive spatial recession to a notional horizon or vanishing point, but now supply a planar surface that can be manipulated to produce the illusion of a humanoid figure protruding through it. The figure of the Harlequin is instantly recognizable, seeming to stretch and distend the black and white grid as it pushes through the planar surface. The distortion of the grid allows distinct forms to appear without the use of outline to define shape and without modeling to produce volumetric effects. Thus, it is the visible division of the plane into a grid that gives the figure in *Harlequin* the sense of being part of a total material fabric of object, space, and world.

Both *Harlequin* and a simpler 1937 drawing, *Martian*, reveal Vasarely's preoccupation with the morphogenetic qualities of the grid, which will eventually take a second place to the encoded color-form permutations of his *alphabet plastique* and planetary folklore paintings. In *Planetary Folklore, Number 3* from 1964, Vasarely works through a series of color-form permutations. The painting, which is decidedly more "digital" in its emphasis on individual, discrete units rather than the overall gridded "fabric," as in *Harlequin* and *Martian*, is structured along a strict, rectilinear grid. However, the eye is drawn not to the grid but to the black to grey gradations within the background of each square, paired with colored shapes whose hues are widely varied, and often clashing, and whose shape and size range from ovoid to circular and small to large. This painting has a mathematical look to it—it is immediately apparent that, even if the system cannot be readily detected, the composition follows a set of rules. Its aesthetic is digital, coded, ordered within a grid but are not fundamentally *about* the grid. *Planetary Folklore* instead institutes a visual system based on discrete elements. The strategy behind *Harlequin* and *Martian* of subtly stretching and compressing the overlaying grid might be said to occupy an intermediate position between traditional, *disegno*-based approach to drawing and the digitally configured visual algorithms of *Planetary Folklore*.

Vasarely's paintings that exploit the grid, such as *Harlequin* and *Martian* do not demonstrate the true discreteness necessary to break through the barrier of the grid and into the zone of the matrix, precisely because Vasarely is treating the grid as an overall fabric. This overall structure does not allow the disjointness and articulation necessary to define a system as fully discrete and, by extension, digital. It is only in his later visual systems—the *alphabet plastique* and planetary folklore—whose conceptualization begins to emerge in the late 1950s and comes to fruition in 1963 with the exhibition *The Plastic Unit* at the *Musée des Art Décoratifs* in Paris that his digital world view becomes fully apparent. Conceived as an alphabet of basic elements or building blocks, possessing their own structural limitations that in turn govern the array of possible outcome for the image, Vasarely's system, initially titled "planetary folklore" and ultimately named the *alphabet plastique*, was the product of a career-long goal to compose a formal language of pure, irreducible units of shape and color upon whose principles would develop a universally legible (because based on a systematic program) and infinitely permutable visual program.

III. Programming the *Alphabet Plastique*

Educators of modern art have undoubtedly encountered with some frequency in their teaching career the protest from students, when confronted with Rothko, or Malevich, or almost any Abstract Expressionist that "a child could do it." With respect to

Vasarely, we encounter a different problem—that “a computer could do it.” Vasarely’s work looks to the 21st century viewer like a trippy screen-saver application or a retro graphics program. Similar to the now quaint outdatedness of the diegetic video game space in the film *Tron*, Vasarely’s art has the look of technology about it, but more precisely, it has the look of technological obsolescence.²³⁸ It appears digital but outdated. However, Vasarely devises a digital aesthetic, and even a digital notational schema in the form of his *alphabet plastique*, long before personal computing was ever available to artists.

Especially when confined within the small, regular scale of printed books, which contain relatively few installation shots and thus reveal little of the variety of scales, materials, and contexts implemented in his work, Vasarely’s images might appear dry, lifeless, drained of the animated vivacity or warmth that index the empathic creativity and the capacity to infuse life into inert materials attributed to the great masters. But such an interpretation would fail to take into account how Vasarely, and Watz after him, locate their particular brand of optical and structural beauty in the elementary stages of construction. Vasarely, in particular, does not utilize a pared-down method of abstraction, but rather creates a mathematical universe built from the ground up, bound not to mimesis but to its own exactly formulated constructivist parameters.

According to granddaughter Michèle Vasarely, biographer and champion of her grandfather’s life and artistic practice, the *alphabet plastique* is a theoretically functional notational system that also qualifies as digital.²³⁹

Vasarely acquires a singular place in the history of art as he erases the boundaries between two apparently opposite worlds, art and computer science. Following a rigorous and unrelenting path of experimentation, he arrives at the standardization of the means of creation within a small number of regular forms and color codes, a plastic alphabet, an aesthetic system of multiple combinations duly numbered and classified.²⁴⁰

The *alphabet plastique* brings together computing and pictorialization, and functions as a manually-computed (non-automated) visual programming language, similar to Processing, the programming language developed by Casey Reas and Ben Fry used to produce *ElectroPlastique*, Marius Watz’s homage to Vasarely. The question is whether this is a rhetorical sleight of hand that draws an artificial connection between the digital appearance of Vasarely’s work and the digital processes of electronic stored-program digital computers that render integer values as pixels on a raster-grid. In both his practice and in his theoretical/philosophical work Vasarely demonstrated a consistent fascination with the notion of a systematic method of picture-making. The result bears some similarity to Klee’s “visual language” that bends his interest in musical notation to produce a notational “alphabet” of pictorial symbols, but Vasarely’s project ostensibly envisions a greater computational-programmatic capacity than did Klee. “The

²³⁸ For an engaging interpretation of the spatial and technological dynamics of *Tron*, see Scott Bukatman, *Terminal Identity: The Virtual Subject in Post-Modern Science Fiction* (Durham: Duke University Press, 1993), pp. 215-227

²³⁹ Michèle Vasarely, *L'affaire Vasarely: art, pouvoir et corruption* (Aix-en-Provence: Vents contraires, 2002).

²⁴⁰ Michèle Vasarely, "Victor Vasarely: Chronology: The Father of Op Art," *Galeria Renes*, <http://renes.com.pl/wystawy/Vasareli/Informacja.htm> (accessed May 6, 2010).

codification of these elements allows for the creation of a bank of plastic possibilities that can be stored in electronic memory. Vasarely conceives the principle of an interactive program capable of recalling millions of colored combinations that can be readily exploited as an inextinguishable source of compositions and as a reliable statistics test of aesthetic preferences.”²⁴¹ But for Michele Vasarely’s claim to be correct, not only would Vasarely’s language require the assignation of values to his modular forms, but these values would have to be regularized and specified to the extent that each symbol could stand for one character and one character only, as per Goodman’s parameters for a true notational system. Moreover, this system would have to be available to other “programmers” as well. One aspect of Vasarely’s thought that suggests the likelihood that his *alphabet plastique* could at least notionally fulfill this requirement is his desire to create a universally legible art form. To reach the level at which a system is truly programmable, it must be possible for that language to be both readable and writable. Legibility opens into the possibility of full literacy, according to which a notational system functions because it is both readable and writable. To create an “art for the common man” begins in a subtle notional manner to integrate viewer and user. If this is truly a programming language, then it should in theory be available for future applications and reiterations.

Vasarely’s own experiments with abstraction led to a collection of writings and visual art that, in a much more developed way than previous artistic forays into digital systems using analog tools, began to articulate a theory of plasticity distinct from the “already known” in its imagination of an understanding of matter, form, and structure in digital terms. “As I work, I reduce all the date of my creations to invariables, so that I might retrieve identical values at the moment of re-creation.”²⁴² For Vasarely, expressing the possible relationships between discrete elements or units unlocks the possibility of seeing through new eyes the structural and architectonic principles that configure world, universe, and even social organization. His art and writing unfold from the notion that the world is fundamentally calculable, that all natural and artificial forms and all events are susceptible to calculation. There is also an assumption here that a particular system of knowledge, experience, and expression arise out of this calculability, which eventually manifests in the development of a new visuality aligned with and attributable to a numerical/numericized universe.

Vasarely’s obsession with a cybernetics-influenced pancomputationalism manifests in his formulation of a series of notational schemata, including a decimal-based scale of color-form permutations and several instantiations of a “plastic alphabet” that notated discrete, articulate, and interchangeable elements out of which, often through algorithmic processes, an image or a visual field is constructed. The following is Vasarely’s description of the evolution of the plastic alphabet from concept to materialization.

Once I had discovered my alphabet, I hastened to put it into material form. I selected six basic colors: a chrome yellow, an emerald green, an ultramarine, a cobalt violet, a red, and a gray. From it I obtained six scales, each with 12 or 13

²⁴¹ Michèle Vasarely, "Victor Vasarely: Chronology: The Father of Op Art," *Galeria Renes*, <http://renes.com.pl/wystawy/Vasareli/Informacja.htm> (accessed May 6, 2010).

²⁴² Vasarely, *Vasarely* p. 11

nuances, ranging from light to dark, and I added colored blacks—a blue black, a red black, a green black, and so on. Then I had tens of thousands of sheets printed by the serigraphic process, and had all the units of my alphabet punched out of them. Placed in cases, like type characters, they are so many form-colors which form the surest and fastest method of realizing my programmings executed on scale paper. By simple collage I obtain exactly what I want, that is, a combination which is both formal and colored, and which I call *algorithm* or *permutation*.²⁴³

In his repetitive process of experimentation with digital rules for image processing, Vasarely struggled to discover the grammatical rules for a universally legible and infinitely reproducible visual language. This ambitious project, though it yielded results that have ghettoized Vasarely's art, helps us to understand something about first, the qualities and characteristics of contemporary computer graphics, and second, the reception of and attitude towards this type of mediated imagery. In particular, the description of his process resonates with early computers in its evocation of punch-card coding, reproducibility, efficiency, discrete, interchangeable units (a necessary property of notational systems), automation, and expandable-compressible scalability.²⁴⁴

In his attempt to find a universal language he is looking at the way images can be broken into grammatical units and built up in complex architectures. His is an architectonic rather than a mimetic approach, as can be seen in the development of layered spaces similar to voxels in raster-based 3-D computer modeling (which are often characterized by the stepped quality of a surface as opposed to smooth vector-based curves). In 1954, Vasarely discovered that by drawing outlines, which he called "networks," on successive, thin layers of plexiglass and then superimposing these tracings over one another, he could build "a space which no longer owned anything to Euclidean perspective, or to any other kind of perspective."²⁴⁵ The process of layering enabled Vasarely to "translate real space into a plane."²⁴⁶ Most importantly, this translation entailed a new disjoint, segmented and articulate notation of individual depthless sections, which in combination would create the perception of real space. The geometry here, however, is neither a product of the infamous modernist grid (which is not a digital form), nor of any other spatial methodologies treated thoroughly by art historians. Instead, two-dimensional "layers," similar to those in computer graphics, are constructed to produce an illusion of three dimensionality or virtualization without the aid of Cartesian perspectival spatializing techniques.

In response to the perhaps now-prosaic observation that "to go fast is to forget fast, to retain only the information that is useful afterwards, as in 'rapid reading,'"²⁴⁷ Vasarely generated his own hypothesis about how abstraction is a condition and a consequence of the machine age.

'The increase of speed in all sectors of our existence has necessitated a proportional enlargement of designs.' This quickened pace forces us to be hurried and impatient. We are no longer given to prolonged reflection; we have lost our

²⁴³ Diehl p. 64

²⁴⁴ This last term I borrow directly from Vasarely: "The format of every abstract composition is expandable-compressible." Vasarely p. 14

²⁴⁵ Diehl p. 55

²⁴⁶ Diehl p. 55

²⁴⁷ Lyotard, *The Inhuman* p. 3

love for detail. Moreover, technology has left our hands unskilled and at the same time endowed us with devices—in this case, photography—that instantly provide us with detail. Our lives have become entangled and cluttered with countless tools, the appurtenances of civilized man. Instead of saving, we are losing enormous amounts of time. As a result, we try to speed up our perception; we seek out the immediate, powerful impact of the moment. This new human requirement is being met by big shapes and bold, flat colors.²⁴⁸

While Vasarely appoints Malevich's square as the representative figure of this epistemology, not only of industrial acceleration, but most importantly of accelerated calculability, the results of this tendency towards broad, flat, and bold color-form selection in information visualization and design, places a premium on simplicity and almost instant legibility.²⁴⁹

IV. The New Abstraction

In 1954, Victor Vasarely summed up the current state of abstract art and pointed to the future of abstraction with his statement that “the term abstract in painting refers not to an established fact, but to an irresistible trend toward plastic creation different from the kind we already know.”²⁵⁰ Around this time high modernism was reaching its apogee of medium-specificity, hermetic self-referentiality, and worst of all a bland decorativeness. While visionary at its outset, Clement Greenberg's pronouncements about the ideal function of painting had initiated a monolithic form of abstraction and abrogated the possibility that abstraction might operate outside a closed circuit of flatness and pure opticality. In the above quote, Vasarely advocates a new trend in plastic creation different from what we know. This would encompass new technologies but also new ideas about what abstraction is good for—how and what it is capable of communicating that pure opticality covers over or forecloses. What we are looking at, here in Vasarely's modular plastic landscape, is a new kind of abstraction. But this new abstraction is not Abstract Expressionism, with its overtones of spirituality, totemism, and the externalization of an interior emotional life buried deep by the machinic pressures of modern life. The new abstraction does not repeat the spiritualist purisms of Malevich and the Suprematists, Kandinsky and the Blaue Reiter, or Pollock's secrets of the deep. Thus abstraction is not “pure” at all, but rather is about technics, that is, about the kinds of expression provoked and made possible by the particularities of the technical means and mechanisms developed in the 20th century and beyond.

The properties and combinatory possibilities latent in the programmatic, discrete model of color-form developed by Vasarely in the mid 1950's find coherence under the rubric of what I am calling a “new abstraction.” I argue that Vasarely proposes a new basis on which to evaluate abstract art. My claim for a “new” version of abstraction works against a false assumption that previous models of abstraction were stable and monolithic. Whether the abstract is formulated as a pathway to the unconscious, a

²⁴⁸ Vasarely, *Vasarely* p. 15

²⁴⁹ John Maeda is most famously the champion of simplicity in the field of computer art and design. See also Edward Tufte for further reflections on the value of simplicity in information visualization. John Maeda, *The Laws of Simplicity* (Cambridge: MIT Press, 2006). Edward R. Tufte, *The Visual Display of Quantitative Information* (Cheshire: Graphics Press, 2001).

²⁵⁰ Vasarely, *Vasarely* p. 13

conduit for pure expression, or a purifying dissociation of structure and figuration (a way to show that the communication of meaning is independent of figuration), abstraction is often conceived as a means of uncovering, laying bare, or revealing something fundamental about nature, human expression, or experience by removing the false trappings of illusionistic imitation. Thus, the new evaluative framework proposed by Vasarely's art and writing pushes beyond a high modernist theory of abstract painting, which fails to account for the specific relationship between abstract form and the computationalist worldview that begins to gain momentum in the mid-twentieth century.

I maintain that Vasarely's approach to plasticity revises the expectations about what abstraction is supposed to do—before, it accessed the unconscious, expressed emotion, played with color, with the pure qualities of medium. Now art is not about the painterly medium at all, and not about expression, but about something *inhuman*. And what is more inhuman than fully automated computation, carried out at greater speeds and with greater capacity than is possible by the human mind? If there is a fascination here about the relationship between computation and life, it is not human life that is seeking to be explored and understood, but rather an all-encompassing notion of form and matter that Vasarely hopes will explain the fundamental principles of organic life and the physical structure of the world. Ultimately, I want to view the relationship between Vasarely and Watz less in terms of parallelism or perfect stylistic continuity than as an example, first, of the experimentation advocated by Vasarely with the fundamental units of form, nature, structure, and second, of the value of practicing this experimentation under the rubric of a digital-computational system.

To flesh out his idea that abstraction is a “trend”—a way of thinking and seeing—that moves inexorably and dynamically towards new, undiscovered, or as-yet inarticulate figurations of the plastic/material world, Vasarely traces five phases through which he predicts abstraction will pass if it is permitted to fulfill its transformative potential.

(1) The plastic unit becomes unidentifiable (that is, non-representational); (2) exterior vision is transformed into interior vision (early abstract phase); (3) abandonment of the conventional workmanship of painting—touch, glazes, materials, and other elements—for pure color, pure composition; (4) abandonment of all inherited techniques—canvases, pigments, brushes—and the advent of new materials; (5) abandonment of the two-dimensional plane surface as an end in itself, thus opening up the supra-dimensions of space-movement-time...²⁵¹

These stages in a progression towards the last, still struggling to be attained, transitional fifth step are visible in the modernist trajectory beginning with Manet and reaching apotheosis and decay with the likes of Newman and Rothko. As has been well documented by specialists of early modernist art history, late 19th century painting begins to collapse the perspectival illusionism of picture plane that dominated Western art from the 15th century onward. In so doing, artworks begin to straddle figuration and abstraction and gravitate towards an interest in locating the basic elements or minimum units by

²⁵¹ Vasarely, *Vasarely* p. 13

which meaning can be expressed.²⁵² The first phase finds solid ground and moves into the second with Expressionism and Surrealism. Cezanne, Matisse, Kandinsky, Malevich, and Mondrian, each in their particular location in time and space, develop third-phase, non-identical theories of pure composition and pure color. Rauschenberg, Flavin, Beuys, Oldenberg and Kosuth all represent the abandonment of traditional materials that heralds growing inapplicability of the title “painter.” While Vasarely saw these phases as subject to continuous revisitation and reworking, many of the most notable instances in this phase came later chronologically than his own conceptualization of these phases. Stopping short of claiming Vasarely’s status as a techno-aesthetic prophet, it is important to note that he views his own work as a progressive marker and catalyst for future innovation but not the pinnacle of abstraction; in fact, his primary aim is to establish the latent potential in abstraction for ongoing experimentation rather than a brief period signaling the end of art.

In rethinking the function of abstraction, Vasarely develops a mode of art practice (primarily but not solely issued through the medium of painting) that is not merely a style, but represents a new conceptualization of the possibilities inherent in thinking and creating with abstract form. Vasarely’s painting, and Watz’s generative computational art after him, both fall into a loose category of geometric, as opposed to expressive or lyrical, abstraction. For Vasarely, the association of particularity and figuration will yield to an abstract essentialism. In other words, figuration lends itself to particularity, while abstraction lends itself to the presentation of essences. To make an initial generalization, the new abstraction revises principles of materiality and its representation. It is not just about compositional strategy, but a more general consideration of the composition of structure itself.

However, whereas the essentialism of the expressionists was primarily emotional and spiritual, Vasarely’s vision of the abstract-essential is conceptual and technological. “Whereas the Art of yesterday strived to *feel* and *make*, today it has the capacity to *conceive* and *cause to be made*. If the conservation of the work previously resided in the excellence of materials, their technical perfection, and the mastery of the hand, today it lies in an awareness of the possibility of *re-creation*, *multiplication*, and *expansion*.”²⁵³ Yesterday’s art, extending backward well beyond the threshold of abstraction, was an art of feeling. Artistic genius could be measured by how successfully an artist combined technical skill with a delicacy and quickness of feeling to produce an overall sense of emotional and technical dexterity in his craft. When painting moves into an abstract modality, the logical extension of this art of feeling would become an expressive abstraction, in which painting now conveys a purified and essential emotional charge without remaining beholden to figuration. Moreover, if art in the past was a transmission of genius, it also represented an originary moment of creation, of *techne* in the Platonic sense of *making*, and making as a direct conduit of presence and expression from artist to viewer.

²⁵² This tendency also begins to gain momentum outside the realm of visual art, as we see in structuralism and semiotic theory, and, I would argue, is a symptom of the informatic worldview that comes to fruition in the mid-twentieth century with the advent of cybernetics.

²⁵³ Vasarely, *Vasarely* p. 14

Vasarely's causal construction is much more in line with the evolutionary algorithms set into motion by the computational generative art I will explore later in this chapter. *To cause to make* is to build a machine that will carry out the act of making; to cause to make is to start a process that will continue to change and to build on itself even with the removal from the picture of the artist's hand. The mark is no longer a conductor of genius but one switch in a living, dynamically changing circuit. Thus, technique and form become part of an aesthetics that is eminently social and emphatically political. "Technique has evolved from manual to industrial; language, from personal to universal; morality, from egocentric to communal."²⁵⁴ Vasarely dreams of an art that utilizes his new aesthetic parameters towards social and communal ends. Technology exists to make art universally practicable and universally accessible, a sentiment echoed in the democratizing potential within digital art.

In the same breath Vasarely is both suspicious of and celebratory about technology: "Only works endowed with great informative strength shall victoriously withstand depreciation cause by mechanical transposition."²⁵⁵ Thus, he is not merely championing mechanical reproduction, but the inauguration of an art of "*recreation, multiplication and expansion.*"²⁵⁶ He envisions not a machine that transposes the art of yesterday into a cheap, easily circulated form of today, but rather the machine that at the outset produces multiples, expanding algorithms, and notational systems whose coded machine-language can be exchanged, appropriated, read and rewritten. Originality and uniqueness are no longer to be sealed and safeguarded but made available to diffusion, translation, and mutation. Recall from Chapter 1 that a defining characteristic of digital systems is the identity and interchangeability of units. The moment of re-creation is not reproduction, in a mechanical sense. Whether or not he is able to create actual interchangeability or to determine a truly invariable metricized system for non-metric values, such as color, the very fact that Vasarely theorizes this translation of non-digital values into a digital schema indicates his desire to discover the poetic and structural potentialities within a notational system.

Vasarely's work demonstrates a tension between the conceptual and the visual. His clear examination of the relationship between the notion of structure, individual structural components, and the properties of a computational universe are deeply conceptual and heavily invested in the question about a modern world view, upon which scientific and technological innovations exert a profound influence. The peculiar way in which Vasarely blends concepts and materials has afforded a rather fecund comparison between his own practice and *Art Concret*, the mechanical, exact, and anti-impressionistic art that did not consider itself to be an art of abstraction because abstraction refers to, simplifies, or deconstructs a pre-existing world. In other words, *Art Concret* does not re-present a material reality but constructs visualizations of abstract thought. A term coined by Theo Van Doesburg in 1930, *l'art concret* is intended to characterize a non-figurative approach to art distinct from abstract art in its commitment to unify materiality and abstract thought. Unlike Conceptual Art, which discards the image or places it in a secondary position to the primacy of the "idea," *Art Concret* resists

²⁵⁴ Vasarely, *Vasarely* p. 14

²⁵⁵ Vasarely, *Vasarely* p. 14

²⁵⁶ Vasarely, *Vasarely* p. 14

an ontological separation between idea and image, and suggests that the image is a direct rendering of the pictorial devices, such as color, line, and shape, that are the visual expressions of intellectual activity. The theory expounded by proponents and practitioners of *Art Concret* about the sensibility of concepts realized through abstraction provides a comparative framework from which to examine Vasarely's abstract modality, and ultimately argues against a false distanciation between concept and form, ideation and visuality.

The similarity to *Art Concret* in Vasarely's thought issues from his exploration of the possibilities within and parameters of abstraction itself without mimetic reference to the external world. Abstraction, for both concrete artists and Vasarely, occupies a dimension separate from the physical world, a dimension that is constructivist and architectonic in its examination of basic structural forms but simultaneously abandons figuration and direct reference to forms observed in nature. In a sense, it is this paradox that facilitates his nomination not only as the father of Op Art but also as a father of digital-computational art. Digital modeling is fundamentally constructivist in the sense that it builds its abstract architectures from stripped down, elemental units of form. As Siegfried Kracauer noted about the difference between painting and photography, painting gives meaning a spatial form, but photography tries to make meaning out of an indexed fragment of space.²⁵⁷ Likewise, Vasarely's constructivist, concrete images search for the way that structure makes meaning—they attempt to uncover by depicting structure itself the semiotic territory—shape, topographical features, natural and artificial borders—of structure without the shackles of utility or mimetic attachment. While Robert Morgan has described Vasarely's work as “dematerialized pictorial spaces,” these paintings are eminently material insofar as they render imagistically the availability to semiosis of materiality itself.²⁵⁸ Vasarely depicts the infrastructure of materiality, and for this reason his paintings and mosaics seem to exhibit a hyper-materiality in a similar fashion to the uncanny density of certain digital imaging techniques.²⁵⁹

As Christine Mehring has suggested in an article exposing a formative presence of abstraction in early television art, a discovery most likely quite surprising to contemporary viewers who have observed the transition from sitcoms to reality TV, proponents of this mid-20th century technological abstraction mark another instance of the emergence of an increasingly ubiquitous cultural and artistic fascination with *transformation*—of material to information, of discrete parts into overall fields and vice versa, of continuous line and volume into aggregated pixels, beams, and electrons. Mehring cites early T.V. artist K.O. Götz: “The most extreme consequence of the

²⁵⁷ Siegfried Kracauer, "Photography," in *The Mass Ornament: Weimar Essays*, trans. Thomas Y. Levin, 47-63 (Cambridge: Harvard University Press, 1995).

²⁵⁸ Morgan p. 30

²⁵⁹ James Elkins has referred to a subtle and all-too-often unremarked “anti-naturalism” in his discussions of digital modeling of the human body. Particularly germane here is the “stickiness,” the slightly-too-dense rubberlike solidity that marks an image of a cross-sectioned mummy's head as a digital rather than a photographic artifact. James Elkins, "Art History and the Criticism of Computer-Generated Images," *Leonardo* (MIT Press) 27, no. 4 (1994): 335-342, p. 338

dissolution of classical form principles in painting...to me appeared to be the statistically programmed electronic pixel painting.”²⁶⁰

Vasarely, likewise, views painting as a transformative agent in the formation of cultural knowledge systems. He includes his painting in a complex interrelated network of discrete systems, including “strata,” “crystals,” “interstellar clusters,” “microscopic beings,” “electrons,” “suns...” that in conjunction with one another comprise the universe and all the activity within it.²⁶¹ However, Vasarely does not insist that he is the initiator of this world view, and draws analogies between his “linear networks”—whose formal shape draws its influence from various sources including woven fabric, maps, and the lines and grids of modern physics—and the drawing systems of the futurists and Paul Klee. For Vasarely, there are two types of art, one based on “genetic heredity” and a current type, exemplified by Klee and the futurists, that is based on information and its transformation into visual color-form. Thus, “only world endowed with great informative strength shall victoriously withstand depreciation caused by mechanical transposition.”²⁶²

Vasarely’s writings and his images combine a populist ideology and a view of art invested in and informed by science and mathematics. There seems to be a connection between his desire to create a universal language of art (manifested in his algorithmic, notational *alphabet plastique*) and the highly discrete or even digital abstract surfaces that characterize his art practice. It does speak to the interest in the look of machine-made imagery. But note that in the 19th century Seurat preserved the handmadeness of painting despite his goal of creating (similar to Vasarely) a regularized and systematic painterly technique. Technologies existed at this time for mechanical color printing but Seurat did not incorporate this into his work. It was only when early 20th century avant-garde art sought the near-total destruction of the pictorial tradition, that an allographic art (i.e. one that replaced the artist’s signature with mechanical and chemical processes) could claim a place in the artistic canon. Historians of the visual traditions in art and science have since focused extensively on the deep imbrication of art and technology receding well past the horizon of written history. Whether we think of art as *techne*—as making—or if we ascribe to the post-18th century definition of art—divorced from utility and segregated from everyday life—it is a brute fact that art is always-already technological.²⁶³ But the question at hand is about the degree to which technology is indexed in the artifact, or whether the role of technology is suppressed in service of the excision of utilitarian characteristics.

Pertinent to this issue, which is ultimately about whether Art, to be so named, must suppress its technological mechanisms, is the cultural disimbrication of art from decoration, design, ornamentation, and entertainment, to say nothing of notation, information visualization, or other types of non-art depiction. Innovations in visual technologies, such as the panorama, photography, and cinema, were at their inception frequently allied with a “media of attractions” that exerts a influence-by-proximity on the

²⁶⁰ Götz cited in Christine Mehring, “Television’s Abstract Starts: Europe circa 1944-1969,” *October* 125 (Summer 2008): 29-64, p. 37

²⁶¹ Vasarely, *Vasarely* p. 7

²⁶² Vasarely, *Vasarely* p. 14

²⁶³ For discussion of the relation of art and *techne* see Martin Heidegger, “The Origin of the Work of Art” and “The Question Concerning Technology,” both available in Martin Heidegger, *Basic Writings*, ed. David Krell (New York: Harper and Row, 1977).

history of art but whose context of exhibition and reception is dissociated from fine art proper.²⁶⁴ Consequently, a populist history of image-construction and reception cannot mute the apparent cultural desire to distance this tradition from fine art, even despite its resistance to fine-art elitism that surfaces in scholarly research on popular entertainment media such as video games and trash cinema.

Part of the reason Vasarely's oeuvre warrants closer examination in this context is precisely because it operates outside of the normative tropes of art historical discourse. Taking from my earlier investigation of analog and digital systems, I reiterate my claim that the criteria for the attribution of artistic success have been determined on the basis of properties circulating exclusively within the domain of analog systems. The ambiguity, density, and determinacy of analog systems derive from the necessary transition through indeterminate states. Although the absolute discreteness of digital signals is a theoretical proposition not borne out in actual practice (digital systems in fact may exhibit indeterminate conditions, as in the case of pixel artifacting, in which the leftover traces of illuminated pixels may be burned into a screen subjected to prolonged exposure of a static image), the facility of digital processing in producing mathematically calculated, discretely compiled images is anathema to the standards by which aesthetic achievement is traditionally measured in the history of art.

V. *ElectroPlastique: A Generative Appropriation of Op Art*

Thus far, my thread of analysis has been about a model of image-production that looks computational without using computers. Now, I want to extend that thread into an examination of a particular branch of contemporary digital picture-making. I want to see how Watz's 2005 "remix" of Vasarely's aesthetic extends Vasarely's ideas through the introduction of computational processing and generative code. With Watz's work we are no longer simply seeing computational and programmatic metaphors, but rather the execution of commands via generative code, which leads us to ask: what new information or phenomenal experience is yielded by the refiguration of Vasarely's aesthetic into a computationally coded medium?

In 2005, Marius Watz, a Norwegian digital artist and graphic designer, created *ElectroPlastique #1*, a "temporal composition" built with the programming languages Processing and Java for the electronic arts festival *Territoires électroniques*, held at the *Fondation Vasarely* in Aix-en-Provence. Over a duration of five minutes, an uncannily organic landscape of abstract moving images blooms and decays across four screens, accompanied by an electronic soundtrack composed by James Welburn. Taking as his inspiration the work of Op Art progenitor Victor Vasarely, Watz's *ElectroPlastique #1* pays tribute to Vasarely's intricate, transformational abstract landscapes whose contours are dictated by a grammatical alphabet of basic geometrical, modular forms. According to Watz' description of the work, "in *ElectroPlastique #1* a regular grid is deformed and then used as the basis of a series of organic abstract systems that evolve over time (5 minutes). Due to the panoramic format of the 4-screen projection, the impression is much

²⁶⁴ Tom Gunning, "The Cinema of Attractions: Early Film, Its Spectator, and the Avant-Garde," in *Early Cinema: Space, Frame, Narrative*, 56-86 (London: British Film Institute, 1990).

like a landscape. In the end the grid is exploded and disappears, hinting at a non-Cartesian vector space.”²⁶⁵

Watz creatively and professionally identifies with a group of young artist-programmers who utilize the productive constraints of software to produce algorithmically evolving code-based abstractions that they call “Generative Art”. Put simply, a work of Generative Art comes into being when an artist defines a set of rules that set into motion a process or series of processes resulting in a complete work of art. Algorithmic, generative strategies have existed in art production for centuries and do not inherently require the aid of electronic computers; in 1787, Mozart designed his *Musikalisches Würfelspiel*, a generative musical composition whose operative mechanism was a set of dice and a 177 measure score. Chance, instrumentalized through a toss of the dice, determined the order in which the measures would be played and thus superseded authorial control as the primary organizing principle of the aleatoric musical “piece.” That Mozart supplies an early example of algorithmically unfolding art is not accidental—the history of generativity in the visual arts has been inextricably linked musical composition, particularly to experimental avant-garde composition, on one side, and to the hedonistic rave scene of the 1990s on the other. Interestingly, the distance between these two musical genres has collapsed, to a certain degree, as the popularity of raves has dissipated and VJ culture has begun to align itself with the experimental art scene.

Generative Art is a term that applies to a depictive strategy rather than to a particular style or genre, and does not necessarily rely on electronic computation for its success. Most often, however, it describes a computer-based trend in software art in which randomness is built into a chain of executable coded commands to introduce unpredictable results into the “final” work of art. Influenced by the conceptual, algorithmic practices of artists such as Sol LeWitt, Victor Vasarely, the Algorithmists, Jean Tinguely, Jean-Pierre Hébert, the early digital artist Manfred Mohr, and Roman Verostko, generative Artists are deeply invested in the questions of 1) how code and algorithmic proceduralism can shape the final outcome of artworks and 2) whether code bears a specific materiality that imprints itself on the face of the artwork. In short, Watz, Casey Reas, and many of the self-identified group of generative artists take principle of structure and form as their central conceptual and aesthetic material.

Some reservations about the historicization of generative art have led Watz to comment that “[u]ncritical use of the term [generative] risks conflating artists from different periods and assuming that their artistic interests are the same, when in fact the contexts in which they produce their works are very different.”²⁶⁶ Nevertheless, Watz in *ElectroPlastique* creates a necessary and explicit link to Vasarely’s earlier investigations by performing a series of formal permutations of Vasarely’s basic elements of structure. Watz suggests ultimately that his optical surfaces contain a latent multidimensionality that reveals itself when the structure is subjected to stretching and compression both spatially and durationally. In other words, while Vasarely’s optical constructions can

²⁶⁵ Watz, Marius. *ElectroPlastique #1* (2005). <http://www.unlekker.net/proj/electroplastique/index.html>. Accessed April 6, 2010

²⁶⁶ Marius Watz, "Theory: Vague Terrain," *Generatorx.no*, June 6, 2006, <http://www.generatorx.no/20060620/theory-vague-terrain/> (accessed April 6, 2010).

gesture towards spatial play and dynamism, there is also a sense in which their kinetic energy becomes frozen or dormant on the canvas, forcing the viewer's attention to the static format of Vasarely's depictions rather than to their dynamic potentiality. Rewriting Vasarely's interest in kineticism into the context of generative code, Watz adds actual instead of virtual duration and dynamism to the image. In so doing, he echoes Vasarely's fascination with the optical possibilities in kineticism, which he believed could supply the activating element that would "engender a humanistic and philosophical concept of the plastic arts" by encouraging a conceptual, technological, aesthetic realm that placed mutation at the center of thought and experience.²⁶⁷

ElectroPlastique is not a reiteration of Vasarely's plastic alphabet, or a straightforward performance of his visual language. Rather, it explores in an associative manner the visible and physical properties of Vasarely's plastic universe. Vasarely's Op Art canvases might be said to create a kind of virtual space with different physical rules than the ones belonging to the space occupied by the viewer. In *ElectroPlastique*, Watz similarly seeks to build a fictional digital space with its own physical properties and parameters. But this fictional space would be, for Watz, kinetic instead of static, in order to test how the system would develop within its parameters if given the added dimensions of time and movement. Beginning with the grid, the original form of computational graphic space, Watz's composition progressively distorts that perfect originary order, not destroying it but subjecting it to a slow, ongoing series of permutations from the perfectly regular grid to a more anamorphic or even potentially chaotic form, which represents a different concept of the nature of order. Thus, we have to think about Watz's project not only as a transfer of Vasarelian optical schemas into a computational, kinetic form, but as a test case of what experiential dimensions can be added by the dynamic visualization of growth, change, and decay.

Just as painting is more adept at expressing certain kinds of emotions, concepts, and experiences (or more adept at expressing certain aspects of these varieties of experience) than poetry and vice versa, computers have a certain range and domain of expression that they are best at as well. It is not just a fuzzy humanistic bias to claim that art based on code is a product of programmatic logic. It is a truism that the language used to convey information conditions the kind of information that can be conveyed. Thus, legal language will convey different information about a civil dispute than would a novel or a newspaper article. To say nothing of the complexities and opacities that arise in translation between French and English or Spanish and Japanese. Artist Peter Bentley has joked that coding is literal, unambiguous, and tends to produce literal, unambiguous thinking in human programmers. After all, if what computers are best at is efficient calculation then the artifacts they make best must be about, reference, or be comprised of calculations. But another less tangible effect of the development of procedural computer programming languages is that the methodical nature of code restructures the way we conceive of and perceive the world by reaching to the bare bones of structure itself. Given the compositional and procedural organization of digital images, then, it seems quite natural that digital structure and abstraction should go hand in hand.

Looking again at the specific characteristics of Vasarely's oeuvre and the issue of translation and appropriation introduced by *ElectroPlastique*, it is important to take into

²⁶⁷ Diehl p. 44

account how both of these artistic models respond to and deviate from representational norms pertaining both to abstraction and figuration. If we examine the kinds of imagery that have shaped the popular perception of digital graphics, it is immediately noticeable that the spare, pixilated and geometric abstraction of *Pong*, *Space Wars*, and *Tron* has given way to an immersive cinematic experience of shot through with a nearly unquestioning faith in the mimetic naturalism made possible by 3-D modeling. Graphics subscribing to this newly-possible and ever-increasing digital naturalism ask that viewers or users, even as they interact with the moving images on the screen with the aid of technological prostheses such as pushbutton, and now motion-sensing, controllers or touchpads, think of these figures as not merely lifelike but imbued with real vitality. The most mimetically accurate computer-generated imagery asks us, in short, not to think about computers at all. The designer's success in constructing and programming digital figures is measured by the disappearance of any signs of its digital ontology; in a digital universe, every object begins its existence as a simulated sculptural amalgamation of balls, grids, and squares, only later acquiring the layers of tissue, hair and fabric that guarantee its lifelike effect.

For example, recall Disney's Pinocchio, who prior to his transformation into a "real boy" by his beneficent fairy godmother is marked as literally and symbolically "un-real" by the presence of hinge-and-screw joints and squared-off wooden limbs. After his transformation, those limbs take on the rounded contours of flesh and the "hinges" of his joints are hidden under implied layers of organic tissue. Of course, the technique of hand-painted cell animation disappeared from Disney's production model before the turn of the 21st century, in an industry-wide echo of Pinocchio's own neurotic complex that he is not real enough. CGI animation ups the ante one step further, so that Pinocchio's cell-animated real-boy body remains too closely lashed to tradition of line-drawing instead of the new, more mathematically complex technology of 3-D modeling. But for all this appearance of reality, a digitally modeled world still seems too clean and frictionless to be fully organic. Even a head of hair, each strand of which undulates according to a perfectly calculated and calibrated probabilistic motion curve, cannot seem completely natural precisely because it is numerically calculated. In a computational universe, even randomness is a probabilistic value calculated into an equation and thus does not seem up to the task of the unpredictable surprise of the phenomenon known as *chance*.

I diverge into this brief discussion of digital naturalism to illustrate that digital producers attempt to disguise the tools and procedures of the act of digital composition. If underlying every digital graphic is a pixel, a vector, a raster, a grid, a bitmap, the illusionistic impulse of digital naturalism covers over and disguises the structural principles of the image. The architecture of digital images is anchored by and initiated from the foundational geometries of the point, line, and grid. In their nascent state, like the not-yet-real Pinocchio marionette, most digital figures look more like precarious stacks of cones, spheres, and cubes than the uncannily organic characters they eventually become. Even the most naturalistic animations begin as roughshod wire-frame or geometrical models, only gradually acquiring the layers of mathematically modeled tissue—the muscle, skin, hair, and fabric—that complete their illusionistic circuit.

In contrast to the illusionism pursued by digital naturalists, the artists I call digital formalists, including Watz, their predecessors, in this case Vasarely, foreground the tools and the technical means of production. Digital formalists are interested in the particular

revelations made uniquely possible by digital tools, and they bare the formal properties of digital structure in a kind of unashamed and even celebratory nakedness. While most computational images obscure the tools of their production, and strive for a complete illusionism, both Watz and Vasarely obsessively reiterate the properties elementary structures, and in so doing effectively reverse the illusionist teleology that seems to have taken hold in many areas of digital image production. In their continual presentation of basic forms, such as circles, squares, spheres, and cubes, Watz and Vasarely rehearse the process of digital fabrication from the ground up. But while most makers of digital artifacts attempt to conceal evidence of the tools of production, such as pixilation, Watz and Vasarely announce a finished product at the point where most digital craftspeople begin.

This does not mean that their works imitates the anti-aesthetic procedures of conceptual artists. Conceptual Art self-reflexively interrogates the ideological, aesthetic, and philosophical underpinnings of art, but most often does so in a decidedly ascetic manner that branded it as embodying a sometimes parodic, sometimes deadpan exposure of the architecture of bureaucracy that Benjamin Buchloh has named the “aesthetic of administration.”²⁶⁸ The digital formalism exhibited by Watz and Vasarely, on the other hand, displays a visual hedonism that blossoms, somewhat paradoxically, within the constraints of the pared-down modular form of the grid. Both Watz and Vasarely subject the grid to anamorphic shifts, either in the temporally extended realm of moving images or in a synchronic, static form. But in both cases, the two-dimensional grid is imbued with a sense of organicity as spheres, cubes, or other volumetric shapes push against the fabric of the grid—distending, compressing, and distorting its perfect regularity, and in so doing exploring the experiential possibilities latent in a mathematically computed visual terrain.

Marius Watz’s appropriation, alteration, and intensification of Vasarely’s “software” transforms Vasarely’s creation of something “like software” or “like a program” into the technological phenomenon—a computationally executable, binary machine language—that Vasarely can only imagine and describe. The incorporation of generative change and the replacement of intention with algorithm make this art even less humanistic than Vasarely’s but more about the form, movement, and actions of an anti-humanistic, perhaps even vitalist organic force. We are dealing with a paradoxical organicity here, precisely because the works are generated by a computational language and epistemology within an enclosed computational universe. The unfurling of branchlike structures, the growth and decay of forms does not, contrary to discourses surrounding artificial life, need to mimic biological life to evoke poetic associations with biological processes; we might anthropomorphize computational output, the shapes bubbling on the screen, or even invent associations between computational and biological processes that are reinscribed within the code, but there is nevertheless a sense of the alien, of synthetic artificiality to the graphic output of computational processes that makes them seem too smooth and our interactions too frictionless, ultimately calling into question the veracity of the organic metaphors that are too easily applied to digital graphics.

²⁶⁸ Benjamin H.D. Buchloh, "Conceptual Art 1962-1969: From the Aesthetics of Administration to the Critique of Institutions," *October*, no. 55 (Winter 1990): 105-143.

But this frictionless quality of digital space is another (paradoxical) artifact of its discrete ontology. The very fact of digital particulate composition enables each particle to be filtered, engineered, cleaned up and perfected. In analog snapshots of the earth from space, the surface of the earth is marbled with cloud cover, and these swirls of white over the glowing blue surface have conditioned the way in which we imagine the earth's surface to appear. In contrast, an image of the earth (whose ontology is photographic, not computationally generated) from which all traces of cloud-cover have been erased through the amalgamation of cloud-free pixels drawn from many digital photographs, loses the sense of multilayered complexity and density we get from the analog photograph, and instead becomes too smooth, too frictionless. It lacks the indeterminacy, the density, and the repleteness that characterized analog systems. This does not mean the digitally compiled photograph is not beautiful, but that it is both qualitatively and quantitatively a different object than the one captured by the analog camera.

Rewriting Vasarely's interest in kineticism into the performative context of generative code, Watz adds actual instead of virtual duration and dynamism to the image. Vasarely saw more than just optical possibilities in kineticism, and believed that it could supply an activating element that would "engender a humanistic and philosophical concept of the plastic arts" by encouraging a conceptual, technological, aesthetic realm that placed mutation at the center of thought and experience.²⁶⁹ While echoes reverberate between Watz and Vasarely in the relationship between conceptual and visual elements in their work, there are also some notable differences between them. While Vasarely painstakingly devised a "toolbox" of units that would take the first steps toward the realization of algorithmic, programmed pictorializations, for Watz the programmatic basis for his pieces is already a given. He is therefore able to initiate his work from a different starting point, which pulls his focus toward a different set of artistic concerns than the ones central to his pioneering predecessor. Vasarely's conceptual goal, to prove that it is possible to invent an iterable system for producing graphical models, has already been demonstrated by the very fact of computational programming. Op-Artists set themselves the constraint of working largely within static frameworks, but within this constraint they want to elicit a sense of pulsating dynamism.²⁷⁰

There is thus a preoccupation with virtual perceptual effects in Op Art that fades in *ElectroPlastique* because the dynamism is made actual. Moreover, Watz's graphical schemas act quite differently upon the viewer's sensorium than Vasarely's. Vasarely's constructions produce their illusory kinetic effects by using optical patterns to generate a sense of physiological instability in the viewer. Viewer space and pictorial space, then, are magnetically pulled toward one another, but then revealed as radically incongruous as the viewer struggles and fails and struggles again to cut through the visual disorientation effected by the pictorial schema. Watz's lugubriously morphing visual field, on the other hand, is less aggressively confrontational, more harmonious in its otherness. It seems

²⁶⁹ Diehl p. 44

²⁷⁰ "Perceptual and kinetic art have an intertwined development that cannot be totally disentangled; nevertheless perceptual, optical, or 'virtual' movement—which always exists in tension with factual immobility—is an experience of a different order. Carefully controlled static images have the power to elicit subjective responses that range from a quiet demand made on the eyes to distinguish almost invisible color and shape difference to arresting combinations that cause vision to react with spasmodic afterimages..." Seitz p. 9

content to uphold the distinctions between the parameters of vector space and that of cardinal viewer space without resorting to the dizzying oscillations of Vasarely's earlier paintings.

Watz sets himself to a different experimental task, not to trick the eye but to construct a world with its own physical forces, actions, and reactions. This world is less dependent on employing its underlying system to "trick" the viewer's sensorial apparatus into seeing movement and change where none exists. Vasarely's work is, both conceptually and aesthetically, more about a system of interacting and interlocking discreet parts. Watz's formal strategy, in this instance, is more about creating an overall field that becomes susceptible to topographical distortion. Where Vasarely's schemas are composed of individual units or elements, the spatiality of *ElectroPlastique* begins with a virtual webbed "sheet" under which solid forms pass, producing protrusions and distortions in the otherwise flat plane.

Both 20th century Op Art and 21st century Generative Art fight to uphold the retinal as a viable aesthetic characteristic. Vasarely sought to explode the overvaluation of expressionism in the fine arts by experimenting with the visual possibilities latent in systems and algorithmic permutation. Watz's generative compositions work to redeem the retinal from its summary dismissal after conceptualism by enfolding the theoretical richness of dynamic systems and the visual hedonism of his screen based moving abstractions. Often in analysis a greater emphasis is placed on the introjection of randomness and chance into time-based systems, but less attention is granted to visual and other sensory elements of the pieces, as though these qualities are either self-evident or perhaps resistant to language. It seems crucial, however, for the theory and criticism of both Op-Art and Generative Art, not to privilege either side, the conceptual and the aesthetic, as if they are independent entities, but rather to find a vocabulary to articulate the inextricable relationship between system and surface, and to realize their symbiotic support, without which the underlying structure and the *raison d'être* for these visual fields breaks apart and dissipates from view, like the bits of color sliding from the screen in the final moments of *ElectroPlastique*.

Chapter 4: Spectral Analogies: From Wall Drawing to the Art of Programming

Thus far, the chapters of this dissertation have encompassed theories and artworks that make the distinction between analog and digital systems readily perceptible. They have all supported the idea that there is a marked difference in the phenomenological experience of digital and analog notational and depictive strategies, and as a result a difference in the way we must conceptualize digital objects through the lens of our phenomenological experience of them. But in this penultimate chapter I want to show the work of an artist who operates in a more indeterminate range of picture-making, one that is fundamentally tied to the specific functions made possible by a digital computer, but whose morphological structures are dense, continuous, and remarkably and markedly painterly. Many of the works I have discussed thus far, from Seurat to Daniel Rozin to Vasarely, are palpably discrete, programmatic, and digital, foregrounding the digital at the level of interface. But I will now turn to the “programmed paintings” of Casey Reas, an artist whose work is technologically digital insofar as it is derived from computational processing, but is, largely, aesthetically analog. As opposed to Rozin, Reas treats the digital as a primarily technological category, rather than an aesthetic one. As such, his work only occasionally and tentatively reveals the digital architectonics underlying his graphic schemas; most often his work is suffused with the analog properties of continuity, smoothness, and gestural quality. I want to resist calling his work “hybrid,” but in that resistance, will another productive terminology reveal itself?

In his essay describing his 2004 project *{Software} Structures*, commissioned for Whitney Artport, Casey Reas describes his creative process, stating that he wants “programming to be as immediate and fluid as drawing” and that he “work[s] with software in a way that minimizes the technical aspects.”²⁷¹ Reas is perhaps best known for designing the programming language Processing, for which he and co-author Ben Fry won the Golden Nica award at Ars Electronica in 2004. For an artist who so explicitly and emphatically values immediacy, fluidity, and organicity in his own artistic production, it might seem curious that he made computational programming his medium of choice. It might also seem odd to select Reas’s work as an exemplar of a sensorially apprehensible digital aesthetic, predicated on the laying bare of discreteness, syntactic and semantic disjunctness, and so forth. However, the digital structure of Reas’s conceptual and instrumental process reveals itself only furtively, and more often cloaks the digital in dense, continuous, and analog surface effects. The final output of his work, in other words, is not heavily discretized in the manner of Vasarely or Watz—Reas’s pictorial schema does not overtly embrace the pixel as a fundamental expressive unit, as in the case of John Maeda, Reas’s teacher, or John F. Simon. Rather, the works create an aesthetic of emergence, or a *computational* aesthetic by foregrounding the aesthetic possibilities of algorithmic variation within a given visual system. But the fact that the underlying processes generating this work are electronically computational, and even if the overall piece is comprised of individual units, properties of discreteness and

²⁷¹ Casey Reas, *{Software} Structures: A Text About Software and Art*, 2004, <http://artport.whitney.org/commissions/softwarestructures/text.html> (accessed April 16, 2010).

disjunctness are occluded in Reas's work, drawing his work closer to an analog aesthetic despite its computational ontology.

Reas's processes explore the limits of computation, but without necessarily offering up a digital aesthetic; according to my categorizations of analog and digital, Reas's work does not appear to be digital in the strict sense. While his prints are less clearly computationally generated, his screen-based installations are clearly rendered with the aid of software processes, and they are situated in the context of multi-media installation; even his prints are often placed in juxtaposition with streamlined hardware configurations on which moving images bloom, swirl, decay, and disappear in ongoing cyclic sequences. And yet, despite the presence of screens and screen-based, non-photographic animations, his work seems to conform to the evaluative criteria of analog pictorialization.

Reas's pictorial schemata set into motion a complex series of analogies between the digital and analog, and the organic and the technological, but the digitality of the work is largely unavailable for direct sensory apprehension; the digital becomes the hidden infrastructure, the causal mechanism of the graphic configuration that in the end is made invisible by a proliferation of painterly layers of texture and color. Reas's production might be thought as a hybridization of the analog and the digital, or, more accurately, to use the digital to "analogize" the analog.²⁷² On the one hand, he is deeply invested in a computational, proceduralist logic. On the other hand, the richness, ambiguity, and organic harmony of his output revel in painterly abstraction. His choice of medium is not accidental, and can be construed as a manifestation of his post-Conceptualist understanding of information architecture as the processing of discrete functions that resolve into a complex, aesthetically rich visual landscape. If Reas's use of digital technology is haunted by the spectre of analog painting practices, by a desire for the spontaneity and gestural contact that is traditionally associated with painting, this tension that arises in his work makes him an ideal springboard from which to see how the analytic category of the "digital" can, and should be disaggregated from electronic-computational machines. His work demonstrates how artists can utilize computational technology in a multitude of ways—to highlight the properties of digital graphic composition by foregrounding pixels or other structural building blocks, or to occlude the picture's digital infrastructure, leaving only indirect clues, or none at all, to its digital ontology.

I. Reas, LeWitt, and the Legacy of Conceptual Art

Reas's painterly aesthetic sensibility commingles with his fascination for the history, legacy, and contemporary computational application of Conceptual Art. In 2004, Reas produced a multi-layered, collaborative, textual and visual project entitled *{Software} Structures*, commissioned by the Whitney Museum for the Whitney Art-port, an online exhibition space showcasing internet-based art projects by prominent artists working within the nebulous field of "new media." Reas envisioned this project as an

²⁷² I am once again referencing Whitney Davis's term here. Reas's "programmed paintings," as I am calling them, analogize the analog by "looking like" analog painting. Thus, "the looking-like—the noetic resemblance—can be secured and relayed in analog *or* digital modes or in analog *and* digital modes or in what *seem* to be analog and/or digital modes." Davis p. 88.

assessment of the relevance of Conceptual Art to contemporary software-based art practice. *{Software Structures}* addresses Conceptualism by testing the possibility of importing the strategy, philosophy, and aesthetic of Sol LeWitt's Wall Drawings into a computational, software-driven form. The project begins, as Reas avers, from "a simple question: 'Is the history of Conceptual Art relevant to the idea of software as art?'"²⁷³ In the following section, I will begin to formulate an answer to this question through a general consideration of the seductiveness of Conceptual Art for both digital artists and theorists of digital art practice by examining Reas's conceptual indebtedness to Sol LeWitt, whose influence suffuses the work of the younger artist. Sometimes referenced explicitly, sometimes only peripherally, Sol LeWitt's deeply nuanced ideas about the primacy of "process" nevertheless provide the conceptual ground from which Reas's art unfolds.

The relationship between the digital and the "conceptual" and, more specifically, Conceptual art of the 1960s and 70s, is a muddy terrain, especially with respect to existing tropes in media studies. Media theorists such as Edward Shanken, Eve Meltzer and Warren Sack have drawn important connections specifically between Conceptual art and software art, gesturing to the "information world" that emerges with the birth of cybernetics and information theory in the mid-20th century.²⁷⁴ Cyberneticists described a world no longer comprised of solid matter, but rather of impulses, of continuous feedback loops between signals and noise. Most importantly, both signals and noise are themselves composed of individual "bits," a number of elements that can be measured and computed. Information then, becomes a measurable quantity. And if the world is made up of information, all systems, from biology to consciousness to electricity, are also quantifiable, measurable, and calculable.

In the 1960's and 70's Conceptual artists launched rigorous critiques of the technological and bureaucratic systems at work in shaping the cultural imagination and social practices in the burgeoning information age. For the 1970 Information show at the New York MoMA curated by Kynaston McShine, Hans Haacke created the participatory work *MOMA Poll*, asking museum-goers to respond to the question "Would the fact that Governor Rockefeller has not denounced President Nixon's Indochina policy be a reason for you not to vote for him in November?" Participants were asked to register their response by voting "yes" or "no", and to drop their ballot in a clear plexiglass box in which the collected results would be volumetrically visible. Governor Nelson Rockefeller was at the time a prominent member of the board of trustees of the MOMA. Two-thirds of those who chose to vote dropped their ballots in the "yes" box. This work was conceived by Haacke as an algorithmic system that concretized the abstract notion of "feedback" in a quasi-sculptural, dynamic, and politically charged form. Although the work does not use computers, it is often, and correctly, viewed as exhibiting a parallel logic to the procedural, programmatic systems at work in electronic computers.

²⁷³ Casey Reas, "Process/Drawing," ed. Mike Silver, *Architectural Design* 76, no. 4 (July/August 2006): 26-33, p. 29.

²⁷⁴ Warren Sack, *Aesthetics of Information Visualization*, ed. Victoria Vesna, Margot Lovejoy Christiane Paul (Forthcoming, n.d.). Eve Meltzer, "The Dream of the Information World," *Oxford Art Journal* 29.1 (2006): 115-135. Edward Shanken, "Art in the Information Age: Technology and Conceptual Art," *Leonardo* (MIT Press) 35, no. 4 (2002): 433-438.

Conceptual artists interrogated the bureaucratic and statistical systems of social order and control by applying a proceduralist logic to their art practice. The link between bureaucratic proceduralism and contemporary software art is made on the basis of the strict logic of programming. Software is a tool that can only be activated, its procedures executed, if it follows a causal progression or chain of command. However, just because a work is procedural—because it presents the “rigorous, “axiomatic” “look of thought” that critic Donald Kuspit associated with Conceptual Art, does not mean it is digital.²⁷⁵ A work of Conceptual Art like MOMA Poll participates in the new epistemological horizon characterized by technological developments in computing and information science, but its aesthetic sensibility is vastly different from that of Rozin’s *Wooden Mirror*, which I discussed in detail in Chapter 2. Conceptual art has been characterized as anti-visual, anti-aesthetic, and most famously by Lucy Lippard, “dematerialized.”²⁷⁶ Rozin’s *Wooden Mirror* is emphatically material, and equally emphatically about sensory experience. Likewise, Casey Reas’s programs, as we will see, adamantly reject dematerialization and anti-visualism. The exemplary cases of Conceptual Art’s “systems aesthetic” lead their charge in a text-based, anti-visual rebellion against what they perceived as the soporific, normatively constrained domain of academic pictorialism. But in fact, the pieces by Reas that announce themselves as most strongly indebted to Conceptual Art turn out not only to preserve the centrality of the visual, but also to be no more aesthetically “digital” than their supposedly more painterly or “organic” counterparts.

Consequently, while the answer to Reas’s question about whether the legacy of Conceptual Art is relevant to contemporary software-based practice seems to be an obvious “yes,” in the sense that Conceptual Artists, as discussed above, often applied a proceduralist logic to their art practice and engaged in rigorous experimentations with and reflections upon more or less specific objects and themes (ranging from, on the largest scale, cultural processes of making meaning, to aesthetics, to more deceptively narrow issues such as local mayoral elections, as in the case of Haacke’s *MOMA Poll*), upon further inspection a monolithic affirmation of their similitude becomes less feasible. Both Conceptual Art and computationally-generated art participate in and/or critically interrogate their status of artifacts of the information age, but particularly in the exemplary cases of Reas and LeWitt, the frigid, machinic application of procedure is shot through an almost romantic aesthetic sensibility—what has been identified as mysticism in LeWitt’s work and thought, and that in Reas’s art leads to a suppression of a digital aesthetic in favor of an investigation of analog traits, such as fluidity and organicity.

The argument for the link between computational and Conceptual Art of the 1960s and 70s has been launched primarily on the basis of similarities between the trends in technologically driven media art and conceptual experimentation through the figure of information given by cybernetic theory.²⁷⁷ In fact, the emphasis on conceptual critique,

²⁷⁵ Donald B. Kuspit, "Sol LeWitt: The Look of Thought," *Art in America*, September/October 1975: 43-49, p. 48

²⁷⁶ Lucy Lippard and John Chandler, "The Dematerialization of Art," in *Conceptual Art: A Critical Anthology*, 46-51 (Cambridge: MIT Press, 1999).

²⁷⁷ See, especially, Edward Shanken, "Art in the Information Age: Technology and Conceptual Art," *Leonardo* (MIT Press) 35, no. 4 (2002): 433-438. See also Florian Cramer, "Concepts, Notations, Software, Art," *netzliteratur.net*, March 23, 2002, http://www.netzliteratur.net/cramer/conepts_notations_software_art.html (accessed April 10, 2010).

the dismantling of traditional aesthetic values in favor of a procedural “aesthetic of administration”²⁷⁸ has led to the dominant assumption held by many artists and media theorists that the self-reflexive, critical art created with or about digital systems is a direct descendent of Conceptual Art. Rosalind Krauss has decried the propensity of historicist discourse to reduce new practices by reframing them in the terms applied to previous models²⁷⁹. While this critique must always become a point of consideration for those researching the structural and social paradigm shifts potentially effected by new technologies, there are not only demonstrable conceptual and stylistic parallels between the procedural, rule-based art of the late 60s and 70s and the self-reflexively programmatic art of the late 90s and early 2000s, but the historical (not merely historicizing) argument develops from a central principle that both Conceptual Art and computational technologies emerge from a set of cultural fascinations, curiosities and critiques that could only have arisen within a particular epistemological horizon.

That horizon, the generative framework that fostered the rapid growth, flowering, and (apparent) decay of Conceptual Art, and the slower but inexorable unfurling of computational technology, was the post-cybernetic figure of information, and the accompanying fantasy of a total “information world,” a world view in which all matter, phenomena, movement—anything and everything—can be explained in terms of information science or “informatics.”²⁸⁰ An “information world,” a term I have appropriated from Eve Meltzer is a world seen as an interlocking system of relations, in which the behavior and transformations its parts are dictated by the parameters of the system.²⁸¹ Information, defined as unstructured data organized into a coherent, significance-bearing pattern, becomes the trope according to which the underlying structural order of the universe is understood. If it is possible to reduce and process phenomena into their constituent parts, and grasp their operational principles by

²⁷⁸ The aesthetic of administration occurs, and is most visible when “aesthetic identity is structured much the way this class’s [the postwar middle class] social identity is, namely, as one of merely administering labor and production (rather than producing) and of the distribution of commodities”. Benjamin H.D. Buchloh, “Conceptual Art 1962-1969: From the Aesthetics of Administration to the Critique of Institutions,” *October*, no. 55 (Winter 1990): 105-143. Reprinted in Rosalind Krauss, et al., *October: The Second Decade, 1986-1996* (Cambridge: MIT Press, 1997), p. 140.

²⁷⁹ In “Sculpture in the Expanded Field” Krauss writes: “And through this pulling and stretching of a term such as sculpture is overtly performed in the name of vanguard aesthetics—the ideology of the new—its covert message is that of historicism. The new is made comfortable by being made familiar, since it is seen as having gradually evolved from the forms of the past. Historicism works on the new and different to diminish newness and mitigate difference.” Rosalind Krauss, “Sculpture in the Expanded Field,” *October* 8 (1979): 30-44. Reprinted in Rosalind Krauss, *The Originality of the Avante-Garde and Other Modernist Myths* (Cambridge: MIT Press, 1985), p. 277

²⁸⁰ Katherine Hayles has defined informatics as “the material, technological, economic, and social structures that makes the information age possible. Informatics includes the late capitalist mode of flexible accumulation; the hardware and software that have merged telecommunications with computer technology; the patterns of living that emerge from and depend upon access to large data banks and instantaneous transmission of messages; and changing habits of posture, eye focus, hand motions, and neural connections that are reconfiguring the human body in conjunction with information technologies.” Hayles attributes the initial use of the term to Donna Haraway, who employs the term to differentiate traditional (modern) systems of information and control to the (postmodern) informatics of domination. Katherine N. Hayles, “The Materiality of Informatics,” *Configurations* 1, no. 1 (1993): 147-170, p. 149.

²⁸¹ Eve Meltzer, “The Dream of the Information World,” *Oxford Art Journal* (Oxford University Press) 29, no. 1 (2006): 115-135.

observing interactions and relationships between these parts, the world is hypothetically knowable as a totalized system. This notion of information links Conceptual Art and digital computing; both construe information in terms of modular structure—in terms of ones and zeros and patterned data.

The logic of the grid has become easily associated with the informatically structured world; in other words, “the look of information” is often conflated with ledgers, graphs, or grid-based depictive schemas. My contention here is that the foregrounding of the grid, which is often taken to signify Conceptualism in the sense that it reveals the system governing pictorial configuration. Traditionally, the grid is the framework or the scaffolding within which, and according to whose rules, a pictorial scheme is conceived and assembled. In the final product, however, the gridlines are erased or covered, lending to the perceptual seamlessness of the virtualization. Conceptual schemas, on the other hand, bring to the forefront visual signifiers, such as the grid, of the underlying configurative system. They are designed to interrogate the ideological nature of all forms of representation—visual, linguistic, or otherwise.

Meltzer evaluates the grid as a symptomatic form of the informatically-enframed world view, which is made both visible and legible, paradoxically, in anti-visual Conceptual Art practices. However, in so doing she aligns herself with the theoretical position that when pictorial structure is dictated by the grid (even as the grid remains invisible on the picture plane) it aspires to an epistemology of visibility in which total vision produces total knowledge. The grid, in its production of total visibility, is, for Meltzer, “immune to opacity.”²⁸² What Meltzer, in her emphasis on language, does not emphasize is the way in which, on the one hand, “information” is profoundly and stubbornly *resistant* to visibility, or at least is resistant to interpretation by way of the visible, and on the other hand, that the grid is a tool for submitting a rationalized, mappable, and calculable knowledge of the physical world to the visual register. While related in their quest for a transparent and fully knowable world, the grid and information are not coextensive. One aims for total knowledge through visibility, the other for total knowledge achieved through calculation and databasing. Whereas the grid orders space, information becomes knowable through the identification and manipulation (or exploitation) of the ordering principles underlying a given system. Both achieve mastery but in different ways.²⁸³ For Conceptual Artists of the 1960s as well as for contemporary artists like Ben Rubin and Mark Hansen, whose piece *Listening Post* (2002) displays data-mined information from conversations in internet chat rooms on a grid of LED screens, information unfolds as a series of lists, of endlessly scrolling, infinitely permutable combinations of letters and numbers. In the 1990s the scientific practice of information visualization, which shapes raw numerical data into pictorial form, begins from the premise that information is not an inherently visible quantity. In *Index* (1972), the group known as Art and Language shuts what are presumed to be printed ledgers away in closed file cabinets, thus rendering the possibility of knowledge, or at least information acquisition, literally invisible. It is true that the grid is associated with a

²⁸² Meltzer p. 133

²⁸³ The position of the subject relative to the grid and to an informatic system is also interesting to consider, though outside the scope of the discussion here. Whether the subject is integrated into the system or whether it positions itself outside the system, as in a bird’s or god’s eye view, changes the degree to which employing the grid or the figure of information as a tool for inquiry implies the possibility of mastery.

“scientific claim to reason,”²⁸⁴ but in its strongest case, reason conceptualized through the lens of information theory becomes most reasonable, most like itself, when it escapes the visual register altogether.

If Meltzer is arguing that the cultural imagination of the 1960s and 70s participates in a mutual pattern of influence with the structuralist ethos, we must ask whether the “informatic” epistemological topology of the early 2000s exhibits a different attitude towards its own structures. These structures—network maps of all varieties and infinitely searchable databases, for example—are both made possible by information technology and reflect the world as an entity constituted by informational quantities. One thing that has changed, notably, is the kind of language that circulates most popularly about information technology itself; the question now is less how to “informationalize” or map physical structures, but how to give sensorially legible, quasi-physical form to immaterial quantities that nevertheless have material effects (such as stock market values). Whereas early respondents to a burgeoning world picture inspired by cybernetics and systems theory saw both repressive and utopian possibilities latent within this technology, the “representation” of the cultural imaginary surrounding this technology centered less on the model of open-ended, distributed networks we find today, and more on the relentlessly deterministic feedback mechanisms (a more binary vision of direct cause-effect, signal-noise patterns) that have come to be so illustrative of the cybernetic world view. This is not to say that one model is more accurately descriptive than the other, but it does serve to explain some of the differences between the attitude towards “generative”—rule based, semi-autonomous—systems in LeWitt’s generation, whose algorithmic imagination was not realized in high-speed computational processing vs. Reas’s, in which computational operations have become less visible for a variety of reasons, including processor speeds, “black-boxed” hardware and software design, and the cultural normativity of computationally driven interactions including email, word-processing, and social networking.

Reas, echoing my own argument for a “digital method” that functions independently of the technical specificities of computer hardware and software, affirms that the history of “software art” begins with two groups of progenitors that emerged in the 1960s.²⁸⁵ One of these groups contains the small collection of artists whose experiments with the graphic possibilities of early digital computer are only recently receiving scholarly attention.²⁸⁶ The other group is comprised of artists who explored procedural thinking and algorithmic processes without directly accessing computational technology, namely Conceptual Artists and members of Fluxus. Ironically for an artist whose production is so emphatically visual, Reas bolsters the connection between software and Conceptual Art (which we recall, for Donald Kuspit,²⁸⁷ exhibits “the look of thought”) by asserting that “software is an immaterial medium, much like thought.”²⁸⁸ While electronic processes may be conceptualized as immaterial, art is most often realized as a visible or sensible quantity/entity. Consequently, we must consider how this immateriality inflects the sensible, aesthetic qualities of the resulting artifact.

²⁸⁴ Meltzer p. 132

²⁸⁵ Reas, “Process/Drawing,” p. 33

²⁸⁶ These artists include A. Michael Noll, Manfred Mohr, Georg Nees, and Vera Molnar

²⁸⁷ Kuspit pp. 43-49

²⁸⁸ Reas, “Process/Drawing” p. 33

Johanna Drucker has argued for a critical interrogation of the rhetorical equation “between the idea of ‘data’ and the actual materiality of its existence in digital form.”²⁸⁹ According to Drucker, the materiality of digital form is often elided in the “rhetoric of electronic cyberspeak, where data has somehow mistakenly come to carry an aura of immateriality as a feature of its fundamental identity.”²⁹⁰ Borrowing from Adorno, Drucker claims that a sinister effect of the rhetorical maneuver defining information in a closed, self-referential or self-identical loop, is the negation of the possibility of seeing this equation as anything other than inevitable, self-evident, or natural. Correlatively, then, the view that the graphic output is “merely” epiphenomenal or “merely” contingent on interface design is to posit graphic output as providing less access to its ideological nature, whereas the software art model of critical code production is somehow more philosophically or conceptually replete. Reas’s statement that “the software implementation is closest to the concept” underscores any allegiance he might have not just to software art, but perhaps most prominently, to Sol LeWitt, who maintained that the artistic core of his wall drawings lay not in the inscription of lines or the application of paint to the wall’s surface, but instead in the written instructions for the drawing. The success of LeWitt’s wall drawing practice, however, is in large part due to the incommensurability between the visual and the non-visual, their inability to overlap seamlessly and signify congruently.

Wall Drawing #51 (1970), for example, is one of LeWitt’s most didactic experiments in the relationship between built, architectural space, the “immaterial” dimension of the concept, and the practice of drawing as an inscription of a two-dimensional pictorial schema upon or within an architectonic configuration. The instructions for the piece are remarkable simple: “All architectural points connected by straight lines,” but the visible results demonstrate the rule far more appreciably than some of his more obfuscating works. Whereas the grid and a simple catalog of linear elements, rather than real spatial features, govern the visual logic of *Wall Drawing #146* (1972), in which a wall is covered loosely by a series of arcs, straight lines, broken, and not straight lines,²⁹¹ *Wall Drawing #51* illustrates the principle of site specificity by calling attention to architectural idiosyncracies, including light switch plates and electrical sockets or irregular angles in the intersection of walls and ceiling. In *Wall Drawing #146*, the grid dictating the length of lines and arcs remains visible, but the arrangement of the line fragments within the modules—the order in which arcs, straight lines, broken, and not straight lines appear, their meeting point with the edge of their modular constraint—appears more vulnerable to the draughtsperson’s interpretation, more contingent on decision rather than the immovable contingencies build into the architectural parameters of the site. In 2008, net-based artist Benjamin Bruneau, demonstrated the multiple configurative possibilities for *Wall Drawing #136* in an online work that, without textual commentary, presents a photograph of a white gallery wall and its brick floor. The only link on the page is the word “another” printed in unassuming typeface on the left hand side of the screen that, when selected, cycles through different possible renditions of the

²⁸⁹ Johanna Drucker, "Digital Ontologies: The Ideality of Form in/and Code Storage--or--Can Graphesis Challenge Mathesis?," *Leonardo* 34, no. 2 (2001): 141-145, p. 141

²⁹⁰ Drucker p. 141

²⁹¹ The instructions for this piece read: “all two part combinations of blue arcs from corners and sides and blue straight, not straight, and broken lines.” Blue crayon. Site-specific dimensions.

drawing, graphically conveyed in blue lines on the surface of the gallery wall presented in the photograph. Like *{Software} Structures*, Bruneau plays with implementing LeWitt's natural language algorithms in code in order to explore the combinatory possibilities latent within them. However, whereas Reas is more interested in the differences between media that come to light in the process of *implementing* the instructions, or in other words is more invested in testing LeWitt's claim that the "idea" is core of the work and that its actualization is secondary, Bruneau's rendering engages the liminal zone between the immateriality of code structures and the materiality of wall drawing in a more literal fashion.

{Software} Structures offers a more complex view of the processes involved. If LeWitt's wall drawings depend for their conceptual success on the gap between instruction and execution, there is an analogous moment in Reas' practice, whether they are direct adaptations of LeWitt's algorithms or in the series of indirect homages entitled "Processes." The appellation "process," instead of drawing or programming in Reas's post-2004 work follows from a dual interest in principles of emergence and LeWitt's mystical proceduralism.²⁹² Beginning with *{Software} Structures* and continuing into his most recent work, Reas began to call his works processes in order to reveal their open-endedness and availability to realization across multi-media platforms; a Process "defines rules and instructions which describe a relation between Elements outside of a specific physical media."²⁹³

In *{Software} Structures*, Reas begins by implementing three of LeWitt's wall drawings--#85, #106, and #358—in order to explore deviations between the products of physical and computational media. The primary and the most immediately apparent distinction between these computational implementations and their realization in real architectural is, first, their coarseness—the slight pixilation of the lines indexes their discrete digital composition—and second, the facility of computational systems to subject structures to expansion, multiplication, and magnification, or conversely contraction, attenuation, and diminution. This trait is most visible in Reas's adaptation of *Wall Drawing #106*, in the original instance of which arcs are drawn in black pencil from the midpoint of a wall. Unlike his screen-based rendition of *Wall Drawing #85*,²⁹⁴ which

²⁹² The opening three statements in LeWitt's Sentences on Conceptual Art," which Reas includes in his documentation of *Software {Structures}* read: "1. Conceptual Artists are mystics rather than rationalists. They leap to conclusions that logic cannot reach. 2. Rational judgments repeat rational judgments. 3. Irrational judgments lead to new experience. Benjamin Buchloh has claimed, with respect to LeWitt's address of mysticism, that these statements throw into high relief "the radical difference between the logic of scientific production and that of aesthetic experience." Where positivism, a product of modernist self-reflexiveness, ends in a *reductio ad absurdum* of empiricism—that is, the "condition of tautology" performed programmatically by Kosuth, mystical experience would be associated with the model of aesthetics that is now most often ignored, if not outright denigrated, a model characterized in terms of a cult of beauty and outmoded universalist theories of shared subjective response. Buchloh p.141

²⁹³ Casey Reas, "Process/Drawing," p. 27.

²⁹⁴ "85. Same as 63, but with four colors. 63. A Wall is divided into four horizontal parts. In the top row are four equal divisions, each with lines in a different direction. In the second row, six double combinations; in the third row, four triple combinations; in the bottom row, all four combinations superimposed." Casey Reas, *{Software} Structures: A Text About Software and Art*, 2004, <http://artport.whitney.org/commissions/softwarestructures/text.html> (accessed April 16, 2010).

remains static and alters the optical properties only in the sense that the low resolution and the lighting conditions given by the screen interface cause a slight sensation of pixilation and of a rainbow “ghosting” in the cross-hatched squares, Reas’s software implementation of *Wall Drawing #106* opens the work to user interaction and to the temporal dimension. As the user drags a mouse to the left over the surface of the software-driven “drawing”, the density of arcing lines multiplies rapidly, far surpassing the number of intersections of the original, until the delimited area is covered by a screen of fine black lines, revealing a pattern reminiscent of the concentric wave effects produced by the warp and weave of synthetic fabrics, or of a jaggedly stylized op-art, or John Whitney’s early experiments with the cinematic possibilities in computer-generated abstraction. The simple level of interactivity introduced here transforms LeWitt’s process, in which a single instance presents one of many possible interpretations, into a more determinate demonstration of all possible graphic renderings of the idea compressed into a single, interactively-animated frame.

Reas and Bruneau most definitively cease to overlap in the following step of *{Software} Structures*, presented on the webpage in several columns or “sections”, entitled “Structure,” “Implementation,” “Interpretation,” “Material,” and “Process.” Here Reas no longer draws his structural support from LeWitt’s existing wall drawings, but instead generates twenty-six individual implementations of three primary “software structures”—three sets of natural-language-based instructions imitating LeWitt’s instructional approximations of a core “Idea”— that isolate and put pressure on different aspects of the foundational structures. Reas employs several related strategies for highlighting possible indeterminacies, inconsistencies and flexibilities in computational processing, and to duplicate the collaborative unfolding from conceptualization to inscription enacted by LeWitt and his draughtspeople. As LeWitt asserts with respect to his own practice, Reas’s work begins as a vague idea that requires a second level of linguistic articulation to take form.

Similar to LeWitt’s translation of Idea into Text into physically implemented wall drawing with the aid of a draughtsperson or draughtspeople, the initial step of Reas’s process defines a text-based software structure whose source text is written in English. *Structure 003*, for example, is described in English as follows: “A surface filled with one hundred medium to small sized circles. Each circle has a different size and direction, but moves at the same slow rate. Display: A. The instantaneous intersections of the circles B. The aggregate intersections of the circles.”²⁹⁵ The second step enacts the translation of the structure into computational software. In *Structure 003*, which I will describe at each stage, from text to graphical implementation, when Reas translates code—the computational software—into graphical output, he creates two instantiations of the process, one of which is more aesthetically digital, the second of which approaches a smooth, analog aesthetic. In the first graphical instance, Reas reveals lines that measure the intersections of the circles. As two circles cross one another, the distance between the two points of intersection will increase and diminish. If a line is drawn connecting these two points, it in turn will lengthen as the circles become more overlapped and shorten as they move apart. When Reas sets this system loose on a screen filled with invisible

²⁹⁵ Casey Reas, *{Software} Structures: A Text About Software and Art*, 2004, <http://artport.whitney.org/commissions/softwarestructures/map.html> (accessed April 16, 2010).

circles, this visually manifests a field of line segments that elongate and diminish as they tumble across the screen. In the second frame, Reas shows the intersections aggregating over time, leaving warped, grey ovals whose transparency produces a layering effect as they gradually collect, like damp fallen leaves, with increasing density on the screen. With each successive step of the process, the metric character of the lines—in which pixels are added and removed like inches in a ruler—disappears. As such, the initial, digital aesthetic gives way to a smooth, continuous analogicity.

For the following “Interpretation” section, Reas commissioned three artists to implement his wall drawing software structures in the manner of LeWitt’s draughtspeople, thus allowing for the openness of interpretation while experimenting with the notion that the three instantiations will prove the existence of an undergirding “deep structure that reveals the intention of the author.”²⁹⁶ All three interpretations, by Jared Tarbell, Robert Hodgin, and William Ngan, all built with Processing, indeed disclose an underlying structural consistency that suggests their common ideational origin. This structural logic is conveyed in a scattered, overall field; the visible surface is comprised of a distributed array of interacting or intersecting elements. These elements are clearly individuated, behaving as discrete units, but their collisions produce both immediate and residual effects that determine the overall textural quality of the animated visual schema.

In “Material,” the penultimate section of the work, Reas demonstrates Larry Cuba’s earlier claim, in 1986, that the capabilities of the software—the medium—will alter the visual qualities of graphic output.²⁹⁷ Just as steel, wood, and oil and tempera paints will exhibit different material and properties, so to do programming materials yield variant effects in the perceptual qualities of the work. Processing, a language developed at MIT by Reas and Ben Fry, was built as a platform designed for artists; Reas and Fry built it as a tool for teaching of and research in graphics-based programming. Its relatively simple and minimal application makes it easy to operate as a sketchbook, a way for artists and designers to quickly and easily render their ideas visually. Although it is open source, easily accessible, and runs well on the web, it runs slower than C++/OpenGL, another programming environment tested in this section of *{Software} Structures* that is capable of graphic rendering at far higher speed and resolution than either Processing or Flash, but does not run on the Internet. C++ produces the most elegant, delicate and continuous visual structures, and is therefore most proficient in masking its limitations and the particularity (or eccentricity) of its characteristics as a tool. Flash MX, by contrast, was authored to support efficiency in web animation. It calculates more slowly than Processing, however, so a work with a high number of

²⁹⁶ Casey Reas, *{Software} Structures: A Text About Software and Art*, 2004, <http://artport.whitney.org/commissions/softwarestructures/text.html#interpretation> (accessed April 16, 2010).

²⁹⁷ In his 1986 interview with Gene Youngblood, Cuba describes his iterative process and the effects of using new tools to generate depictions that are irreproducible across platforms. “There was an evolution of the tool simultaneously with the evolution of the pictures—to the extent that I’d get way down the line and look back at the early pictures and realize I couldn’t generate those pictures anymore because the software had evolved. I’d opened up new dimensions and closed off others.” In Gene Youngblood, “Calculated Movements: An Interview with Larry Cuba,” *Video and the Arts Magazine*, Winter 1986. Available online at Gene Youngblood and Larry Cuba, *Calculated Movements: An Interview with Larry Cuba*, <http://www.well.com/~cube/VideoArt2.html> (accessed April 16, 2010).

elements and calculation demands becomes slow and fragmented, ultimately losing compositional clarity and cohesion.

Lastly, Reas includes a “Process” section to underscore the “open”—available to multiple, ongoing interpretation, iteration, and evolution—aspect of his processes. Reas begins his explanation of this section of the project by raising the spectre of Hans Namuth filming Jackson Pollock at work, pointing to the extent to which the emergent, process-driven act of painting and other traditional forms of art-making have been exposed through criticism and media attention. Conversely, programming has, according to Reas, remained hermetically closed, due in part to its precision, and the fragility due to that precision, as a technical language—a strictly notional system—that is not available to the same free “play” as physical materials. This section reveals intermediate steps in the development of Reas’s implementation of *Software Structure #003*. Moving from the first, mouse-controlled calculations of the line resulting from the mobile overlapping of two circles, to the removal of user input via automation, to the erasure of the circles, displaying only the stretching and shrinking line segments and center points of the circles, to the disappearance of the center-pixel, and onward to the final rendition of the software structure, this section is the most overtly didactic in the project. Whereas the previous sections focus more heavily on the openness and multiplicity inherent in the artistic-interpretive act, this addendum seems the less conceptually linked to the project as a whole, though it is pedagogically informative.

This online project is more didactic than Reas’s other works, containing explanations and visual demonstrations of how a software structure transforms an aesthetically digital schema, characterized by single, moving pixels and short, spinning falling lines into a more replete painterly surface, as the screen blooms into textural richness. However, in the end it is no more “digital,” aesthetically, than his analog systems. Despite Reas’s claim that the conceptual strain of his practice is “more formal and explores the nature of software, representation, notation, and process,” in the end, computational process is foregrounded in both his so-called “Conceptual” and “organic” pieces, whereas the digital occupies a more unstable position at both ends of the spectrum.

While one vector of influence is clear between LeWitt and Reas, and indeed between many instances of Conceptual and computational art, it is not enough to say that Reas simply ups the ante of LeWitt’s linguistic algorithms by submitting them to the automation of computational processing. Not only does Reas translate linguistic programs into a form executable by digital computation machines, but he also brings the emphasis back to the visual register. Reas’s programs, in all their visual richness, refuse the “dematerialized” anti-visualism of Conceptual Art of the 1960s and 70s. The influence of conceptualism on Reas’s practice is in many cases obscured and difficult to read in his screen-based animations. And, moreover, the digital properties of these animations, in the way I have been defining them to this point, is also made more subtle by the presence of continuousness and ambiguity in his graphical forms. The exemplary cases of Conceptual Art’s experimentation with a “systems aesthetic,” instances of which we find in Darboven’s *Month* drawings, Art & Language’s *Index* and LeWitt’s 1967 Dwan Gallery announcement, led their charge in a far more critical, anti-visual and self-reflexive manner than do Reas’ programmed paintings. While Conceptual Art might be the ghost in the shell of *{Software} Structures*, when considered in light of Reas’

compendium of existent work, and even his serialized, conceptually-inflected yet painterly “Processes,” it becomes clear that Conceptual Art holds a troubled, persistently unstable status in Reas’s practice. Rather than preserving the tenets of Conceptual Art in a mummified state, the visual landscape and constructive methodology of his work profoundly alters the philosophic, artistic, and ideological terms offered up by Conceptual Art in the late 1960s.

II. Software Art: Computing Conceptual Critique

Because the operations of computational machines are hidden, it might be said that computation escapes or exceeds the possibility of imagistic representation. Electronic digital processing, in which vast numbers of invisible calculations are carried out at the speed of light, far beyond the human sensorial threshold, is in one sense emphatically opaque. Arguably, the graphic interface is only an epiphenomenon of the constitutive opera of computational processing. In one sense, then, the computationally-rendered depiction might be said to mislead the viewer, to lull him or her into contemplation of a false idol or a weak shadow of technical operations. For this reason, some artists have made the focus of their work not images but the hidden processes undergirding graphical representation. By refusing to cloak the form of code in the spectacular garb of pictorialization, these artists, often sited as the torch-bearers of an updated Conceptual Art, seek to show the ideological nature of code that functions beneath but ultimately structures the visible layer of representation that appears on screens and monitors.

Placing Conceptual Art outside the sphere of visual arts aligns it with or even defines it as software. Such an unholy alliance is not farfetched. Jack Burnham’s *Software* show, Kynaston McShine’s *Information*, ICA’s *Cybernetic Serendipity*, among other exhibitions, along with the formation of the *Radical Software* group/journal, all occurred within a narrow historical window, all around the years of 1968-70. Software, as a concept, captured the cultural imagination long before personal computing became a reality in American households.²⁹⁸ Conceptual Artists, including Sol LeWitt, became interested in the proceduralist logic of software and the cybernetic and systems-theory-based notion of information in part because these models offered a distinct method for abrogating subjectivity from the process of artistic creation. LeWitt and his allies, aware of the subject-shaping power of ideology and its incursion into the criteria by which art and artists are included in and excluded from the artistic canon, began to expound upon the possibilities opened up by automating the creative process, imagining that such automation would permit new qualities to manifest which would have otherwise remained outside the socially-historically constructed realm of imaginative possibility.

Due to its bent towards aggressively self-reflexive ideological critique, the niche of digital art production most commonly linked to the precepts of Conceptual Art is labeled “software art.” The primary attribute of this genre of digital production is its emphasis on the reflexive and critical examination of the software processes underlying the final graphic output. One of the central tenets adopted by software artists is that software is shot through by ideology. Whereas one might assume that computer

²⁹⁸ Edward Shanken, "Art in the Information Age: Technology and Conceptual Art," *Leonardo* (MIT Press) 35, no. 4 (2002): 433-438.

programs and interfaces act as a blank screen on which we imprint or project intellectual/conceptual and social/communicative output, the systems we use have been designed to excel in specific capacities. But while it is clear to a non-programming literate user that each application is limited in the type and tasks it can carry out, it is less obvious that each programming language also has a specific range of communicative aptitude. Reas and other artists choose software as their medium in order to make transparent the fact that individual programs are not neutral, and that therefore the selection of one language will produce a different kind of result than a different program. For Larry Cuba, a pioneer of early computer-driven abstract animation, using computers to generate abstract, mathematically structured landscapes “affects your vocabulary.”²⁹⁹ This is especially true of abstraction; the mathematics and algorithms executed by computational technology will create a particular visual dimension and set of visual parameters that are most visible in an approach to graphic configuration that exposes and foregrounds the structural principles underlying pictorial construction. While this realization should perhaps come as no surprise in the light of art historical arguments about medium specificity, software artists have based a good part of their inquiries on the idea that the ideological underpinnings of programming languages and software applications have been obscured, through ignorance (imposed not willfully but through a lack of education) if not outright acts of suppression.

Starting from the premise that software art examines the genotypic processes underlying the phenotypic output (the pictorial/graphic output visible on the computer screen), it is easy to see how a theoretical-historical bridge forms between the “dematerialized” Conceptual Art practices of the 1960s and 70s and the software art at the turn of the 21st century. Software art frequently allies itself with the anti-aesthetic tendencies of Conceptual Art, and specifically orients its critical and reflexive processes along the trajectories of the performance art, the art-and-technology movement, and the critique of information, systems theory, and the aesthetic of administration introduced by Benjamin Buchloh in reference to Robert Morris, Hans Haacke, Mel Bochner, and Joseph Kosuth, among others.³⁰⁰ Like software art, which sets itself to the task not of creating visually compelling works of art but rather to the ideological critique of power/knowledge networks supported by software, according to Buchloh,

beginning with the readymade...[i]n the absence of any specifically visual qualities and due to the manifest lack of any (artistic) manual competence as a criterion of distinction, all the traditional criteria of aesthetic judgment—of taste and of connoisseurship—have been programmatically voided. The result of this is that the definition of the aesthetic becomes on the one hand a matter of linguistic convention and on the other the function of both a legal contract and an institutional discourse (a discourse of power rather than taste).³⁰¹

Art after Duchamp, then, opens itself to reflexivity, tautology, and both internal and external (cultural, ideological) critique, because it becomes incorporated into the same social, political, and economic systems from which it is excluded by the Kantian

²⁹⁹ Gene Youngblood, "Calculated Movements: An Interview with Larry Cuba," *Video and the Arts Magazine*, Winter 1986. Gene Youngblood and Larry Cuba, *Calculated Movements: An Interview with Larry Cuba*, <http://www.well.com/~cube/VideoArt2.html> (accessed April 16, 2010).

³⁰⁰ Buchloh pp.105-143.

³⁰¹ Buchloh p. 130

viewpoint. Art becomes a product of institutional discourse and subject to evaluation based not on its universal legibility as an object of beauty but on its eminently contingent linguistic, juridical, and ideological definitions.

The crucial part of this argument is the turn away from a traditional model of aesthetics derived from *aesthesis*, or sense perception, and towards an aesthetics of governance, in which visualizations index the operations of power/knowledge systems but relegate visibility to a mere placeholder for an alternate order of communication. The aesthetic of governance, bureaucracy, or administration establishes Conceptual Art and the visual arts as distinct zones with little to no area of overlap; while Conceptual Art's critical reflection upon the history of ideologies embedded within traditional aesthetic systems has earned Conceptualism a reputation for being anti-aesthetic, the assumption persists that Conceptual Art remains a branch of the visual arts. But delimiting a new aesthetic of bureaucracy and control isolates Conceptualism from the domain of visibility, placing it instead within the realm of language or other procedural systems like mathematics, cryptography, or "programming" as it was known prior to the advent of personal computing.³⁰²

Contrary to Lev Manovich's assertion that information aesthetics are inversely related to the Kantian theory of the sublime, Warren Sack has argued that given the entanglement of computation with bureaucratic organization and systems of control, that political and economic systems provide more apposite reference points than Kantian aesthetic philosophy. Whereas Manovich asserts that information visualization brings the incalculable sublime into an organized frame of reference, accessed through the visible, Sack assesses visualization practices in terms of an "aesthetic of governance," to determine "what sorts of governance they support or reflect:" government via the *demos*, the people, or the *bureau*, the office.³⁰³ By extension, Sack diagnoses artistic visualizations, such as those produced with Radical Software Group's Carnivore Client software, which allows artists to interpret and visualize network traffic, in terms of an "appropriation and *détournement* of bureaucracy."³⁰⁴ In other words, to make his link between mid-to late century Conceptual Artists and digital practitioners, Sack focuses on the Conceptualists' reflexive critique of bureaucracy (often achieved by incorporation of the material signs of bureaucracy into their artwork, such as the filing cabinets in *Index* or Robert Morris's 1963 *Statement of Aesthetic Withdrawal*) paralleled with the demonstrable claim that "metaphorically and literally, computers are an outgrowth of bureaucracy."³⁰⁵ While Sol LeWitt performs the role of the bureaucratized subject, carrying out his repetitive duties with the same cadence as an industrial factory machine,³⁰⁶ computers are designed to function exclusively according to the rules of

³⁰² Wendy Chun, "On Software: Or the Persistence of Visual Knowledge," *Grey Room*, no. 18 (Winter 2004): 26-51.

³⁰³ Warren Sack, "Aesthetics of Information Visualization," in *Context Providers*, ed. Victoria Vesna, Margaret Lovejoy and Christiane Paul (Forthcoming). Available online at <http://hybrid.ucsc.edu/SocialComputingLab/Publications/wsack-infoaesthetics-illustrated.doc>. Accessed June 24th, 2009, p. 8

³⁰⁴ Sack p 11

³⁰⁵ Sack p. 6

³⁰⁶ In "Serial Project #1," LeWitt describes the ethos of the serial artist as follows: "The aim of the artist would be to give viewers information....He would follow his predetermined premise to its conclusion voiding subjectivity....The serial artist does not attempt to produce a beautiful or mysterious object but

procedural logic. Computer technology can therefore be understood as both an effect and a re-producer of bureaucratic ideology.³⁰⁷ Given that Conceptual Art critiques traditional aesthetics by way of embracing an administrative anti-aesthetic (mobilizing metaphors of tables, graphs, maps, files, lists, and so forth), it seems to integrate seamlessly with a mode of computer-based art practice that exploits the practical and technical uses of computational media. Art that reflects upon the invention of the computer as a bureaucratic tool—an aid to a frictionless administration of bureaucratic tasks—would relate closely to Conceptual Art, which places under a microscope the various forces at play in social, cultural, economic, political, scientific, and urban systems.³⁰⁸

While reception of Conceptual Art has turned largely on the premise, whether applauded or derided, that the movement as a whole was self-reflexively critical, aggressively programmatic, vehemently anti-aesthetic, and consequently visually dry, there is also another way of seeing it as struggling to develop an aesthetic appropriate to the times. Where a surfeit of subjectivity could only tie the artist to the dead and dying traditions of the past, automation stood a chance at yielding something truly new because the processes would allow the development of the as-yet unimaginable. While the dream of the information world imagined by Conceptual Artists has undoubtedly exerted a strong influence on artists now working with computational software, I want to caution against seeing this link as absolute or the correlation as too perfect, lest other tensions and nuances in the art are lost. A one-to-one correlation between software and Conceptual Art not only limits software art to a derivative positions, but also fails to account for the complex relationship between visuality, art and instrumentality of these works, and also the way that the status of software as an immaterial medium means that it is all too easily bound into the category of “dematerialized” art.

As is the case with many software artists, it is easy to focus primarily on language as the most direct representational correlate of digital systems. As a notational system, alphabetically-configured written language is analogous to the digital in that it utilizes a small number of components that can be recombined into a potentially infinite world of

functions merely as a clerk cataloguing the results of his premise.” Sol LeWitt, "Serial Project #1," *Aspen Magazine*, Sept 17, 1967: n.p.

³⁰⁷ See, for example, Douglas Engelbart’s “Augmenting Human Intelligence: A Conceptual Framework,” in which his vision of augmented intelligence is tantamount to the development through technological means of a hyper-productive office worker bee: “The objective of this study is to develop a conceptual framework within which could grow coordinated research and development program whose goals would be the following: (1) to find the factors that limit the effectiveness of the individual’s basic information-handling capabilities in meeting the various needs of society for problem solving in its most general sense; and (2) to develop new techniques, procedures, and systems that will better match these basic capabilities to the needs, problems, and progress of society.” Douglas Engelbart, "Augmenting Human Intellect: A Conceptual Framework," in *Multimedia: From Wagner to Virtual Reality*, 64-90 (New York: Norton & Co., 2001), p. 69. See also Jean-François Lyotard on the topic of performativity and pedagogy applied to operational logic. Jean-François Lyotard, *The Postmodern Condition: A Report on Knowledge*, trans. Brian Massumi (Minneapolis: University of Minnesota Press, 1984), pp. 51-2.

³⁰⁸ Victor Burgin clarifies the interlocking mechanisms of art and ideology. First asserting the deep investment in socialist ideals endemic in the conceptualist ethos, he goes on to claim that “the first requirement of a socialist art practice is that it should engage those codes and contents which are in the public domain. These present themselves, and thus ideology, as natural and whole; a socialist art practice aims to deconstruct these codes, to unpick the apparent seamless ideological surface they present. Victor Burgin, "Socialist Formalism," *Studio International* 191, no. 980 (March/April 1976): 148-152.

expression. But when we are dealing with aesthetics, a one to one correlation between digitality and alphabetical and grammatical structure skirts the issue of images. In a 2009 lecture at UC Berkeley, artist Ben Rubin described his Masters thesis, which, following Rubin's fascination with the properties of language, and especially written language, as a recombinatory code, attempted but failed to exhume a grammatical structure governing film images.³⁰⁹ The problem with pictures, it seems, is that they are far more difficult than written language, which has already undergone the parsing necessary to become a notational system, to discretize and database in the manner necessary for computational sorting and recombination. How does one dictate the elements for which the program selects? As we will see in the next chapter in the case of Jason Salavon (the case subject of the following chapter), it is possible to average hue or tone values in corresponding pixel locations. But because the grammar of pictures is far less determinate than language, it becomes more difficult to assign a fully notational descriptive code that is iterable in all instances.

If Buchloh and Sack are correct that Conceptual Art resists categorization as a member of the visual arts, the analogical relationship between digital and Conceptual Art becomes more tenuous when the digital practice under study—in this case, Reas's—is resolutely visual. Even within the subgenres of digital media Reas has remained, again like LeWitt, difficult to classify. Aspects of various genres appear in his work, but no work adheres too firmly to the (sometimes outspoken sometimes implicit) tenets of more militant approaches to digital media. For example, Reas treats software as his primary medium,³¹⁰ but he cannot be called a software artist given his outspoken interest in textures and surfaces. Software art, as Inke Arns has argued, while related to generative art—another genre with which Reas is frequently associated—in its use of predefined processes and rules used in the service of a “negation of intentionality”³¹¹—cannot be equated with software art, which is fueled by the premise that “the medium—or rather: the material—of software allows for a critical reflection of software (and its cultural impact).”³¹² Software art sidelines visible results and critiques or even denigrates the visible in a similar fashion to Conceptual Artists of the 1960s and 70s. Software artists see code through the lens of ideology, and examine coded processes as a form of cultural production whose potential to act as a system of control is obscured. Software artists perform a technological and cultural critique, whereas generative artists more often use the software medium to explore possibilities of emergence and dynamic change without necessarily regarding the facilities and constraints of software through an overtly political

³⁰⁹ Ben Rubin. “What’s That Ticking Sound.” Lecture for *The Art, Technology and Culture Colloquium*. University of California at Berkeley, November 2, 2009.

³¹⁰ In order to do so, of course, he first must take the step of defining software *as* a medium. “I like to think of software as a medium and my work is not possible without it. I didn’t create any form of art before I began creating software. I’ve drawn my whole life and I didn’t approach drawing with the rigor I now produce software. The essence of my work is dynamic systems and software is the medium in which I’m able to construct my vision.” Casey Reas, “Organic and Conceptual Systems: Casey Reas Answers Bert Balcaen’s questions for Sonic Acts X, Amsterdam 2004,” *Reas.com*, 2004, <http://reas.com/texts/sonicacts.html> (accessed April 18, 2010).

³¹¹ Inke Arns, “Read_me, run_me, execute_me: Software and its discontents, or: It’s the performativity of code, stupid!,” in *Read_me: Software Art and Cultures Conference*, 176-193 (Åarhus: University of Åarhus Press, 2004).

³¹² Arns p. 178

frame/lens. For this reason, generative art has been viewed with some suspicion as an overly aestheticizing or depoliticizing strain in digital art, whereas software art adheres more closely with brands of activist art that have received more attention in the field of media studies.

III. From Wall Drawings to Processes

Reas makes visible some of the variations between programming languages in the “Implementations” section of *[Software] Structures*. In his exploration of the facilities of Flash, Processing, and C++ for rendering the “same” instructions, Reas scrutinizes on a microcosmic scale the degree to which the parameters of a given system determine the scope of possible results, and thus, by extension, the extent to which programming languages are aesthetically, socially, and politically both performative and deterministic.³¹³ As we have seen in the example of *Software {Structures}*, Sol LeWitt’s assays with natural-language algorithms prompt Reas to test the deterministic attributes of individual programming languages. Not only do LeWitt’s wall drawings provide the substrate for Reas’ project as a whole, and for the test-cases in each section of the project, but the Conceptual underpinnings of LeWitt’s practice motivate some of Reas’s own questions about the possibilities and pitfalls inherent in working with software.

It was in 1968 at the Paula Cooper Gallery in New York City that Sol LeWitt for the first time drew on the wall and called it an artwork. This simple enough act carried enormous ramifications for the contemporary art world and resonated strongly with many of the issues occupying the front lines of the Conceptual avant-garde. Not only did the practice of wall drawing eliminate completely the problematic “support,” already under critical investigation by the likes of Frank Stella with his shaped canvases and Irregular Polygon series (the latter beginning in 1967), but it also undercut the commercial viability of the work by refusing to produce a clearly defined object of exchange. Later his practice of hiring draughtspeople to realize his sometimes vague, interpretively resistant instructions also called into question the primacy of the singular authorial hand and fractured the linearity of attribution.

But perhaps the most significant aspect of LeWitt’s innovation, the facet of his work that continues to resonate with digital artists and programmers, was the built in distantiating of drawing from instruction, or graphic rendering from code. To review the

³¹³ Inke Arns has argued that while generative art, exemplified in the previous chapter by Marius Watz, is focused primarily on the (open-ended) results produced by executable code, software art is typically more invested in the social and political spheres because it engages specifically in investigations of the performative aspects of code.

In the instance of generative art, code provides the possibility conditions for form to arise, or in a more extreme reading, code is the underlying, quasi-material form behind the graphic virtualization that appears on the screen. However, generative art does not assume that code-as-form is the endpoint, the primary object of inquiry. Whereas generative art uses code to execute the aesthetic-graphical pictorializations, and thus positions graphical output above the characteristics of the medium in the work’s ontological hierarchy, software art performs a critical investigation of the software itself, so that the graphical interface is secondary to the conceptual interrogation of the underlying process. Software art examines the effects that software can have given its performative structure; software does not simply reflect or represent, but conflates the acts of saying and doing. Programming languages only “speak” in the act of executing commands. They cannot speak at a metalevel “about” a topic. Instead, in the event of an utterance not only are “words” (in machine or binary code) processed, but those words catalyze an action. Arns pp. 176-193.

process, LeWitt's method separated the Idea—what he considered the core of the artwork—from a set of written instructions that he would pass on to a selected draughtsperson or draughtspeople to be drawn in a given site. These artists, including Adrian Piper, were often friends and young up and coming figures in the art world.³¹⁴ The instructions could be more vague or more precise, and LeWitt himself could participate to a greater or lesser extent in the planning of the drawing and control over its outcome. However, of primary importance was the fact that the signifying capacity of the work was ultimately located somewhere *between* the drawing, the instructions, and the elusively immaterial, even non-linguistic "Idea."³¹⁵ The effect of this procedure was the disentanglement of the creative act into its constitutive elements. Where any temptation

³¹⁴ Although this is not a topic I can address within the scope of the present argument, it is important to note that both LeWitt's predetermined system for the production of wall drawings and Reas's open source programming language Processing work to build artistic communities. While the technical parameters of Processing contribute to defining the range and types of pictorial content generated within it, another aspect of Reas and Fry's collaborative project ties it to a less object, more practice-driven trend in contemporary art, one which would be tied to Nicolas Bourriaud's "relational aesthetics" Reas and Fry's creation of processing contains a strong pedagogical and community-building function, which extends relational, and post-conceptual practices into an aesthetic and technological field. Sol LeWitt's initiation of artists to the art world by employing them as draughtspeople to carry out his wall drawings, and Andrea Fraser's gallery tours, provide perhaps the most direct precedent for the pedagogical aspect of Reas's practice. But three are others as well, such as Gordon Matta-Clark's *Food*, in which a group of artists opened a restaurant that would sustain local "starving artists" nutritionally and monetarily, by offering them shifts as servers or cooks. Later, at the Aperto exhibition for younger artists at the 1993 Venice Biennale, Rikrit Tiravanija installed tables and chairs in the exhibition space and cooked pots of noodles for gallery visitors in his "relational, collaborative performance" entitled *Untitled (Twelve Seventy One)*, while Felix Gonzales-Torres offered candy or posters for viewers to take away. All of these works aim to initiate individuals into a temporary or ongoing community—likewise, Reas's Processing, its satellite blogs, travelling workshops, weighty handbook, and online exhibition "spaces" gather a community of artists who form a bond, a sense of common purpose, by learning, deploying, and pushing the boundaries of the techno-aesthetic "tool" known as Processing. This also helps to explain why Reas would, in particular, undertake the project of transcoding LeWitt's Wall Drawing practices, as well as their pedagogical and community-building function, into the context of the online, programming-based, and collaborative project of {Software} Structures. It must be noted, however, that Reas's teaching practices, carried on within an institutional framework now at UCLA, in service of an education for a new generation of artists in software literacy, are less oriented towards the institutional critique enacted by, for example, Fraser's gallery tours, which not only introduce viewer groups to framed artworks marked and validated by wall texts and protected by museum guards, but also the infrastructural spaces of labor and bodily relief, such as the museum restroom.

Despite the similarities of the event-rather than object-based aspects of Reas's work to those of Fraser, Tiravanija, and the Food artists' collective, the community-building, pedagogical activities that have sprung up around Processing are less determinately "artistic" than those described above, and is linked more strongly to the acquisition of technical expertise than to the coming together of a community of participants.

Thus, the notion of open-source system-development, programming, and computation almost necessarily addresses the role of subjectivity in information processing. Both LeWitt's and Reas's projects are distinctly about computers (whether human computers or machines), about the way they process information and render that information graphically. If Conceptual Art performs an "aesthetic of administration", it only takes one look at both LeWitt's and Reas' endeavors to open up their creative systems to an artistic community to realize that part of this ostensibly administrative, systems-oriented approach to art practice carries a pedagogical, educational community-building function as well.

³¹⁵ Linguistic articulation already imposes a layer of filtration on the Idea, and therefore cannot be considered pure or unmediated.

to conflate inspiration and realization had existed, LeWitt replaced it with the assertion that multiple, or perhaps infinite channels for the manifestation of a concept open themselves materially against the backdrop of a single idea.³¹⁶

a. The Open Work

LeWitt at least nominally regarded the experimentation in Conceptual Art with “all types of mental processes” as, bluntly, “purposeless.”³¹⁷ Although it would be easy to use this to launch a discussion of Kantian aesthetics, I am interpreting this statement in the context of Rosalind Krauss’s 1977 essay³¹⁸ describing the perverse absurdity underlying LeWitt’s apparent adherence to a “logical” system.³¹⁹ Beginning with Donald Kuspit’s premise that “In LeWitt, there is no optical induction; there is only deduction by rules” and that, linked up with the “larger Western tradition” of “the pursuit of intelligibility by mathematical means” LeWitt’s work can be characterized as a deterministic quasi-mathematical exploration of the rules of form.³²⁰ Leaving aside for the moment LeWitt’s own contrarian remonstrance that “Conceptual Art doesn’t really have much to do with mathematics, philosophy, or any other mental discipline,”³²¹ I pick up from Krauss’s contestation that LeWitt’s processes ultimately fail the logic test and tend instead towards an obsessive, irrational combinatorial cycle. In testing all possible combinations of lines, cubes, curves, isomorphic shapes, and on *ad infinitum*, LeWitt mimics the “mindless,” or worse, soul-less calculations of digital computers. Krauss maintains that in their refusal to capitulate to the forms of classical logic, which,

whether diagrammatic or symbolic, are precisely about the capacity to abbreviate, to adumbrate, to condense, to be able to imply an expansion with only the first two or three terms....The babble of a LeWitt serial expansion has nothing of the economy of the mathematician’s language. It has the loquaciousness of the speech of children or the very old....³²²

Made first indirectly by intermittently injecting passages from Samuel Beckett’s *Molloy*, Krauss’s analysis of LeWitt’s serial cube constructions, and later, his wall drawings analogizes his process to “the spinning gears of a machine disconnected from reason” or

³¹⁶ Donald Kuspit in 1975 discussed cogently the counterfactual stability of the “idea.” While LeWitt proposes, tongue in cheek or not, that the idea should resist the discrepancies in communicative facility that inevitably occur between different media, it is clear that media are not, and cannot be, equivalent; they cannot transmit the same aspects of the same idea in the same manner. At the very least, then, they expose the idea as open to variable interpretation by shifting focus from one facet of the idea to another. Kuspit argues that LeWitt does not attempt to hide the incommensurability of media, but rather “exploits the insoluble paradox” of medial non-equivalence. Donald B. Kuspit, “Sol LeWitt: The Look of Thought,” *Art in America*, September/October 1975: 43-49, p. 44-45. See also Sol LeWitt, “Paragraphs on Conceptual Art,” *Artforum*, Summer 1967: 79-84. Reprinted in Alexander Alberro and Blake Stimson, *Conceptual Art: A Critical Anthology*, 12-16 (Cambridge: MIT Press, 1999).

³¹⁷ LeWitt cited in Alberro, p. 12.

³¹⁸ Rosalind Krauss, “LeWitt in Progress,” in *The Originality of the Avant-Garde and Other Modernist Myths*, 245-258 (Cambridge: MIT Press, 1986).

³¹⁹ LeWitt also seems to be responding, here, to the increasingly political bent of contemporary art, and arguing that his practice in particular (and potentially all of Conceptual Art, despite protestations to the contrary) cannot in and of itself function as a political actor.

³²⁰ Kuspit pp. 43-49.

³²¹ LeWitt cited in Alberro p. 13

³²² Krauss p. 253

“the aesthetic manipulations of an absurdist nominalism.”³²³ Earlier, in 1968, Robert Smithson had also remarked upon the clutter of language, the disarray and dissolution sense that resulted paradoxically from LeWitt’s compulsive referencing of a realm of idealized, perfected order. Smithson writes, “The ‘original idea’ of his art is ‘lost in a mess of drawings, figurings, and other ideas.’ Nothing is where it seems to be. His concepts are prisons devoid of reason.”³²⁴

LeWitt ultimately performs the trappings of order to an absurdist end; his experiments result in a stubbornly regressive nominalism and an endless retreat of logic. Both LeWitt’s minimalist and Conceptualist projects initiate a critique of logic, computation, and information—concepts that begin to overtake the cultural imagination in the latter half of the twentieth century and persist, now with hegemonic invisibility, in the twenty-first century. LeWitt’s “digitality,” most clearly visible in the obsessive iterations of his *Variations of Incomplete Open Cubes*, with his cataloging of discrete, disjunct, modular forms and combinations, is metaphorical and partial. He uses precision as a foil against which to throw into relief an underlying desire for chance, error, and irrational leaps towards mystical asubjectivity.

When we turn from LeWitt’s modular constructions back to his wall drawings, it is immediately notable that the visual/visible drawing representing one possible “result” of the written instructions executed by a draughtsperson or draughtspeople problematizes their status as dematerialized icons of Conceptualism. Like his enigmatic contemporary, Robert Smithson, LeWitt is less easily classified as a strict proponent of systems theory and structuralism as some of his fellows, like Kosuth or Art&Language, have been. While ultimately there exists little art that thoroughly dispenses with the visible (even if visibility is invoked only in order to critique or denigrate it), many of LeWitt’s drawings retain a sufficient degree of optical, or even haptic, interest that they can effectively resist the evacuation of sensorial experience often attributed to Conceptualism. In light of the significant and signifying presence of indeterminacy in LeWitt’s drawing systems, it is impossible to maintain a faith in Conceptualism’s adherence (from which LeWitt has always admittedly deviated) to absolutism and bureaucratic, encoded precision.

Even if only teasingly, LeWitt’s drawings are accessed phenomenologically not just as regular, cold, information-ridden structures, but as networks of forms that have a life of their own. His repetition *ad absurdum* of a rationalized, modular plan not only underscores the impossibility of transcendence but also allows a distinct physicality, a new but immediately recognizable compositional (material) structure, to emerge from the world of concepts. His work operates similarly to Siah Armajani’s *A Number Between Zero and One*, in which the number 10-205,714,079 was printed out on individual sheets of paper resulting in a nine foot stack whose sheer physicality, as Meltzer has argued, render[s] palpable the terrain not accounted for by the structural logic of information. . . . After all, paper’s surface is the very site of our institutional practices; on it, we map the world, graph the rise and fall of the economy, certify our titles, legalise our relations. But in Armajani’s nine-foot stack, paper’s

³²³ Krauss pp 255, 256.

³²⁴ Robert Smithson, "A Museum of Language in the Vicinity of Thought," in *Robert Smithson: The Collected Writings*, 78-94 (Berkeley: University of California Press, 1996), p. 79.

behaviour subverts such functionality. One sheet after another, surface abuts surface, two dimensions become three, abstract space becomes real.³²⁵ Likewise, LeWitt's engagement with metrics, rules, and modules,³²⁶ and his deliberate excision of artistic subjectivity is ultimately not about signaling the end of art or the end of the subject, but rather about opening up a new space of experience not bound and limited by the existing horizon of expectation.

Paralleling LeWitt, Reas works within instructional constraints to produce unpredictable results. In his comments on organic and Conceptual systems, he acknowledges the administrative function of computational technology—the fact that “computers are built to be predictable.”³²⁷ Computers, taken both within and outside of an art context, are tools constructed to facilitate regular, repeatable, and efficient calculations. LeWitt's wall drawings, despite their algorithmic design and flirtation with proceduralism cannot be fully notational, nor digital, because they are indeterminate. Conversely, computers' functionality rests on their ability to make precise, accurate, calculations. They cannot interpret or detect nuance. Even randomness, such a central component of generative art, must be simulated in a digital computer, so that the chance operations that defined LeWitt's “algorithmic” processes possess a different quality of indeterminacy than do the generative functions carried out by digital programs. Digital computers and human decision-making each impose different constraints on the ostensible open-endedness of chance. Of course, “pure chance” is always mitigated by the system in which it acts, so as Reas, as well as many generative artists and pioneers in the simulations known as “Artificial Life” have shown, it is also wrong to assume that the determinacy of computers forecloses the possibility of truly aleatory experiments.³²⁸

In an attempt to combine the indeterminacy inherent to LeWitt's natural-language based “programs” and the dynamism made possible by computational systems, Reas builds into his processes a degree of open-endedness, couched as a guard against

³²⁵ Meltzer p. 126

³²⁶ One particularly relevant passage from his “Paragraphs on Conceptual Art” compares his visual/spatial module to a biorhythmic pulse or a musical beat. “The intervals and measurements can be important to a work of art. If certain distances are important they will be made obvious in the piece. If space is relatively unimportant it can be regularized and made equal (things placed equal distances apart) to mitigate any interest in interval. Regular space might also become a metric time element, a kind of regular beat or pulse. When the interval is kept regular whatever is irregular gains more importance.” By invoking these alternate sensorial modalities LeWitt successfully disrupts the one-to-one feedback loop between intellection and visibility—the notion that seeing is the sense most closely related to reason and propositional knowledge. See Martin Jay, *Downcast Eyes: the Denigration of Vision in Twentieth-Century French Thought* (Berkeley: University of California Press, 1993). In this brief passage LeWitt also activates the figure of difference through repetition, theorized famously by Gilles Deleuze. Here metrics do not serve a totalizing or totalitarian regime; instead, a regularized structure can act as a support for subtle shifts and nuances to appear, as a slight irregularity in an otherwise smoothly woven fabric. Gilles Deleuze, *Difference and Repetition*, trans. Paul Patton (New York: Columbia University Press, 1994).

³²⁷ Casey Reas, “Organic and Conceptual Systems: Casey Reas Answers Bert Balcaen's questions for Sonic Acts X, Amsterdam 2004,” *Reas.com*, 2004, <http://reas.com/texts/sonicacts.html> (accessed April 18, 2010).

³²⁸ Max Bense, the German mathematician and physicist made famous in media studies for coining the term “information aesthetics,” defined “generative aesthetics” in a brief essay published for a companion volume to the exhibition *Cybernetic Serendipity*. “The aim of generative aesthetics is the artificial production of probabilities, differing from the norm using theorems and programs.” Max Bense, “The Project of Generative Aesthetics,” in *Cybernetics, Art and Ideas*, 57-60 (London: Studio Vista, 1971), p. 58

technical obsolescence, that enables them to more closely mirror the play between ambiguity and procedural determinism set into motion by LeWitt's instructions. Granting primacy to natural language rather than programming language enables the "idea"—the principles of structure and interaction between parts within the work—to migrate across platforms, and mitigates the problems that occur when software becomes obsolete and no longer runs on ever-newer, ever more powerful machines. But additionally, replacing of precision-dependent programming language with English natural language phrasing injects ambiguity and multiplies possibility into an otherwise determinate system.³²⁹

In 1962, Umberto Eco published *Opera Aperta (The Open Work)* in which he proposed a model of the work of art comprised of discrete structural elements that can be moved, recombined, and recontextualized to create differentiated works.³³⁰ Intrigued by Eco's notion of "openness," practiced by the likes of John Cage contemporaneously to but independently of Eco's publication, Reas adapts it to his own art production, realized across multiple media platforms including ink and 3D printing in addition to screen projection and monitor-dependent interfaces. Conceptualized within the framework of Eco's open work, Reas's multimedia processes can be seen as working against computational determinism. Paralleling LeWitt's wall drawings, which for their material instantiation must adapt to the technical, spatial specificities of the installation site, Reas's processes preserve their vulnerability to constantly shifting technological parameters as a fundamental aspect of their "openness;" in Reas's appraisal, "an open work presents a field of possibilities where the material form as well as the semantic content is open."³³¹ Despite their surface appearance of dry, even bureaucratic proceduralism, Witt's wall drawings thrive on radical contingency—the eccentricities of draughtspeople, irregularities within the installation site, the uneven texture of walls or materials used to mark their surfaces. It is here that an unexpected tension appears between the determinacy of code and computational processing and the contingency and ambiguity of natural language, and to an even greater extent, of unsystematized, analog drawing and precisely and unambiguously mapped digital graphics. For Reas' adaptations of LeWitt's natural language instructions to preserve the openness and ambiguity present in the earlier linguistic algorithms, they must attempt to subvert some of the characteristics of digital technology. Accordingly, he writes the instructions for his Processes in English, so that they may be adapted to new programming languages or adopted and reinterpreted by different artists.

Despite computers' inability to handle ambiguity, they are also tools that allow dynamic change to occur within their programmatic constraints; hence, Reas takes

³²⁹ In a foreshadowing moment in 1975 Donald Kuspit remarked Sol LeWitt's own elaborate, inconcise use of natural language to articulate his instructions for his *Variations of Incomplete Open Cubes*. Kuspit dismisses LeWitt's foregrounding of process as simultaneously unwieldy and acetic. With respect to the diagrams and hand-written descriptions of each item's location within the floorplan of the John Weber Gallery, Kuspit declares that "written in archaic (from today's point of view, belletristic) mathematical language, they described positions that could equally well have been expressed succinctly in algebraic form, as a function of coordinates." The issue here is not the threat of algebra's obsolescence, but it is demonstrative of the tension that appears between language systems when art begins to take on the look of technology. Kuspit p. 43.

³³⁰ Umberto Eco, *The Open Work*, trans. Anna Cancogni (Cambridge: Harvard University Press, 1989).

³³¹ Casey Reas, "Beyond Code," in *Network Practices: New Strategies in Architecture and Design*, 166-177 (Princeton: Princeton Architectural Press, 2007), p. 166

advantage of the dynamics of computational systems to generate “incongruous results which I find more satisfactory than randomness.”³³² In this statement Reas is gesturing to the concept of emergence, a frequent referent for theorists of A-Life but also of generative art.³³³ Later in the interview, he expands on this idea, giving a more thorough explanation of emergence as it relates to his work:

The concept of “emergence” refers to the generation of structures that are not specified or intentionally programmed. Instead of consciously designing the entire structure, I write simple programs to define the interactions between elements. Structure emerges from the discreet movements of each organism as it modifies itself in relation to the environment. The structures generated through this process cannot be anticipated and evolves through continual iterations involving alterations to the programs and exploring the changes through interacting with the software.³³⁴

With respect to his investment in the notion of emergence, Reas explains in 2006: “My work in the past year has synthesized ideas explored in *{Software} Structures* with my previous explorations into emergence. Each new work is called a Process and defines rules and instructions which describe a relation between Elements outside of a specific physical media.”³³⁵ As opposed to a model of abstraction which is about smooth, all-over color fields or stark monochromes, Reas’s approach, one that would be friendly to theories about artificial life, which posit AL systems as narrative and relational—is digital in the sense that it is at its core about the dynamic relationships between elements in a system, about the pressures these individual elements can exert upon one another in real time and within systemic parameters to direct movement and behavior in unexpected ways. Part of his rationale for using software is that these relations are not static—the software creates elements that interact and develop through these interactions over time. And the use of multimedia, as I have argued, magnifies certain facets of the work—i.e. each medium provides a different perspective on the various kinds of interactions the work produces, whether between bodies and spaces, states of the system, actors within the system, and so forth.

Consequently, it is particularly compelling for Reas, as an artist using computational software to adapt LeWitt’s algorithmically produced, exported, and graphically rendered natural language based “software,” that some kind of processing must occur to translate between the levels of LeWitt’s wall drawings, from the concept to the instructions to the draughtsperson to the specific spatial and material parameters of the installation site. Reas’s acts of re-coding and implementing LeWitt’s instructions as computational programs necessitates that the original work have an original “source code” that is open to interpretation, retooling, and trans-medial implementation. The capacity of LeWitt’s instructions to be subjected to restructuring at the level of the base code but to remain, at the level of concept, the same work, is a property of the openness

³³² Casey Reas. “Organic and Conceptual Systems.” Interview with Bert Balcaen for *Sonic Acts* 2004. np.

³³³ Philip Galanter, “What is Emergence? Generative Murals as Experiments in the Philosophy of Complexity,” *philipgalanter.com*, 2004, philipgalanter.com/research (accessed April 18, 2010).

³³⁴ Casey Reas, “Organic and Conceptual Systems: Casey Reas Answers Bert Balcaen’s questions for *Sonic Acts X*, Amsterdam 2004,” *Reas.com*, 2004, <http://reas.com/texts/sonicacts.html> (accessed April 18, 2010).

³³⁵ Reas, “Process/Drawing” p. 29

of “software”—whether natural language or computationally driven—to transformation and realization in multiple media formats.

The critical approach to digital ideology taken by software artists advocates or even requires interpretation of computational processing as linguistic and textual—namely, as a programmatic exploration the permutational possibilities generated from the interactions of digital parts rather than a rich, continuous aestheticism based on analog principles— and thus easily linked to Conceptual Art. Of course, language and image are inherently textual and inextricably linked; an art history without words, of which Aby Warburg dreamed, is a counterfactual ideal. Nevertheless, given the multilayered visual richness of Reas’ graphics, that at times display a kind of organic hedonism, it is striking for Reas to claim that “the most important element of each process is the text.”³³⁶ Moments like this evidence of a fundamental struggle in his practice between the visual and the conceptual, a tension that obtains in several modal dialectics; between algorithmically encoded emergence and drawing, between hardware and software, between text and image. In one sense, the text has primacy; it is the text that will permit the translation, in one direction, from natural to programming and finally to machine language, and in the other direction, into graphic output. On the other hand, the proliferation of images and artifacts manifesting across media, from 3-D printing to C-prints, constitute an aesthetic exploration of the properties of these physical media that at the same time continuously asserts the underlying, driving mechanism of the software, but also interrogates the limits and affordances of each physical medium. According to Reas, “different manifestations of the process in diverse media such as software, print and installation give a more complete view of the concept,”³³⁷ but perhaps more than this, they also reveal subtle, or not so subtle, differences in the kinds of visual or tactile experiences different media enable. In “The Origin of the Work of Art,” Heidegger’s view is that the meta-utility of art is to disclose “earth”—the thingly aspects of materiality, such as the stoniness of stone or the coloredness of color.³³⁸ Reas’s transmedial experiments do not ultimately privilege the software, but rather constitute an appraisal of the deviations between material substrates, or the disparities in what these substrates can reveal, visually, conceptually, experientially. Reas’s practice can then be viewed as a playful exposition of the revelatory, world-disclosing properties of materials and media. This is quite a different notion of the “conceptual” than that derived from information theory and propositional analysis conducted by Conceptual Artists. We move, here, from the aesthetic of administration to Heidegger’s theory of the profound utility of art that comes from its world-disclosive power.

Like LeWitt, Reas argues that the concept underlying each of his multimedia projects stands regardless of medium. Thus, Reas does not regard software as the only medium through which to communicate his concept, as a self-identifying software artist would be likely to do. Rather, the software both provides a framework for interactivity, and acts as a conduit that can translate the generative structural principles of the work—the computational construct—into a variety of media. Specific media highlight specific

³³⁶ Reas, “Process/Drawing” p. 29

³³⁷ Reas, “Process/Drawing” p. 29

³³⁸ Martin Heidegger, “The Origin of the Work of Art,” in *Poetry, Language, Thought*, 15-86 (New York: Perennial, 1971).

features of the work. So, for example, in *MicroImage*, Reas employs several “platforms” as follows: “I work in print to reveal the resolution of the system, I work with animation to have complete control of how the image unfolds over time, and I implement the structure in software so it’s possible to interact with it. The software implementation is closest to my actual concept, but the other media provide additional views into the structure.”³³⁹ In general, computer screens do not have the same capacity for resolution as prints, which highlight the delicacy and complexity (or, indeed, multiplicity) of Reas’s imagery. Likewise, animations show the dynamic properties of his systems, but alter the sequence, duration, and variety of processes visible in any given slice of time by allowing Reas to control its cadences. Many of Reas’s choices of physical media have to do with resolution; creating controlled animations bypasses limitations in processor speeds, which permit only a certain number of lines to be drawn in a given frame. Reas’s intervention here produces a greater degree of density of lines in the frame, and thus a greater sense of density and repleteness in the picture itself.

Similar to the way on which information visualization must select for data, and thus exclude other data, in its creation of a coherent graphical structure, each of these different media platforms is capable of revealing particular aspects of his system. Multimedia, in general, broadens the range of perceptual interaction one might have with an artwork. This of course does not necessarily make the artwork *better*, but it does emphasize that worldly experience, and our interpretation of it, is always multisensorial, and that using a single channel of sense perception artificially partitions our phenomenological apparatus for sensing and thinking. In the case of Reas, presenting his work in a multimedia context permits an application of this argument specifically to computational design. Given cultural expectations about what makes a work more phenomenologically dense and rich (the use of analog technologies), computationally generated or assisted work easily runs the risk of appearing “flat” or dimensionless. But by employing several different physical media Reas underscores the density and multidimensionality of his “Processes.” For Reas, similar to LeWitt in his strategy of implementation-via-draftsperson, “the concept exists outside of any physical media and seeing different manifestations in diverse media give a more complete view of the whole.”³⁴⁰ But most importantly, they show the topography of the whole is much more complex than one might assume in glancing at a wall drawing or a screen-based process. Interestingly, the overall effect of transmitting his “concept” through these various media channels is to highlight the density of the concept, so that when an aspect like fineness of resolution is intensified through printing, the viewer can see that there is more to the abstract tangle of tracelines than would meet the eye if the same piece were viewed on a screen. Recall that density is a term used to describe and, more importantly, to evaluate the merit of analog pictorial techniques. Consequently, the operative question remains whether Reas’s technical choices, while embedded in a digital substrate, effectively cover over the digital foundations of his processes in favor of promoting an aesthetic based on painterly abstraction.

³³⁹ Casey Reas, "Organic and Conceptual Systems: Casey Reas Answers Bert Balcaen's questions for Sonic Acts X, Amsterdam 2004," *Reas.com*, 2004, <http://reas.com/texts/sonicacts.html> (accessed April 18, 2010).

³⁴⁰ Casey Reas, "Organic and Conceptual Systems: Casey Reas Answers Bert Balcaen's questions for Sonic Acts X, Amsterdam 2004," *Reas.com*, 2004, <http://reas.com/texts/sonicacts.html> (accessed April 18, 2010).

However, printing in this manner does not negate the computational ontogenesis of Reas's "Processes." The print represents only one possible form of the process, so that even in this apparently "closed," unalterable, non-interactive form of presentation, there is always inherently embedded another possible way of seeing. In some senses, this open-ended space of multiple graphic possibilities encourages one to interpret Reas's work as simultaneously, and quite paradoxically, formalist (painterly, object-driven) and Conceptualist (placing idea over material, process-driven). Each interface (paper, screen) makes visible different details. Each sets up its own visual world, its own points of access to the diverse array of latently visible details. Thus, on the one hand this fostering of the visible ultimately promotes a formalist visuality in which the viewer derives meaning by seeking subtle cues in the visible register. On the other hand, the formal result, similar to LeWitt's wall drawings, can be viewed as an epiphenomenon of the underlying "concept," or, more specifically the underlying, driving mechanism, which is of course the software itself.

One important difference to note between Reas and LeWitt is that a central aspect of LeWitt's innovation depended on his abrogation of "painting," where painting signifies handmadeness, contingency, and the authorial mark. His "formulation of a predetermined system" precluded easy classification of his Wall Drawings into medium-determined categories such as drawing or painting.³⁴¹ Here, the medium itself became a mirage, shimmering in and out of visible clarity and refusing to cohere in a singular, stable physical form. Was the primary medium located in the relatively stable, if immaterial, notion of "the idea"? Or is the location of the work of art still more elusive, oscillating continuously between the marked surface, the idea, the instructions, and their interpretation and execution by a draughtsperson? In his most thoroughly conceptual mode Sol LeWitt advocates for a model of administratively executed art in which the artist plays a clerical role rather than one of a genius master craftsman.³⁴² But his work seems to perform a series of contradictions as it make its way into a visual format; LeWitt's argument that the final form is incidental is belied by their adamant visuality. Ranging from delicate webs of graphite to bold, almost alarming bars of saturated color, LeWitt's wall drawings, as well as many of his modular structures (like *Serial Project #1*) are visually compelling with or without the accompanying conceptual armature of text/instruction.³⁴³

³⁴¹ Bernice Rose, "LeWitt and Wall Drawing," in *Sol LeWitt*, 31-42 (New York: Museum of Modern Art, 1978), p. 31

³⁴² "The aim of the artist would not be to instruct the viewer but to give him information. Whether the viewer understands this information is incidental to the artist; he cannot foresee the understanding of all his viewers. He would follow his predetermined premise to its conclusion avoiding subjectivity. Chance, taste, or unconsciously remembered forms would play no part in the outcome. The serial artist does not attempt to produce a beautiful or mysterious object but functions merely as a clerk cataloging the results of his premise Sol LeWitt, "Serial Project #1," *Aspen Magazine*, 1967: n.p. Reprinted in Gary Garrels, ed., *Sol LeWitt: A Retrospective* (San Francisco: San Francisco Museum of Modern Art, in association with Yale University Press, New Haven, Conn., 2000), p. 373.

³⁴³ The only given about the status of visuality in LeWitt is that it is stubbornly paradoxical. Whereas Lucy Lippard in 1971 attempts to recuperate his "idea art" to a standard of beauty and visual pleasure, Kuspit insists on the outmodedness of beauty as an evaluative criterion for art criticism. To Lippard's avowal of the beauty of LeWitt's structures, and her claim that he embraces the paradox in making visual art while proclaiming the utter lack of consequence in the look of art, Kuspit rejoins: "The paradox is that LeWitt's

Visibility thus remains at the heart of LeWitt's Wall Drawing practice, but coyly, ironically, and often coolly. Even when they emblazon walls with broad, dizzying swaths of saturated color, LeWitt's drawings often maintain the look of industrial mechanization, of a graphic simplicity that conjures the figure of mass production. Reas, on the other hand, makes an about-face, back to the painterly, even as he claims that the "core" of his work is "about creating processes and not images."³⁴⁴ If computational technology is founded upon bureaucratic principles, and if many day to day human-computer interactions retain ties to its particular model of utility, Reas turns the ruthless, exhaustive and exhausting logic of John Simon's *Every Icon* (a piece I will discuss later in greater detail) against itself, and toward the multiplicity of entities, tracelines, transparencies and filaments that compose the painterly surfaces of many Processing sketches.

His *MicroImage* (2001-3) and *Tissue* (2002) series, for example, layer fragile, transparent webs of spindly lines, creating a dense, continuous and replete painterly surface, which would seem to position his work at odds with the constitutive features of digital aesthetics. As I will explain in further detail momentarily, the lines themselves are generated by the movements across the screen of small bots or vehicles that leave trails of line and color behind them. The point I want to emphasize here is that while the technical, procedural and programmatic constraints of computers make them unable to process or deal in ambiguity, *Tissue* and *MicroImage* mobilize the programmatic logic of computation towards an ambiguous end.

The characteristics visible in *MicroImage* and *Tissue* do not appear to be digital in the sense I am using it. However, the elements that produce the analog, painterly, ambiguous surfaces in these works turn out *not* index the gestural immediacy implied in the act of drawing, as we may have thought. Even though the surface appears to be aesthetically analog, it is in fact a set of digital elements drive the graphic output of the piece. As I have indicated, the lines extending across the screen or the print are created by digital "vehicles." These elements mimic the mechanical sensors in neuroanatomist Valentino Braitenberg's studies of nervous systems in the 1980s. Reas's simulation of Braitenberg's "vehicles"—each containing two sensors to detect environmental conditions and two actuators to propel the machine—are the discrete elements governing the compositional structure of the piece. Rules for the vehicles' interaction—the behavior they will exhibit if they come into contact—control the movement and location of the vehicular agents. What the viewer sees, however, is not the vehicles themselves but their path of travel.

In an electrocardiogram, only the ordinates and abscissas are informationally relevant—the lines connecting them are insignificant. *Tissue*, on the other hand, privileges the connecting lines: what would be, in a notational system like the EKG, secondary "information." What the viewer observes, instead of the digital units themselves, as in the case of Daniel Rozin's *Wooden Mirror*, which we saw in Chapter 2, or Vasarely's *alphabet plastique*, from Chapter 3, are the tracelines extending behind the elements, similar to the line of frozen vapor trailing an airplane in the sky. In a time-based version of the piece, after a period of scrutinizing the lines as they loop and

objects barely generate any sensuous intensity, and instead seem to generate an intellectual response." Kuspit, p. 43

³⁴⁴ Reas, "Beyond Code" p. 4

intersect in seemingly random patterns across the screen, the intently watchful viewer might glean relationships between elements, and even potentially their position on the screen. We might think, then, of this moment of revelation as an instance of the digital furtively showing itself, coming into a partial visibility, but remaining camouflaged by the analog. Rather than directly seeing the simulated mechanisms, as in the see-sawing movement of Rozin's wooden pixels, we gather their information second-hand. We can guess at their level of activity and the length of their simulated lifespan as drawing agents from the complex curvatures of the lines and the density of their entanglement. These knotted skeins become the sensorially apprehensible effect of the setting-into-motion of a digital system. What we have before us is a painterly, seemingly analog visual world that is actually a visualization of the byproducts of a digital system in the act of calculation and computation, but it is not itself aesthetically digital. This is an area in which a potential divide between "computational" aesthetics and "digital" aesthetics becomes visible. What the viewer observes, more than digitality itself, is the area *between* the disjunct units constituting the digital system. The system operates computationally, and perhaps we could classify the continuously unfolding loops of multi-colored lines as exhibiting a computational aesthetic insofar as we are watching the graphic output of computational processing proliferate before our eyes. But the "digital" stubbornly conceals itself within the tangle of lines.

Here, the "digital" does not lay itself bare by foregrounding its compositional discreteness. Relationships between elements (rather than their demonstrable "behavior"), gleaned from the complexity of lines, the temporal extension implied by their length and density of entanglement become the sensorial apprehensible *effect* of the setting-into-motion of a digital system; the visual world implied by this depictive schema is about the digital system in the act of calculation and computation. The fibrous mass that results from this experiment signifies a "world"—not necessarily one that imitates our own, but a horizon of temporality, event, and exchange that belies the work's outward aspect of decorative abstraction. Discreteness and disjunctness operate as the underlying logic that gives rise to another set of characteristics, identified as the computational, but not digital, aesthetic of complexity/multiplicity.

b. Aesthetics of Multiplicity

In 2007 on their respective blogs Mitchell Whitelaw and Douglas Edric Stanley began, but never pursued, a debate about the aesthetics of Reas and Fry's programming environment, Processing, addressed through the rhetorical figures of complexity and gestalt. Whitelaw engages a comment by Stanley about the preponderance of delicate, often densely interwoven filaments in Processing sketches to suggest that Processing produces structures possessing a certain aesthetic nature, and by extension that "simple code structures contribute to the formation of gestalts."³⁴⁵ Stanley writes:

I'm interested in the nature of all those lovely spindly lines we see populating so many Processing sketches, and how they relate with code structures. Complex forms come cheap in code; all you need is an iterator: it costs almost nothing —

³⁴⁵ Mitchell Whitelaw, "More is More: Multiplicity and Generative Art," *The Teeming Void*, October 29, 2007, <http://teemingvoid.blogspot.com/2007/10/more-is-more-multiplicity-and.html> (accessed November 28, 2009).

from the programmer's perspective — to draw 1 line and n lines, especially when you take performance out of the equation. But beyond the economy of drawing hundreds of thousands of millions of bajillions of lines, what about the perceptive field that emerges from this code? If there is a machinic relationship between the visual forms and the code forms (one our basic tenets), what do these code structures generate in terms of perceptive structures? And does computer code — if treated as a series of recursive abstractions (at least in practice) — form new perception-fields at each stratum of abstraction, synchronized to the code abstraction layers?³⁴⁶

Stanley considers not only how to account for the fact that Processing seems to have a particular set of aesthetic properties and how to articulate what those properties are, but also to understand how and what this aesthetic means. I have already proposed the notion that the aesthetic nature of made objects is a product of what kinds of depictions are facilitated by the material properties of the medium/tool. In sketches created with Processing, it is just as easy for the program to generate many lines as it is for it to generate one line. But, this does not suffice to explain why an artist would want to avail him/herself of this programmatic capacity, which leaves open the issue of what artistic reason exists to make use of this technological function. Unlike software art that abrogates or challenges human-computer interaction at the surface level of the graphic interface, Processing is a graphics-oriented language written for visual artists, and consequently privileges visual thinking. However, the operative problem here is what particular visual idiom is most easily produced from working in Processing, and what kind of “perceptual field” results from this complex linear configuration. A medium operates most effectively within a particular perceptual modality: it appeals to one or more senses in a specific way. But this line of reasoning in turn leads to a further question concerning the relationship between the structure of code and the formal/material structure of the resultant pictorialization. Does the structure of the computer code yield not only new (perceptible) kinds of images, but a new way of perceiving the nature of abstract, computer-generated depictions? Is there a gestalt of Processing, and if so, what characterizes it?

Stanley suggests, indirectly, that this gestalt is defined by complexity in a one line comment inserted between two long passages quoted from Italo Calvino's *Mr. Palomar*, a novel that performs complexity in its formal, stylistic, and conceptual performance of fractallic unfurlings from microscopic to cosmic scale.³⁴⁷ Stanley's provocative but undeveloped statement, that “ultimately, all of these questions of abstraction and gestalt are in fact questions about our relationship to complexity and the role algorithmic machines (will inevitably) play in negotiating our increasing *complexity malaise*” is decidedly less utopian than Lev Manovich's take on abstraction and complexity, in which

³⁴⁶ Douglas Edric Stanley, "Complexity and Gestalt," *Abstractmachine*, October 6, 2007, abstractmachine.net (accessed November 28, 2009).

³⁴⁷ To illustrate: the first chapter contains painstaking and minute descriptions of the plants in Mr. Palomar's garden, which introduce questions of identification, classification, perception and the organization of perceptions that repeat on a larger and larger scale until, at the end of the book, Mr. Palomar's thoughts have replicated and expanded upon the themes elicited by his garden meditation to a contemplation of the nature of the universe.

modernist reduction gives way to an exuberant proliferation of shapeshifting arabesques in contemporary software driven abstraction.³⁴⁸

In his differentiation of the aesthetic properties of modernist abstraction from the complexity proffered by computational abstraction in the 21st century, Manovich begins by setting what he calls the “perfect image,” based on two and three dimensionally modeled simulations, against “the swirling streams, slowly moving dots, dense pixel fields, mutating and flickering vector conglomerations coming from the contemporary masters of Flash, Shockwave, Java and Processing.”³⁴⁹ From this point, Manovich proceeds with the goal of articulating the differences between modernist and contemporary computational abstraction, characterized by reduction and complexity, respectively. Reduction, as the governing paradigm of modernist abstraction, has been frequently linked to the development of modern science, which alters the horizon of visibility, and thus visibility, by zooming microscopically underneath the threshold of visibility, no longer focusing on surface but on the elements, often invisible to the naked eye, of the constitutive mechanisms comprising an organism or physical body. Examples of this modernist reduction are found, of course, everywhere from Mondrian’s gridded reductions to the essence of a tree, to Kandinsky’s visual notations of the essences of musical compositions, to the Cubists’ de- and recomposition of volumetric forms into faceted planes.

The complexity-based abstraction that emerges alongside electronic computational technology also accompanies, responds to, and is inspired by later 20th century approaches to science and technology. Whereas the modernist model is fairly one-to-one, linear, and deterministic—for example three moving parts will comprise a mechanical whole with predictable behaviors—a complexity driven aesthetic focuses on emergence, or unpredictable results garnered by chaos and randomness within or across systems. Manovich’s definition of an aesthetic of complexity relies heavily on the dynamism and organic curvatures of the systems, mostly pulled from the online portion of the Kunstlerhaus Wien’s 2003 exhibition *Abstraction Now*, for which this essay was written, that he takes as his primary examples. In each instance, the graphic presentation of algorithmic processes yields “dense and intricate fields” that “are never static, symmetrical, or simple—instead they constantly mutate, shift and evolve.”³⁵⁰

The issue of complexity is one frequently referenced with respect to digital art and new media. John Maeda, Reas’s mentor at the MIT media lab, in his book *The Laws of Simplicity* identifies his contribution to the prevalence of visual complexity in computer graphics, but simultaneously disowns this trend, dismissing it as a mere “unrelenting stream of ‘eye candy’ littering the information landscape.”³⁵¹ In Stanley’s brief post, which, as Whitelaw points out, introduces questions rather than proposing definitive answers, he concludes that “all of these questions of abstraction and gestalt are in fact questions about our relationship to complexity and the role algorithmic machines

³⁴⁸ Lev Manovich, “Abstraction and Complexity,” in *Abstraction Now*, 80-85 (Vienna: Edition Camera Austria, 2004). Available online at <http://www.abstraction-now.at/?catalogue>. Accessed November 28, 2009.

³⁴⁹ Manovich p. 80

³⁵⁰ Manovich p. 85

³⁵¹ John Maeda, *The Laws of Simplicity* (Cambridge: MIT Press, 2006).

(will inevitably) play in negotiating our increasing complexity malaise.”³⁵² Thus, he acknowledges that a problem that seems formal, or even more precisely technological, is actually a cultural one.

As is visible in Manovich’s catalog essay for *Abstraction Now*, a rhetoric of complexity, infused heavily with metaphors of biology, evolution, and organicity has become nearly endemic in the (albeit small collection of) criticism of digital abstraction. In his essay, Manovich attaches the paradigm of “reduction” to modernist abstraction, in contradistinction to contemporary “complexity.” Whereas the trope of reduction in modernist art follows the scientific “deconstruction of the inanimate, biological and psychological realms into simple, further indivisible elements, governed by simple and universal laws,” an aesthetic of complexity emerges in response to a new scientific paradigm.³⁵³ The contemporary scientific view, radically different from the classical model of the clockwork universe, produces chaos theory, artificial life, and network theory. Here, simple elements may combine, but their combination results in behaviors that emerge in unpredictable, non-linear fashion. Both scientifically and metaphorically, in the popular imagination and in artistic interpretation, complexity tends to evoke associations with the biological and physical sciences, and thus with the narratives of artificial life. In its easy application to a huge percentage of contemporary cultural production, from the social networking sites endemic to the Web 2.0, to increasingly esoteric branches of physics, to the parallel study of biological and information systems, complexity is an appealing trope for the digital age. But it is also a term that becomes quickly monolithic and artificially stabilized. Does it really apply across the board, where and what does it contribute to our perceptual and intellectual understanding of the world, and where does it cease to function productively as an operative term?

An absolute division between “modernist” reduction and “contemporary” complexity in itself oversimplifies the artworks in question, given both that the “complex” aesthetic yielded by Reas’s computational programming results from a definitive, pared down number of elements and that, for example, any interpretation of Wassily Kandisky’s musical complexity is severely limited when viewed through the lens of reduction. Moreover, compulsive use of the term complexity limits works like Reas’s to mere demonstrations of the fundamental principles of emergence, a fine exercise but not conducive to the discovery of finely-tuned observations about individual works of art. Because it is less compartmentalized in a particular and somewhat esoteric branch of technoscience, I find multiplicity to be a more useful term to apply to the aesthetic sensibility—the phenomenal encounter—proffered by Processing’s, and particularly Reas’s, software-driven abstraction.

Whitelaw also alleges that multiplicity is more resonant and metaphorically illustrative to explain the dynamics of Processing sketches than “complexity.” Whereas complexity, according to Whitelaw, refers to “causal relations that are networked, looped, and intermeshed,” multiplicity might appear complex, but does not necessarily require networked feedback between structural elements.³⁵⁴ Both terms have been attached, if not indiscriminately, often interchangeably, to digital code-based artwork. Whitelaw

³⁵² Stanley np.

³⁵³ Manovich p. 81.

³⁵⁴ Whitelaw np

quickly sidelines the problem of complexity, or the reasons behind its ubiquitous application to code-based systems, to discuss instead the possibilities and limitations of thinking in terms of multiplicity. He cites various theories in neuro-aesthetics for why we might find multiplicity perceptually satisfying,³⁵⁵ but ultimately he is right in pointing out not only that these theories are overly deterministic, but that a deterministic reading of multiplicity—that it is simply a hard-wired drive in us to find patterns in our perceptual field—fails to account for nuances in our phenomenological experience of these works, and also for specificity and nuance in the processes themselves. Likewise, while it is difficult when looking through a collection of work made with Processing to “find an image that *isn't* some kind of swarm, cloud, cluster, bunch, array or aggregate,³⁵⁶” to equate the array of depictions made with Processing by dismissively calling them the inevitable result of using a system that is designed to generate multiples fails to account for the reasons why the program is designed this way and for specificities in unique applications of the programming language.

Whitelaw’s conclusion is that the aesthetic of multiplicity is “a way to get a perceptual grasp on something quite abstract—that space of possibility. We get a visual ‘feel’ for that space, but also a sense of its vastness, a sense of what lies beyond the visualisation.”³⁵⁷ The fundamental characteristic of generative systems is their open-endedness—their ability to create spaces of inexhaustible potential that are not “virtual” in the mimetic sense, but fundamentally about ongoing transformation. Similar to LeWitt’s wall drawing instructions, Processing launches simple linear algorithms and recursive functions—redrawing (aggregation), overlay, accumulation, and compression—to gesture towards the fundamental mutability and expansiveness of rule-based systems. Generative systems and spaces are thus, in principle, inexhaustible. By creating sets of constraints and letting the system play itself out within those constraints, they visualize the vast possibilities for mutation and transformation even within closed systems.

Launched at 9:42 am on January 27, 1997, *Every Icon* is an online Conceptual artwork that artist John F. Simon claims he envisioned in response to the 1980’s postmodernist intonations about the death of art and the end of images. In this work, every possible combination of black and white squares runs sequentially within the parameters of a 32x32 grid (enclosing 1,024 squares). Although Simon’s (who, in an interview with Reas acknowledges his own deep indebtedness to Sol LeWitt’s algorithmic imagination) *Every Icon* falls more neatly into the grid-based aesthetic of early computer art, this work provides an interesting point of comparison to the seemingly organic proliferations of Processing sketches.

In 1997, with Pentium processor speeds capable of generating 100 combinations per second, Simon estimated that all possible combinations in the top line—about 4.3 billion variations—could be completed in sixteen months. But given the exponential expansion of these combinatorial possibilities, it would take about six billion years to

³⁵⁵ “Ramachandran and Hirstein have suggested that perceptual “binding” - our tendency to join perceptual elements into coherent wholes - is wired into our limbic system, because it’s an ecologically useful thing to do. Finding coherence in complex perceptual fields just feels good. The perceptual fields in generative art are almost always playing at the edges of coherence, buzzing between swarm and gestalt - just the “sweet spot” that Ramachandran and Hirstein propose for art in general.” Whitelaw, np.

³⁵⁶ Whitelaw np

³⁵⁷ Whitelaw np

complete the second line. For the grid to reach its final state, in which every square turns to black, it would take several hundred trillion years—an ungraspable number that Simon asks us to consider as a “human perceptual limit.”³⁵⁸ In 1997 he offered the *New York Times* the following explanation: “Because there's no word for that amount of time and no word for that large a number, several hundred trillion years is my way of making you think about a very, very long time.”³⁵⁹ And even if processor speeds increased enough to shorten that time span, the speed of transformation would vastly exceed the capacity of the human eye to stabilize the field of black and white squares into an image.

Every Icon falls much more heavily to the side of Conceptual generative systems than organic systems such as *Tissue* (a distinction Reas offers with respect to his own work). Whereas the multiplicity of “spindly lines” executed so frequently by Processing gives a sense of biological proliferation, *Every Icon* recalls much more strongly the strictly rectilinear organization of the grid that so intrigued artists modern artists spanning the twentieth century. *Every Icon*'s digital aesthetic, in the strict sense of the word, in which each unit is discrete, regular, and interchangeable, is tied intrinsically to the conceptual framework of the piece, which is built on the airy, translucent fabric of computation itself. The work is constructed on an idea of the computational sublime, on the massive computing power of the machine but its fundamental situatedness in time. Although the system is designed on the basis of a successive algorithmic process, the sheer number of calculations necessary to achieve its end point and the span of time it would require to do so make the program practically if not theoretically (or experientially if not mathematically) open-ended and indeterminate. While the piece makes itself available to the viewer through a graphical interface, the built in possibility that the grid will reveal something like a picture—a face, a landscape, or even a triangle—is in practice only a counterfactual dream, as even the second horizontal line will never run through all its possible combinations in ten, twenty or fifty generations.

Thus, the aesthetic in *Every Icon* simultaneously engages sense perception and refuses to grant visual resolution or completion. It initially calls upon the viewer's sensorium only to render the senses impotent in grasping the aim of the work. In contrast, what Whitelaw calls elsewhere the “system story” of the more sensorially rich aesthetic of Processing is less confrontationally conceptual. *Every Icon* evokes Conceptualist dematerialization by promising eventual pictorialization but ultimately frustrating that desire. But the rich, painterly abstractions tracing and unfolding themselves in Reas's installations seem to work contrary to the highly digitized Conceptualism exhibited in Simon's 1997 piece.

John Simon uses the digital—the way it looks, the way it behaves, its constitutive features and properties—as a generative motor for *Every Icon*. Simon's overtly digitized interface functions as a conduit for its theoretical underpinnings. The activation of simple combinatorics references the digital sublime, its exploration of the counterfactual ideal that a “machine” can “produce every possible image,” its paradoxical combination of programmatic linearity with open-ended irresolvability. As Simon himself

³⁵⁸ Matthew Mirapaul, "In John Simon's Art, Everything is Possible," *The New York Times on the Web*, April 17, 1997, <http://www.numeral.com/articles/041797mirapaul/041797mirapaul.html> (accessed November 30, 2009).

³⁵⁹ Mirapaul np

acknowledges, “while *Every Icon* is resolved conceptually, it is unresolvable in practice. In some ways the theoretical possibilities outdistance the time scales of both evolution and imagination. It posits a representational system where computational promise is intricately linked to extraordinary duration and momentary sensation.”³⁶⁰ But the unresolvability of this piece is thrown into relief by its clinical simplicity. It is not anaesthetic, but rather exhibits a resolutely *digital* aesthetic, which emerges not just from the fact that it is obviously always in the process of computing something, but also from its adherence to the strict definition of the digital.

IV. From Conceptual to Organic Systems

The attribution of digital aesthetic qualities to *Every Icon*'s schematic digital landscape bolsters the link between Conceptual Art's bureaucratic aesthetic and the ethos driving the visualization of digital systems. The precision and severe simplicity of this visual landscape might strengthen the perception that if digital graphics are rife with conceptual rigor due to their computational/programmable ontology, they are also concomitantly devoid of visual nuance. *Every Icon*'s diminutive size and its extremely pared-down color scheme bespeak an attitude towards the art object similar to that of the Conceptual Artists of the 1960s and 70s. However, while the “look of thought” as rigorous, axiomatic, “digital” is the calling card of Conceptual Art, the majority of Reas's production shifts the graphic simplicity of *Software {Structures}* to an analogy between digital systems and organic life.

Reas has claimed that his art production falls into two distinct types of systems. He applies the terms “organic” and “Conceptual” to these systems—terms whose problematic relationship to analog and digital I will take up here. He repeats aspects of the distinction made by Manovich between modernist reduction and contemporary complexity in his own differentiation between “Conceptual” systems, which “are more formal and explore the nature of software, representation, notation, and process” and “organic” systems, which explore “the phenomenon of emergence,” a notion often applied to the simulation of biological processes using computational means.³⁶¹ While Reas sees these trends developing separately in his work, both stage visual explorations of software, representation, notation and process. And, while we might suppose that one graphic mode would appear more digital than the other, both combine digital and analog aesthetic elements, thus demonstrating that computational technology does not necessarily result in a digital aesthetic.

At first, Reas's distinction between “Conceptual” and “organic” seems like it should map evenly onto the parameters of “digital” and “analog.” Descriptively, the organic would appear to be differentiated from the digital because it refers to continuously unfolding processes, such as the growth of a plant. Organic growth, and life itself, are analog because between each two states of growth we can always locate another state between them to an indeterminate degree of fineness. Organic systems are, then, continuously variable. In digital systems, on the other hand, states are

³⁶⁰ John F. Simon, "Artist's Statement," *Numeral.com*, <http://numeral.com/articles/paraicon/paraicon.html> (accessed June 24, 2009).

³⁶¹ Casey Reas, "Organic and Conceptual Systems: C.E.B. Reas Answers Bert Balcaen's questions for Sonic Acts X, Amsterdam 2004," *Reas.com*, 2004, <http://reas.com/texts/sonicacts.html> (accessed April 18, 2010).

determinate—either on or off, black or white—there are no gradations or intermediate steps between digital symbols. They are fully disjunct from one another, discrete, and articulate.

But is this organicity coextensive with analog aesthetic properties, which Reas champions in his effort to make his digitally programmed virtualizations seem as immediate and fluid as possible? Is the distinction between Conceptual and organic systems subtly masked rejection of a digital aesthetic in favor of a traditional analog aesthetic? On the contrary, the aesthetic of multiplicity, what Reas names “organicity” complicates the equivalence between a digital aesthetic sensibility and minimal graphic schemas in which discreteness and disjunctness are not only present but enhanced (what Manovich might deem a reductive modernist machine aesthetic), as in the case of *Every Icon*. While I do not want to adopt uncritically the notion of “organicity” here, I do want to allow that digital systems can maintain digital aesthetic properties while successfully rendering more complex, multiple, and even spectacular depictive schemas.

Reas’ desire to “minimize the technical aspects” of his work and to make working with software as fluid as drawing underscores the resistance to the determinate properties of computational media exhibited in his “Processes.” In his introduction to the *Processing* handbook, Reas offers a brief account of his transition from traditional analog media into the experimental use of software as an artistic medium. Despite an early exposure to early personal computing programs such as BASIC and Logo, Reas relates that he preferred drawing and set computers aside for many years. During his training in design at the University of Cincinnati, Reas reconnected to computers and began to use Illustrator and Photoshop. But, in light of his interest in the fluidity and immediacy of drawing, Reas’s reasons for continuing to pursue computer-aided design are particularly revealing: “As I shifted my work from paper to screen, static grids and information hierarchies evolved into kinetic, modular systems with variable resolutions and compositions. The time and energy once spent devoted to details of materials and static composition shifted to details of motion and response.”³⁶² What is suggested here is that while the construction of informatic systems is possible in LeWitt’s realm of linguistic algorithm, digital systems change information from a spatial category into a temporal one. Other time-based media, such as film, performance, or video, are interested in other aspects of time—duration, extension, acceleration and deceleration, continuous and fragmented narrativity—but Reas addresses the question of what happens to information when it becomes dynamic. He wants to know what shape information takes, what interactions can take place between modules, how these interactions change the overall shape of the information-based structure. Information—conceived here very differently than in the instance of information-visualization, here taking on the sense of the “material” of digital systems—becomes a living organism, not trying to *copy* life or liveliness as in the case of AL projects, but becoming an entity in itself whose transformational capacities are revealed in the performative execution of code.

Conceptual systems do not embody the immediacy or the qualities of handmadeness, perceptual density and fluidity that Reas seeks in his organic systems. One approach seems much more about the facilities of computational technology itself;

³⁶² Casey Reas and Ben Fry, *Processing: A Programming Handbook for Visual Designers and Artists* (Cambridge: MIT Press, 2007), p. xxiii

the Conceptual area focuses on foregrounding the particularities of technological systems. His 2003 project, *Ora*, for example, shows the compositional/foundational substrate—the building blocks—of digital pictures. Unlike Salavon’s mottled Rothkoesque color fields, which I will examine more thoroughly in the next chapter, *Ora* attempts to make perceptible the fact that digital images are comprised of individual “signals” or numeric sequences that contain the information for specific color values by presenting the signal as layered, sequenced “leaves” of color. This, similar to another project *Mediation* (2002), which dissolves the representational content of the picture and rearranges it into vertical striated bands of color, echoes Salavon’s painterly amalgamations and other averaging projects, revealing the way in which even the most aestheticized, painterly examples of digital abstracting are still deeply informed by the performative aspect of their medium—the ability of digital technology to calculate data, and the need for objects and phenomena to be reduced to data—to be numericized—in order to be calculated. Reas describes the results of *Mediation*’s image-processing as an “empty aesthetic surface.”³⁶³ The bands of color are certainly emptied of easily legible symbolic content, but they signify nevertheless, about the inhuman processes of computation itself. Computers are devices for computation, and these various abstractions are directly and unapologetically the product of a computational process, whether that process consists of averaging, compression, or some other data-mining function.

Conversely, Reas’s organic systems, as we have seen in the example of *MicroImage*, animate a field of parts, which, through their interactions, create “complex holistic structures.”³⁶⁴ Works like *MicroImage* are inspired by Reas’s interest in artificial life but should not merely be seen as “demonstrations” of computational evolutionary algorithms. These overall patterns of delicate lines, circles, or shapes reminiscent of underwater plants, reveal what occurs when the disjunct digital “vehicles” are let loose, leaving behind their imprints as layers of color, and etched-in afterimages of their generative elements. But the overall structure is still dependent on the operations of and interactions between each element, so that the syntactic and semantic disjunctness of the system is preserved despite the painterly qualities of the final result. If one looks beyond these obvious “painterly” qualities—the *colorito*, the “freedom of line and interplay of light and shade” that are “satisfying to the painterly taste”—the architectonics of Reas’s most visually arresting works remain somewhat flat, even “decorative” precisely because their *raison d’être* is not in the representation of traditional Western subjects of painting.³⁶⁵ The motif appropriate to Western painting—“that which lends itself to be painted”³⁶⁶—incorporates dynamic relations between parts. However, many theories of Western painting have argued that the primary effect of these relationships has been to shape a coherent impression of volume, depth, and motion. These theories presuppose that depiction has moved progressively through stages of virtualization or, with the

³⁶³ Sebastian Campion, "Code: In Conversation With Casey Reas," *Artificial.dk*, October 10, 2003, <http://www.artificial.dk/articles.reas.html> (accessed May 1, 2009).

³⁶⁴ Casey Reas, "Organic and Conceptual Systems: C.E.B. Reas Answers Bert Balcaen's questions for Sonic Acts X, Amsterdam 2004," *Reas.com*, 2004, <http://reas.com/texts/sonicacts.html> (accessed April 18, 2010).

³⁶⁵ Wölflinn p. 29

³⁶⁶ Wölflinn p. 29

advent of modernism, towards the antithesis of virtualization in the form of a radical refusal of depth achieved through optical flattening. Reas's artistic production embraces visuality, refusing to accept, in the manner of Kosuth, art as a sensorially evacuated propositional form. At the same time, he demonstrates a clear commitment to procedural operations and system in the production of visual art objects. His processes are simultaneously painterly and digital, gestural and yet thoroughly grounded in a visual world executed by and reflective of the properties of computational code.

V. Processes as "Painting": Painting and Digital Media

In several recent Processes, Reas puts into play the various slips, gaps, and incommensurabilities that occur between the various instantiations of the underlying "idea." In fact, it is after his *{Software} Structures* project that Reas begins to allow the digital literally to parallel the analog aesthetic exhibited in *Tissue*. Reas's works after 2004, which he calls "Processes," exhibit a tri-partite structure, in which natural language "instructions," in homage to LeWitt, are accompanied by a divided screen. The divided screen of Reas's Processes display on their right half a simplified notation of the underlying processes, while the left half transfers attention from the skeletal structure of the piece to its surface. The visual component of the piece consists of two screens, side by side, each one showing two possible implementations of the instructions. In *Process 18*, the right screen displays a simplified digital schema of the underlying processes of the generative software. Here, a skeletal array of short white lines against a black screen reveals the "mechanism" determining the behavior of individual parts as they touch, collide, and rebound. Similar to *{Software} Structures*, Structure 003, in which lines demarcating the intersections of the moving circles are shown in the "intermediate" phase of implementation, in *Process 18* the right screen gives up the "trick" or the "game" or the "conceptual undergirding" of the work, precisely by showcasing the schematic, digital structure that underlies the painterly swaths on the left screen.

The notational visuality of the right screen more closely approximates the textual form of language-based instructions in the sense that it provides a concrete illustration of the rules governing the behavior of the elements and the surface qualities of the outermost layer or "skin" of the piece. On the left screen the mechanistic structural elements—the skeletal backbones—are erased, as the orthogonals and transversals disappear from a perspective painting, leaving the surface effects—here, curved, layered lines, of varying degrees of transparency and various degrees of saturation on a grayscale—available to sensory apprehension. In contrast to the austere structuralism of the right hand screen, then, its neighbor on the left reveals the more "painterly" aspect of Reas's multi-layered process compendium, offering up an abstract, gestural surface that, minus the textures, is more reminiscent of Jackson Pollock's Action Painting than Rozin's heavily digitized *Wooden Mirror*. However, these works are more "digital" than the others I have discussed with you today because the digital and analog surfaces are placed in parallel. In *Process 18* the side-by-side placement of the screens does not erect a hierarchy in which the analog is granted final pride of place.

In both the "Conceptual" case of *{Software} Structures* and the "organic" cases of *Tissue* and *MicroImage*, digital mechanisms, such as a line of a specific number of pixels, become drawing "agents," but in the act of drawing, they obscure their digitality, rendering the digital, in Reas's practice, a technological rather than an aesthetic category.

In this sense, Reas reverses the schema of Rozin's *Wooden Mirror*. There, the motion of the servomotors is perceptually analog—their movements and adjustments register as continuously correlated to the position of the viewer, just as a needle in a pressure gauge rises and falls smoothly, as a direct effect of the modulations in the physical quantity of pressure in the gauge. It is only the outermost layer of the interface—the array of discrete, modular wooden lozenges—that defines Rozin's mirror as aesthetically digital. In *Tissue*, on the other hand, the computationally simulated bots mimicking Braitenberg's neural motors are digital—they are registered by the system in terms of their position at any given moment. But whereas the bot's position is digital—it can only occupy one encoded position at a time, the visible output of the system is continuous, fluid, and aesthetically analog. In the end, Reas's work does not evidence two entirely separate strains, one towards the organic, and one towards the conceptual. Instead, these two impulses swirl playfully around one another in a noisy feedback loop. They are each practices built on digital platforms, but shot through with the spectre of the analog.

In contrast to the austere structuralism of the right hand screen, then, its neighbor on the left reveals the more “painterly” aspect of Reas's multi-layered process compendium. Line, color, depth, and volume are all terms used frequently to describe the formal qualities of a painting. But one word I take to be of utmost importance, and one that is elided by the terms above, is *gesture*. As was well demonstrated in Abstract Expressionism, the brushstroke, the direction, force, and texture of the application of paint to a surface, bears an indexical relationship to the hand of the markmaker. Reas writes in 2003, “gesture is a critical aspect of every continuous medium and software has the ability to convey and interpret gesture.”³⁶⁷ While painting bears the indexical impression of the gesture, and as such effects a sense of “presence,” no matter how ghostly or distant, software is a medium that can only simulate gesture. It can “recognize” movement and calculate paths of travel. But in and of itself it can only convey, theatrically³⁶⁸, and interpret, computationally. Looking back to Walter Seitter's explication of digitality derived from the individuated “digits” of the hand, a theory based on Leroi-Gourhan's research on the relationship between evolution, physiology, technology, and meaning, we can observe a split in the relationship we have to “the hand” in its figural sense. The hand is, in one instance, an accounting device, a tool, that first exists not as an extension but as part of the body itself, but which leads nevertheless towards the development of tools for abstract, disembodied calculation. This is one extreme. And in the opposite instance the hand becomes something different—a mark of presence, a signature, an index of movement whose force (pressure) and propulsion (momentum) had been at some point exerted by a living body, and is now captured as a trace in a physical medium.³⁶⁹ In the first example, the hand activates a bond between the

³⁶⁷ Casey Reas, “Programming Media,” in *Code: The Language of Our Time*, 174-179 (Osterfilden-Ruit: Hatje Cantz Verlag, 2003), p. 177

³⁶⁸ I use the term “theatrically” in its perjoratively loaded sense—in the sense of an attenuated or inauthentic performance of sincerity, as J.L. Austin would use it, or with inflections of another kind of inauthenticity: the aggressive, hulking anthropomorphism of “theatrical” sculpture derided by Michael Fried. J.L. Austin, *How to Do Things With Words* (Oxford: Oxford University Press, 1976). Michael Fried, “Art and Objecthood: Essays and Reviews,” 148-172 (Chicago: University of Chicago Press, 1998).

³⁶⁹ For more on the relationship between hand and inscription, and technological mediations between the markmaker and the mark as trace, see Jacques Derrida, “The Word Processor,” in *Paper Machine*, trans.

body and its technological extensions, while in the second, it acts as a bridge, providing a metonymical link between the mark and the embodied producer of that mark.

In his brief catalogue essay for *Code: The Language of Our Time*, the 2003 Ars Electronica festival in Linz, Austria, Reas appends Roy Ascott's and Myron Kruger's characterizations of the visual, cognitive, and relational affordances of computational media. Ascott proposes that we have transitioned from think of media tools in terms of "content, object, perspective, and representation,"³⁷⁰ all of which derive from the distantiating of sight and intellection from the "lower" end of the human sensorium, to a system in which media are oriented to "context process, immersion, and negotiation."³⁷¹ Kruger maintains that human-computer interactions turn on dialog, amplification, ecosystem, instrument, game and narrative.³⁷² But Reas suggests that these terms fail to reveal the basic genotype of software-enabled communication; for him, software-generated expressivity emerges from "dynamic form, gesture, behavior, simulation, self-organization, and adaptation."³⁷³

In LeWitt's wall drawings, aspects of subjectivity (if not the artist's subjectivity, but rather the draughtsperson's) are visible in the draughtsperson's particular imagination, configuration and execution of LeWitt's instructions. Elements of gesture may be found in small irregularities in lines and contours; however, LeWitt's work is far less focused on gesture than Reas's, which ironically contains no actual index of a marking hand. Artist Penny Feuerstein's has used her art practice to open dialogs and pathways between the analog and the digital. Feuerstein identifies not just the deviations in phenomenology of *viewing* painting vs. digital structures, but in the process of *making* as well. The practice of painting is, for Feuerstein, a highly physical, embodied experience, in which

the tangible, kinesthetic experience of holding a paintbrush in my hands, feeling the movement between brush, oil paint and canvas traveling up my hand, arm, and into my body is totally different from manipulating images with a mouse, on a screen, then clicking a button that tells a machine to print. Paint is thick and juicy. A print is flat and smooth. There is no getting around the visceral differences.³⁷⁴

This is not, however, to dismiss the computer as conceptually or perceptually dimensionless. Instead, the construction of digitally rendered imagery encourages her to consider the shape of life "from a subatomic perspective."³⁷⁵ This seems to be another way of saying that the composite structure of digital artifacts might press us to think more clearly about the architectonics of the material world rather than at properties of surfaces.

Rachel Bowlby, 19-32 (Stanford: Stanford University Press, 2005). See also Jacques Derrida, "Signature Event Context," in *Limited Inc.*, 1-23 (Evanston: University of Chicago Press, 1988).

³⁷⁰ Roy Ascott, "Moist Ontology," in *The Art of Programming* (Amsterdam: Sonic Acts Press, 2002). Cited in Casey Reas, "Programming Media," in *Code: The Language of Our Time*, 174-179 (Osterfilden-Ruit: Hatje Cantz Verlag, 2003), p. 175

³⁷¹ Reas, "Programming Media" p. 175

³⁷² Myron Kruger, "Responsive Environments," in *Multimedia: From Wagner to Virtual Reality*, 104-120 (New York: Norton Publishing, 2001).

³⁷³ Reas, "Programming Media" p. 175

³⁷⁴ Penny L. Feuerstein, "How Does the Analog Talk to the Digital? The Art of Penny Feuerstein," *generativeart.com*, December 12-14, 2007, <http://generativeart.com/on/cic/papersGA2007/20.pdf> (accessed April 18, 2010).

³⁷⁵ Feuerstein np

Of course, volume, depth—dimension—can all be explored using techniques of applying paint to canvas. The point I want to drive home, here, is that a “digital aesthetic,” conceived broadly, as I have done, extending past the techno-historical horizon of the invention of the computer, presents us with a view not just of the surfaces of the material world, but of its architectonic principles: the bits and pieces that comprise it, the dynamic forces that hold these bits together, and the principles of movement and change which permit forms to grow, decay, or recombine.

By way of conclusion, in the following chapter I will explore in further detail the relationship between digital media (technoscience) and painting. In this final chapter, I will examine the work of Jason Salavon, an artist who bridges art and technoscience by using computationally generated or digitized data to create painterly visual surfaces deeply resonant of high modernist abstraction. If the visible elements of painting can be transcribed through the action of digital processing, then what do we achieve by maintaining the distinction between painting and digital imaging? Digital imaging is more often compared to photography than painting, partly because there seems to exist a much larger intuitive gap between painting and digital image production. Painting requires the gestural application of pigment to surface; it communicates not only on the level of shape, color, depth, and volume, but also of texture, viscosity, the materiality of the paint itself that might be sensed as hardness and reflectivity in the case of lacquer or oil paint and soft, diffuse transparency in the case of watercolor. Hand-paintedness does not necessarily imply imprecision, as we have seen in the work of Lichtenstein. Conversely, the use of automated tools is certainly no guarantor of regularity and digital interchangeability, as we can see in the screenprints of Warhol and that we have examined more carefully in the raster paintings of Sigmar Polke. Painting, then, seems to occupy an insistently analogical position on a continuum between “pure” digitality and “pure” analogicity, both of which are nearly counterfactual extremes due to the rarity of their appearance in a pure and unmuddied state.

Conclusion: Amalgamations: From Painting to Information Visualization

The preceding chapters of this dissertation have not, largely, questioned the boundary between art and non-art. I have argued that pictorialization, as opposed to other forms of symbolic communication including writing or time-keeping, is expected to conform to analog aesthetic characteristics. Picture-making, as a mode of “capturing” or encapsulating individual views of what the eye sees, or what the eye might see in an alternate physical universe, engages with—even as it twists, anamorphizes, facets, or pixilates the pictorial field—what might be called “natural vision.” And while arguments in vision science suggest that vision might, itself, be digital, the analog experience of vision, as continuously correlated to the perceived surface, and as smoothly resolved, in defective cases tending towards blur rather than dissolution into a field of digital granules, means that despite the possibility that physiologically vision is digital, experientially (or phenomenologically) it is analog. This is not to say that all pictures inherently try to imitate “natural vision” (whatever this would be) or to create perfectly continuity between real and pictorial space. As we have seen, and as many more examples, extending further back into deep and pre-history show, there is far greater evidence that depiction does something else—it does not try to imitate, but instead, as art, it attempts to make strange, to exaggerate, to defamiliarize.

Many very different scholarly approaches have arrived at this conclusion. “Defamiliarization” is a term famously applied to the literary arts in 1917 by Russian critic Viktor Shlovsky. “The technique of art is to make objects ‘unfamiliar,’ to make forms difficult to increase the difficulty and length of perception because the process of perception is an aesthetic end in itself and must be prolonged.”³⁷⁶ Recent arguments by proponents of “neuroaesthetics”—the notion that there are underlying neural, evolutionarily-developed, adaptive, biological structures of the brain that can explain not only why humans make art, but how biologically hard-wired aspects of “human nature” validate the notion of cross-culturally and trans-historically common aesthetic responses. For example, Ellen Dissanayake has argued that making art, what might be called artifying, has an adaptive function, and is thus a biological propensity that has been evolutionarily hard-wired into human psychology.³⁷⁷ In particular, what differentiates the aesthetic experience of art from non-art—for example, a stunning view of a natural landscape—is the idea that what Dissanayake calls “artifying” is an act of “making special.” And, according to Dissanayake, “‘making special’ not ‘beauty’ or ‘display,’ explains the difference between a collection of decorated yams and a field of wildflowers, or a headdress composed of the colored feathers of thousands of birds and the feathers of the bird itself.” Making special bears a marked resemblance to Shlovsky’s defamiliarization, despite the very different origins of the theoretical, philosophical and scientific armature supporting these two terms. If we abandon the culturally and historically narrow definitions of art inherited from Enlightenment ideals (based on the

³⁷⁶ Viktor Shlovsky, “Art as Technique,” in *The Critical Tradition: Classic Texts and Contemporary Trends*, 716-726 (Boston: Bedford Books, 1998), p. 720.

³⁷⁷ See Ellen Dissanayake, “The Arts After Darwin: Does Art Have an Origin or an Adaptive Function?,” in *World Art Studies: Exploring Concepts and Approaches*, 241-261 (Amsterdam: Valiz, 2008), p. 252.

idea of the autonomous art object, the cult of artistic genius, the non-utility, or purposiveness without purpose of art, the valorization of art's stimulation of contemplation, its ability to remove the viewer, instead of reasserting his/her embeddedness in, everyday life), and if we are also willing to give up the delineation of pictures from other symbol systems and adapt the idea that artificing or ratifying is about "making special"—it is not too far a leap to incorporate information visualization into the category of art on the basis of not only its making special, but its making *visible*, at the outset, of patterns of information. That which seemed at the first instance not to have a perceptible "body" is given shape, but it is a shape whose relationship to high art is on shakier ground than even Pop-Art was to skeptics in the 1960s.

Moreover, information visualization gives what is perceptually abstract—fields of numerical values, for instance—a concrete shape in which relations between values are made visible. In its most utilitarian guise, information visualization surely strives for clarity, and works to make the invisible visible, but it also renders the visible relational. It shows the interconnectedness of quantized values, and how those connections can take shape, can be shown to exert mutual patterns of influence by creating a meaningful network of relations that possess architectonic features. Information visualization, in other words, shows how unorganized "data" becomes "information" when it is systematized and ordered. Systems of structuring and patterning meaning can be thought of as immaterial architectures that influence and/or direct human thought, feeling, and behavior. Information visualization shows how even immaterial quantities have distinct material effects.

Nevertheless, artifacts do not seem to conform to the Western, post-18th century criteria accorded to art objects. This is specifically true of pictures, especially if they are utilitarian, that is, if they are designed to visualize information, as maps and charts do, or if they illustrate other forms of knowledge, as a mathematical diagram does. Musical scores notate an art form, but are themselves, in their state as relatively mute visual artifacts, not the art object. Instead, as in the case of Conceptual Art, it is the "idea," the performance or manifestation of the content notated on the score that becomes the art. The typeset in which a poem by Shakespeare is printed contains a significantly lower "art quotient" than the strings of words that comprise the poem. Thus, notationality, the overarching framework within which the digital is a categorical subset, might be a medium, a channel, or an instrument for the delivery of an art experience, but it is not itself the *sine qua non*, the endpoint and or the final, objectival token of the type known as "art."

There are many reasons for this rejection of digital and notational systems, or least for the frequent suspicion of their status with respect to normative definitions of art. As I have argued, within the history of aesthetics it has been presumed that pictures would be a product of analog processes, and would therefore exhibit aesthetic features which include continuity, smoothness, and perceptual ambiguity. The analog picture is irreducible, both on the level of form and content, to a distinct quantitatively assessed set of values. In an analog scheme, one can discern, hypothetically, an infinite gradation of detail. The aesthetic markers of analog processing have appeared in many aesthetic accounts. For example, we can find it in Wölflinn's theorization of "the painterly," associated with the dissolution of the line, an "indeterminate character," of depicted

forms, a roiling, open-ended sense of movement and an indistinct yet insistent gravitational weight conveyed by the play of light and shadow.³⁷⁸

The digital, as we have seen, emerges from a very different structural logic; digital composition is inherently discrete, schematic, metric, and modular. In Goodman's classic example of the morphologically similar but semantically distinct illustrations of an EKG and a painting of Mt. Fuji by Hokusai, the Hokusai painting is exemplary of analog values, so that every linear modulation, every increase in pressure or thickness of ink potentially affords a new layer of meaning.³⁷⁹ The EKG, by contrast, exemplifies a digital system, in which only the abscissas and ordinates bear meaning but the lines connecting them are insignificant. As a subset of notation, the digital is characterized by "digits" which become discrete units for tallying and counting. Information is, of course, processed digitally in today's electronic computers, but the digital as an analytic and perceptual category can be disaggregated from the technical specificities of today's hardware and software. Rather, the digital refers to a particular configurative schema—to a state in which materials or signals operate and are operated upon as discrete states, as distinct from the continuous variation of the analog. Digital symbol systems may appear in the form of pixels, but may also manifest in a variety of other mark-making practices, such as points on a graph, in which a unit of measure has been assigned and outside of which no indeterminate state can be registered.

The digital renders what might appear to be dense, infinitely graduated, or irreducible to a discretely legible quantity that can then be placed into relationship with other quantities, and, ultimately, can be used in calculating processes. Turing's "machine"—the notional thought-experiment proposed by Turing in 1950 that simulates all possible computers, and thus becomes the basis for computer science—and subsequent instruments of technoscience all require the "finite, fixed" values of a symbol system such as an alphabet or binary 1s and 0's, outside of which no intermediate values are permissible, recognizable and computable by the machine. In an alternate articulation of what I have been naming density, repleteness, ambiguity, and irreducibility, Warren Sack writes that "Turing's definitions assume that one will ignore 'inconvenient' or 'unprofitable' details, while it is never *a priori* obvious for the functioning of a 'desiring machine' which details are significant and which are to be ignored."³⁸⁰ In other words, information machines select for which values will be communicatively relevant and suppress all (or most) other values, in contrast to the traditional view that works of art are to be accorded *greater* worth based on their irreducible, constantly proliferative and "eccentered" zones of meaning. Based on this estimation, the aims of technoscientific machines are fundamentally at odds with the aims of art to make strange, to exaggerate, or to defamiliarize. It is for this reason that Sack goes on to argue that painting should be viewed "*not* as equivalent, in some sense, to the artifacts and processes of high technology but, rather, as distinctly different than the kinds of work that scientists and engineers currently engage in."³⁸¹ Technoscience works toward determinacy,

³⁷⁸ Heinrich Wölflin, *Renaissance and Baroque* (Ithaca: Cornell University Press, 1964), p. 29

³⁷⁹ Nelson Goodman, *Languages of Art: An Approach to A Theory of Symbols* (Indianapolis: Hackett Publishing Co., 1976), p. 229. See also, for a more detailed account of this distinction, Whitney Davis, "How to Make Analogies in a Digital Age," *October* (MIT Press) 117 (Summer 2006): 71-98, p. 75

³⁸⁰ Warren Sack, "Painting Theory Machines," *Art and Design*, May 1996: 80-92, p. 83

³⁸¹ Sack p. 82

quantization, and repeatability while art creates a field of semantic possibility that cannot be contained in a single interpretive thread.

What is held in common between these two depictive methodologies, however, is that art, information, and other visual models provided by technoscience seek to make visible what had been previously invisible, whether that invisibility is imposed by the limitations of the human eye—its inability to see areas of brain activity or immaterial data sets—or by the oversights produced by normatively constrained “scopic regimes.”³⁸² Information visualization adds another layer of recursion to the process of “digitizing” the world—of parsing the world into discrete units—by translating a data set that has already been quantized into a sensorially apprehensible, qualitative entity. In most cases, information visualization attempts to deliver information with the greatest clarity and efficiency, while also, and this is where the term “aesthetics” as it is mobilized in infographics circles becomes murky, offering up an aesthetically pleasing visual schema. Its primary objective of translating numerical data into digestible visual form with a minimum of loss and/or obfuscation correlates to the communicative function of art objects, which convey meaning visually, but pictorial meaning is less definite or deterministic than the visual semantic mode of information visualization.

All the artworks I have discussed in this dissertation have retained a certain degree of analogic ambiguity, and as such have not pushed the boundaries of “art” past the breaking point, into the domain of design or information visualization. In this conclusion, I want to approach this limit more closely by addressing the work of Jason Salavon, an artist whose work hovers at the boundaries of art and information visualization. Although it ultimately lands on the side of art by obfuscating its data sources rather than working towards visual clarity, Salavon’s medium, with which he creates painterly abstractions, though in a different manner than Reas, is information itself.

Jason Salavon, an artist and professor at the University of Chicago, combines his training in fine arts and computer science to create software-based works that blur the line between photography and information visualization. Salavon’s “data sets,” selected from the cluttered vaults of culturally communal material, have included every playboy centerfold between the years of 1988 and 1997, and state and county information collected by the US census bureau between 1790 and the year 2000. He designs and implements software processes that generate images whose overall shape and structural patterns derive from relationships, computed by the software, between discrete elements of the data that fall within the described parameters for the “set”.

But rather than attempting to deliver pertinent information as straightforwardly as possible, the images rendered by Salavon’s data-analysis software depict the collapse of information that occurs when the isometric pressure exerted by layering data onto itself becomes too great for the image to maintain a clear distinction between signal and noise. His images are beautiful, fascinating, and even hypnotic; but they are quite a different beast from charts and graphs one might find in science textbooks or on the pages of the *New York Times*. I read Salavon’s art as a series of experiments that test the idea that one can never have too much information, and that inquire into the artistic and semantic

³⁸² Martin Jay, “Scopic Regimes of Modernity,” in *Vision and Visuality*, 3-23 (New York: The New Press, 1988).

possibilities that emerge when information is pushed beyond its capacity to transmit data as a range of related but differentiated values.

Why visualize information? What does information visualization try to “do” with data? Typically, the goal of information visualization is to give a perceptible shape, a way of making conceptual and phenomenological sense of a large and/or complex data set. Emerging as a formal discipline in the early 1980s, when scientists began to consider how to render abstract data more quickly and easily legible at a glance, information visualization set itself to the task of translating numerical data into graphical patterns that would reveal internal relationships between data elements, and would make possible the topographical mapping of the informatic territory in question. Martin Wattenberg, a manager at IBM’s Visual Communication Lab and a central figure in info-viz and digital art circles alike, points out that “visualization technologies can represent the ‘unrepresentable;’ things that could not possibly be seen can be visualized. For instance, the flow of blood in a heart cannot be seen, but a visualization generated from sensor data can create an image that represents the flow or lack of it.”³⁸³ There is an implicit equation here between visualization and clarity. To visualize a data set within a particular design schema is to make it knowable, sensible, and digestible.

Information visualization, the mode of digital image-making that motivates the kinds of artistic appropriations that are the backbone of this chapter, does not typically fall within the borders of art. Even in its non-artistic instantiations, however, it is representative of a mode of digital depiction invested in aesthetics, and particularly in issues surrounding the effects of aesthetics on visual communication. Data visualization originated in the statistics and science, domains in which empirical verification and the pursuit of objectivity hold sovereignty over such philosophically muddy notions as “aesthetics,” “beauty,” and “taste”. In a 2005 posting to the IBM website, Wattenberg informed curious “info-viz beginners” that

some of the biggest scientific discoveries hinged on turning data into pictures. One famous example of visualization is the periodic table of elements: When Mendeleev published a grid-like arrangement of elements for a textbook in 1869, not only did he create a beautifully simple display of known data, but his diagram highlighted gaps in current knowledge that told scientists where to search for new elements.

Visualization has always involved a partnership between science and art. A wonderful example is the work of Santiago Ramon y Cajal in the late nineteenth century. Ramon y Cajal, a doctor who trained as an artist, used a new staining technique to examine brain tissue. He created a series of drawings that are so clear and precise they are still used today in introductory neuroscience courses.³⁸⁴

Wattenberg emphasizes in this statement the simplicity of Mendeleev’s periodic table and the precision of Roman y Cajal’s drawings. Wattenberg’s text argues for the effectiveness of simplicity and precision in the visual register, but in so doing, reveals a gap between the notions of aesthetic success in mathematics and in art. According to

³⁸³ Martin Wattenberg, "Introduction to Visualization: From Data to Pictures to Insight," *IBM*, May 16, 2005, <http://www.alphaworks.ibm.com/contentnr/introvisualization> (accessed April 18, 2010).

³⁸⁴ Wattenberg np

Gian-Carlo Rota, the phenomenological experience of beauty in mathematics tends to be associated with brevity—a theorem, for example, should arrive at proof in the smallest number of steps.³⁸⁵ For John Maeda, design should give the viewer just enough information, but not too much. Both Rota and Maeda assert that aesthetic principles play an instrumental role in the ascertaining the validity of mathematical proof (Rota) or clear communication in design (Maeda).

Because it appears more frequently on Wall Street than in blue-chip galleries, information visualization resides in a liminal state, somewhere between being art and being an industry tool. When it appears in festivals and galleries, information visualization might be considered a form of outsider art that is intellectually interesting to a small number of practitioners and theorists but fails to make the leap into an emergent canon of contemporary art. Although the surface of the image might contain a sufficient degree of complexity and harmony to warrant aesthetic analysis, the foundation of information visualization in statistical notation rather than in the fine arts seems to place it outside an art-historical chain of reference. However, it is precisely in this resistance to canonization that information visualization shows its potential simultaneously to reproduce and to reflect upon the effects of the figure of information on the contemporary worldview as well as on representation itself.

However, the aesthetic variability in specific info-vis examples shows that effective communication (simplicity and accessibility of design) does not necessarily overlap with the achievement of *artistic* success. Wattenberg's *Map of the Stock Market* is a well-known example of an information visualization piece that rests primarily in the "function" category. Produced for Smartmoney.com, the website for *Smartmoney* magazine, whose subtitle, *Investing, Saving, and Personal Finance*, identifies the magazine as a decidedly business-oriented publication rather than an artistic one. Wattenberg's map is designed to allow viewers to absorb the state of the world economy at a single glance, and to track the rise and fall of each major player without sifting through columns of numbers. The map is laid out in a rectilinear grid format and utilizes a red, green, grey and black color scheme to convey information. There is less of the poesy or playfulness in this piece that we see in other Wattenberg visualizations. But the crucial thing to consider here is that this work is not typically included in the selection of Wattenberg's work that crosses over from industry to the domain of art festivals, exhibitions, galleries, and so on. Granted, the notion that information visualization fits at all into the art world is contentious, and many practitioners grappling with the issues raised by information visualization, such as Jason Salavon, set themselves more firmly within art-historical and art institutional contexts.

Although many words have been written about Jason Salavon, some emphasizing his reframing of photographic practices, others the formal similarities in his work to painters Kenneth Noland or Giorgi Morandi, and still others the latent commentary in his images about the mass distribution of sexual norms, none of them position him squarely within the field of information visualization in its most straightforward sense. It is not just the surface appearance of Salavon's "pictures" that differentiate him from the field. Info-graphics no longer necessarily conform to the rectilinear patterns imposed on data

³⁸⁵ Gian-Carlo Rota, "The Phenomenology of Mathematical Beauty," in *The Visual Mind II*, 3-14 (Cambridge: MIT Press, 2005), p. 3

by charts and graphs, and even employ similar palimpsestic compositional strategies that both visually and conceptually echo Salavon's software-generated averaging processes.³⁸⁶ For example, Christopher Baker's *American Toys* presents a two-part visualization of 500 patent applications for toy guns submitted since the 1800s. The primary visual artifact of the project combines the totality of the diagrams of the toy guns into a visual average, similar to Salavon's amalgamations. Alongside this picture, evocative in form of a charcoal sketch, Baker supplies a page of the individual drawings that comprise the average, arranged on the page in a rectilinear grid format, evoking the official visual language of an informational pictorial array. The authors of *Data Flow* describe the project in somewhat utopian language, claiming that the hazy tangle of black lines "becomes a collective *expression* of the prototypical American toy."³⁸⁷ When we consider this vague shape in conjunction with its accompanying chart-like array of drawings, arranged not by year but somewhat haphazardly—perhaps by morphological characteristics?—we realize that the combinatory picture exhibits "expressionistic" traits; in other words, it carries signifiers of handmadeness in its progression from center to periphery from densely overlaid black to wispy outlying tracelines. It recalls the sketch, that first stage of pictorial brainstorming in which the artist inscribes his or her first experimental musings onto a material substrate.³⁸⁸ The accompanying compendium of drawings refers in turn to bureaucratic modes of classification and communication; its arrangement in a grid format seems obvious, transparent in the sense that this layout goes largely unquestioned as a form of information collection, organization and dissemination. However, another voice is faintly audible through the structure of the grid. Once the viewer notices that the drawings are not arranged chronologically, s/he begins to search for a pattern, a *modus operandi* governing the sequence in which the data is presented. One begins to wonder if Baker is poking fun at a viewer who accepts unquestioningly bureaucratic rationality. In failing immediately to discern a numeric pattern, one questions whether it is the US Patent Office that sequences the toy guns in this manner or if we are observing a sly authorial intervention into a seemingly mechanized presentation of information. Baker's *American Toys* project, in its mobilization of something akin to a computational palimpsest, is similar to some of Salavon's impressionistic visualizations. In employing traditional tropes of information-bearing graphics, however, Baker maintains a more obvious connection to info-vis practices than to the kind emphatically inexact painterly adaptation of info-vis performed by Salavon. Ultimately, Baker's finished product adheres more strongly to the semantics and syntactics of a digital format; whereas Salavon's prints evoke (whether critically or not, a problem I will

³⁸⁶ A question that arises here, to which I will return later in my discussion, is how, or whether, Salavon's visual model establishes itself as in any way unique, or if his blurry, impressionistic surfaces lose something by simply reflecting an automated process. In other words, painting, even in its most "automated" instantiations (Warhol), always invokes the gesture, with all its connotations of flawedness and subjectivity. Also recall the oscillations between mechanical and gestural occurring in Polke and Richter. Does Salavon's "painterly" aesthetic thus contain an element of disingenuousness? Might it be a "gimmick" used to mask the coldness of the work's basis in digital processing?

³⁸⁷ Robert et al Klanten, *Data Flow* (Berlin: Gestalten, 2008), p. 209, emphasis added.

³⁸⁸ The word "sketch" is problematized when we consider the notion of a computational sketch made, for example, in Processing, as was demonstrated in the previous chapter.

address later in this chapter) a high modernist sensibility, Baker's argument is made via direct reference to digital parsing and compilation.

Wattenberg's *Map of the Stock Market* provides a convenient foil to Salavon's ghostly amalgamations, but it is by no means the case that info-vis specialists have not attempted, with varying "success" (depending on what one deems as successful) to explode the frame of infographics. The authors of *Data Flow*, a recent book charting trends in visualization, relegate examples of "blocky" graphics to a single chapter out of six.³⁸⁹ The remaining five quite deliberately collect projects that open themselves to a greater rage of experimentation with the ways visual models can prompt an intuitive absorption of statistical information. While these alternative maps seek to reveal the possibilities wrought by new approaches to visualization, they are often unwieldy and difficult to navigate. As such, their goal seems to be to impart a sense of movement or gestalt more than facilitating an incisive look into the precise cardinal or ordinal shifts that a) demarcate elements in the data set and b) consequently avail themselves to comparison and conceptual organization in the viewer's mind.

But inescapably, *because* he works with the vast accumulation of pop cultural records, and the way these records present themselves as a statistical database, his artwork must be viewed through the lens of data visualization. Moreover, because the particular materiality of his work is situated at the intersection of traditionally analog imaging technologies (photography, film, television) and software, Salavon's work is clearly *about* the conversion of analog pictures—that are imprinted or burned in their totality onto celluloid or photographic paper by the chemical processing of light—into digital pictures, which are a radically discontinuous array of bits that only resolve into a recognizable image when instructed by the computer to execute a series of commands. Not only does he gather his subjects from the vast bank of pop-cultural detritus, stored and found on the internet, but Salavon also asks, without anticipating the answer, how the nature of pictures might change when subjected to particular software-based processes. Thus, we experience the work not only as a meditation on the vastness, ubiquity, or mundanity of digital information, but also on what happens between the specificity of a single instance (the irreproducible, the particular) and its exponential multiplication (the generic, the popular). Because Salavon subjects analog images to computational processing, there is some expectation that they must look computed. But what, finally, might this mean?

In his 2005 series *Everything, All at Once*, Salavon filters each video frame of a cable television broadcast through a program that transforms the signals into concentric bands of color that radiate outward to the edges of a wall-sized screen. The hypnotic, sensual rhythms of Salavon's pieces might seem to replicate the spectacular seduction of the televisual image. Or, they might simply reinscribe modernist theoretical valorization of abstraction and pure opticality over academic mimesis. But Salavon's work resists such easy categorization by creating an irreducible play between multiple channels of information transmission. First, Salavon identifies his source material by synchronizing the abstract visual output with the unmodified soundtrack of the TV program. In the corner of the installation space, the unaltered broadcast is presented through the familiar channel of the TV monitor. Typically, the verisimilitude of a live-action video obscures

³⁸⁹ Robert Klanten et al, *Data Flow* (Berlin: Gestalten, 2008).

the fact that this “copy” of real life is merely the product of a delivery of a stream of informational bits that are meaningless without their reconstitution into a legible signal. By writing a program that places a filter between input and output, Salavon reveals the deeply mediated nature of recorded images and also radically undercuts the implied truth-value of information visualization.

The highly constructed documentary quality of reality TV and network news is evidence enough to obliterate the notion that television delivers information with minimal mediation. But Salavon’s work performs the impossibility of a direct, unmediated link between sender, channel, and receiver. The images filtered through his program are sensually captivating in and of themselves, but Salavon demonstrates that processing the same units of information through different mediating devices can produce a multiplicity of possible results. The magnetic pull of the color bands radiating outwards on the wall-sized screen proves the potential for information to be viewed through an aesthetic, rather than a merely utilitarian lens. At the same time, however, it also resists an uncritical belief in the truth-value of information itself and the objectivity of information visualization. What the viewer sees on the screen reveals the capacity of data transmission to exclude or conceal the fundamental mutability of the informatic signal.

As we see in the example of *Everything, All at Once*, Salavon immerses himself deeply in questions about information. What is a unit of information? What happens when an amalgamation of similar informational propositions or data sets reduces precise statistics to an ethereal fog of line and color? Is the resulting image still “informative,” and if so does the quality of available information change due to the artist’s manipulation? Whereas a straightforward instance of information visualization—for example, a graphic in Al Gore’s *An Inconvenient Truth* demonstrating the skyrocketing CO2 levels in the Earth’s atmosphere since the 1970s—implicitly assigns aesthetics to a supplemental role by using aesthetics to enhance the utility of the object, Salavon self-consciously denies the viewer an experience of total mastery over social “data.”

Not only does he not give graphical indexes of the type of information he is assessing, (announcing that one very blurry, painterly image is an amalgamation of photographs of real estate for sale in a given area of Chicago, for example) he also refuses to reduce his material to numerical or statistical data. He does not visualize numerical values, such as the cost of a real estate property, nor does he arrange his source material in a relational manner, as a graph or a chart would. Instead, he manipulates and amalgamates *pictures*. Consequently, even if the process of amalgamation or the stripping down of signals to patterns obscures individuating features, leaving only generic outlines, the vestiges of particularity hover within the pictures, provoking a yearning for the familiarity of home in the uncanny muteness of color and mottled texture.

In viewing *Everything, All at Once* we must remind ourselves that without the successful execution of the encoded instructions described by a program, digitized numerical data can never resolve into a picture. When the program stops running, the image is gone, without a trace. Because the visual manifestation of digital images is dependent on computational process, the ontology of the image is fundamentally unstable and dependent on real-time information processing. In other words, to appear at all, the image must be computed and rendered in real time, and will just as quickly disappear as soon as the machine is powered off. Although the computational origin of digital pictorialization is often effaced, just as the orthogonals and visual angles are eventually

covered over perspective drawing, Salavon's strategy of "anti-visualization"—his actuation of the mutability of code and his methodical decomposition of indexical images—suggests that the aesthetic richness of digital images lies in their fragility and ghostliness. As opposed to the material solidity of painting and sculpture, the digital image is haunted by a strange mortality. In each instance, it is born, dies, and is reborn again, phoenix-like, not rising from its own ashes but from a machine-readable string of ones and zeros.

Salavon's exhibited works convey his obsession with what he calls "the relationships between the whole and the part, the individual and the group." Although the thematic content of his works varies widely, each work repeats a seemingly compulsive reenactment of the translation of subjects and substance into statistical data. In *Every Playboy Centerfold*, a program written by Salavon compiles a point-by-point digital average of all Playboy centerfold foldouts from January 1988 to December 1997. The seductive poses of these soft-porn icons dissolve into what Salavon calls a "shroudlike," indistinct form. Like a digital offspring of Duchamp's *Nude Descending a Staircase* and Rothko's *Red on Maroon*, the amalgamation of photographs in *Centerfold* allows a few mechanical angles and repeated abstract shapes to surface from a deep, muddy background. In the area where flesh is most concentrated, a reddish, ovoid shape emerges, only to fade away again.

Even at the center of the image this textural quality visually analogizes gestural brushstrokes, which would, if it were a painting, signify artistic style, but here it is only a record of digital noise in the averaging process. This noise, however, does not "fail to communicate." It reconfigures the boundaries of information visualization to suggest that digital computation of data can generate poetically resonant, sensuously rich imagery that uses information as its medium but is not dependent on communicating a particular set of statistics for utilitarian ends. The process of averaging would seem to eliminate variation and to depict the informatic world as a flattened, neutral plane of obdurate consistency. But instead, the human figure hovers just outside the limits of perception, and the image acquires a ghostly, pulsating dynamism.

By definition, information visualization as a design practice relies on notational features for its communicative success, but sometimes designers blur either the semantic or syntactic discreteness for the sake of producing a rather uncritical version of "visual pleasure" dependent on analog aesthetic typology. For example, a graph describing fluctuations in American population and demographics taken from data collected by the census bureau derives its communicative efficacy from the legibility of discrete, distinct values. These values are not inherently digital, insofar as they can appear on an analog scale, but nevertheless interrupt the smoothness, fineness, and ambiguity of a classical linear scheme based on *disegno*.

If you see a somewhat tragic beauty in Salavon's amalgamations, you are not far off the mark. Salavon writes about his 1998 "self portrait"—*Flayed Figure, Male, 3158.75 Square Inches*—that the photographic deconstruction of the surface of his body into 12,000 half-inch squares and its subsequent reconstruction into a "complete" image results in a "contradictory self-portrait in which every intimate detail of my body is

revealed and yet the clinical detachment of the generic pervades.”³⁹⁰ The pictorial fields in Salavon’s amalgamation series hang in suspension between continuous and discrete surface characteristics. Again, “texture” signifies not only artistic intention (the gesture, the deliberate mark), but also the variability and irregularity that is the hallmark of non-automated painterly process. In some of Salavon’s works, such as *Flayed Figure*, discreteness is not suppressed, as it is in *Every Playboy Centerfold* and his Chicago real estate series, but made more subtle, more adequate to the brushstroke, than for example the pixelated portraits of Chuck Close, whose offering up of a resolved, recognizable portrait is less compelling than the concomitant invitation to approach each individual pixel and examine the (analog) content within. Emphatically in Close’s portraits but more evanescently in Salavon’s cutting up and layering of photographic material, the digital comes in and out of focus. Both *Flayed Figure* and *Every Playboy Centerfold* obscure the informational substrate from which the works are configured by producing a gestural, painterly topography. However, they also possess an uncanny quality that derives from the very fact that their underlying materiality—the stacks of photographic images submitted to the compiling and averaging mechanism of the software—has been translated from a continuous whole into discontinuous information. In other words, an analog photograph reads as a fragment of reality, pulled from its situated context, but within the boundaries of its artificial edge it is a single unit, a continuous whole. But once that photograph is subjected to a digitizing process, it disintegrates into a collection of new fragments, each of which is extracted and bounded according to the rule governing the informational content of a single digital unit. The figure, then, is flayed by the digitizing process. The flayed bodily surface is recombined without respect to the laws of biological or organic systems. Instead, the “figure” is further flattened—from the already flattened plane of the photograph—into an abstract field of color-values arranged continuously from light to dark.

In an implicit parallel to the rhetorics of genetics and molecular biology, individual bits of data act as the basic code—the DNA—of Salavon’s imagery, but the final product does not suggest that the reconstitution of these bits into visual form will reveal the essence of information, just as deciphering human DNA will not reveal the whole truth of what it means to be human. Indeed, Salavon has claimed that at some level his work seeks to “nullify the individual.”³⁹¹ In *Centerfold*, “as all individual characteristics and overt sexuality are subsumed, abstracted generalization becomes central”. Does Salavon’s work, then, celebrate likeness over difference, or can it uncover difference within repetition, averaging, and abstraction? In fact, Salavon’s apparent nullification of the individual through the processes of averaging and amalgamation ultimately preserves, rather than suppresses, the power of “the part” to mark itself against the grey and brown hues of a data-mined, informatic landscape. While the presence of a central area of color-saturated flesh tone marks the mean or the norm, these less-nuanced regions are less interesting than the wispy traces of outlying color values. Thus, while averaging would seem to crush nuance, deviations haunt this landscape, and suffuse it

³⁹⁰ Jason Salavon, "Celebrating/Nullifying the Individual," *CIRCA: Irish and International Contemporary Visual Culture*, Winter 1999-2000. Online at <http://www.recirca.com/backissues/c90/16.shtml>

³⁹¹ Jason Salavon, "Celebrating/Nullifying the Individual," *CIRCA: Irish and International Contemporary Visual Culture*, Winter 1999-2000.

with a much warmer light than we find in the precise, if airbrushed, outlines of playboy centerfolds.

Looking again at Salavon's art through the lens of information visualization, I propose that there is at least one statement we can make confidently about how the technological conditions of digitality productively limit the kinds of signification that digital images can produce; the existence of a digital artifact is governed by and predicated upon information processing. Computers are tools that process information at the levels of both input and output. Digital objects of any kind, then, are both composed of information and are fundamentally *about* information. Computationally constructed images communicate most successfully about information. But, what forms of meaning fall outside the limits of information? Moreover, how do we determine whether information has been communicated successfully or not? The artistic intervention into data visualization practices staged by *Every Playboy Centerfold* activates our capacity to feel aesthetic pleasure and fascination in the *dissolution* of information that occurs, seemingly oxymoronically, at the point of informatic oversaturation. It is in this sense that Salavon's work can be labeled as "anti-visualization."³⁹² Paradoxically, as the informational content of the data set increases, the putatively information-bearing image blurs into unrecognizability.

Thus, Salavon's images challenge the idea that visualization always aims for clarity or revelation by depicting the de-resolution that occurs at the point of informational oversaturation. The field of noise generated by the amalgamation of centerfold photographs reconfigures the boundaries of information visualization to suggest that digital computation of data can create poetically resonant, sensuously rich images that use information as their medium but are not dependent on communicating a particular set of statistics for utilitarian ends. Salavon "hints at profound hidden meaning, but ultimately obscures or ridicules it."³⁹³ As a result, his work follows in the tradition of avant-garde intervention into crystallized and emptied cultural signifiers and practices. We recognize Salavon's work immediately as art because if it has utility, its function lies partly in its critical appraisal of the effect of digitality on traditional representational models. But to an even greater extent its success can be identified in its resistance to theoretical reduction. The images created by his programs make visible the philosophical and aesthetic complexity of information. *Every Playboy Centerfold* not only evokes a continual stream of interpretive possibility, but its textures, its visual richness, and its mischievous play between high art formalism and cheap pornographic solicitation make a different kind of information available for sensuous apprehension.

If one of the most powerful attributes of successful art is its capacity to reveal the hidden, unthought, or concealed mechanisms of everyday objects and events (as Heidegger maintains about Van Gogh's shoes in the "Origin of the Work of Art"), Salavon's adoption of information visualization for artistic ends offers the possibility of awakening viewers to unexpected interactions between abstract data and worldly

³⁹² Marius Watz, "Salavon's Golem," *Generatorx.no*, December 2, 2005, <http://www.generatorx.no/20051202/salavons-golem/> (accessed April 18, 2010).

³⁹³ Marius Watz, "Salavon's Golem," *Generatorx.no*, December 2, 2005, <http://www.generatorx.no/20051202/salavons-golem/> (accessed April 18, 2010).

phenomena.³⁹⁴ Even in moments of failure or breakdown, when visualizations manifest the instability of information or reveal the extent to which accuracy and breadth of communication is dependent on representational codes, Salavon's artworks expose us at an intuitive level to the fluidity of what counts as valid or important information, and ultimately triumph by calling into question the very stuff of which their foundations are built.

When thinking through the varieties of depiction and the ways in which they are, rightly or wrongly, delineated and compartmentalized into non-intersecting categories, cases such as Salavon's, in which not only different modes of depiction, but also notions such as medium specificity begin to overlap dangerously, are helpful in thinking about how adding the figure of the "digital"—both in its technological and aesthetic sense—to the discursive mix can expand domain of art. Adding the digital to an art-critical vocabulary expands the way art is conceptualized, experienced, and delimited from other forms of cultural production. *Every Playboy Centerfold* calls into questions categorical distinctions between abstract painting and information visualization, as well as painting itself, and digital artificing,

As we have seen in previous chapters, the 2003 exhibition *Painting Pictures* at the Kunstmuseum Wolfsburg, and its accompanying catalogue, takes as its central problematic the very *possibility* of painting in the digital age. The catalogue essays ask whether "Painting has Always been a Digital Affair" or whether it is "A State of Utter Idiocy." It asks how the coming into being of various technologies, from photography forward to digital computers, has fundamentally altered painting practices. But the essay unsurprisingly comes to no stable conclusion other than that painting and technology have always been, and will continue to be, fundamentally linked and mutually influential.

I. Beyond the Digital

Painting and digital artificing do not seem to render the world in the same way and with the same aims. Metric systems such as perspective mean that the picture is governed by an overarching numerical system that plots the position of any given feature of the painting according to a modular, infinitely extensible grid. Seurat and his fellow pointillists deploy a proto-digital system to produce particular perceptual effects, while Klee incorporates musical notation and digital modules into his painting practices in various ways at various times. Vasarely is the most explicit in his translation of computationalist ideas into plastic forms, due, it must be imagined, at least in part to the fact that his practice, and his process, unfolded around the birth of contemporary computationalist paradigms such as cybernetics. I have argued that instances in which painting uncovers its constitutive digitality destabilize the conventional association between picturing and analogicity, but also reveal how analog and digital modalities rarely retain perfectly distinct from one another. As Turing, Von Neumann and others have pointed out, even in thought experiments it is only notionally tenable to think that any "discrete state machines" would exist. According to Turing, "Digital computers... may be classified amongst the 'discrete state machines'. These are the machines which move by sudden jumps or clicks from one quite definite state to another. These states are

³⁹⁴ Martin Heidegger, "The Origin of the Work of Art," in *Basic Writings, revised edition*, ed. David Ferrill Krell (San Francisco: Harper Collins, 1993), pp. 158ff.

sufficiently different for the possibility of confusion between them to be ignored. Strictly speaking there are no such machines. Everything really moves continuously.”³⁹⁵ Seurat and Klee meshed a traditionally analog medium with a notionally digital procedure, a mixing process that results in artifacts that partially inhabit both states—they are technologically analog, but lean towards aesthetic digitality. In this dissertation, I have offered up a series of examples of paintings that are constructed according to a digital logic, and argued that these pictures activate a different set of expectations and perceptual experiences than their analog cousins. When the digital is disaggregated from electronic computational technology, it becomes clear that digital methods have been employed in visualization and depiction for centuries—well beyond the inception of metric perspectival constructions in the Renaissance—though I have only expounded upon a very small slice of that history, beginning around the turn of the 20th century, here. When the co-presence of digital and analog modes in painting and other forms of depiction becomes visible, it prompts a consideration of what kinds of meaning are afforded by each model separately in order to see how they put pressure on one another.

Digital depiction is part of a philosophical world view that equates knowledge with quantization; digital artificing is eminently concerned with capacity of representation and symbolic forms to make the world measurable, to create schemas and algorithms that impose regularity and pattern on an otherwise entropic, irreducible, analog universe. According to Félix Guattari, “the paradigms of techno-science place the emphasis on an objectal world of relations and functions.”³⁹⁶ While the conventions of analog pictoriality are, themselves, also about the world of objects, relations between them, and the human perception of them, the paradigm of technoscience, as Guattari describes it, arranges the object-world in terms of functions and coordinates—it makes the world mappable, metric, algebraic, probabilistic, knowable in terms of all manner of calculations. Art, in contrast, is for Guattari ever more “eccentered”—thrown outward from the confines of “preformed structures and coordinates.”³⁹⁷ Again, we see that while technoscience works towards clarity and disambiguation, art seems to thrive on its irreducible density and ambiguity. And yet, it is in the very impossibility of perfect clarity, articulation, discretization that the digital becomes an artistic, not merely a technoscientific communicative form. In seeming to offer the promise of a world that is totally knowable in its utter calculability, the digital ultimately proposes a new ambiguity, a new way of seeing and conceptualizing the world before our eyes. But the digital is not merely a technological marvel. If we look closely, through eyes now accustomed to computational formats, the digital makes its presence known, in more and less subtle ways, as a structural principle and structuring force that shapes the architecture of depiction. It is precisely the genealogical model, in which the paradigms and scopic regimes of the present allow the digital forms of the past and the present to become visible in this particular way. Thus, it is contemporaneity that provides the language for the past to speak, but it is the deep historicity of digital modes of inscription that gives it a new meaning, extending beyond the contemporary technological milieu to connect what

³⁹⁵ Alan Turing, "Computing Machinery and Intelligence," in *The New Media Reader*, 49-64 (Cambridge: MIT Press, 2003), p. 53

³⁹⁶ Félix Guattari, *Chaosmosis: An Ethico-Aesthetic Paradigm*, trans. Paul Bains and Julian Pefanis (Bloomington: Indiana University Press, 1995), p. 100

³⁹⁷ Guattari, p. 101

seems radically new to a long but often silent history of digital knowledge and digital depiction.

Fin

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