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From Keyhole to Big Brother: The Legacies of Early Cold War Surveillance

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Abstract

Much of contemporary surveillance, with its reliance on remote sensors, big data, networks, and algorithmic simulations, has its origins in early Cold War technologies that were designed to provide air defense surveillance. Though the SAGE system has been examined by other historians of technology, this paper examines the origins of this system by applying a different interpretative approach by emphasizing the interdependence of epistemology (how human beings know something) with ontogeny (the emergence of things independent of whether human beings know it). The mediation between the two is identified as information, drawing attention to the importance of surveillance as a social and technical practice.

The machines are social before being technical.
(Deleuze 1988: 34)

Introduction

Surveillance is an ancient practice—one that has always entailed human beings ‘watching over’ others, primarily focused on narrowly defined targets and territories. However, since the 1940’s, the scope of this practice, increasingly abetted by sensors, computers, software applications, networks, and other technologies, has progressively shifted from individual targets to an undifferentiated persistent stare over entire populations across vast dimensions of space and time.

The question that arises is the following: if modern surveillance is driven by the need to control (Deleuze 1992), where the degree of control is constrained by the quantity and timeliness of information (e.g., Yates 1989), necessitating investing in and inventing more efficient and efficacious information technology (Beniger 1986; Noble 1986), then in what ways are the possibilities of contemporary surveillance largely driven by advances in how we think about information and the technology that generates it?

The premise of this paper is that this revolution in surveillant affairs would not have been possible without an underlying paradigmatic transformation in the ways we think about what constitutes data and information. In this sense, data was once understood as arising from human observation of events, while information was the construction of human-interpretable narratives based on that data. By contrast, contemporary data and information are the products of algorithmic abstractions made possible by

increasing layers of technology (sensors, networks, computers, algorithms, and visualization tools) that alter how we sense, record, filter, analyze, prioritize, and act upon the objects of our observations. The composition of data and information as human products has been displaced by technical production.

In this paper, I consider this question with a new approach to surveillance—one framed by an empirical ontogeny emphasizing the interdependent material and conceptual processes that underlie surveillant practices: a) empirical because its theoretic value can be extracted from the specific conditions to which it gives rise; b) ontogenetic (literally, ‘the origin of that which is’) because it metaphysically presumes that these conditions are processes undergoing continual and successive states of adaptation, emergence, and transduction, altering the very status of what constitutes surveillance; c) such that the materiality of these processes can be traced archaeologically to the technological artifacts which mediate and incite the potentiality of these processes; and, d) which provide evidence of the continuous reconfiguration of practices and knowledge constituting the system’s components and processes. In this way, metaphysical questions are not disparate and apart from those that are epistemological but integrated as part of interdependent processes.

I will apply this philosophical approach to my specific research question with an investigation of one of the earliest examples of a computerized information system developed for the primary purpose of surveillance. Initiated by the United States Air Force with the assistance of IBM, the Massachusetts Institute of Technology, Burroughs Corporation, and Western Electric, this surveillance system, known as the Semi-Automatic Ground Environment (SAGE), established the first real-time computers connected to real-time sensors (radars) distributed around the North American continent with the ability to automatically collect, filter, sort, and identify potential threats, and direct and control appropriate responses. This assemblage is the progenitor of many, if not most, forms of contemporary surveillance.

In the balance of this paper, I outline how, at the intersection of epistemology and ontogeny, we can understand some of the seminal conceptual and technical innovations that made this revolution in surveillant affairs possible—the distillation of objects into digital data; the theorization of this data as form without content, algorithmically fungible, and informatically probabilistic; and where these processes constituted the basis for self-regulated systems. In Part II, I summarize the work of Michel Foucault and his legacy, wherein I suggest that the limitations of Foucault’s approach necessitate the development of a new theoretic interpretation. In Part III, I summarize what this alternative theorization should look like by building on the contributions of Gilbert Simondon, Bernard Stiegler, and Bruno Latour. In Part IV, I provide a brief narrative of some of the antecedent epistemological paradigms that made this revolution in surveillant affairs possible. In Part V, I apply my ontogenetic approach to a reading of the SAGE system and the ways in which it redefined the possibilities of surveillance, both epistemologically and ontogenetically. Finally, in Part VI, I point to the ways in which SAGE influenced successive implementations of technically-mediated surveillance in Vietnam and contemporary surveillance. I then conclude by showing how the philosophical approach I have taken helps to explain the predominant role of technology in contemporary surveillance applications.

Foucault and the Discourse of Surveillance

The traditional approach to understanding surveillance has largely been inspired and shaped by Michel Foucault (1977), both in terms of thinking of surveillance as a set of discursive practices and as a historicization of these discourses, revealing a succession of epistemic structures. These discourses include both technical practices and the articulation of those practices by which they are organized. The inter-penetrating totality of these discourses justifies its own coherence—what Foucault refers to as *epistemes*. In the case of early nineteenth century surveillance, these *epistemes* were interpreted by Foucault as empowering the production of negative or repressive authority—characterized as a practice of discipline.

The influence of Foucault's insights continues to guide many researchers. For example, Foucault metaphorically represents this kind of discipline as a "Panopticon," a concept he borrowed from Jeremy Bentham's book of the same name (Bentham 1995). In short order, this trope came to represent an essential focal point for much of surveillance research, implying that the all-seeing eye of power maximizes discipline in furtherance of political order. The contradictions of the trope, however, quickly revealed that the "eye," the "power," and the "discipline" constituted a panoply of forms with a plethora of objectives. Soon, there were several dozen kinds of ~opticons—to wit, a "superpanopticon" (Poster 1990), a "panoptic sort" (Gandy 1993), the "synopticon" (Mathiesen 1997), and so forth. Even as recently as 2017, we find innovative variations, such as Ajay Singh's "prolepticon" (2017).

Some critics posit that the panopticon model is no longer applicable. As early as 2000, Roy Boyne proposed that researchers needed to start addressing a "post-panopticism" (Boyne 2000). Kevin Haggerty criticized the multiplicity of ~opticon tropes as analogous to T.S. Kuhn's interpretation of what happens to scientific theories when an accumulation of anomalies in an existing theory inspires a shift towards a new and incommensurable paradigm (Haggerty 2006).

A corresponding problem plagues those who define surveillance under multiplying forms of ~veillance, such as "dataveillance" (Clarke 1988), "sousveillance" (Mann, Nolan, and Wellman 2003), or "counterveillance" (Welch 2011). Indeed, the proliferating facets of surveillance have undermined any confidence in the possibilities of a unified theoretical framework, resulting in what David Murakami Wood (2013) describes as "multiple and multiplying 'veillances'" leading "towards ubiquity, pervasiveness, or ambience" (324).

It is in this context that we can also theoretically locate and frame early Cold War surveillance, in which Foucault has exerted a powerful influence on how we think about technically mediated surveillance. For example, Paul Edwards (1996) interrogates the ways in which computational epistemics shaped Cold War strategies and language. David Golumbia (2009) elaborates on how these rhetorical constructs amplified positions of power and domination. While Orit Halpern (2015) investigates how the rise of cybernetic science reframed perception within and through these discursive practices. These historians provide, in substantial detail, the discursive forms of a Cold War surveillant technology. Collectively, they demonstrate the convoluted ways in which science, war, politics, perception, and power became epistemologically entangled and determinative of the possibilities of knowledge and the language that is used to express it.

But an epistemological *account*—*how we can know something*—is only half the story. What is missing is an examination of *what really exists in the world*—an ontological consideration. Only when we assume that *how* we know something about the world constitutes the bounds of *what* we know—a position generally held by social constructivists and many idealists—can we exclude the possibilities of knowing that which *is* outside of our own cognitive constructs. The quandary of this limitation is what philosopher Quentin Meilliasoux (2008) refers to as "correlationism," in "which we only have access to the correlation between thinking and being, and never to either term considered apart from the other" (5).

A Theoretic Alternative

Ontology is the theoretical analysis of *what is*. But what kind of ontology can wrestle with questions of transcendental existence while acknowledging Foucault's demonstration that the existence of things (both material and ideational) are fortuitous and transient, accidental and temporal? One approach is *ontogeny*, wherein we substitute questions of being with those of *becoming*, substance with *process*, entities with *events*, objects with *connections*, and identity with *difference*. The ironic consequence of this theorization

is the possibility of integrating epistemological questions, like those with which Foucault was concerned, with ontogenetic investigations—awkwardly embracing Foucault with Deleuze, Whitehead, and Leibniz.

In this paradigm, there is a co-determinate individuation of things (corporeal and incorporeal, organic and inorganic) maintaining, at the same time, unstable or indeterminate relations among these same things. What kind of world is it in which these things exist? I cannot possibly begin to fully explicate this universe in such a short paper, but let me suggest the following essential characteristics, which I will draw upon in the empirical portion of this paper.

The starting point is *noise*. Noise is ontological—the grounding of a first philosophy. It is behind, between, and amid everything. Noise is material and asserts itself as background radiation, a vibration, static, a parasite, and so forth. Noise, cyberneticist Gregory Bateson (1972) argues, is a “bit of information” with a “difference that makes a difference” (272, 318). This noise is material and incorporeal simultaneously. With respect to the material, media theorist Hillel Schwartz (2011) suggests that “Static, then, [is] the audible expression of an elemental condition of matter and of all communication” (648). At the same time, noise is also incorporeal, the potentiality of difference among multiplicities of bits of things. Deleuze (1994), writing of Leibniz’s “murmuring of the sea,” states,

Either we say that the apperception of the whole noise is clear but confused (not distinct) ... or we say that the little perceptions are themselves distinct and obscure (not clear): distinct because they grasp differential relations and singularities; obscure because they are not yet ‘distinguished,’ not yet differentiated. (213)

This kind of noise resists order, form, and structure. Noise lacks identity but is pure potentiality. Bateson (1972) asserts, “all that is not information, not redundancy, not form, and not restraints—is noise, the only possible source of new patterns” (416). Noise is an ontological principle but embedded in and through the principles of difference, multiplicities, and potentiality.

Noise in space is a state of juxtaposition—it persists in its relations and resists alteration. But the kind of noise that is the *difference* that makes a difference in a field of multiplicities is temporal. It is through the unfolding of time by which potentiality reveals itself as change within a becoming. These changes correspond to and are referred to as events. Events are liminal, always on the edge between potential moments of things as they may become and as things as they are. Events are the material instantiation of temporality—though much of the time, we are insensitive to their presence. As Georges Eliot (1994) wrote, “If we had a keen vision and feeling of all ordinary human life, it would be like hearing the grass grow and the squirrel’s heartbeat, and we should die of that roar which lies on the other side of silence” (194). Rather, our focus turns to the persistent noise which rises to the point of interruption, an annoyance which refuses to dissipate, inciting a sense of disequilibrium.

Events pour forth and their emergence from a liminal state results in perturbations with and connections among each other. Sometimes events coalesce into relations constituting a state of meta-stability (Simondon 1992) suspended between creation and dissolution. We refer to these as things. (These terms correspond to Whitehead’s “occasions” [my events] and “events” [my things], where “change is the difference between actual occasions comprised in some determinate event” [Whitehead 1978: 73]). One can theorize a bolt of lightning as a thing but, simultaneously, consider it a flow of temporally cascading events.

Things, as such, have *boundaries*—borders are what distinguish a thing from anything else. Borders define the limits of a thing’s topological space—its interiority, as well as what it is not—its exteriority. Following Kant, one cannot ontologically know a thing in itself—it withdraws, as Heidegger would say,

into itself. But that does not mean that borders are not porous or subject to transgression, only that the identity of a thing is its difference among other things.

The exteriority of a thing is defined by its encounters with other things as *intersections*—what Whitehead calls a nexus. Intersections establish relations. Things can combine with other things to form assemblages (DeLanda 2006) or machines (Bryant 2014). As Jane Bennett (2010) puts it, “bodies enhance their power in or as a heterogeneous assemblage” (23). This enhancement, as Bennett puts it, is the agency, not of a doer but as a doing.

The smallest and largest of things engage in communication (mechanism) through the exchange of information (content), including the briefest of adjacencies, perturbations, and encounters, as well as sustaining loosely coupled relations (networks) or more integrated combinations (assemblages or machines). This communication is continuous with and inseparable from a thing’s environment, including noise. Following Stacy Alaimo (2010), I refer to this continuity as *transcorporeality*, which “opens up a mobile space that acknowledges the often unpredictable and unwanted actions of human bodies, non-human creatures, ecological systems, chemical agents, and other actors” (2). This is consistent with an agency that spreads across what Bennett (2010) refers to as an “ontologically heterogeneous field” (23).

This approach is not concocted *sui generis* but arises from studies of science and technology. For example, in the early years of the Cold War, Gilbert Simondon wrote a seminal investigation into the “mode of existence” of technology and its components, analyzing the layers of complexity, the evolutionary process of technics towards concrete technological ensembles, and the self-momentum of technicity itself. For Simondon, technics presents a unique evaluative problem.

Although the technical object is subject to genesis, it is difficult to define the genesis of each technical object, since the individuality of technical objects is modified throughout the course of this genesis; technical objects are not easily defined by attribution to a technical kind; it is easy to summarily distinguish kinds according to practical usage, as long as one accepts grasping the technical object according to its practical end; however, this is an illusory specificity, because no fixed structure corresponds to a definite usage. (Simondon 2017: 26)

Inspired by Simondon, theorist Bernard Stiegler proposes that in our originary state, human beings were bearers of tools, while in turn, these same tools made possible our own humanness. Innovation reflects our anticipatory thoughts, inspired and contoured by the memories of what is embedded in what we have already created (the stereotype). Stiegler (1998) asks,

...where is the memory of the stereotype kept, if not in the material trace of the stereotype in which the pre-existing tool itself consists, repeated, duplicated by its “maker” and guiding the latter much more than being guided by him or her? In this sense, the archaic cortex and equipment are codetermined in a structural coupling. (158 [italics in the original])

The epistemic formations that inspire ontological revelations are a process of ontogeny in which the *how* and the *what* are iteratively bound to the *who*. Stiegler writes,

If the individual is organic organized matter, then its relationship to its environment ... when it is a question of a *who*, is mediated by the organized but inorganic matter of the *organon*, the tool with its instructive role (its role *qua* instrument), the *what*. It is in this sense that the *what* invents the *who* just as much as it is invented by it ... the *who* and the

what are constituted as the *twin faces of the same phenomenon*. (177, 178 [italics in the original])

There is an indeterminacy in this relationship, which, according to Bruno Latour, is comprised of a multiplicity of associations. In Latour's model, the actions of an individual agent are a contingent effect of the actions of many other actors, all intruding upon, irritating, and affecting those around them. As with Simondon and Stiegler, even inanimate objects are actors with agency. As a result, what constitutes facts, conditions, or states arise from the interests or concerns of the multiplicity of associations. For Latour, the documentation and theorizing of these associations, their effects and realignments, are an "empirical metaphysics" (Latour 2005: 51). Associations are constantly being reconstituted as new assemblages that are similar and yet different. These raise fundamental questions about agency and identity. Biologist Donna Haraway proposes that categorical boundaries are increasingly being transgressed, reconfigured, and reconstituted. Specifically, the traditional categorical differences between animal and human, between organic and machine, and between the material and immaterial are being transgressed and dissolved (Haraway 1991: 151-153).

The theoretic foundations of ontogeny presume a fluidity between and among assemblages and their categories, agency, relations, and differences. We must acknowledge that, at any point in this confluence of possibilities, we only perceive what we think exists, constrained by our own epistemic limits. Nevertheless, this should not restrict us from speculating about that which we cannot see but which is conjecturally possible. The entanglement of epistemic and ontogenetic inquiries should complement, not exclude, the other.

Epistemological Antecedents

The material realization of early Cold War surveillance systems was preceded by a series of theoretical and material innovations and inventions around communication, perception, information, and computation. These antecedent discoveries enabled researchers to epistemologically envision an entirely different approach to surveillance. This section traces some of the more important transformative moments leading to a surveillant revolution.

Technical foreshortening of time and space: The military historian John Keegan (2003) points out that the capabilities of intelligence in the age before electricity were, at most, limited to distances of no more than one hundred miles simply because the speed of communication was restricted to what could be accomplished by human couriers (18). The invention of the telegraph, in the mid-1830's, radically foreshortened the perceptual dimensions of time and space in the act of communicating. As early as 1854, strategists in London and Paris were conducting remote battlefield assessments in the Crimean War. The success of telegraphy accelerated the development of newer technologies to extend and expedite the transmission of information in the form of wireless telegraphy, telephony, and radio. The extended effect of these capabilities was to relocate decision making from field to central authorities, which by World War I enabled the operationalization of remote command-and-control.

The extension of perception: As early as 1904, German engineers propagated radio waves that reflected off objects—in this case ships—where the returning reflection was detected as far as a mile away (Watson 2009: 29). By the 1920's, British and American engineers calculated the azimuth and elevation of flying objects by timing the difference between the transmission of a radio signal and its reception as a reflection (Brown 1999; Buderer 1996: 67). By 1934, U.S. Navy researchers demonstrated a similar technique they called radar (*R*adio *D*etection and *R*anging) (Allison 1981: 204). It was, for one German engineer, a means of "seeing with electromagnetic waves" (Hollmann 1936: 160). But how does a human being "see" microwaves? This is the challenge of technical representation. And, even when the otherwise invisible is made visible, there remains a problem in the interpretation of what is perceived—a process Foucault refers

to as “the gaze” (1973). As a result, a two-fold challenge must be overcome: a technical transformation and a social representation.

Perception as technical representation: The simplest transformation is nothing more than the conversion of microwaves to a frequency corresponding to the visible light spectrum detectable by human eyesight. The real challenge is how to interpret these previously invisible signals into something that is meaningful, i.e., data? For example, the signal must trace the difference of events over time using the amplitude of the trace to represent distance. This representation of microwave backscatter represents data in *one* dimension. By adding a second (and even a third and fourth) antenna in parallel, the angle of difference among antennas (measured as difference in time) could be used to triangulate the source of backscatter on X-Y coordinates, representing *two* dimensions. By adding yet another antenna just behind and slightly higher than the primary antennas, the difference in time between the fore and aft antennas could be used to approximate the elevation of an object in space—data in *three* dimensions.

Abstracting representations: Microwaves, like other natural vibrations, constitute analog waves. The challenge is that analog data is infinitely divisible and thus, lacks calculable precision. This infinite divisibility is also associated with signal drift and noise. If sensory input is to be precisely manipulated, it needs to correspond to a more discrete form of encoding such as whole integers, and as Gottfried Leibniz asserted in 1703, integers represented in binary form are “the simplest progression of all.” In signal engineering, binary representation also offers noise immunity under all but the most chaotic circumstances.

Digitalization of data: The advantage of representing the world in binary data becomes very clear when digital computers are employed to manipulate and calculate this data. In the mid-nineteenth century, George Boole developed a propositional calculus employing a binary logic. As a result, the representation of data and operators were simultaneously represented by binary values. In 1938, Claude Shannon demonstrated Boole’s logic (instructions) and binary data (values) could be mapped to “relay and switching circuits” configured to convey or inhibit electrical impulses representing binary values—0 (off) and 1 (on) (Shannon 1938: 471). He suggested that if a series of such circuits “are taken to represent propositions, we have the calculus of propositions in which variables are limited to the values 0 and 1” (474). At the same time, Alan Turing theorized how data could be processed in a finite function, referencing itself as the basis for further elaboration of itself. The model presumed a sequence of instructions (operations) and data (computable numbers) that were encoded on a linear tape that moved stepwise through a *universal machine*, applying the instructions to the data. The universality of this approach meant that a computing machine could be constructed wherever there is an intuitive computable function (Turing 1936: 249-254). As a transformative agent of logic and data, the computer becomes “another form of communications apparatus” (Wiener 1956: 265).

From sensor to computing machine: Researchers at a number of institutions, most notably the Massachusetts Institute of Technology (MIT), realized that between the movement of an enemy plane, the radar and a computer to calculate and control the hydraulic steering mechanism of anti-aircraft artillery—all of the components necessary for a closed-loop control system—were available to solve the problem of air defense (Mindell 2003: 260-275). However, in their enthusiasm to build a prototype, researchers failed to notice that pilots do not respond linearly to events, particularly when artillery shells are exploding around them, and they often alter speed, elevation, and direction.

Stochastic representations: Norbert Wiener and his colleagues at MIT proposed that systems capable of recalibrating their behaviors to achieve specific purposes presented a different kind of computational problem—a solution space comprised of future probabilities based on current states, noise, and uncertainty (Rosenblueth, Wiener, and Bigelow 1943; Wiener 1942). In 1949, Wiener summarized his wartime research by declaring that “we have made of communication engineering a statistical science”—a science

he called “cybernetics” (1949: 17). Key elements of this new ‘science’ included classified research on algorithms for locating patterns in non-continuous behavior. Wiener also proposed that the concept of entropy could explain the ways disorganized data might produce statistically meaningful information. As Orit Halpern (2015) puts it, “perception became a probabilistic channel whose capacities were variable and capable of being engineered, enhanced, and modified” (64).

The epistemological foundations at the beginning of the nineteenth century were contested visions of the ways human beings could know the world. Sensory data could only be understood by intuitive reason (Descartes), through the association or adjacency of ideas (Hume), or by the transcendental unity of apperception (Kant)—but it all depended on the crucial role of human sensations and judgment. By the middle of the twentieth century, the centrality of this human experience, with its sensations and appearances, was being displaced by the abstraction and flows of signals, data, and information, increasingly captured and processed by machines and exchanged among other machines, only to be translated into simulations for human consumption. These changes were largely epistemic in nature. But with the onset of the Cold War, the challenges would require a paradigmatic shift, not in *how* we know but in *what* we know—exploiting the difference between epistemological questions and those that are ontological.

Information as Surveillance

Surveillance is, as Foucault proffered, an epistemic practice. But, it is also an ontogenetic process, materially situated in time and space—as well as performative—an *episteme* that anticipates the contours of this ontogeny. In this section, I define some of the more important aspects of this ontology and how they are manifested in the instantiation of the specific system of surveillance called SAGE. The objective is to delineate the ways in which the epistemic discourse inter-penetrates an emergent ontogeny.

Cold War Noise

I theorized earlier that the foundation of a first philosophy must be identified as noise. From Greg Hainge (2013), I extend this by arguing that noise has the following properties: it resists order, persists within and about all material existence, co-exists with everything else as difference, and obsists as this difference resists structure. In relation to the subject of the self, noise has a multiplicity of affects. In the context of this study, I am particularly interested in the negative affects of these properties in the form of anxiety, fear, disorientation, dislocation, disturbance, and unresolved agonism. In other words, a form of noise consistent with its etymological roots in *nausea* or “seasickness.”

From 1929 until 1945, Americans endured successive waves of deprivation. By the end of World War II, Americans envisioned a better life without economic anxiety and the losses of war. As President Truman (1945) put it, “From this day we move forward. We move toward a new era of security at home [and]...a new and better world of cooperation, of peace, and international goodwill.” But beneath this hope, there was a residual noise that would not abate—the threat of annihilation by atomic weapons. That the United States had a monopoly on this weapon offered only modest assurance to a more generalized anxiety about security and safety.

This anxious anticipation was realized on August 29, 1949 when the Soviet Union detonated its first atomic bomb. The *New York Times* wrote: “the absolute dominance of the United States in atomic weapons had virtually ended” (Levier 1949: n.p.). The resulting public apprehension over the implications of atomic weapons was palpable. As one alarmed government official put it, citizens experiencing irrational fear “could well interfere with an important military mission in time of war” (Laurence 1948: 13). Though the government knew civil defense programs would never work *en masse*, their purpose was not about public safety but about dampening psychic noise and maintaining political unity (McEnaney 2000).

The significance of analyzing these vectors of noise is not to perform an autopsy on the anxiety or irrationality of the early Cold War. It is rather to point at just a few of the many chthonic distractions and interruptions that enveloped those who lived in this period. In these times, nothing seems closer to the truth than the beginning of the 1955 film, *It Came from Beneath the Sea*, “Since the coming of the atomic age, man’s knowledge has so increased that any upheaval of nature would not be beyond his belief.” Under these circumstances, noise is like a pathogen that deceptively lurks undetected. Only by watching-over can one be prepared for what might emerge from a field of noise.

Cold War Events

As defined in this paper, *events* are liminal—always potential, but not yet fully material. They are paradoxical in that they can be perceived but never grasped. Events flood a consciousness with signals overwhelming any sense of grounding or context. In that sense they are ephemeral and elusive. Without reflection or consideration, they seem incoherent and indifferentiable from noise. With moderate attentiveness, events can conjure up patterns like ripples in a stream but remain no more sustaining than when one tries to seize hold of it. In a similar way, Katherine Hayles (1999) writes of whether one can faithfully read (decode) a text, wherein “decoding implies that there is no original text ... There are only the flickering signifiers, whose transient patterns evoke and embody ... the context of no context” (47). Flickering signifiers represent the traces of instability, even incoherence.

For Americans in the late 1940’s and early 1950’s, the liminal edges at which flickering signifiers appeared without context emanated most often from radio and newspapers, providing daily testimony to the presence of global instability. Though different from noise because it lacks immediate presence in the reader’s experience, these signifiers nevertheless amplify and justify the underlying anxiety about the source of noise. Here we locate destabilizing events, such as the rapid emergence of Communist governments in Eastern Europe; insurgencies in Greece, India, Vietnam, China, Kashmir, Paraguay, Palestine, and Indonesia; and the disassembling of the French and British empires. At home, instability seemed pervasive. In 1946 alone, there were nearly 5,000 labor strikes against every major sector of the U.S. economy, involving more 4.6 million workers. In late 1947, anti-Communist hysteria led to investigations of subversion and treason. Perhaps the residual proxy for these flickering signifiers are revealed in sci-fi horror films unleashing prehistoric creatures (in black lagoons), overgrown spiders (tarantulas), irradiated insects (ants), and alien plant spores that snatch bodies.

The important question posed by events is not their materiality, historicity, or reality, but rather the affects that are instilled by a constant barrage of events. The cumulative affect includes disorientation, disturbance, and dislocation in ways that provoke anxiety, paranoia, and horror. In short, events are materializations of noise representing a contestation between what is real and unreal, known and unknown. As Jodi Dean (1998) puts it in considering this period,

Military legitimacy rested on a disavowal of the unknown. Truth referred to what could be established, identified, secured. That which was unidentified could not be true. It was outside the parameters of truth, dangerously threatening to a security ever dependent on a stable, predictable, containable real. (41)

Under these conditions, anxiety—be it invaders, traitors, or aliens—becomes manifest, so that while the subject may have been latently aware of noise, events make the elements of that noise visible. In the practice of surveillance, events make it possible to differentiate one event from another amidst a field of noise and of discerning which events are more significant than others.

Cold War Things—Borders

Ontologically, all ‘things,’ by definition, have boundaries that separate what is *within* a ‘thing’ from what is *without*, making it possible for a ‘thing’ to be a ‘thing’ in its difference—in other words, to manifest an identity. This line of distinction constitutes a border that has three inter-dependent consequences: it establishes for a thing the spatial limits of its interiority—the inside from the outside; it reinforces the definition of what or who belongs inside or outside; and every border delimits its porosity—the degree to which transgression is restricted or tolerated.

Borders are not immutable. Technology often alters not only boundaries but the rules that apply to these borders. Consider a technology which increases the speed by which something can traverse or circumnavigate a border, thus altering the quantitative and qualitative characteristics of a border by shortening its perimeter or increasing the vulnerability of the interior, etc. Technology can obviate the limits of borders by using previously undefined dimensions to pass over borders (e.g., satellites travelling beyond legally-defined national airspace). It can nullify the rules that apply to passing through borders (e.g., telephony penetrates the boundaries between public and private). And technology can be used to reassert those boundaries, limits, and rules (e.g., firewalls to protect digital territories). By altering the relations between time and space, technics reshapes spatial relations, including borders.

At the end of World War II, the continental United States was effectively an island—its east and west borders were bounded by large oceans. Its northern border, Canada, was vast and seemingly untraversable. American confidence in these amorphous boundaries was exemplified by the fact that the U.S. had only five radars for air defense (del Papa and Warner 1987). However, when confronted by a successful Soviet test of an atomic bomb, the U.S. government made an about-face and funded the construction of an additional forty-four new radar stations in late 1949. That this was a public relations stunt was clear from the deployment of these radars in northeastern and northwestern states, with a detection range that offered only a 20-30-minute warning of imminent attack. (U.S. Army 2009). The vast northern border extending from the Arctic was not addressed.

In 1950, the Soviet Union began deploying the Ilyushin-28 bomber, a plane capable of flying more than 470 miles per hour or 35% faster than the older Tu-4 bomber. Though the Il-28 was incapable of making a round-trip from Murmansk to New York, the United States reacted to the potential threat by authorizing the development of thirty-nine radars across the continental expanse of the U.S.-Canadian border in 1951—the Pinetree Line. Strategists, though, quickly discovered that data from this system was noisy (filled with interfering clutter) and offered insufficient time to react to incoming threats (Winkler 1997).

As a result, American planners projected a more extensive border beyond the Arctic Circle. This system, known as the Distant Early Warning (DEW) Line, running from Greenland to the Bering Straits, was comprised of sixty-three radars capable of detecting objects at distances of 160 miles. (Schaffel 1991: 213-216). DEW went operational in April 1957. The technical and ontological effect was the establishment of a new virtual territory with northern borders 1500-2000 miles beyond the continental United States. The amorphous zones of influence expanded beyond issues of national sovereignty into vast regions of surveillant concern.

Things—Metastability, Assemblages, Machines, and Networks

In this virtual border, comprised of an electromagnetic signal (a kind of event) reflected (another kind of event) from an object and detected and converted into a datum (two other kinds of events), are a set of flows or processes. As described earlier, unassembled flows of data have little value. Only when data is aggregated and algorithmically transformed into information is it possible for these events to be transformed into knowledge. Given the numbers of events occurring simultaneously across such an enormous field, much of which is noise (meaningless signals), the importance of quickly detecting, discriminating, identifying, and tracking successive flows of events is imperative. Yet there were no

competent technologies to accomplish these tasks. This moment exemplifies the problem which arises when incommensurate ontological structures intersect inadequate epistemological presumptions.

In 1950, the materialization of this intersection was problematic. Radars were too few and limited in their detection range and there was no computing technology adequate to the task of processing large volumes of real-time data. There was no online data storage for buffering large data sets. Transmitting data from one computing device to another had not been developed and the technology of software programming had yet to be invented. And finally, the interface between human beings and computers consisted of nothing more than paper printouts and the traces of oscilloscopes. As a result, the flows of signals circling the earth remained largely unexposed.

With the advent of a Soviet nuclear threat, scientists and strategists began to understand that the gap between ‘seeing’ these signals (as events) and determining which represented threats (as actionable information) was a crucial problem they were uncertain about how to solve. Researchers already possessed the theoretical foundation for thinking of air defense as a problem of information—the epistemological problem. What they lacked was a framework for the materialization of this problem in the form of technical surveillance—which proved to be an ontological challenge.

MIT physicist George Valley proved instrumental in aligning the interests and visions of multiple parties to realize just such a framework and its technologies. A former member of MIT’s laboratory for developing radar for bombing missions, Valley was acutely aware of the problem of air defense. In pursuit of a solution, he visited military bases, met with engineers at various private companies, and investigated current research and development programs at universities and military laboratories. In November 1949, Valley requested a formal investigation into the problem of automated air defense. A month later, authorization was granted to establish an Air Defense Systems Engineering Committee (ADSEC), with Valley as its chairman. Valley became a principal agent of the ensuing assemblage.

In January 1950, Valley had two inadvertent encounters which defined the future of the American technical strategy. The first encounter was learning of the Air Force’s Cambridge Research Laboratory invention of a modulation-demodulation technology (modem) enabling digital devices to communicate over analog telephone lines (Harrington 1983). Thus, data captured at disparate and distributed points could be aggregated at a central computing center so that raw data could be processed into information.

The second encounter was the discovery of a highly classified project at the Servomechanisms Laboratory, located only a few hundred meters from Valley’s own office at MIT. Originally funded by the Navy, this project was developing a real-time computerized flight simulator. The computer, known as Whirlwind, was unique among projects at the time because it was digital, solved calculations in real-time, utilized stored programs, manipulated data in parallel, and synchronized all of its internal operations by a clock. With the war over, the Navy was no longer interested in continuing to fund this project (Redmond and Smith 1980). Valley saw an opportunity for the Air Force to absorb the project into air defense.

At the time, Whirlwind still had limited primary storage (memory), no external on-line storage, no programming protocols, employed oscilloscopes for displays, and no networking capabilities. Nevertheless, at Valley’s urging, and following a successful field test in April 1951, the Air Force decided to move forward with a research and development initiative, contracting with IBM to manufacture the final computer system. Within three years, the project had matured to the point that the Air Force was comfortable upgrading the R&D project to implementation status as the Semi-Automatic Ground Environment (SAGE).

One of the principal obstacles SAGE developers encountered in developing a real-time system was performance. Not only did Whirlwind have to quickly process large streams of data from radars but it also

needed to coordinate this data with other data sets on civilian flights, weather conditions, and availability of air defense reaction forces. This kind of processing required fast internal memory to store and retrieve data. Whirlwind had been designed with vacuum tubes, but for high-performance calculations this mechanism was simply too slow. SAGE engineers invented a new technology combining the electromagnetic properties of ferrite rings interlaced by metal wire, the phenomenon of hysteresis, and the design of a logic matrix that corresponded to addresses and binary data values (on/off) (Redmond and Smith 1980: 181-185). The first installation of core memory was tested in August 1953.

The second major problem for converting data into information is the ability to quickly synchronize data so that all events are evaluated equitemporally and normalized for errors. Data from different sources also need to be synchronized. These operations require the application of algorithms that can be implemented with the electronic logic of a computer—what today we call software. In the early 1950's, there was no such thing as software, no professional programmers, no programming language, and no standards. These functions had to be constructed in the absence of any model. In 1955, the RAND Corporation sponsored the organization of the System Development Corporation (SDC)—the world's first software firm. SDC became responsible for most of the development of SAGE applications, and over three years they “wrote the 7,000 pages of plain English instructions which reduced to a thousand pages of mathematical formula and translated to 3,000,000 punch cards” (Baum 1981: 25; cf. U.S.A.F. 1961). In the mid-1950's, SDC accounted for 85% of all programmers in the world.

The final assemblage of SAGE entailed constructing thirty-two “bomb-hardened” facilities around the United States. Each center had two redundant massive computers (AN/FSQ-7), each weighing more than 250 tons, using 60,000 vacuum tubes, and processing 75,000 instructions per second (Redmond and Smith 2000). Attached to each system were: 1) an arithmetic unit that performed calculations; 2) four high-speed core memories; 3) a processing control executive to direct all operations; and 4) an input-output controller to coordinate the flow of data to/from auxiliary devices (IBM 1959: §3.2.3.2). Each center was designed to concurrently track up to four hundred enemy aircraft and automatically direct their interception by fighters or BOMARC missiles. This assemblage of hardware and software enabled the collection, distribution, identification, discrimination, sorting, and tracking of data that started as radio signals on a distant border and was transformed into actionable information (knowledge).

Transcorporeality

The challenge of building the AN/FSQ-7 computer was hardly the only significant problem facing the SAGE team. The radars and computers needed to be integrated with the human beings for whom the system was built. Thus, technology needed to be invented to connect disparate components, provide for the temporary storage of excess data, and facilitate an intuitive means for humans to read and understand the output of information from the computer. In short, human beings and technology needed to be jointly embedded as components within technical systems as part of larger military missions.

The major challenge for engineers was the development of auxiliary devices—none of which existed at the time the SAGE project was initiated. First, raw data from surveillance radars needed to be correlated with range and azimuth, identified as friend or foe, buffered for transmission, and demodulated for transmission across telephony networks. This phase was productized as the AN/FST-2, built by Burroughs Corp (see Ogletree et al. 1957). Second, on-line storage units were required to temporarily hold the overflow of data from primary core memory, buffer data arriving asynchronously from AN/FST-2s and forward to adjacent combat centers (networking), as well as serving as repositories for SAGE software. These units, invented by IBM, were “magnetic drums” storing 405,504 bits of data (IBM 1957). Third, video display devices were necessary to translate machine data into a format consistent with a user's way of thinking about the world as they knew it. As the documentation for these devices put it, “the prime purpose of air defense is to provide flight-path instructions for interceptor air weapons. To accomplish this effectively, a clear picture of the compiled information must be available to personnel who are able to act

upon this data in directing retaliatory air defense” (IBM 1958: §1.1). Fourth, the development of a point-and-click device, known as light-gun, was needed to let users interact with simulated events appearing on the display unit. Fifth, all of this technology needed to be integrated at MIT’s laboratory spun off to manage SAGE, called the Lincoln Laboratory, jointly managed with the U.S. Air Force.

Managing the flow of data and its analytic reassembly into information was the task of a large set of software subroutines. The principle guiding their development was that no subroutine was to be larger than what a single programmer (or a small “closely knit group of programmers”) could feasibly and reliably accomplish. The division of labor corresponded to information flows (analysts), structures (programming analysts), and outputs (programmers). As a result, the technical constraints of building and operating the system were, in the end, epistemic constraints (Sackman 1967: 143-144).

The integration of human beings and machines was a crucial objective of the SAGE undertaking. Throughout its development, the SAGE system was guided by input from behavioral psychologists and human factors engineers at SDC. It was their responsibility to map the engineering requirements of SAGE to the limits of human capabilities. At the same time, the objective of the SAGE engineers was to amplify those same capabilities beyond their limitations through technology. Meeting these objectives included the analysis of four “human command functions”: intelligence buildup, threat evaluation, warning implementation, and weapons allocation (Sackman 1967: 125). The regimentation of air defense labor was necessitated by the structure of the technical systems in which they were embedded and to displace more and more of that labor with automaticity.

The integration between human beings and this assemblage of machines was ultimately achieved through a transcorporeal simulation, in which machine and human each treated the flows of data as real. Radar data came into the AN/FSQ-7 in near real-time but was synchronized with other data by the cycles of ‘SAGE time’ to create a unified ‘reality.’ In fact, these flows were algorithmically reassembled events, reconstructed in software, which SAGE officers watched and acted upon as if they were direct representations of real space and time. With SAGE, air defense space was decoded and deterritorialized into virtual space, only to be reterritorialized in the heuristics of combat and the projection of kinetic force, constructing “the double logic of remediation,” which seeks “both to multiply its media and to erase all traces of mediation: ideally, it wants to erase its media in the very act of multiplying them” (Bolter and Grusin 2000: 5).

Implications and Conclusions

In June 1958, the first SAGE installation went live at McGuire AFB in New Jersey, followed by the construction of 22 more direction centers. In the end, SAGE was built for a direct cost of \$60 billion and another \$20-30 billion in indirect costs (all in 2016 dollars). However, SAGE, as an air defense system, was already anachronistic. A year earlier, the Soviet Union launched an intercontinental ballistic missile (ICBM) with the Sputnik aboard. SAGE and its radars were never designed to detect an ICBM.

Nevertheless, the underlying technology and processes, as well as the first proof of the value of real-time data analysis, was established in several important ways. It justified the distribution of remote sensors and their networked connection to real-time computers, the conversion of the analog signals from those sensors into digital data, the integration and synchronization of this data with third party sources, and its automated interpretation (simulation) into actionable information. SAGE may have been thought of, in its time, as an air defense system, but its legacy was a model for large-scale surveillance.

One of the first successors to SAGE came in Vietnam. ‘The fog of war’ demonstrated that asymmetric wars could be fought if one side had the elements of deception and surprise, while the other side lacked the information to detect the magnitude of this imbalance. Frustrated with the ability of North Vietnam to

resupply the irregular forces in the south, Secretary of Defense Robert McNamara proposed the construction of a physical and virtual border around the northern perimeter of South Vietnam to interdict North Vietnamese Army troops and supplies on the Ho Chi Minh Trail. This part of the strategy came to be known as Operation IGLOO WHITE, which mimicked the architecture of the SAGE system.

Instead of radars, the U.S. Air Force air-dropped over 20,000 sensors to detect sound, heat, vibrations, or uric acid along key segments of the trail. When these sensors detected something, a short radio alert was sent to observation planes circling above target zones. These signals were automatically relayed to the Infiltration Surveillance Center (ISC) at Nakhon Phanom, Thailand, a facility modeled on a SAGE air defense center. A combat direction team triaged this data and directed air strikes against suspected targets at the sensor's location (Bergen 1986; Correll 2004; Gaitlin 1968). Whereas SAGE was an airspace surveillance system, IGLOO WHITE was ground-based surveillance, enabling what political and military leaders were to publicly acknowledge three years later, as the first example of an "electronic battlefield" (U.S. Senate 1971).

In its contemporary form, mass surveillance systems intercept microwave, cell phone, satellite, fiber optic communications, and Internet traffic, aggregating this data into massive data warehouses. This data is then "mined" to identify even the least obvious connections and anomalies to find patterns that match to a threat taxonomy. Much of this contemporary capability was designed by the same organization originally created to build SAGE—MIT's Lincoln Lab. (National Security Agency 2007: slide 3). As a result, air and ground space are subsumed into a virtual space.

An archaeological examination of what is known about these systems illustrates an evolutionary path that can be traced back to what might be described as a "Cambrian explosion of diversity" arising from SAGE. The technical genesis is one of continuous innovation and adaptation. Technically-mediated surveillance is now deeply embedded in the daily practices of consumers and citizens. The discourse of this surveillance is no longer an anomaly and ontologically pre-figures the ways we performatively encounter the world. But, what the history of SAGE suggests is that the boundaries of this mediation are circumscribed by the technology itself—by what it is designed to accomplish, as well as by its epistemic limitations. It is bounded by noise, reacting to putative events, presuming to discriminate known from unknown, imputing the intentions of the unknown, and delivering what is referred to in the trade as 'actionable intelligence.' In short, what we find is a technology iteratively seeking certainty from a flow of possibilities originating out of a field of noise.

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