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Geometry of empire: radar as logistical medium

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GEOMETRY OF EMPIRE: RADAR AS LOGISTICAL MEDIUM

by

Judd Ammon Case

<u>An Abstract</u>

Of a thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Communication Studies in the Graduate College of The University of Iowa

May 2010

Thesis Supervisor: Professor John Durham Peters

This study introduces *logistical media* and considers one example of such—radar. Innis (1972; 1951), Mumford (1970; 1934), Carey (1988), Virilio (1997; 1989; 1986) and others are discussed as preparing an understanding of logistical media as subtle but powerful devices of cognitive, social, and political coordination that affect our experience of time and space. Radar is presented as significant because of its progressive-catastrophic potential. Radar was invented for national defense and to remotely survey the earth and its atmosphere, but it also allows new collisions with "others."

American radar was primarily developed at the Radiation Laboratory at MIT during the 1940s. Historical objects, principally from the MIT Radiation Laboratory Historian's Office, are arranged and discussed according to Walter Benjamin's (1999) historical method. Benjamin theorized that historical debris can be arranged as a *dialectical image* or constellation that can momentarily disrupt our sense of chronological progress and denaturalize ideology. Benjamin described this disruption as the interruption of the *present* with the *now.*

Radar is considered in terms of *authoritarian modernity*, and as contributing to a politics of distance, speed, angle, movement, and perception. Objects from radar history are marshaled to illuminate radar's pre-history, its use of feedback to identify and coordinate objects, and its susceptibility to error and disruption. *Present* understandings of the 9/11 attacks are challenged by the *now* of these objects, and an understanding of logistical media is furthered.

Abstract Approved: ______________________________________

Thesis Supervisor

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Title and Department

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Date

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Graduate College
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CERTIFICATE OF APPROVAL

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PH.D. THESIS

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This is to certify that the Ph.D. thesis of

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has been approved by the Examining Committee for the thesis requirement for the Doctor of Philosophy degree in Communication Studies at the May 2010 graduation.

Thesis Committee: ____
John Peters, Thesis Supervisor

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Kembrew McLeod

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Christopher Merrill

For Joanne and Gabriel

It was thus natural to consider radar as a branch of communication theory.
--Norbert Wiener, *Human Use of Human Beings*

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CHAPTER 1: GEOMETRY OF EMPIRE

As far as I know, this project is the first sustained treatment of *logistical media*. Logistical media mimic the communicative cosmos. They intrude, almost imperceptibly, on our experiences of space and time, even as they represent them. They are devices of cognitive, social, and political coordination that are so fundamentally communications media that they intersect and envelop much of our lives without our conscious awareness. Lighthouses, clocks, global positioning systems, temples, maps, calendars, telescopes, and highways are just a few of them. In modern terms logistical media are at once bureaucratic and militaristic. They intersect issues of social organization, power, and economics. My tidy description of logistical media is this: *logistical media are media of orientation. They have to do with order and arrangement first, and representation second, if at all.*

This study will reveal the critical and historical impact of radar as a logistical medium, as a technological architecture that was developed for national defense and to remotely survey the earth and its atmosphere, but that also contributes to the endocolonization of the “masses” and controls their collisions with “others.” Principally I am interested in how historical objects, including those from MIT’s Radiation Laboratory in the 1940s, inform what Walter Benjamin (1999) theorized as the *now*, in how their arrangement as a dialectical image or constellation can momentarily disrupt our sense of chronological progress and denaturalize ideology. In its simplest form radar is an application of electromagnetic waves for purposes of communication, a fact not lost on early information and transmission model of communication theorists, or on thinkers like Harold Innis and Marshall McLuhan. But even as it was intended to expand and secure the nation state, to coordinate first military and later civilian movements, and to function as an electronic rampart, it contained the potential for catastrophe. This study will explore radio detection's catastrophic potential and its implications for understanding the more conventional media practices of television and radio broadcasting. Our trip through radar history will have us thinking about TV screens, audiences, 24-hour news networks, and situation rooms (including those of the CNN variety) in new ways.

Various scholars have paved the way for my efforts. Harold Innis' (1951, 1972) opaque and contradictory understandings of the bias of communication and political power have a logistical air to them; he was preoccupied with the ways media arrange bodies in space and time. He wrote that because of modern forms of communication, "the balance between time and space has been seriously disturbed with disastrous consequences to Western civilization" (1951, p. 76). James Carey (1988) discussed how, "with the development of the railroad, steam power, the telegraph and cable, a coherent empire emerged based on a coherent system of communication" (p. 212-213). Paul Virilio (1989) wrote of the *logistics of perception* that the movie camera brought to World War I, of the ways generals thereafter observed battlefields remotely. Lewis Mumford (1964) described how *authoritarian technics*—things like air traffic control systems, interstate highways, and camera networks—endanger nation states even as they are supposed to keep them in synch. More recently, Kevin Robins and Frank

Webster (1999) argued that the scientific management of society has overlapping economic and military implications. When it comes to logistical media, plenty of salvos have been launched; but, like the Scud missiles of Gulf War 1.0, few ever hit their intended targets. This is my attempt to do just that, and to do so with an eye for moments in radar history.

My first two chapters deal with methodological and theoretical issues, and are probably too far beyond the horizon or interest of anyone but highly specialized communications historians and theorists. In *Dialectical Image* I argue for the validity of a Benjaminian approach to radar history, for the disruptive power of debris on the historical landscape and the value of challenging the *present* with the *now*. I wrestle with Benjamin's famous dialectics at a standstill, French Surrealism, psychoanalysis, the idea of the "state of emergency," and modernity itself as a progressive-catastrophic dialectic. In *Authoritarian Modernity* I elaborate my understanding of modernity in order to prepare an analysis of radar's historical objects. Together, the two chapters function as a literature review, but also as an argument for the relevance of the historical chapters that follow. They are both collections and dispersals of information that gesture to the radar display; information appears, disappears, and reappears.

Remote Control, Antenna Architecture, and *Measure* all delve into my MIT research, and are proper historical efforts, albeit in a Benjaminian sense. In addition to the MIT objects, I gather an assortment of other artifacts: magazine and newspaper clippings, comic books, cold war TV shows, musings of radar historians, and the like, and I martial these in the spirit of the *now*. Their relevance to the *present*, and specifically to our post-9/11, post-Katrina, War on Terror, and pre-apocalypse world is explored. *Remote Control* gives us glimpses of radar's connections to the torpedo, radio, death ray, remote control, and World War II strategies of identification and coordination. It positions both the radar reader (the formal name for those who interpret radar screens and gauges) and the "other" in militarized, and even ballistic, terms. *Antenna Architecture* considers how information pours through radar antennas and the platforms that rotate them, and introduces *ground control*, one of radar's primary forms of remote control. *Measure* traces the flow of radar information through the master receiver, forms of display, and radar readers' construction of ground control. *Countermeasure* summarizes the main points from previous chapters before presenting case studies in the disruption of radar logistics: fragments from World War II and the 9/11 attacks.

The following research questions receive extensive treatment and are central to understanding the importance of radar as logistical medium. They are addressed through the arrangement of, and tensions between, historical objects, and guide the disruption of the *present* with the *now*: 1) How does radar inform an understanding of logistical communication? 2) How is radar a feedback system (a form of information system that allows control through adjustments) and a form of remote control? 3) How do radar and radar readers create and maintain remote control? 4) How might radar be manipulated by its objects? Many contributing issues are discussed as these questions are answered—they will give my discussion contour and texture—but these four blips are always on my radar screen. They are my identified objects.

The remainder of this chapter elaborates on what I mean by *logistics.* It also explains radar as a concept, its development and functioning, and some of its earliest forms of display. I think of it more as an effort at estrangement than introduction; I want this most mundane of technologies to seem odd, bewildering, and uncanny. I suspect that it will be peculiar for communications scholars in particular, as I draw on natural science and religious myth in addition to the usual humanities and social science approaches. Today, natural science and religious myth inhabit disparate cultural spaces, but both are fountainheads of logistics.

Innis (1792; 1951) and Carey (1988) underpin my discussion of religious myth. Innis' work on astronomy, the movements of the Nile, and the beginnings of a powerful priestly caste in ancient Egypt is deeply logistical. So too is Carey's (1988) assertion that religious thought "not only described communication; it also presented a model for the appropriate uses of language, the permissible forms of human contact, the ends communications should serve, the motives it should manifest. It taught what it meant to display" (p. 31).

My appeal to the natural sciences is inspired by John Peters (2003). Peters argued that:

> Communication theory has most typically drawn upon the humanities and the social sciences, with occasional forays into the natural sciences (mostly in the hunt for metaphors), but the natural sciences, medicine, and engineering are full of considerations of time, space, signals, distance, contact—central concerns and topics of communication theory. (p. 398-399)

Peters has an accurate lay of the land here. But my sorties into natural science go beyond the bounds of theory. I hope to lay a tentative groundwork for a useful coupling of physics, historical objects, and critical theory, a groundwork that can help us understand a politics of cosmos and logos. I now initiate that by discussing radar in terms of the Big Bang, an event of utmost significance for considerations of time, space, signals, distance, and contact.

The Big Bang

Electromagnetic waves—radar's channels, if you will— are central to the Big Bang explanation of the origin of the universe. We could think of them anthropomorphically as "light waves" or just as "light," but if we do this we need to keep in mind that we are considering light that goes far beyond the visible spectrum, light that is moving, and light that can be packed more loosely or tightly into measured space (Hobson, 2007).[1] Big Bang theory, which is supported by almost all scientists and which I find compelling, is established by the existence of the *Doppler effect, red shift,* and *cosmic microwave background radiation* (CMB) (Levin, 2007). These phenomena confirm that the universe is expanding and that it has structure. They are foundational for radar in a scientific sense. A police officer who zaps speeding motorists relies on the Doppler effect, the same effect Vesto Slipher observed when he noted that nebulae were moving away from the earth (Slipher, 1913). Slipher's discovery allowed for an archaeological dating of the universe.

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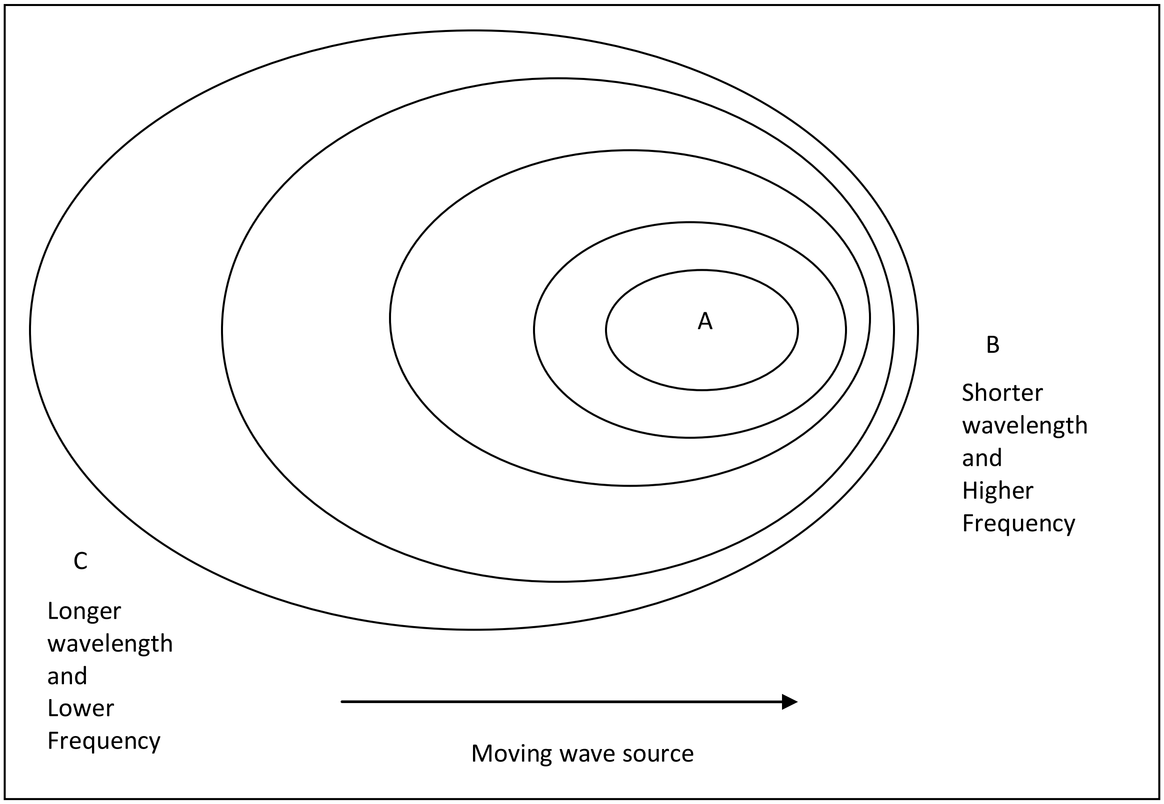
[1] Moreover, in that light has both wave and particle aspects, I am neglecting the importance of its particle (or photon) properties.

[2] Examples of phase transition are changes from a gas to a liquid and from a liquid to a solid. These changes reflect a difference of energy, of the speed, density, and distribution of a substance's particles. In too simple terms, the original universal singularity (which had no particles and simply was a thermally dense expansion) developed spots of lesser density as it grew, and these spots eventually became

The Doppler effect can be observed in waves of many kinds—electromagnetic, sonic, and oceanic. If you've ever noticed that when an ambulance approached you the pitch of its siren was high, but that after it drove by the pitch was low, you've observed the Doppler effect. Figure 1.1 illustrates how it works.

Figure 1.1: The Doppler Effect



If "A" is the ambulance siren, the wave source, and it is moving toward you at position "B," the waves are more frequent and shorter, and since we are dealing with sound waves, the pitch you would hear would be higher (and the amplitude, or intensity, would increase). If you are at point "C," the wave source is moving away from you and so the sound waves are less frequent and longer, and the pitch is lower (and the amplitude would decrease). When it comes to a cop with a radar gun (or speed camera), her gun, which can be either at a standstill or moving along in the car, projects electromagnetic waves at your vehicle, receives those that bounce back, measures their length and frequency, and calculates your speed. In the case of a fixed, unmoving radar gun, the cop would read how many mph you were traveling, a conversion of waves-per-meter into miles-per-hour. If both you and the cop were moving, she would see how many miles per hour faster or slower than her vehicle your vehicle was going, and then could look at her own speedometer to decide whether or not to give you a ticket (unless she had a sophisticated radar system which automatically calculated both). When it comes to the universe, this same observation tells scientists whether light waves are approaching or receding from the earth and allows them to approximate from whence they originated. This observation tells scientists that the universe is expanding and radar readers that objects are moving toward or away from their speed cameras.

Red shift is closely related to the Doppler effect. It is the phenomenon that as electromagnetic waves become more distant from an observer (from any observer anywhere) they get longer, less frequent, and redder (although the redness can, of course, undershoot that of light visible to the unaided human eye) (Dodelson, 2003). Conversely, as electromagnetic waves approach an observer they get shorter, more frequent, and bluer (they experience a *blue shift*, or rather, we do in our perception of them). So red shift helps scientists use the Doppler effect to measure the trajectory (or direction) of light waves. The light from Polaris, the North Star, which is much more distant than the light from our own sun, is, to those of us on the earth, much redder than it would be if we were approaching it. If we could travel toward Polaris and away from our sun, Polaris' electromagnetic waves would become shorter, more frequent, and bluer, and those of our sun would become longer, less frequent, and redder. The measurement of trajectory enables radar's logistical functions of detection, identification and coordination (I say more about these later).

Cosmic microwave background (CMB) radiation is at the core of Big Bang theory, and it suggests the origin of some concepts important to understanding radar. In the beginning, you have a singular density and temperature in finite time. Whether this singularity could be God, matter, consciousness, or Halliburton, or whether that singularity was caused by any of those things, or something else, is anybody's guess. Scientists admit that they have to extrapolate back to this point, some 13.7 billion years ago, but they're sure that what they find there is hot (thermally energetic), dense, and expanding. As this singularity expanded it cooled and went through an abrupt phase transition, and thereafter you have a universe that sustains communication—subatomic particles moving at relative speeds—what Einstein would eventually describe in his Special Theory of Relativity (Hobson, 2007).[2] One can also now talk about *transmission, information* and *feedback* and can conceptualize such things as *senders* and *receivers,*

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[2] Examples of phase transition are changes from a gas to a liquid and from a liquid to a solid. These changes reflect a difference of energy, of the speed, density, and distribution of a substance's particles. In too simple terms, the original universal singularity (which had no particles and simply was a thermally dense expansion) developed spots of lesser density as it grew, and these spots eventually became subatomic—and informative—particles. In terms of energy, the universe went from being more like a gas to being more like a liquid. In a later phase transition it also went from being exclusively thermal to having radioactive energy (energy not bound to matter). These phase transitions constitute the big bang.

phenomena that are featured in the information model of communication and are useful for discussing radar systems (Shannon & Weaver, 1949; Wiener, 1961/1948).

As the universe continued to expand it cooled, and particles that might have been discussed in a physics class abounded: quarks and gluons, then a little later, protons, antiprotons, neutrons, and antineutrons. When the universe cooled sufficiently, some protons and neutrons began moving slowly enough to take hold of each other and formed deuterium and helium. 380,000 years after that, hydrogen formed. The formation of these elements separated electromagnetic waves from matter, and that separation instituted the radiation of space. This radiation is CMB, is the residue of the earliest instance of electromagnetic waves that can be *received* by a radar system. If we think of the universe as a cosmos, as an orderly and informative system, CMB is always and everywhere part of its *message.* As the universe expands, CMB expands and its most distant waves appear redder and redder to an observer on earth. In the cosmos, there is no transmission without noise.

The King's Postal Service

Admittedly, radar is not only scientific, is not only waves, transmissions, and Doppler effects. My reading of Innis (1972) suggests that radar is also rooted in religious, governmental, and military logistics. Innis describes the priests of Osiris and Ra, the kings and royalty, and "military nobility" in logistical terms (p. 41). Throughout his discussion of Egypt, these three—*religion, government, and the military*—undulated with power derived from the Nile. As Innis relates:

> The Nile, with its irregularities of overflow, demanded a coordination of effort. The river created the black land which could only be exploited with a universally accepted discipline and a common goodwill of the inhabitants. The Nile acted as a principle of order and centralization, necessitated collective work, created solidarity, imposed organizations on the people, and cemented them in a society. In turn, the Nile was the work of the Sun, the supreme author of the universe. Ra—the Sun—the demiurge was the founder of all order human and divine, the creator of gods themselves. Its power was reflected in an absolute monarch to whom everything was subordinated. It has been suggested that such power followed the growth of astronomical knowledge by which the floods of the Nile could be predicted…. (p. 32)

Hearkening to the Nile’s movements, religion, government, and the military cultivated an Egyptian mythos as surely as peasants cultivated its flood plain. Innis wrote that, “The demands of the Nile required unified control and ability to predict the time at which it overflowed its banks,” and religion, government, and the military inscribed themselves in those demands (p. 44). Soldiers oversaw the ordering of resources and arranging of people in the construction of pyramids that projected the power of the Nile’s kings and priests over time and space. Astronomer priests created a calendar that “became a source of royal authority” through synchronizing religious festivals and the Nile’s movements (p. 32). With the advent of papyrus kings’ holy messengers were transformed into a divine, private postal service.

As taken as I am with Innis’ narrative, I am not suggesting that radar is the progeny of the Egyptians’ divine postal service. Radar transmissions are not embodied messengers and do not possess a holy mandate. Radar stations measure movement and order, but are not equivalent to shrines to Thoth (an Egyptian god to whom Innis attributes rules of conduct). Moreover, modern nation states do not usually blend religious, governmental, and military authority as frequently or directly as did ancient

Egypt. Today, the Potomac River initiates orderings of time and space that aren't altogether different from Innis' Nile logistics: port procedures, fishing seasons, contracts for water use, watercraft speed limits, farm runoff regulations, minimum bridge heights, riverboat casino licensing, and dumping statutes shape the movements of people near the Potomac. Still, no one thinks officers of the Coast Guard, Fish and Wildlife Service, or EPA bear missives from the mighty god of the mid-Atlantic.

Nonetheless, the mythos of the pharaohs' divine postal service continues to shine, Ra-like, through the founders of all order in our day. In that sense, it informs an understanding of radar. Conflicts such as those between Israel and Palestine and between Tibet and China mingle religious, governmental, and military logistics. Addresses in Salt Lake City pinpoint the distance to the Mormon temple and its battlements. 9/11 hijackers pointed at Mecca before they pointed at the World Trade Center, Pentagon, and Pennsylvania field.[3] Even today, the religious, governmental, and military cultivation of mythos occasionally resembles Innis' (1972) descriptions of ancient Egypt and Babylon.

In his biography of Innis, Alexander John Watson writes that consistencies between ancient civilizations and the contemporary U.S. were exactly what Innis had in mind when he wrote *Empire and Communications*. According to Watson, *Empire and Communications* was "the foundation on which [Innis] built his understanding of the contemporary world, in particular his view of the United States of America, its foreign

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[3] The *9/11 Commission Report* concludes that, "Usama Bin Ladin and other Islamist terrorist leaders draw on a long tradition of extreme intolerance within one stream of Islam (a minority tradition)….*That stream is motivated by religion and does not distinguish politics from religion*…." (p. 362, emphasis mine).

policy, and its effects on other cultures" (Watson, 2007, p. 18). Innis, a Canadian, paralleled the ways papyrus changed the politics of ancient Egypt with the ways the newspaper changed the politics of the United States, Canada, and Europe. He traced the relationship between the natural—the Nile and Canadian trees—and the mythical and logistical—the kings' holy papyrus carriers and American paper boys.

In this study, historical objects from MIT's Radiation Laboratory Historian's Office lead to an Innis-like mixture of the ancient and the contemporary, of religious, governmental, and military logistics. Some of the objects that anticipate radar—such as lighthouses—have significant religious logistics. Others, like Nikola Tesla's death ray, are wrapped in a mythos of military power and quasi-religious utopianism. 9/11 has elements of all three, and helps me draw conclusions about both radar and logistics in a general way. With these in hand, I now integrate my preceding discussions of the Big Bang and Innis into a discussion of the intersection of science, religion and radar logistics.

Let There Be Light and Logistics

Electromagnetic waves recur in some mythic explanations of the origin of the universe, and can help us think about how deeply aspects of logistics and radar are rooted in the Western mythos. Genesis 1:3 says that "And God said, Let there be light: and there was light," and then posits a foundational digitalization, "and God divided the light from the darkness."[4] The Qur'an has a passage that reads like a description of the Oscillatory Universe, a scientific model that argues that the universe perpetually alternates between expansions and contractions. The New Testament has a passage that could be consistent with the Big Crunch, with the universe ending in a multi-billion year collapse into itself.[5] Perhaps most importantly, the Old Testament notion of the firmament puts the earth at the center of the universe and divides the observable from the unobservable:

> And God said, Let there be a firmament in the midst of the waters, and let it divide the waters from the waters. And God made the firmament, and divided the waters which were under the firmament from the waters which were above the firmament: and it was so. And God called the firmament Heaven. (Genesis 1:6-8)

For the ancient Hebrews, the firmament, or heaven, was a boundary beyond which they could not see. It was a perimeter, an absolute and fixed range (not an ever expanding universe), and it was established with them at the symbolic and logistical center.[6]

There is something of both firmament logic, of the sky as something that can be mapped, and modern science in many radar systems, something that technologically

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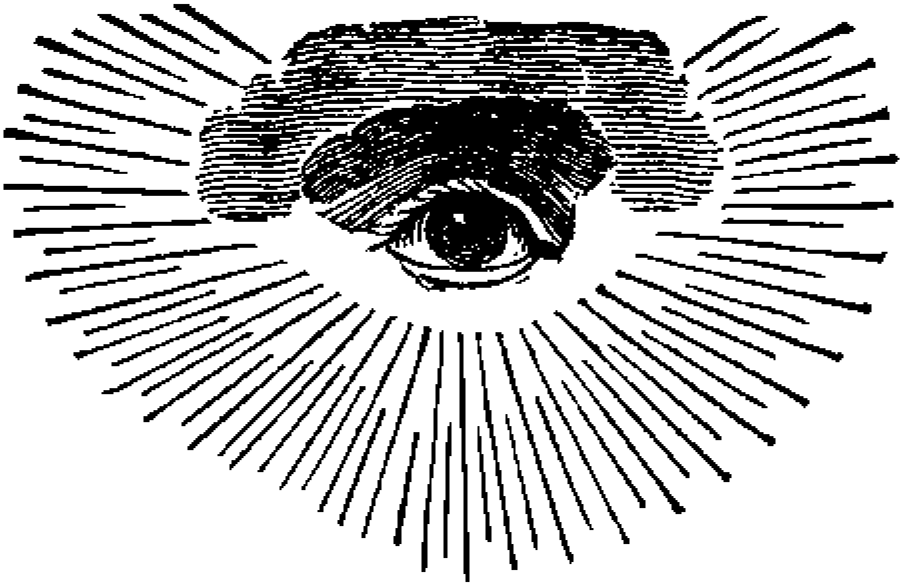
[4] Friedrich Kittler (1997, p. 118) has noted the Biblical digitalization in both Genesis and the Gospel of John ("In the beginning was the Word…").

[5] The passages in question are 21:104, "On that Day, we shall roll up the skies as a writer rolls up [his] scrolls. We shall reproduce creation just as We produced it the first time…" (Haleem, 2005, p. 208) and Revelation 6:14, "And the heaven departed as a scroll when it is rolled together; and every mountain and island were moved out of their places."

[6] The logistical aspects are most directly implicated in "man's" dominion. Genesis 1:26 says, "And God said, Let us make man in our image, after our likeness: and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth." Also, Genesis 2:19: "So out of the ground the Lord God formed every animal of the field and every bird of the air, and brought them to the man to see what he would call them: and whatever the man called every living creature, that was its name."

puts the radar operator at the center of an apparently set and circumscribed universe. The radar reader is a surveyor, a would-be All-Seeing Eye or Eye of Providence (see figure 1.2) who perceives, differentiates, and orders objects in relation to himself. Airplanes, satellites, and storm clouds emerge and swirl just as the stars, moon, and sun did on the ceiling-sky of the ancient Hebrews, and the radar operator's position seems objective and superior, even as it perceives only the surfaces of select objects. Twenty-four hours a day, during smog and fallout, through season finales, reruns, and writers' strikes, radar systems can fill space with live transmissions and provide their readers with mathematically-precise information, with coverage. Like the astronomers and priests of ancient Egypt (Innis, 1951) they mimic aspects of the cosmos and make traffic of the masses.

Figure 1.2: All-Seeing Eye



An early 18th Century Masonic depiction of the All-Seeing Eye. The lines surrounding the eye represent electromagnetic radiation. Image is in the public domain. (Eye of Providence, 2004)

Like pyramids, obelisks, totems, shopping malls, and cathedrals, the Old Testament Tabernacle was a logistical medium, a device of orientation, an artifact for urban planning, symbolically a microcosm of the universe as the ancient Hebrews understood it. It had an inner, most-holy area that was partitioned from the holy area, which itself was bounded as though within a firmament (Smith, 1900). Only particular bodies and objects were allowed in particular spaces, and then, only at prescribed times, after required procedures, and for the duration of strictly controlled activities. Once a year, on Yom Kippur, the High Priest entered the Holy of Holies in memoriam of Moses' experience at the burning bush, of his witnessing the thermal and electromagnetic mode of God. The Tabernacle always faced east, which was believed to be the direction from which God, like the rising sun, came. The Levites, who cared for the Tabernacle medium and controlled the communications, camped immediately around it on three sides (not on the east side) and the tribes of Israel were assigned to camping spots on the north, south, east, and west.[7] The dead and the unclean had to remain outside the perimeter of the camp. No one of another nationality was to camp freely with the Israelites; the Israelites' presence made it holy land, made it national space.[8]

The ancient Hebrews traveled in camp formation (except on Shabbat), with the Ark of the Covenant preceding them. The speed of the Ark was the speed of the entire nation. It was a divine pace car, a police cruiser that no one dared pass. When the

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[7] Innis (1951) refers to the Egyptian astronomers and priests communication control as "monopoly of knowledge" (p. 35).

[8] See Numbers 2.

Israelites stopped, the Ark rested in the Holy of Holies, in the center of their civilization. But when they marched it was put to use building highways, clearing the land, and wiping out enemies.[9] The *Jewish Encyclopedia* (1906) records that:

> The Ark was not merely a receptacle for the Law; it was a protection against the enemies of the Israelites, and cleared the roads in the wilderness for them. Two sparks, tradition relates, came out from between the two cherubim, which killed all serpents and scorpions, and burned the thorns…. (Jewish Encyclopedia, 1906)

We should then, think of the ancient Hebrews as nomads. Like retirees driving RVs, they took their civilization with them wherever they went. Logistical media such as the Ark can enable the compression and portability of culture.

Muslims also have an object at the logistical center of their religion, the Kaaba ("sacred house") in Mecca. Five times a day, Muslims face the Kaaba and pray in its direction. Their messages are sent during different increments of the day, such as between dawn and sunrise. As part of transmission, Muslims resituate their transmitter-bodies and assume new subject positions in relation to the Kaaba. They stand, raise their hands, sit, lie prostrate, and tilt their heads in a precise sequence that makes them aware of their own bodies, and of the bodies of those around them (Cragg, 1970). All of this coordinated, harmonious movement and message sending is a performance of both Muslim unity and narrowcasting (because it involves a homogenous audience). Muslims also perform unity during the pilgrimage to Mecca, through what they call the *tawaf*, a counter-clockwise circling and touching of the Kaaba during the Hajj. During *tawaf*, a pilgrim's speed and trajectory must yield to other participants if collisions and trampling

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[9] See Numbers 31, Joshua 6, and 1 Samuel 4-6 for examples of the Ark as a weapon.

are to be avoided. The centralized management of moving bodies is the primordial task of logistical media such as radar and the Kaaba.

Praying in the right direction is so important that mosques have alcoves in the wall to tell Muslims which way to face and lay their mats. Muslims also have qibla compasses, compasses that have 40 zones marked around the edge so users can know where they are in relation to Mecca and decide the correct direction for prayer. The most advanced digital qibla compasses are Mecca-centric GPS systems that require no knowledge of either angles or distances. They simply tell users which way to pray by presenting an arrow on a digital display. Where stationary radar systems give information about their proximity to selected objects, and usually moving objects, qibla compasses tell moving Muslims where they can find the stationary Mecca. An airline pilot using a radar system to locate the airport and a Muslim traveler using his qibla compass to find Mecca coordinate their movements in logistically similar ways.[10]

Still, to think that qibla compasses are the sole mediators of a Muslim's daily transmissions is to pave over the different logistical paradigms inherent in regarding the world as flat (or map-like) and spherical (or globe-like). Early on, Muslims who traveled from Mecca simply pointed themselves back the way they came, and placed alcoves in their mosques accordingly. A little later, maps were made with Mecca in the exact center and with angles and rings radiating all around. But eventually it was discovered that the earth is spherical. Trigonometry was deployed and Muslims in North America

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[10] Radar is the inverse of the compass, a portable magnetic pole. Instead of telling you where you are in relation to a magnetic pole, it sets the observer up as an electromagnetic pole and allows her or him to evaluate the proximity and speed of objects.

now typically face northeast to send their daily messages. In the spherical paradigm, those who happen to be somewhere near Samoa or Hawaii can pick their direction, as each way they face is equally distant from Mecca. That Mecca's distance has always been measured in terms of the earth's surface, and not, say, through the crust and core of the earth is a point of recent controversy (Hamidullah, 1992), and one that could lend itself (at least in theory), to some Muslims' wanting to perform prayers on a ramp, or vertically and upside down. This could make the required prayers look like a circus act, as congregational prayers are lead by an imam who is physically closer to Mecca than are the other worshippers present.

Islam orders many of its rituals around the positions of the sun and moon in the sky, including the five daily prayers and observance of the holy month of Ramadan. When Malaysia's National Space Agency launched the first practicing Muslim into outer space in 2007, the problems were cosmic (Lumpur, 2006). For an orbiting Muslim, the performance of prayers in relation to the sun's position in the sky is daunting (to say the least). There are also issues of ritual cleaning, ceremonial clothing, and the direction of Mecca. Islam is a complex air- traffic control system. It assumes that Muslims will be earthbound, that the sun will rise and set, that Muslims will view it through the earth's atmosphere, and so on. A Muslim on Venus would have an easier time keeping the prayers in some respects, as a Venusian day lasts 243 Earth days. But in other ways things would be odd. The Venusian year—225 Earth days in length—is shorter than the Venusian day! No Muslim would survive the month of Ramadan, which requires fasting from sunrise to sunset (but then many wouldn't have to as they'd live and die before

Ramadan even came along.). As Sitara Hewitt, star of the Canadian sitcom *Little Mosque on the Prairie,* said when no one could agree on when to start Ramadan, “I don’t think the prophet had a telescope from Costco!”

The difficulty of a practicing Muslim in orbit is similar, on the logistical level, to that of being a practicing American in the sky in the early days of blimps and airplanes. The logic of a nation state that conceives of itself geographically, as lines in the Earth, on maps, and in minds (Anderson, 1991) doesn’t transfer to the air without some mediation. Radar is just that kind of medium. It helped nation states understand themselves as their technologies and citizens started moving through the air, and later, as their satellites began circling the earth. In 1957 Sputnik “invaded” the U.S. because the latter had come to see itself as occupying the atmosphere above its geography and had imperialistic designs on the moon. The October 5, 1957 banner headline from the *New York Times* was apocalyptic: “SOVIET FIRES EARTH SATELLITE INTO SPACE; IT IS CIRCLING THE GLOBE AT 18,000 M.P.H.; SPHERE TRACKED IN 4 CROSSINGS OVER U.S.” Khrushchev had thrown a 184 lb. invader right over our yard. And less than a month later, the communist canine Laika would pass over the U.S. without a passport, green card, or worker’s permit.

Of course, other, and even earlier, media have also extended the logic of the nation state. Carey (1988) observed that the telegraph coordinated the expansion of the U.S. across North America in the mid and late 19th century, that it “provided the decisive and cumulative break of the identity of communication and transportation.” He further observed that:

> The great theoretical significance of the technology lay not merely in the separation but also in the use of the telegraph as both a model of and a mechanism for control of the physical movement of things, specifically on the railroad. That is the fundamental discovery: not only can information move independently of and faster than physical entities, but it also can be a simulation of and control mechanism for what has been left behind. (p. 215)

The common quality of logistical media is their grid-like functioning, which may or may not be evident in how they represent information. Carey (1988) wrote that “the grid is the geometry of empire,” (p. 225) and we could certainly think of radar, the telegraph, cell phone towers, traffic lights, parking lots, the Tabernacle, the radio dial, and congressional redistricting in these terms. As Innis does, we could think of the number and density of powerful, ideological, and technological grids that coordinate and control movement in any given space as a measure of its imperial occupation. A continuum of least to most occupied spaces might be: uncharted wilderness, shepherd’s field, federal wilderness area, national forest, rural farmhouse, neighborhood home, suburban tract home, apartment building, gated community, World Trade Center, Disney World, airport, Mecca during the Hajj, the West Bank, military base, missile silo, the Korean demilitarized zone, the Pentagon, mausoleum vault.

Sender and Receiver

How does radar fit into the ‘geometry of empire?’ Radar is a series of technologies that represents objects and facilitates their coordination. Its main functions are detection, identification, and coordination, and it accomplishes these by bouncing electromagnetic waves off objects and receiving their echo signals (which, because they have been reflected, are of a slightly lower frequency). These electromagnetic waves are nothing more than light waves of a particular length and frequency. In the broad spectrum of things, gamma rays, x-rays, and ultra violet rays all have a higher frequency and are shorter than visible light. Infra red waves, microwaves, radio waves (including UHF, FM, and VHF), and long waves all have a lower frequency and are longer than it. Typical 1930s and 40s radar operated in the 100-200 MHz range of the spectrum, the range that would soon be used for commercial FM radio and network television. Today radar systems operate on frequencies as low as a few MHz and as high as 248 GHz (Skolnik, 2001).

But how, you might be wondering, do radar transmitters work? How does light come off of an antenna? An example is in order. As mentioned above, electromagnetic waves are different from sound waves (which are mechanical and are not made of light and are much, much slower), and the two should never be confused.[11] But, if you think of a radar transmitter as the electromagnetic equivalent of a tuning fork, you're on the right track. If you strike a tuning fork, you can see it vibrating and can hear sound waves radiating from it. If you have several tuning forks, each of a different mass, and you strike them all at once, you can hear different notes. These notes are different because their frequencies are different—the tuning forks vibrating more quickly are producing higher notes. If we think of a radar transmitter as a tuning fork, what strikes it is an alternating current (AC) of electricity. Electromagnetic radiation will emanate from radar transmitters at the same frequency as the AC current they conduct. The same goes for

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[11] Implicitly, this is the fundamental difference between radar and sonar. Sonar may operate on anything from infrasonic to ultra sonic frequencies, but it is a system that uses sound waves and not electromagnetic waves (as radar does).

television transmitters, the FM station across town, and the microwave oven in your kitchen.

Receiving and measuring the echoes, the diminished waves that bounce off objects and back to an antenna, are both necessary and useful for radar systems. Because the speed of electromagnetic waves is known (in a vacuum, they travel at exactly 299, 792, 458 meters per second) the time between transmission and reception provides the range (or distance) from the object to the transmitter. Moreover, an object's (or target's, as the terms are interchangeable in radar parlance) location in angle to the transmitter can be learned by pointing the transmitter and receiver (often they are the same antenna) at different angles and observing which angle produces the strongest echo, the echo with the least frequency loss. Once the distance and angle are known, speed, azimuth, altitude, and even acceleration can be measured by repeatedly hitting the object with waves. Not all of the waves bounce back to the receiver (in fact, only a tiny fraction of them do), and those that don't are clutter, or noise, in the system. All of this may remind you of Shannon and Weaver's (1949) SMCR model that I mentioned earlier. Wiener (1961/1948), while using feedback to predict where Axis planes would fly to next so that flak could be there to meet them, was plowing much of the same ground as I am (although he did so as a physicist and I do so as a historian-critic).

Radar reception involves many intricacies, and so some further explanation is a good idea. In its capacity as a receiver, a radar antenna behaves very much like a human eye. Healthy human eyes, after all, assist the meaningful interpretation of electromagnetic waves of approximately 400-700 nanometers in length (400-700 billionths of a meter). We tend to think of seeing as *looking out*, but really it’s about electromagnetic waves and particles *radiating in* and stimulating our optical nerves in ways that can be interpreted by our brains. Our pupils are apertures that try to keep signal strengths within optimal limits. Our corneas and lenses focus the waves. Our retinas are like the film in a camera. They are full of cells that respond to and help process light, but that can also be damaged by light of the wrong frequency (like ultraviolet light). Our lids, lashes, and tear ducts are both emergency cut off and maintenance systems. Our extraocular muscles allow us to change the angles and azimuth of our antenna-eyes. Our brains are the cathode ray screens where the video output is displayed. Radar systems have comparable components: amplifiers that make them focus and increase signal strength, filters and demodulators that recognize frequency changes (what would be, in the visible spectrum, akin to recognizing a change from blue to green, or from yellow to red), processors that reject unwanted noise (and thus ‘brighten’ desired frequencies), steering platforms that allow gazing in various directions, and displays so that all of this can be meaningful to our eyes and brains.

Radar blinks, after a fashion, and suffers from both hyperopia and myopia, from nearsightedness and farsightedness. Transmission fouls reception for a nanosecond and the receiver is thoroughly radiated with the transmission. A flock of birds, or even a cloud of insects, could take off in close proximity to a radar antenna and not be seen, only to later be detected coming from the direction of the radar antenna itself! Similarly, objects too close to the transmitter don’t reflect waves with sufficient frequency loss to be detected and easily blend in with all of the clutter, with the uninteresting hillsides, ocean waves, and sides of buildings that, like backgrounds in cheap animation, are taken for nuisances or logistical constants. Other transmitters that might be too close and at a confusing angle to the radar system can also cause problems, which is why the FAA won't let you use your cell phone during take offs and landings. Their transmissions take precedence over yours. Objects too far away haven't reflected all of their signals before the next pulse of AC. This can be confusing in the extreme as it can make objects that arrive just after a second pulse seem as though they are much closer than they really are. This sort of thing, for example, might lend itself to mistaking the moon's electromagnetic resonance for incoming Soviet missiles, such as happened to North American Aerospace Defense Command's (NORAD's) Thule radar station on October 5, 1960 (*New York Times*, 1962). Radar has spawned millions of UFOs, ghosts, and erroneous speeding tickets.

Some radar systems avoid this pulse, this blink, by operating with a continuous wave (a CW) of transmission and reception. CW radar, such as that used in airplane altimeters, doesn't suffer from farsightedness the way pulse systems do, and operates with its own antenna constantly fouled, in a sense. The price of this is that a simple, 1940s-era CW cannot measure range at all because it does not measure reflections in calculable increments. These systems are not digital in the sense that there is no alternation, no zero and one, even in nanoseconds, between transmission and reception. They are both the most live and dead broadcasts of any medium, perfect for instantly visualizing everything that other radar systems categorize as clutter: the immobile and the constantly disruptive (like ocean waves and clouds). In terms of information theory, the sender-message-channel-receiver-feedback occur simultaneously in CW systems, instead of in sequence. They are like **śn** instead of like SMCRF. Even with contemporary technology it is difficult for CW radars to gain information about range. Today's airplane altimeters do it by relying on the frequency modulation caused by the movement of the planes and the earth (in rotation).

Message and Channel

Whether objects can or cannot be detected by radar, and therefore represented by radar, is a result of both their own qualities and the qualities of individual radar systems. Stealth materials, low-profile shapes, electronic countermeasures, window (chaff), and fuzz busters are all attempts to either avoid or distort representations. In a cultural studies sense, these things can be seen as attempts to maintain what Stuart Hall called an oppositional subject position (Hall, 1980), a challenge to the intended meaning of their representations. There is even the possibility, as we'll explore in the *Countermeasures* chapter, of would-be radar objects gaining logistical power through deception. Radar catches objects in its waves, compels them (or rather, their surfaces) to be part of the live message of its broadcast, and therein forces them into the role of senders, into becoming senders in a chain of senders (the transmitter, the object, the receiver, and the cathode ray display) designed to provide information about them. They have no right to remain silent in the sense that they are compelled to 'say' something about themselves.

If we dig further into the idea of radar objects as messages, and specifically into the speed with which they are constantly represented, we can see that radar systems have something in common with phonographs. Phonographs work because as the half-mile (typically) of an LP's groove circles past the stylus, tiny bumps in the vinyl make the stylus vibrate against a cantilever (a tube or bar) which in turn vibrates against a magnet. This vibration disrupts the magnet's electrical field producing an electrical signal, which is then gathered by coils and amplified so your speakers and ear drums will vibrate (and you will hear the sound waves). Moving the stylus instead of the record would work equally well. A radar antenna sweeping around in a circle (not all of them do so) is a lot like a moving stylus, only it detects changes in electromagnetic frequency instead of tiny mechanical bumps. Of necessity, pulse radars are often calibrated (or channeled) to ignore unmoving constants—buildings, mountain sides, stands of trees—just like a stylus ignores the un-etched parts of a record. The objects radar wants to measure are like bumps in a record's groove,[12] only the bumps (blips) are often moving so the "record" often doesn't track exactly the same way twice. In terms of a cathode ray screen the "record" is being wiped clean and re-recorded with every sweep, but of course, a sequential paper record may also be kept.

Also, like many phonographs, radar systems can sweep at different speeds, with detection being blurred (slurred for phonographs), if the system isn't sufficiently sensitive. Reception equipment can be made so that a desired frequency will result in an audible beep in an operator's headphone, an understandable alert considering the

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[12] Kittler (1997) might think of these bumps in a groove as soldiers in a trench. He wrote of the "grave problem of how to mobilize the soldiers stored or buried in the trenches" (p. 122).

hypnosis the mathematically-exact sweeping of a cathode ray screen can induce. Imagine if in commercial TV programming every 30 seconds the program you were watching reset with only slight differences to the circumrotation of a time-keeping line (in technical terms, a wipe transition). Network TV more or less does this, though at a slower pace and without the line on your screen. Radar is the ultimate in reruns, sequels, and systematic programming. That flight from Denver, Colorado to Medford, Oregon will beep the radar operator's headset at as close to the same time as possible every week. Considering Kittler's (1997) assertion that entertainment media are misused military equipment, I'm sure that with the right radar systems and some nice surround-sound speakers, I could produce a wicked dance mix.

Radar systems' channel capacities, their ability to efficiently coordinate and control objects, have everything to do with the speed of pop culture, fashion, commodities, and terrorism. The faster objects like airplanes, ships, and trucks can efficiently move, the faster the goods inside them can circulate. Schivelbusch (1986) placed this efficient movement in the nineteenth century in the "capitalist world's recomposition on the basis of modern traffic," and believed that "from then on, traffic determined what belonged where" (p. 194). Radar undergirds what Peter Peters (2000) called the "instant present," the technologically enabled and economically mandated circulation of everything from the latest fad clothing to bananas out of season. The never-ending swirl of tangibles contributes to the capitalistic phantasmagoria that some of us are living in, even as intangibles such as digital products and services increase in popularity. Bodies are some of the most important tangibles, and their speed and movements have everything to do with politics: those trapped in Louisiana and Mississippi during hurricane Katrina couldn't move fast enough; the highways leading out of New Orleans became parking lots. For some, a speed bump (a fence) is supposed to slow down the "wave" of illegal aliens coming into the U.S. President Bush prepared to read a story about a goat while radar operators in New York—9/11's first (and live) broadcast audience—sat and watched American Airlines Flight 11 diverge from its controlled and coordinated flight path. Highways, fences, airline schedules, and radar systems are all important beats in the rhythm of modernity.

The rise of oil prices in the U.S. in 2007-2008, and the consequent attention to the relationship between speed and gas mileage, suggests that vehicles, citizens, fashions, and the economies they exist in all flow with logistical precision. Skyrocketing gas prices, and the speculative future's markets that drive them, have led to a slight decrease in traffic volume and a general deceleration (Effects of Gasoline Prices, 2008). Not everyone wants to slow down of course; there is immense pressure on truckers and others have the money to not sacrifice their time. But those who slow down exert political power and logistical force. As the Congressional Budget Office report notes, even if only a small fraction of drivers have decreased their speed, "their reduced speeds could cause nearby drivers to slow down as well" (p. 14).[13] Regardless of gas prices, the man slowing down to concentrate on his cell phone carries the Ark of the

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[13] *The Congressional Budget Office Report* further suggests that comparatively high gas prices may create a collective rationality from individual irrationalities. Remarking on the slight decrease in highway speed, the report notes that "Such small responses are unlikely to result from conscious calculations. Few motorists would have the information required to gauge their responses so acutely, nor the time or inclination to do so. However, higher prices make drivers pay more attention to speed" (p. 14).

Covenant. He communicates from his mobile center. On a need to yield and a lack of a passing lane hang all the laws and the prophets.

There remain limits to the power of comparative slowness, though, as channels, in a logistical sense, demand an orderly and arranged flow of messages. Loitering, idling, demonstrating, and trespassing all gum the works, and some police departments now give tickets for idling. Police officers in Minneapolis can use their radar guns to ensure that an idling car moves in three minutes or less (Muelhausen, 2008). In Los Angeles, a woman was ticketed for crossing a street too slowly (Elderly Woman Ticketed, 2006).[14] While I might dream of Transportation Security Administration (TSA) officers being ticketed for airport security lines moving too slowly, in doing so I'd simply be ignoring all of the channels that intersect at the checkpoint: the no more than three ounces of liquid channel, the chemicals channel, the electronic devices channel, the "defense items" channel, the sharp objects channel, the sporting goods channel, the personal items channel, the legal identification channel, the boarding pass channel, and the body channel. Airport security checkpoints are interchanges for many kinds of ordering, a spaghetti highway. Even standing in the security line or simply being in a particular part of the airport is ordering on multiple levels. More than 34 American airports use ground surveillance radar to identify trespassers, to ensure that only authorized personnel are in certain areas (Barry & Czechanski, 2000).

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[14] If she could have gone about "botanizing on the asphalt," like a flâneur strolling past shop windows, she would have fared much better (Benjamin, 1997, p. 37).

Display

The output of early radar screens looks like the graphics of an old video game to today's viewers, and in some senses it should. Cathode ray tubes were used for radar before they found their way to commercial television sets and arcade-style Space Invaders machines. Even today's games often have a radar mode, or radar gauge, designed to inform players of their proximity to enemies and help them see how fast they're moving through the action. Gazing into a cathode ray tube, a behavior that is now so commonplace as to seem 'natural,' was once something that had to be taught, and radar readers had to learn to judge between information and noise. Interpreting an early radar screen was a bit like reading the runes, or trying to make sense of a montage or a constellation; the combinations of lines, blips, and blobs became meaningful representations with experience. When the cake-eating supervisor walks into the Sprint Nextel ad and asks "Who's agitating my dots? Are you agitating my dots?" he's demonstrating his experience with both logistics and abstract forms of representation. His dots are people and his people are dots.

A military consequence of radar displays (and radar) has been the increasing ease of push-button warfare, a phenomenon that Virilio (1989) traces back to World War I and that allows us to think of radar as a medium that both collapses and increases the meaningful distance of its represented objects. In some respects, radar collapses distance because it allows representations of objects to be seen that the unaided eye would never detect. This is especially true of radar networks, like NORAD, that allow people thousands of miles away and inside of a mountain to have more information about what planes are approaching the Western coast of the U.S. than would someone relaxing on a California beach. But conversely, radar can distance our sense of the tangible, and sometimes, living, qualities of what's being represented. [15] Human beings, flocks of birds, hurricanes, and even the 9/11 airplanes seem less real through radar's abstract representations. The sounds, touches, smells, tastes, and even sights of tangible objects aren't meaningful for radar systems. Their speeds, azimuths, origins, perceived destinations, and arrangements, are. The image trumps the object, but the point on the screen, the point of view, trumps them both.

Early radar displays had their own ways of arranging objects that they don't represent, as is evident in the notion of the radar shack and radar station. Radar displays become information hubs, places from which instructions are dispatched and, for the military at least, strategies and tactics are planned and evaluated. Carey (1988) understood telegraph stations in similar terms, but radars' wireless broadcasting and potential mobility make it even more valuable for armies, navies, and other commuters on the move. In the 1940s, radar displays were set up near radio equipment so that large-scale movements could happen quickly and efficiently. Some systems were so portable they could be assembled in the back of a jeep in only a few minutes. Reports of blips or emergencies were written or typed, stored, copied, and distributed. Today, radar systems are fed into TV broadcasts and directly into computer networks. If we consider how the information from radar is controlled, accessed, represented, and used,

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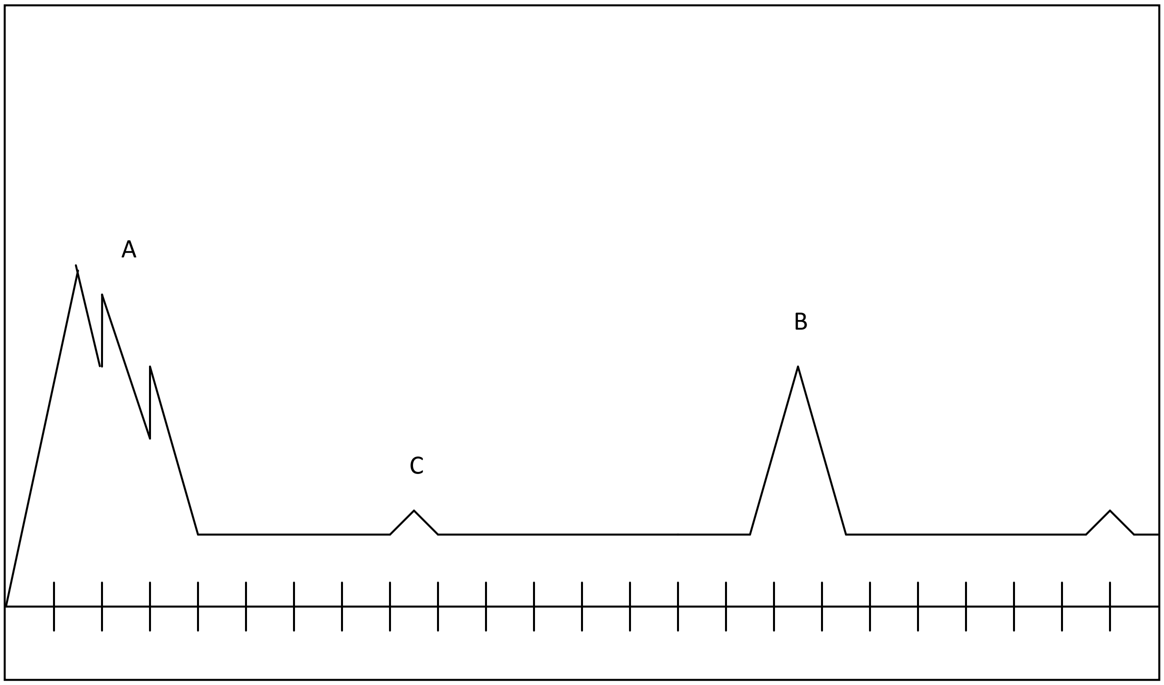
[15] Consider, for example, if the New Orleans highways had radar systems that would automatically ticket vehicles for idling. Those caught in the Katrina traffic jams could have been billed for the hurricane's existence and their own attempts to escape.

we can get a sense of how it situates radar readers to the world around them. A radar station is in every sense a *situation room*.

A few different types of cathode ray tube displays (CRTs) were so popular in the 1940s, and are so prevalent in my discussion of historical artifacts, that familiarity with these displays is a good idea. I focus on the A-Scope and PPI, as they represent the two main radar representations, range and plan-position, and are most salient to my research. I encourage you to refer back to this material if you get lost in discussions of screen content, or in how one radar system, or another, represents information. I do my best to be brief, but accurate. Consider the next couple of page a crash course in radar reading.

The A-scope (see figure 1.3), is really just an oscilloscope, or a screen on which cathode rays are projected each time a radar system pulses. The cathode rays project on the screen, according to the radar's range, with the most distant representations projected on the right edge. As indicated by point "A," A-scopes always have a blot at the left edge of their sweeps, as the transmission fouls the antenna for a nanosecond. Any object within this fouled range is effectively invisible, or indiscernible. Objects that reflect back with sufficient strength look like point "B," and the distance between the radar receiver and the object can be measured using the tracking marks along the bottom of the display. A-scopes work well in situations where direction and trajectory are not paramount, and when pure reflection will suffice for representation, such as when a radar system is aimed at the ground to discover ore deposits, or when the frequency of ocean waves is desired. The A-scope shows a reader where possibly significant bumps are in the LP and whether they are getting closer to, or farther from, the receiver-stylus.

Figure 1.3: A-Scope



Nonetheless, the A-scope's simple display of distance may fool a novice into thinking that it can't be used to discover an object's direction or trajectory. A skillful operator could discover these things if she knows the direction the receiver is pointing or can rotate and/or tilt it.[16] Any signal will be received more strongly when the receiver

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[16] According to Canada's Museum of Radar, many of the earliest radar readers were women: "In 1941, at the height of the Second World War, Britain faced a drastic shortage of manpower. In order to free up men for overseas duties, a massive conscription of single women aged twenty to thirty was enacted. A large number of these women, and others who were later included by a more extensive draft in 1942, found themselves assigned to the ranks of the Royal Air Force's Radiation Detection Finding (RDF)

is pointed directly at it. But this information would be rough and provisional. What if there was more than one object causing the reflection? What if the distance to the object had changed because of the receiver's new angle and the new altitude of the targeted object? And never mind that a cluster of balloons might go from looking like point "C," which could be something almost beyond the receiver's arc, to looking like point "B," and be mistaken for the desired object. Fiddling with the receiver's angle and direction is a messy business when you only have an A-scope for a display, because you're always dealing with objects that are represented but, at least in a technical sense, unidentified. Much of the identification of A-Scope objects is situational and contextual. What is expected is the assumption that rules the day.

By contrast, PPIs (see figure 1.4) display more information about objects. An object's concreteness is more readily apparent than in an A-scope, as the reflection is represented with more individuality (as opposed to the A-scope's mass, wave-like representation). Objects on PPIs are little blips or dots that light up when the transmitter sweeps through the firmament (assuming a rotating and pulsing radar), and their movements can be plotted and even projected.[17] Today's PPIs can even forecast where objects will go next, whether those objects are planes, storm clouds, or incoming missiles. If we assume that "A" in figure 1.4 is the location of the radar receiver, and "B" is a blip representing an object, "C" could be the object's anticipated new position

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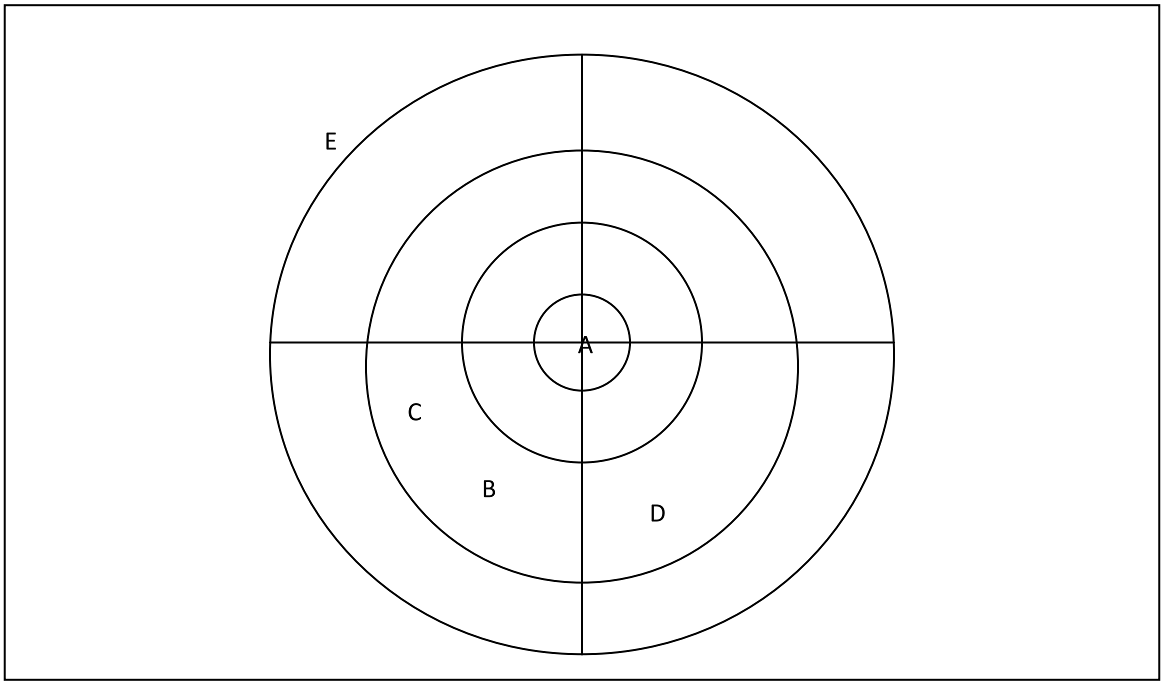
division. Replacing male operators who were needed overseas, members of the Women's Auxiliary Air Force (WAAF) completely dominated the English coastal radar stations by 1943" (Women in Radar, undated, p. 1).

[17] The line that represents the circumrotation of the transmitter is referred to as a "radar sweep" or a "time base." It accurately represents a radar system's rotation speed, duration, and range.

(while "D" could be its previously charted position). "E" represents the radar system's blind spot (a quadrant in this example) as the signal must elapse before the next pulse if the information is to be accurate. The tightest circle around "A" would also be a blind spot, and for the same reason as on the A-scope. Radar systems are as singularities that exist outside their own universes.

Figure 1.4: PPI



The PPI looks a lot like a big bull's eye, dartboard, ring galaxy, or test pattern. Blips emerge, move, and disappear in relation to the physical and ideological position of the radar system and its reader, whether or not anything in or on an object (such as a person) realizes that it is under surveillance or being subjected to a remote form of control. The spacing of the PPI, like an electric map with selected topography and reflected frequencies, allows for an efficient ordering of information. Cosmologically, it is a media space and a channel that contains content. That the PPI closely resembles Wiener's 1950 (Light, 2003, Wiener, 1950) plan for atomic cities, for cities where information—people, supplies, and services—would be dispersed and stored efficiently like bumps in a phonograph record, is less well known but just as important for understanding radar's relationship to logistics in a larger sense. Jennifer Light tells us how Wiener's conception of cities as cybernetic communication systems considered issues of speed, traffic, and collision:

> Wiener was not the first to suggest that U.S. cities were likely targets for attack, nor that dispersal would solve urban problems. Yet this cybernetic view of cities as communication systems offered a rationale for the plan. "A city is primarily a communications center," he explained, "serving the same purpose as a nerve center in the body." Cities functioned best when information could easily be exchanged, and the persistent "traffic jams in streets and subways" signaled these exchanges could be improved. With the basic principles of cybernetics suggesting that "the distinction between material transportation and message transportation is not in any theoretical sense permanent and unbridgeable," Wiener argued that communications technology could knit together a physically dispersed population. In the near future, he predicted, transportation of increasingly sophisticated materials via communications networks would become common. (Light, 2003, p. 35-36).

As we see in the *Authoritarian Modernity* chapter, Wiener's ideas have deep application to the consideration of radar as a logistical medium. We have already discussed how radar might be thought of as an eye, as a vision machine, and that too will be elaborated in *Antenna Architecture*. At the moment, though, we are ready to move on from the introduction/estrangement of radar as a logistical medium into the methodological and theoretical aspects of my approach. I still need to argue for why the historical artifacts discussed in my middle three chapters, my discussion of bits and pieces of radar history, have scholarly and public relevance. In this chapter we’ve considered electromagnetic waves, the Big Bang, logistical mythologies, and various aspects of the workings of early radar systems themselves. Hopefully, we’re now thinking about radar in new and complex—and most importantly, logistical—ways.

CHAPTER 2: DIALECTICAL IMAGE

The key to making sense of this chapter is to realize that my preceding discussion of display, and particularly of the PPI, is a technological counterpart to the present discussion of historical method. I discuss the importance of various blips—dialectic, dromology (the logic of speed), Surrealism, psychoanalysis, flânerie, and emergence—as Benjamin's approach to history sweeps through them like a time base. In this chapter, I consider these blips in proximity to each other, their movement, and their implications for a sustained treatment of radar as a logistical medium. Upon closer inspection, some of these blips are dual contact points. Of necessity, I fail to illuminate some of the stealthier blips (such as where my approach sits more broadly in cultural theory and historical method), but I conclude the chapter with a discussion of criticisms of my approach.

What emerges from this discussion is a scholarly argument for the value of radar's dialectical image, of the constellation drawn between historical and contemporary blips. Radar, even unconventionally considered as a medium, could easily assume a rather lackluster existence in the present. It seems hardly worth a remark today; it is old and out of sight. Nevertheless, I demonstrate that upon closer examination, the image of radar estranges and illuminates. What first appears the epitome of normal, like *Leave It to Beaver's* fictional Mayfield, slowly, and disturbingly, morphs into an all-too-real Doomstown, NV. Benjamin wrote that "The dialectical image is an image that emerges suddenly, in a flash. What has been is to be held fast—as an image flashing up in the now of its recognizability" (Benjamin, 1999, p. 473). In this chapter, I describe Benjamin’s dialectical image, and suggest why it is a worthy goal for a materialist historian.

Benjamin is all over my efforts, but in this chapter he serves as my All-Seeing Eye. It is his ideas that sweep through my blips, and it is to my understanding of his perspective that these are gathered. As I try to peer through his eye, I argue that Benjamin’s historian can hold together the disparate ideas I present, as it is through putting such in dialectic that his historical project emerges. I begin by explicating what Benjamin (and I) mean by dialectic and dialectical image, and then trace their roots to French Surrealism, psychoanalysis, what Baudelaire calls flânerie, dromology, and finally a notion of emergence. By the end of this chapter I’ll have laid the groundwork for my assertion of dialectical, authoritarian modernity and a formal subjection of radar to theory.

I should, at this point, suggest the depth and kind of estrangement I am attempting. There is a method to my madness, as it is, a purpose behind the juxtaposition of the sacred and profane, of the yesterday and today, of the scholarly and popular. In one sense my hope is to accomplish what Vanessa Schwartz (2001) found in Benjamin’s works. She wrote:

> Reading through the examples he gathered does more than enhance the schematic arguments he made in the summary essays, however. They offer a mode of historical argumentation in which to show is to tell. The effect of wading through the actual “stuff” of the text is a striking exercise in historical method through which the reader encounters history as a conversation between the past and the present (his commentary and his citation from historical sources), in which history is written as argument advanced by montage and juxtaposition rather than as a systematic presentation of evidence in support of a clearly stated thesis. (p. 459-460)

For Benjamin, historical method concerned both scholarly inquiry and social change, and so he intentionally approached historical objects though a logic of film. His aphorisms, poetic structure, intentional ambiguity, and image-like arrangement of ideas (montage) were meant to awaken readers to new and liberating subject positions, positions he conceptualized through the medium of film.[18] I elaborate on this in a moment, but for now, his famous "Work of Art" essay lays his intentions bare:

> By close-ups of the things around us, by focusing on hidden details of familiar objects, by exploring commonplace milieus under the ingenious guidance of the camera, the film, on the one hand, extends our comprehension of the necessities which rule our lives; on the other hand, it manages to assure us of an immense and unexpected field of action. Our taverns and our metropolitan streets, our offices and furnished homes, our railroad stations and our factories appeared to have us locked up hopelessly. Then came the film and burst this prison-world asunder by the dynamite of the tenth of a second, so that now, in the midst of its far-flung ruins and debris, we calmly and adventurously go traveling. With the close-up, space expands; with slow motion, movement is extended…[T]he camera introduces us to an unconscious optics as does psychoanalysis to unconscious impulses. (Benjamin, 1968, p. 236)

The grounds for his objection to historicism, and particularly to the Rankean historicism of the 19th century, should now be plain. Benjamin observed that, "the history that showed things 'as they really were' was the strongest narcotic of the [nineteenth] century," and connected the architecture of places like train stations, taverns, and the Paris arcades (of course) with the mythologized historicism of the period (Benjamin, 1999, n 3, p. 463). I'm not taking Benjamin's conclusions about film and transferring them whole to radar; the theaters of representations and operations have important differences. What I am doing, though, is something Benjamin himself

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[18] Schwartz (2001) writes that Benjamin's work presents "an alternative way to think about historical categories and methods—in some measure what Hayden White referred to as 'historiophoty'—the representation of history and our thought about it in visual images, as filmic discourse" (p. 461).

did: I’m adapting what he wrote about film and history and presenting objects (such as radar) in his filmic paradigm. The ways eyes watch films and radar screens are not the same, and neither is the representation of images, but Benjamin’s method and form can help give radar a politically disruptive identity, just as it gave the Arcades. Images and their fragmentary qualities, and not specifically their existence in film, are the seeds of his historical method. As Benjamin declared, “History decays into images, not stories” (Benjamin, n 11, 4, 1999, p. 476).

Early Warning

Admittedly, radar is most frequently discussed as a technology—perhaps as a communications technology—but only infrequently and esoterically as a medium. Radar, apparently, is not even on its own screen. But radar as a medium is at the center of this inquiry precisely because it exemplifies modernization in its simplest form: the disruption of physical space, distance, and matter, and the transformation of objects into mobile signs (Crary, 1990). Radar is a perception machine (Virilio, 1994) used to supervise space and manage distance between subject and object, self and other, spectator and spectacle. But at the same time it can be implicated in the collapse of such distinctions, in sudden emergences that confuse the visual and tactile. In this way radar networks are emergency broadcast systems that, quite literally, give early warning. The Jekyll-Hyde qualities of radar make it a modern watchman, but one who cries wolf.[19]

That radar was settled for only after scientists disparaged the application of electromagnetic radiation for a death ray, a dream at least as ancient as Archimedes' legendary attempt to destroy Roman warships with a mirror (Steele & Dorland, 2005), illuminates not only radio detection's relationship to the searchlight and torpedo, but also radar's integration into a national network of information. After the military conceded the oversight of broadcast radio to Herbert Hoover's Commerce Department, the Navy's National Research Laboratory and technicians in the Army's Signal Corps turned to the very problems that would eventually beset Norbert Wiener and other transmission theorists. The U.S. military needed to overcome the failings of the natural human eye to make continuous war and knew a 24-hour media network would fit the bill. That a media system would emerge instead of a death ray was a matter of insufficient technology and the recognition of purposeful feedback.

Nature itself was a problem for early radar. Technically, it interfered with readers' identifications of objects and lent itself to the seemingly supernatural. Clouds, rain, ocean waves, volcanic dust, meteors, icebergs, the moon, and migrating birds could come and go like so many cathode ray ghosts. Of equal sight (and blindness) night and day, radar is duped by objects that camouflage themselves as natural phenomena. They could be seen for what they are with the unaided eye or a good pair of binoculars,

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[19] One example of radar crying wolf is the Suez Canal crisis of 1956. On November 5, NORAD believed Soviet aircraft were flying low over Turkey to attack British and French forces in the Canal. Fortunately, the migrating swans did not touch off global war.

but such objects are indistinguishable ripples on a pulse meter or are lost in the glow of a televisual display. Radar networks enable objects through accident or trickery to instantly manipulate the positioning of soldiers, equipment, and citizens, and thus magnify the impact of pranks and deceptions. It is no wonder, then, that modern meteorology would proceed from chaff cloud to rain cloud, from flak to hail stone.

Like modernity, radar readers (as those who learn the language of radar displays are called) are 'flying by their instruments,' or are situated through their media, interpretive behaviors, and immediate viewing contexts. Only moderns would sit inside and watch each other through electric windows, spectators to an electronic spectacle of themselves, but that is exactly the situation space shared by radar stations and cold war living rooms. As a national situation room and media center, officers in the NORAD war room were the first audiences to experience live, non-stop national and international news, the first to enjoy a split screen montage of world events. Simultaneously, they were in some measure producers and directors of the programming they watched, interacting with images, scripting performances of their on-air talent, and exercising remote control.

Dialectical Image

Such diverse phenomena as UFOs, death rays, meteorology, and wall-to-wall media coverage in radar history have the potential to disrupt its naturalized place in modernity's progressive chronology. Demonstrating this potential requires extensive argument, as does the deployment of Benjamin's dialectical image (or monad) for this purpose. Historians in Benjamin's modernity are behooved to the absolute of time en lieu of sequence, to allegory instead of myth, to historical objects as technē but not as poesis. The dialectical image is constructed in a manner entirely consistent with tenets in Benjamin's essay, "The Work of Art in the Age of Mechanical Reproduction" (Benjamin, 1968). It is a product and process of the redefinition of history, a historian's decision becoming interruption. It is also overdetermined (Buck-Morss, 1991).

Admittedly, a mythological, historicist approach to a logistical medium like radar would certainly be more conventional. Myth invites a discussion of causes and continuities and invokes grand narratives: utopian, dystopian, Copernican, Newtonian, economic, technological, material, ideal. In the case of radar, mythological historiography could enable the systematic tracing of electromagnetic technology in warfare (Walton, 2005; Thompson, 2003), an event-centered assessment of its surveillance of national airspace and control of traffic (Perna, 2004; Heidenreich & Murray; 2004), an account of the creator-genius scientists behind the scenes (Zimmerman, 2001; Latham & Stobbs, 1996), or a narrative of its relation to the progressive militarization of science (Lieber, 2005; Steele & Dorland, 2005, Handberg, 2000). But therein historicism also casts its villains. As Harry Kessler remembered his friend Albert Einstein's observation, "Faith in the influence of demons is probably at the root of our concepts of causality" (Kessler, 1971, p. 322).[20]

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[20] Kessler clarifies that Einstein was advancing his General Theory of Relativity: "Clearly what he meant was that man's notions have evolved from faith in demons to faith in astrology, i.e., in the influence of the stars; and from there, via Copernican astronomy, to the causal doctrine of a purely mechanistic interpretation of nature" (p. 322).

For Benjamin, historicist epochs are the chrysalis for history as material interruption. “Historical materialism,” he writes in the *Arcades Project*, “has to abandon the epic element in history. It blasts the epoch out of the reified ‘continuity of history.’ It also blasts open the homogeneity of the epoch. It saturates it with ecrasite, i.e. the present.” (Benjamin, n 9, 1999, p. 474). Objects cast aside in the name of mythology are bestowed with allegorical power by the very chronology that excludes them. Forgotten in the ideological impulse to eliminate conflict, such objects emerge through the tensions that precluded their assimilation. They momentarily estrange the present from the naturalized sequence of events thought to have produced it, and simultaneously invite a conception of history as a destructive, non-sequential process without conclusion. As Andrew Benjamin (no relation to Walter) observes, “There is no narrative of truth. There are only moments of interruption. These moments are fleeting; appearing and disappearing as sites of philosophical and political activity” (Benjamin, 2004, p. 112). They are as fleeting as images on a radar screen.

Walter Benjamin’s dialectical image is derived from his literary criticism, and acutely from his discussion of caesura in Goethe (Bullock & Jennings, 1996). He positions the dialectical image (or caesura) as a fundamental quality of art (including literature), as a fleeting gesture to the ideal or “the expressionless,” that nonetheless cannot be reconciled to it. The dialectical image is a poetic window between a work’s particular presentation and the infinite transcendence of the expressionless, an irresolvable and allegorical tension conjured by the mythic processes of dynamic and sequential representation in time.[21] An art critic, then, completes a work through its very partiality, by holding "to particularity, while at the same time, allowing for the particular's absorption into the absolute" (Benjamin, 2004, p. 101). In this framework, criticism, being intrinsic to art work itself, is not a mystical unveiling of fetishized truth.[22] It is not a matter of discovering eternal depth beneath a temporal surface.

Benjamin's movement of the dialectical image from the terrain of the literary or art critic to that of the materialist historian is accomplished in his essays "The Work of Art in the Age of Mechanical Reproduction," "Theses on the Philosophy of History," and in the *Arcades Project*. In "Work of Art," Benjamin is at pains to demonstrate how technologies such as film interrupt the inherited, ideological, historicist aura of authentic art, and therein how film's particles and processes belie their sequential presentation. He observes:

> The stage actor identifies himself with the character of his role. The film actor very often is denied this opportunity. His creation is by no means all of a piece; it is composed of many separate performances. Besides certain fortuitous considerations, such as cost of studio, availability of fellow players, décor etc., there are elementary necessities of equipment that split the actor's work into a series of mountable episodes. In particular, lighting and its installation require the presentation of an event that, on the screen, unfolds as a rapid and unified scene, in a sequence of separate shootings which may take hours at the studio; not to mention more obvious montage. Thus a jump from the window can be shot in the studio as a jump from a scaffold, and the ensuing flight, if need be, can be shot weeks later when outdoor scenes are taken. (Benjamin, 1968, p. 230)

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[21] Any attempt to pull the ideal through the caesura is murder by defenestration. After the fall, the corpse gestures to its living body.

[22] Benjamin (2004) discusses this issue at length: "Criticism needs no motivation, any more than an experiment does, which, in fact criticism undertakes to perform on the artwork by unfolding the work's reflection…The legitimation of criticism…consists in its prosaic nature. Criticism is the preparation of the prosaic kernel in every work" (p. 178).

Benjamin reformulates film (and more generally, art) as an object brimming with rupture whose suturing into a continuous, progressive sequence is mythological. He describes how illusion arises from technē. He implies the connection of dialectical, temporally disruptive art objects to historical objects proper is elsewhere in the same essay, in his discussion of materialism, epochal perception, and Dadaism. He develops it further in "On the Philosophy of History," where he contrasts the perception of those incorporated in the myth of progress (and thus also in that of sequence and continuity), with the perception of "the angel of history" in Paul Klee's *Angelus Novus.* He writes, "Where we perceive a chain of events, he [the angel of history] sees one single catastrophe which keeps pilling wreckage upon wreckage and hurls it in front of his feet" (Benjamin, 1968, p. 258).[23] It comes to full flower, though, in the *Arcades Project*, where he declares that the dialectical image is both the caesura and the historical object.[24]

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[23] The full quote reveals something of the influence of Jewish mysticism on Benjamin: "A Klee painting named 'Angelus Novus' shows an angel looking as though he is about to move away from something he is fixedly contemplating. His eyes are staring, his mouth is open, his wings are spread. This is how one pictures the angel of history. His face is turned toward the past. Where we perceive a chain of events, he sees one single catastrophe which keeps pilling wreckage upon wreckage and hurls it in front of his feet. The angel would like to stay, awaken the dead, and make whole what has been smashed. But a storm is blowing from Paradise; it has got caught in his wings with such violence that the angel can no longer close them. This storm irresistibly propels him into the future to which his back is turned, while the pile of debris before him grows skyward. This storm is what we call progress" (Benjamin, 1968, p. 258).

[24] Benjamin makes this point in *Arcades* in various ways, but the following quote is the most concrete: "Thinking involves both thoughts in motions and thoughts at rest. When thinking reaches a standstill in a constellation saturated with tensions, the dialectical image appears. This image is the caesura in the movement of thought. Its locus is of course not arbitrary. In short it is to be found wherever the tension between dialectical oppositions is greatest. The dialectical image is, accordingly, the very object constructed in the materialist presentation of history. It is identical with the historical object; it justifies its being blasted out of the continuum of the historical process" (Benjamin, 1999, 475, N10a, p. 3).

In filmic terms, the dialectical image is a constellation of irresolvable debris on modernity's cutting room floor. It is the miscellaneous outtakes, blooper reels, and misplaced props of history excluded by continuity editing. But what then is the practice of the materialist historian? Is it essentially the work of the art critic? The materialist historian's work is to disrupt the mythology of progress by rejecting history as a series of causes and effects, of sequential events. Benjamin's historian "stops telling the sequence of events like the beads of a rosary. Instead he grasps the constellation which his own era has formed with a definite earlier one" (Benjamin, 1968, p. 263). But how is the materialist historian in a position to do this? Is the historian, like criticism, prepared in the object itself? How do the angels of history get their wings?

The Surrealist Historian

I should clarify that while I find justification for Benjamin's materialist historian in the technique of French Surrealists, I am not suggesting that his scholarly project can be circumscribed within their movement. He had a critical encounter with Surrealism, and particularly with the work of Georges Bataille's circle in the *Collège de Sociologie* and *Acéphale*, but Surrealism's penchant for non-dialectical mysticism and intoxication made it difficult for Benjamin to find a tenable politics in their efforts (Calderbank, 2003; Cohen, 1993; Benjamin, 1978).[25] Nonetheless, his description of the materialist

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[25] In *Surrealism: The Last Snapshot of the European Intelligentsia*, Benjamin expresses dismay: "To win the energies of intoxication for the revolution—this is the project about which Surrealism circles in all its books and enterprises," but he then asserts that Surrealism has "an inadequate, undialectical conception of the nature of intoxication. The aesthetic of the painter, the poet, en état de surprise, of art as the reaction of one surprised, is enmeshed in a number of pernicious romantic prejudices. Any serious

historian's practice resembles the Surrealist's method of sticking "together otherwise useless or discarded found objects—paper scraps, portions of painted canvas, newspaper, ticket stubs, cigarette butts, buttons," to defamiliarize and disorient (Pensky, 2004, p. 185-186). Benjamin advocates their technique when he asks, "In what way is it possible to conjoin a heightened graphicness to the realization of Marxist method?" and then answers, "The first stage in this undertaking will be to carry over the principle of montage into history. That is, to assemble large-scale constructions out of the smallest and most precisely cut components" (Benjamin, n2, 6, 1999, p. 461).

However, Benjamin's adaptation of montage to historical objects necessarily proposes that historiography can empower truth. Benjamin needs the historian to disrupt, but also needs the dialectical images to present the truth about the objects that comprise them. The Surrealists attempted to manage this difficulty through the elaborate obfuscation of their own subject positions. They got drunk, toked up, practiced automatic writing, sought dream states, and otherwise devised schemes to ensure the random selection and arrangement of objects in their works (Cohen, 1993). They attempted to dislocate their own subject positions in the act of ruining capitalist ideology. But their success in that endeavor is doubtful; the foreknowledge that they attempted to construct shocking, ideologically challenging works suggests prejudice from the outset.

Benjamin's solution is to freeze bits of historical trash in relation to each other by engaging them in a never-ending dialectic of extremes. He asserts that these objects

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exploration of occult, surrealistic, phantasmagoric gifts and phenomena presupposes a dialectical intertwinement to which a romantic turn of mind is impervious" (Benjamin, 1978, p. 189).

select themselves by failing enlistment in any progressive narrative, and that the materialist historian's intervention is a public juxtaposition that awakens the living and the dead (contemporary sleepwalkers and latent historical objects). Susan Buck-Morss observes this tactic and maintains:

> The dialectical image is a way of seeing that crystallizes antithetical elements by providing the axes of their alignment. Benjamin's conception is essentially static…He charts philosophical ideas visually within an unreconciled and transitory field of oppositions that can perhaps best be pictured in terms of coordinates of contradictory terms…. (Buck-Morss, 1991, p. 210)

The weakness in the "essentially static" quality of Benjamin's dialectical image is also its strength. Its emergence is startling, but brief. It can't loiter long enough to hitch a ride on a narrative or be grafted into an ideology, and if it does, then its dialectic wasn't irresolvable in the first place. Plate (2005) argues that Benjamin extends his dialectic by finding "binary" stars in his constellations; that even what initially appears to be an individual historical fragment, is, on closer inspection, two distinct and distorting fragments. Symbol and allegory, metaphor and metonym, and collection and dispersal are some of the conceptual binary stars in the larger constellation of Benjamin's work. But does endlessly destroying and collecting fragments really destabilize a historian's subject position?

It might, if it could be an infinite process—enter Benjamin's engagement with mysticism—but Benjamin offers another possibility. In *The Origin of German Tragic Drama,* he argues that "Truth, bodied forth in the dance of represented ideas, resists being projected, by whatever means, into the realm of knowledge. Knowledge is possession" (Benjamin, 1977, p. 29). So if we take him at his word, the truth of dialectical images can be empowered by historical practice, but not grasped by any historian (or anyone at all, for that matter). The historian's position gestures to the truths in history's debris field, the two are completed in their incompleteness, and each is never quite in possession of the other. Knowledge and truth become another binary star, inseparable but distinct, as do the historian and history.

History on the Street

Benjamin is not so much infatuated with psychoanalysis as he is taken with treating its tenets constellationally. He rips them from the domain of individual consciousness and uses them to inform his own notions of shock, consumer behavior, and urban space (Roff, 2004; Benjamin, 1997).[26] Within these notions lurks the political potential for Benjamin's approach to historical materialism and the relevance of his ideas to a discussion of radar as medium. A mythological understanding of radar positions it in progressive technocracy, in a home that presently seems quaint and rundown when compared to radar's still phantasmagoric successors. But as a dialectical historical materialist I select unknown and forgotten extremities in radar history, arrange them in a kind of public curio cabinet, and enable their emergence in constellation.[27]

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[26] Theodor Adorno's letter to Benjamin, dated June, 1935 reveals something of the politics of Freud in Marxist circles in the 1930s. Soviet Marxists had come to regard Freud and psychoanalysis as bourgeois, and had instead avowed Ivan Pavlov's behaviorism. Adorno writes, "Perhaps without being aware of the fact…you find yourself in the most profound agreement with Freud; there is certainly much to be thought about in this connection."

[27] Penske's (2004) description of Benjamin's method suggests its junctions with both Freud and Marx: "The transmutation of wish images into dialectical images is only possible through a temporal arrest in

The intention to shock, and particularly Freud's notion of shock as a traumatic penetration of the unprepared conscious mind, is central to Benjamin's historical practice.[28] Devoid of comforting chronology, the dialectical image is to estrange the present from its lulling ideology, to reveal that the veneer of progress hides the banal repetition of commodity culture and open the possibilities for an alternative worldview (and world). At the same time, Benjamin's shocking historical object points to his philosophy of language in a manner that clarifies its similarity to Freud's discussion of repression and dream images. Benjamin reasoned that words and historical objects were both dialectical images, and that therein they were also archaic images, images through which an ancient, allegorical, and pre-mythological existence could be accessed (and for the purpose of disrupting capitalism and actualizing his version of socialist utopia in the present). For Benjamin, even modern, linear, and sequential script, the medium inexorably woven into the prosaic and progressive rationality of the Enlightenment, is hieroglyphic (Mette, 1931). Where Freud sees repression, Benjamin sees an impoverished social collective.[29]

The fundamental difficulty with Benjamin's politics lies in the fact that flâneurs, the somnambulist consumers that Benjamin describes as having surrendered to the

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which the dreamlike illusion of historical progress is shattered, and revealed as the hell of repetition" (p. 191). Benjamin himself wrote, "The realization of dream elements in the course of waking up is the canon of dialectics. It is paradigmatic for the thinker and binding for the historian" (Benjamin, 1999, n4, p. 464).

[28] The connection between Freud and Benjamin is clearest in the comparison of Freud's 1921 essay, "Beyond the Pleasure Principle," with Benjamin's "On Some Motifs in Baudelaire." Freud, for his part, was theorizing soldiers' experiences of shell shock during World War I.

[29] See Benjamin's essay, "Books by the Mentally Ill" in Benjamin, W. *Selected Writings: Volume II,* for a thorough discussion of the linguistic connections between Benjamin and Freud.

"intoxication of the commodity" around which they surge, are accustomed to the spectacular presentation of ostensibly endless commodities (Benjamin, 1997, p. 55).[30] Immersed in a culture that presents many objects as enlarged to show texture, as commodities, flâneurs cope through voyeuristic disinterest. Like sleepers who resist waking for fear of losing a splendid dream, they entertain contradiction and astonishment only to the degree they can assimilate and/or forget them. Some years after Benjamin's observations, Horkheimer & Adorno (1972) elaborated the industrial logic of the somnambulist consumer. Writing of media productions in a way that applies to commodities generally, they maintain that in our commodity culture, "No independent thinking must be expected from the audience," (p. 137) so that consumers will prefer "a flight from a wretched reality" (p. 144) over political action.

The task for Benjamin's historian, then, is to present dialectical images with such force and in such a manner that they penetrate the alienated flâneur's malaise. Attempting to do so is a dangerous venture, as capitalism routinely digests radical disjuncture, or failing that, marginalizes it beyond political efficacy. Baudelaire's battles with pen and paper are appropriate here, as Benjamin describes him as a fencer whose blows "are designed to open a path through the crowd for him," for "it is the phantom crowd of the words, the fragments, the beginnings of lines from which the poet, in the deserted streets, wrests the poetic booty" (Benjamin, 1968, p. 165). Benjamin would

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[30] Benjamin's discussion of flâneurs is taken from his reading of Charles Baudelaire's *Les Fleurs du mal, Spleen de Paris,* and other works. Referring to a passage in *Spleen de Paris,* Benjamin writes that "it tells us about the close connection in Baudelaire between the figure of shock and contact with the metropolitan masses. For another, it tells us what is really meant by these masses. They do not stand for classes or any sort of collective; rather, they are nothing but the amorphous crowd of passers-by, the people in the street" (Benjamin, 1968, p. 165).

wrest the living poet from the prose consumer trapped in the endless, hellish repetition of “progress.” In classical Marxist form, he would liberate them from their own alienation; he would wake them from their dreams.

Benjamin’s attribution of architectural power to the commodity, his assertion of a relationship between intoxicating commodities, architecture, and the movement and placement of people, underlies much of his historical analysis of the Paris Arcades (Cohen 2004; Benjamin, 1999). He therein elaborates on the ideological construction and arrangement of urban space, its favoring of particular behaviors and bodies occupying definite spaces, and its cumulative construction of a commodity sensorium. His analysis of the ideological qualities of spaces invites a discussion of logistics, controls, and media that preserve and extend them. The conversion of an unruly mass that would storm the Bastille into a collision-free flow of commuter traffic is principally a result of physical and virtual architectures and technologies. Consequently, the denaturalization of such spaces and their inhabitants can be accomplished through the disruption of such mythologized architectures. Hijacking a plane, flying it through New York City, and crashing it into the World Trade Center is one way to affect such a disruption.

Emergent Debris

A survey of radar’s historical debris field reveals that a historical study of radar’s ruins is further justified through its potential to disrupt present understandings of media and their uses. The dross includes such oddities as rope-guided torpedoes, searchlights, carousel platforms, war horns, failed death rays, Libyan Desert Glass, as well as the 9/11 attacks, pop culture artifacts, and the sundry contents of 47 boxes from the Historian's Office at MIT's Radiation Laboratory.[31] The dialectical arrangement of such oddities, when juxtaposed with the mythic conception of radar as one technology in a progressive series, allows the *now* to emerge and momentarily deform the *present*. In this way, all-too-familiar media practices and processes are estranged and the dominant ideologies they perpetuate are contested.

Conventional radar is an "old" medium when compared to today's orbital surveillance systems and infrared monitoring devices, but the continuing relevance of detection and ranging technologies to control and extend ideological space is considerable. At important historical moments radar has been implemented to protect transportation systems from nature, detect enemy submarines, airplanes, and missiles, identify vessels bearing illegal immigrants and would-be drug traffickers, and track both tornadoes and commuters. Nevertheless, my reading of the detritus of radar history contends that while it facilitates the "ordering" of modern society and its spaces it simultaneously courts their collapse and catastrophic demise.[32]

But what of the *present*? What exactly is being contested?

In a post-9/11 world it has become modish to refer to the United States as a "state of emergency." News sites on the Internet feature a terror alert indicator developed by the Department of Homeland Security, a sort of DEFCON (Defense

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[31] Specifically from RG 227 at the Northeastern Regional Branch of the National Archive in Waltham, MA.

[32] Although I mean "ordering" in this instance in the sense used by Heidegger (1977), my emphasis on the dialectical is not clearly presented in Heidegger's work.

Condition) indicator for consumer tastes, an indicator formerly reserved for NORAD's assessment of the imminence of nuclear war. Terror survival handbooks, like the family fallout shelter manuals of the cold war, depict suburban mise en scène complete with HAZMAT (Hazardous Material) suits, plastic wrapped windows, and packages of camping food. Newscasts and pundit shows note the dangers of suitcase bombs, insecure borders, sleeper cells, and Mother Nature before cutting to commercials for quasi-military sport vehicles and psychotropic drugs. The hurricane is coming! The terrorists are listening! Anthrax is in the mail! Bird Flu is in the nuggets! Swine Flu is on the door handle! The tomatoes have salmonella! Iraq has WMDs! Asteroids are approaching earth! President Obama is a Muslim and his birth certificate is missing! We have received an undisclosed threat! In the *present*, wall-to-wall coverage of imminent demise bombs the eyeballs and eardrums of morbidly curious Americans.

Yet there is little that actually emerges, in a Benjaminian sense, in our so-called state of emergency. “State of prediction,” “state of forecasting,” and “state of spectacle” are more accurate descriptors of the *present*, as prognostication, punditry, and “what if?” fear mongering are deployed in the name of progress, while progress itself is defined in capitalistic and nationalistic terms (McLaren & Martin, 2004; Brown, 2003; Magder, 2003).[33] *Emergency*, something arising that has not always already been anticipated, commodified, quantified, and squirted into a 12 oz can, something carried on in a one-quart Ziploc bag, is exactly what cultural industrialists and their ultimate

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[33] Schirato and Webb (2004) apply the notion of spectacle to media coverage of the 9/11 attacks and the war on terror. For a thorough discussion of the modern spectacle, see Crary (1999) and Debord (1994).

products, consumers, want to avoid.[34] The emergent *now* terrorizes, if it is not in some instances a terrorist, and so the gust of consumers through capitalist architecture in the *present* is funneled by a variety of air marshals: Glenn Beck, Rush Limbaugh, Pentagon censors, cell phone interceptors, those federal officers on the plane, and radar operators. Decidedly, the *present* uses the threat of emergency in an attempt to sustain a state of non-emergency.

Progressive Catastrophe

The significance of such an attempt and of the technologies, architectures, and media that support it are at the intersection of Benjamin's conception of commodity space, Virilio's (2005; with Lotringer, 1997; 1991) theorizations of speed, space, and cybernetics, and other theorists' understandings of modernity wherein the compulsion to progress beckons catastrophe.[35] Virilio is especially important to the present effort, as he argues that modern spaces, including the spaces populated by and constructed for Benjamin's stream of consumers, are imploded, exploded, and fragmented by the technologies that would supervise them. He declares that because of these technologies, "ubiquity, instantaneity, and the populating of time supplant the populating of space" (Virilio, 1991, p. 119). Consequently, he believes that high-speed media implemented to oversee spaces and progressive ideologies have effectively

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[34] I am here advancing the argument of the technological non-revolution as first articulated by Horkheimer & Adorno (1972), but more recently updated by Lacroix (1997), Robins & Webster (1999), and Andrejevic (2004).

[35] In other words, we do live in a "state of emergency" in the sense that paving a road produces a pothole (or rather, the opposite—a pothole produces a road).

squashed them. For him, sight has become touch.[36] Collisions with “others,” disruption, and wreckage are posited as the inevitable results, as are the kind of ruined objects Benjamin’s historian would arrange.

These commonalities between Benjamin and Virilio prompted Kellner to observe that, “To some extent, Virilio exemplifies Walter Benjamin's theory of illuminations and fragments, that constellations of ideas and images could illuminate specific phenomena and events” (Kellner, 1999, p. 121). More generally, both theorists find virtue in breaks and disjuncture, in fissures and absences, and avoid systemic theorizing. But Benjamin’s most poignant contribution is a point of divergence from Virilio: Benjamin, à la Brecht, strategizes ways to relentlessly rearrange the debris into images for social transformation. Despite his nuanced understanding of the physics of communication and the logistical qualities of media, Virilio sometimes settles for straightforward dichotomies: technological-natural, virtual-real, technocratic-technophobic, progressive-catastrophic, explosive-implosive, fragmented-whole, passive-active (Virilio, 1997).[37]

The speed of technologies, and specifically of electronic media, shapes Virilio’s understanding of progressive modernity. For him, the extreme speed of cybernetic technology has made the human body torpid and social movements (which he finds

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[36] Virilio writes that in this circumstance, “The function of the eye becomes simultaneously that of the arm. The ancient astronomer’s glass and Galileo’s telescope are replaced by the telescoping of a nearly instantaneously inflicted destruction” (1991, p. 130).

[37] Although a thorough comparison of Virilio’s idea of critical space with Benjamin’s description of technē in “The Work of Art” essay is beyond the current effort, they both find disruption in the time-space nexus.

inseparable from physical movements) inordinately difficult (Virilio, 1986).[38] In Virilio's world we are suppressed by our own inventions; as it were, strapped in, buckled down, air conditioned, ergonomically incarcerated, and reduced to pushing buttons while modernity flies by its instruments.[39] And considering modernity's ever-increasing velocity, he finds any attempt to surmount technologies daunting. It's like reaching for the ejection handle in an SR-71—one of the fastest and most difficult to turn aircraft ever made—while pulling 6 Gs. In the final analysis, sufficient speed makes anything a weapon:

> Speed is violence. The most obvious example is my fist. I have never weighed my fist, but it's about 400 grams. I can make this fist into the slightest caress. But if I project it at great speed, I can give you a bloody nose…As Napoleon said, "Force is what separates mass from power." (1997, p. 37)

For Virilio, speed is the unexamined element in political, physical, and military power. It permeates industry, class distinctions, and biology.[40] It is also a meta-medium of perception, what Virilio calls the dromoscope (2005). In a manner reminiscent of Schivelbusch's (1986) description of panorama and the mediating train car window, Virilio discusses the seventh art (that of the dashboard) and applies it to the appearance

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[38] In this regard Virilio views are similar to those of his fellow Frenchman, Michel de Certeau in *The Practice of Everyday Life* (1988).

[39] Herman Goering, whose rheumatoid arthritis made him a pilot instead of a foot soldier during World War I, said, "Risk—but in comfort!" In the *Arcades Project* (1999), Benjamin describes the bourgeois interior as a cockpit: "Ever since the time of Louis Philippe, the bourgeois has shown a tendency to compensate for the absence of any trace of private life in the big city. He tries to do this within the four walls of his apartment. It is as if he made it a point of honor not to allow the traces of his everyday objects and accessories to get lost….In the style characteristic of the Second Empire, the apartment becomes a sort of cockpit. The traces of its inhabitant are molded into the interior" (p. 20).

[40] On this point Virilo comments, "We must politicize speed, whether it be metabolic speed (the speed of the living being, or reflexes) or technological speed. We must politicize both, because we are both: we are moved, and we move. To drive is also to be driven…Speed is not considered important. Wealth is talked about, not speed! But speed is just as important as wealth in founding politics. Wealth is the hidden side of speed and speed the hidden side of wealth" (1997, p. 35-36).

of modern reality itself: As driver-directors we sit before our windshield-easels and adjust our scene-speeds with our motor-projectors. We are both actors *in* and producers *of* our own perceptions. Therefore he insists that, "Between the audiovisual media and the automobile (that is, the dromovisual), there is no difference; speed machines, they both give rise to mediation through the production of speed…." (2005, p. 116).

And so it is that forecasting, conjecture, and other forms of technological divination steer somnambulist consumers around pot holes and obstructions, around the emergent and ruined. Reports of shoe bombs, severe weather warnings, and insurgent unrest appear on the horizon, rush toward us, and then shrink in our rearview mirror. But it is our encapsulating technologies that are in motion (Virilio, 2005). That our "progress" is only movement is mostly realized at moments of catastrophe, of collision. Amidst the wreckage we can realize that trees are more than a green blur, that modernity is material, that our odometer is ideological. We routinely observe our trajectory but only reflect on its meaning after we smash into something external: 9/11 precedes the commercial airliner, The Suez Canal crisis is in advance of radar, Hiroshima comes before fission, the Titanic beckons the iceberg, and voting irregularities herald the vote. Minerva's Owl takes time to land.

Virilio's thinking in this regard is a twist on Aristotle. Virilio suggests that:

> In classic Aristotelian philosophy, substance is necessary and the accident is relative and contingent. At the moment, there's an inversion: the accident is becoming necessary and substance relative and contingent. Every technology produces, provokes, programs a specific accident. (1997, p. 38)

Virilio’s point underlines my central assumption—those who look for meaning draw constellations in the debris.

Deflecting Attacks

By my own criteria, the otherwise throwaway quote in footnote 21, above, has disruptive force in my narrative. I’ve prepared my own criticism: “Criticism needs no motivation, any more than an experiment does, which, in fact criticism undertakes to perform on the artwork by unfolding the work’s reflection…The legitimation of criticism…consists in its prosaic nature. Criticism is the preparation of the prosaic kernel in every work” (Benjamin, 2004, p. 178).

As fellow Frankfurt School thinker and author of *The Culture Industry* (2001), Adorno repeatedly pointed out, Benjamin’s historical materialism is an eddy well out of the main current. Benjamin rejected the fundamental notion that culture—superstructure— is a reflection of the economy—base. In the *Arcades Project,* he faced his heterodoxy directly and wrote that, “the expression of the economy in its culture will be presented, not the economic origins of culture” (Benjamin, 1999, n 1a, 6, p. 440). Benjamin’s reasons for placing economy and culture in dialectic were intrinsic to his method, as he, “understood that the formal elements of a cultural product were as important as the ideology that Marxists saw reflected in its content.” For Benjamin, “Form embodied and transmitted the logic of an economic system as much as content” (Schwartz, 2001, p. 463).

Benjamin’s unorthodoxy on this point is discernible everywhere in his approach, from his willingness to make use of the bourgeois Freud and his individualist and idealist states of consciousness, to his willingness to find revolutionary potential in the very habits of the flâneur. Even the technologies and artifacts of mass culture, the gears and scaffolding of Adorno’s culture industry, could be points in Benjamin’s dialectical image. Benjamin bypassed most discussions of class and economic inequality—discussions prevalent amongst his Frankfurt School colleagues—and went right for fetishized commodities, consumer behavior, and architectures of ideology. Benjamin was there with the bourgeois collectors, buying kitschy commodities, and clearly fascinated by the phantasmagoria.[41]

Nevertheless, Benjamin, like Carl Jung, attempted to adapt Freud’s individualistic observations to the social collective (or mass), and to his own notion of “collective dreaming” (a notion that resembles an enduring Marxist critique—that collective dreams are expressed in commodities). Benjamin found opportunity in the masses and their consumerism: “Capitalism was a natural phenomenon with which a new dream-filled sleep came over Europe, and through it, a reactivation of mythical forces,” (Benjamin, 1999, k 1a, 8, p. 391) and his historian was to practice a “technique of awakening,” a technique enmeshed in the peculiarities of the masses mythologized consciousness (Benjamin, 1999, k1, 1, p. 388).

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[41] Adorno’s puzzlement with his friend’s habits and tastes comes through in a quote from Anne Friedberg’s *Window Shopping: Cinema and the postmodern society* (1994). According to Adorno, Benjamin was, “drawn to the petrified, frozen or obsolete elements of civilization…[S]mall glass balls containing a landscape upon which snow fell when shook were among his favorite things” (p. 49).

While at first blush objecting to Benjamin's historical materialism might seem like a proper game of tag, the underlying issue is serious: *after all the fancy dancing, is Benjamin really embracing the historicism he avows to despise? Is his historian a bourgeois collector? A psychoanalyst of history? An ineffectual Surrealist? A victim of his own false consciousness, wandering through Paris?* These are serious indictments of the efficacy of Benjamin's entire project. They suggest that, declarations of revolutionary social change to the contrary, his approach lacks the power to disrupt the *present* with the *now.*

The demythologizing force of Benjamin's approach is either experienced, or it is not. And while unconventional, Benjamin's (and my own) notions of identity and history are anything but historicist. They are dialectical, jumping from the past to the present like so many strips of forgotten film cut together, like so many extremes forced into a frame. And as the film continues, I intend to bring the audience to question the lights, darkness, seating, arrangement of bodies, and the theater itself. In this way, I expect the presentation of history to demythologize, and part of that is my intention to get beyond the merely surreal. As Benjamin wrote of the Surrealists Louis Aragon and André Breton, "Whereas Aragon persists within the realm of dream, here the concern is to find the constellation of awakening…here it is a question of the dissolution of 'mythology' into the space of history" (Benjamin, 1999, n1, p. 9).

The criticism that Benjamin's approach depends on urban environments has some merit. The politics that Benjamin engages are on display there, and he poured the essence of his critique into Paris when he referred to Paris as, "Paris, capital of the 19th century"[42] (Cohen, 1993, p. 203). Benjamin's flâneur is an ideal type that experiences the city and its wondrous techniques of display (Schwartz, 1999). Buck-Morss seems to frame Benjamin's approach within urbanization when she frames the possibilities of his politics as, "Could the metropolis of consumption, the highground of bourgeois capitalist culture, be transformed from a world of mystifying enchantment into one of metaphysical and political illumination?" (1991, p. 23).

There is something to the idea that Benjamin's historical method is restricted to the city; that is, if it is accepted that "modernity cannot be conceived outside the context of the city" (Schwartz, 2001, p. 467). The logic of the city—the logistics of modernity, of Wiener's atomic cities, of the Tabernacle—while still connected to literal architectures and astonishing displays, is not limited to them. Georg Simmel expressed with exactness the argument I am making when he asserted that the experience of modernity was, "the rapid crowding of changing images, the sharp discontinuity in the grasp of a single glance, and the unexpectedness of onrushing impressions" (Simmel, 1964, p. 410). The film-like, fleeting movement of images and objects is the defining marker of modernity, and radar has everything to do with it. Schwartz's (2001) description of Benjamin's method synthesizes:

> Benjamin's notion of history envisioned it as centrally concerned with awakening. This is a key rupture and one of interest to historians, because Benjamin's materialism led him to the archive, which he thought the essential tool through which history would replace mythology. The most literal archive already mined by scholars inspired by the *Arcades Project* has been that relating to the modern city. (p. 465)

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[42] Schwartz (2001) adds that this phrase of Benjamin's has, "come to represent a trajectory of scholarship in which the city has become the crystallization of both modern mythology and history" (p. 466).

There are, of necessity, other criticisms that can be leveled at my project. A major one, that *while I have described Benjamin's method and its roots, I haven't held forth on my notion of dialectical modernity or radar's place in it,* is tackled in my next chapter, *Authoritarian Modernity*. In that chapter, I consider modernity as it collides with Virilio, Mumford, Weber, Lyotard, Deleuze & Guatarri, and others. My notion of modernity also springs from their observations, and from my circumscription of their work within my notion of logistical media. Benjamin is not left behind in *Authoritarian Modernity*, but there is a red shift as I move away from him and toward more obviously militarized aspects of modernity. My pitch lowers as I race past.

Virilio, in particular, is valuable in excavating the visceral ruins in radar's history. Like Benjamin, Virilio's modernity is a city, and also a city in the abstract. But where Benjamin, in the *Arcades Project,* has a vision of capitalism and the transformation of culture from 19th century production to 20th century consumption, Virilio sees the battlefield preceding the marketplace; modernity's images and objects are projectiles. For him, the city is a concentration of such, a concentration camp and fort. In answer to a question concerning the city as a testimony to "the human species' capacities for concentration," Virilio clarified that:

> There are two great schools of thought on urban planning: for one, the origins of the crystallization of the city, of urban sedentariness is mercantilism; for the other—the minor one, with Philip Toynbee—it's war, commerce only coming afterward. Obviously I find myself in the minority, which claims that the city is the result of war, at least of preparation for war. (Virilio & Lotringer, 1997, p. 11)

Benjamin's ruins are Virilio's wreckage; where Benjamin sees astonishing images and marvelous displays, Virilio sees tracer fire.

CHAPTER 3: AUTHORITARIAN MODERNITY

I now elaborate what I mean by *modernity*. This chapter and its predecessor both treat modernity and radar in theoretical terms, but while *Dialectical Image* made a case for a Benjaminian method, this one details aspects of modernity that will help you understand the historical objects that follow. It covers a wide range of thinkers—from Lewis Mumford and Norbert Wiener to Harold Lasswell and David Riesman (and many others besides). The main topics are: 1) Authoritarian modernity, 2) Cybernetics, 3) A politics of distance, speed, angle, movement, and perception (what Virilio calls *the politics of the oblique*), and 4) A side-by-side consideration of Virilio and Kittler. As I speed through these topics, I focus on modernity as dialectical and authoritarian technical civilization wherein radar has both progressive and catastrophic potential.

While the Benjamin-Virilio nexus is critical to my Jekyll-Hyde conception of modernity, other theorizations of history, technology, and the modern experience also engage the discourses of mass management and catastrophe. These theorizations are not wholly compatible with Benjamin or Virilio, or even with each other, but they do demonstrate a deep and enduring investigation of modernity. As I demonstrate, Baudelaire's micro-level description of "the figure of shock and contact" (Benjamin, 1968, p. 165) being jostled by the teeming Parisians has its macro complement in Lewis Mumford's declaration that "the age that we live in threatens worldwide catastrophe, but it likewise holds forth unexpected hope and unexampled promise" (1951, p. 3). Technology, which is frequently invoked as the *deus ex machina* of all quandaries modern, is also spawning its gremlins. What is packaged as triumph can materialize as terror, and not only on Benjamin or Virilio's terms.

New technologies are often understood in terms of technologies that have already been situated by political, economic, and social forces. Whether early cinema is understood as moving photograph, cars are understood as horseless carriages, or DVD players are understood as digital VCRs, the tendency to structure and envision technologies as logical extensions of their predecessors is strong. It's almost as if new technologies are perceived as sequels to old technologies; we follow what's happening in the "sequel" because we've already experienced the "original." And so we rarely grasp what technologies are themselves until moments of catastrophe or collision. The events of September 11, 2001 could not have happened without such "progressive" technologies as the Internet, TV, airliners, and jet fuel. But to extend this argument, the "progressive" march of technology also blurs distinctions between accidents and attacks (for example, we increasingly wonder why technology was not in place to prevent the tsunami disaster of December 2004 or the Sichuan earthquake of May 2008, and then start an investigation to determine who is responsible for the deaths).

Authoritarian Modernity: Mumford and Weber

Mumford's theory of technics, of technologies that encourage "radical transformation of the environment and the routine of life," (1934, p. 3) avoids determinism by placing "ordered" but overlapping institutions, ideologies, and bodies as prefiguration of our modern machine civilization.[43] Mumford considers technology a means of production, and traces materialist history through successive technological complexes (Mumford, 1934). In *Technics and Civilization*, Mumford writes that:

> Looking back over the last thousand years, one can divide the development of the machine and the machine civilization into three successive but over-lapping and interpenetrating phases: eotechnic, paleotechnic, neotechnic…Each phase has its specific means of utilizing and generating energy, and its special forms of production.[44] (1934, p. 109)

Mumford is interested in the foundations of culture and its interconnections with capitalism and warfare. He maintains that “The gun was the starting point of a new type of power machine: it was, mechanically speaking, a one cylinder internal combustion engine” (p. 88). He elaborates the military roots of mass production and consumerism, and observes that “An army is a body of pure consumers. As the army grew in size it threw a heavier and heavier burden upon productive enterprise” (p. 93). Even in 1934, Mumford’s conclusions on these points anticipate Virilio’s work of four decades hence: “The army is in fact the ideal form toward which a purely mechanical system of industry must tend” (p. 89).[45]

Mumford tracks modernity back to medieval Benedictine monasteries and the beginning of the modern clock, a clock modeled after the ordered lives of the monks. He sees in that instance the ideological arrangement of bodies and the measurement of

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[43] Mumford preferred the term “technics” to “technology” because he wanted to emphasize their interaction with humans and their social and historical situatedness.

[44] This is not to say that Mumford’s perspective is predominantly Marxist. He was more influenced by “Plato, Ruskin, Morris, Tolstoy and Kropotkin” than he was by Marx and Engels (Miller 1989, p. 99).

[45] British intellectual Anthony Giddens concurs. He states that “Whether we like it or not, tendencies toward totalitarian power are as distinctive feature of our epoch as is industrialized war” (1985, p. 310).

time as necessary precursors to modern cities, technological architectures, and life. With a nod to Max Weber's (1998) theorization of modern bureaucracy, Mumford argues that human habits of order preceded the ordering habits of less biological mechanisms. Bell towers eventually externalized the clockwork movements of the monks, with time keeping morphing into time serving, accounting, and rationing. The clock-like attributes of modern media and architectures that coordinate movements, like radar, sweep invisibly through such claims as:

> One is not straining the facts when one suggests that the monasteries—at one time there were 40,000 under the Benedictine rule—helped to give human enterprise the regular collective beat and rhythm of the machine; for the clock is not merely the means of keeping track of the hours, but of synchronizing the actions of men. (Mumford, 1934, p. 13-14)

Mumford suggests that the Benedictine beats and rhythms anticipated modernity, including its tensions. He believes that, "The tension between small-scale association and large-scale organization, between personal autonomy and institutional regulation, between remote control and diffused local intervention, has now created a critical situation" (Mumford, 1964, p. 5-6).

Mumford's later work is preoccupied with the technological micromanagement of society and the remote and "invisible" aspects of control that complicate attempts to challenge and transform it.[46] According to Mumford, *invisibility* intensifies remote control:

> There is no visible presence who issues commands: unlike Job's God, new deities cannot be confronted, still less defied....The ultimate aim of this [authoritarian] technics is to displace life, or rather to transfer the attributes of life to the

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[46] Computer architecture, in that its fundamental unit is the command, is a kind of invisible backbone to Mumford's discussion of authoritarian technics.

> machine and the mechanical collective, allowing only so much of the organism to remain as may be controlled and manipulated. (1964, p. 5-6)

Mumford develops this “transfer” of living attributes to machines in spatial terms. On the macro-level, he sees the transformation of the democratic city (metropolis) into what he calls the *authoritarian megalopolis* and the Virilio-esque, *necropolis* which is mostly occupied during the work day, and in which few people reside (Mumford, 1973; 1961).

There are parallels between Mumford’s discussion of technological micromanagement in the megalopolis and theories of the *information society*. The tug of war playing out in discussions of the authoritarian and democratic possibilities of the Internet (for example, Vaidhyanathan 2004; Rheingold, 2002; Robins & Webster 1999; Dyer-Witherford, 1999) was anticipated in Mumford’s treatment of the politics of the *invisible city*. Referring to the network of technics that map his invisible city, he perceives that, “The new grid, in all its forms, industrial, cultural, urban, lends itself to both good and bad uses” (1961, p. 642). The geometry of empire is in some aspects invisible. Radar is one of the technics comprising its grid.

For Mumford, micromanaging, authoritarian technics compromise “natural” space in ways that destabilize territorial borders, even those of the nation state, and tend toward war. In Mumford’s scenario, information systems and storage media become a kind of territory for the symbolic; digital information encloses and outpaces the humans who organize (and are organized by) it. Thereafter Mumford predicts a cascade of difficulties: *Territory itself threatens to destabilize. The military-industrial complex uses this threat to ratchet up its authority and justify the expanded use of* *authoritarian technics. That expanded use sows the seeds of further destabilization. The military-industrial complex obliterates the line between information market and battlefield and the collision-prone citizen-consumer cannot be distinguished from the soldier* (Mumford, 1940).[47]

Mumford is not alone in attempting to discern connections between human practices and technologies. Max Weber's *The Theory of Social and Economic Organization*, is also critical to understanding modernity as mythologized and ordered. For Weber, modernity's capitalism, specialization, and bureaucratic practice have all coincided with a rampant, excessive rationality. Weber argues that rationality legitimates modernity's major divisions—*labor, authority, society*. Moreover, he suggests rational, disciplined exertion and protocol have become a drive for mastery that can be observed in relationships between technology and society. "The active orientation to mastery is very clear in our valuation of technological achievement, and in our attitudes toward social reform," wrote Talcott Parsons in an assessment of Weber's work (Weber, 1947, p. 81-82). In Weber's thinking, the orientation to mastery, while seeming to free modernity from the chains of the magical and irrational, in fact encloses it in a "polar night of icy darkness," in an "iron cage" of rationality (Weber, 1994, p. 368).

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[47] Although Mumford posits that these difficulties almost cyclically intensify because of the consistency of human-technic interactions, like other scholars (i.e. Dewey, Kittler, and Virilio) he finds the mass mobilization of industry and consumers for World War I a distinctive step toward technological totalitarianism. He writes that, "until the outbreak of the First World War, and the faith that had equated technological with human improvement was undermined, indeed, badly shattered by the realization that all the potentialities of evil had been augmented by the very energies technics released. The first intimation that a new megamachine was in fact being assembled came only after the First World War, with the rise of the totalitarian states, beginning with Soviet Russia and Italy" (Mumford, 1970, p. 244).

Weber argues that modernity is a triumph of the *zweckrational* (*zweck* means "aim, goal, or purpose") over the *wertrational* (*wert* means "value"). He makes it easy to visualize rationality, whether in the form of an all-too-real state bureaucracy or of the institutionalization of invention as technique, lend to his discussions of reification (of how the specific, material, institutional, and purposeful have displaced the general, ideal, and valuable).

You might be wondering how Weber and Mumford inform my understanding of Janus-faced modernity. In short, I argue that *the endless waves and interlocking forms of Weber's rationality bear semblance to Virilio's technologically-enabled implosion (concentration).* Moreover, I argue that *there is similarity between emergence from Weberian reification and Virilio's argument that the "reality" of the ship only materializes after the shipwreck.* By pressing Weber's ideas in the direction of compelled interactivity amidst coordinated rationality—of forced collisions with the sometimes contradictory and unknown bars of the "iron cage"—the constraints of modernity produce their own fissures and gaps. In this way, rationality compels Weber's passive modern subject to interactivity and I affirm a dialectical conception of modernity.

Although Weber never used the term *cybernetics,* he implicitly criticizes aspects of Wiener's cybernetics, of Wiener's "entire field of control and communication theory, whether in the machine or the animal" (Wiener, 1961/1948, p.11). For Weber the goal of seamless communication between humans and machines would be a manifest horror, a Frankenstein monster born of rationality itself. But for me, Mumford's early hopefulness for the neotechnic era, a hopefulness that breaks too cleanly from his gloomy depiction of the paleotechnic, has corrective potential (Mumford, 1934). Mumford's narrative of the clock is enmeshed with Weber's interests in Calvinist asceticism and obsessive efficiency, and also with Virilio's politics of speed. Mumford argues that "unquestioned faith in the machine has been severely shaken. The absolute validity of the machine has become a conditioned validity," and envisions such conditioned validity as arising out of disjuncture between machine culture and human needs and also out of a break between capitalism and rationality (p. 365). If Mumford (1934) is believed, Weber's iron cage may be weakening.

Still, Mumford's just-cited optimism, presented in the early 1930s amidst a crisis of capitalism, may be old-fashioned. His privileging of a technological shift to the neotechnic, to the minute, preventive, less destructive, and in effect more natural human experience, might seem out of place amidst contemporary issues of fission reactors, pharmacological behavior management, and genetically modified food. Mumford shares some of Virilio's romance for nature unmarred by authoritarian technics or logistics. But Mumford's optimism is measured. He maintains that the ideology and activities of progress are settling into a dynamic equilibrium. "Our machine system is beginning to approach a state of internal equilibrium," he writes, and then explains that, "Dynamic equilibrium, not indefinite progress, is the mark of the opening age: balance, not rapid one-sided advance: conservation, not reckless pillage" (1934, p. 429-430).

Even though Mumford's references to "rapid one-sided advance" and "reckless pillage" have a military flavor Virilio would appreciate, Mumford's notion of internal, dynamic balance has more immediate import. Where Mumford seeks internal balance, Virilio looks for external collision. Both posit a strong relationship between the technological and the social and find value in relative stasis (Mumford with his balance, and Virilio in understanding technologies in the wake of their wreckage). Both perceive the disconnection of modern technology and human needs and capacities, and posit that disconnection as a potentially catastrophic underbelly of modern life.

For Mumford and Weber it is difficult to overestimate "the technical and economic conditions of machine production which today determine the lives of all individuals who are born into this mechanism…" (Weber, 1998, p. 181). Their cocktail of remote control, invisibility, rational implosion, and expansive bureaucracy are important to my conception of authoritarian modernity.

Authoritarian Modernity: Lippmann & Lyotard

A consequence of most Americans' ballistic cruise through authoritarian modernity is a displacement of conventional politics through weakened state regulation, forced interactivity, and an affinity for "automatic democracy" (Virilio, 2000). Lippmann's (1922) appraisal of public deliberation as too plodding, too *deliberate*, for timely decision-making, is compelling. He decrees, "The rate at which reason, as we possess it, can advance itself is slower than the rate at which action has to be taken," (p. 260) and summarily concludes that "the practice of democracy has been ahead of its theory" (p. 239). Lippmann believes the telegraph's simplified, binary, and decontextualized messages can travel at a rate for necessary action in a democracy, but he envisions them within the grasp of the geographically-bound nation state.[48] The fact that media spaces would extend into and compromise geographic spaces, that they would defy the state's attempts to control them, exceeds his discussion.[49]

Jean-Francois Lyotard, a scholar best known for touching off the exhausted modernity-postmodernity debates with his slim tome *The Postmodern Condition* (1984), intimates that the state's declining ability to regulate is the upshot of the digitalization of knowledge and the technological power of transnational organizations (Gane, 2003). In Lyotard's thinking, speed, efficiency, and commodification are key attributes of current information systems. For him, these obscure boundaries between elected governments, the military, and industry, and no expanding, Weberian bureaucracy can foster clarity. According to Lyotard, knowledge is being simplified into information, data, bytes, and bits (summarily, into an electronic language of 1s and 0s), and the mythology of "progress" justifies this simplification at every level. Lyotard describes a journey from the unique qualitative to the standardized, cybernetic quantitative, from the analog to the digital (Gane, 2003).

Lyotard asserts that quantified, standardized, and calculated knowledge is an "informational commodity" valuable to nation states, industry, and the military alike:

> Knowledge in the form of an informational commodity indispensable to productive power is already, and will continue to be, a major—perhaps *the*

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[48] A case can be made for the telegraph as a digital medium in two senses: Manual (finger-tapping) and binary (key on, key off, 0 or 1). See Standage (1998).

[49] Which is not to say that Lippmann was entirely oblivious to issues of media and space. He contends that "A true conception of space is not a simple matter…In the drawing of boundary lines absurd complications have arisen…statesmen have at various times drawn lines on maps, which, when surveyed on the spot, ran through the middle of a factory, down the center of a village street, diagonally across the nave of a church or between the kitchen and bedroom of a peasant's cottage" (1922, p. 88-89).

> major—stake in the worldwide competition for power. It is conceivable that nation-states will one day fight for control of information, just as they battled over territory, and afterwards for control of access to and exploitation of raw materials and cheap labour. A new field is opened for industrial and commercial strategies on the one hand, and political and military strategies on the other. (1984, p. 5)

How is the nation state's regulatory power weakened? How are conventional politics displaced? Like Virilio, Lyotard believes that technology has compromised the geographic space of nation states. Nevertheless, Lyotard has a stronger hold than does Virilio on how access and commodification weaken nation state's regulatory power and displace conventional politics. He gives the following example:

> Suppose…that a firm such as IBM is authorized to occupy a belt in the earth's orbital field and launch communication satellites or satellites housing data banks. Who will have access to them? Who will determine which channels or data are forbidden? The State? Or will the State simply be one user among others? (Lyotard, 1984, p. 6)

The State needs a qibla compass and the ability to control access.[50] Nonetheless, nation states have reasserted themselves through appeals to patriotism in the face of dangers known and unknown, the endless construction and reconstruction of "others," expanding military and bureaucracy, and forecasting agendas. Although appeals to patriotism and fear are acute in a post-9/11 world, Lawrence (1997) observes that an apocalyptic approach to governance has a long history in the U.S. He notes that "In American history the rendering of danger has often taken a dramatic, eschatological form," and then quotes Campbell (1992) as saying "the apocalyptic mode—in which a

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[50] The State has found a way to allow astronauts orbiting the earth to vote. As National Public Radio reported on June 23, 2008, "Astronauts aboard the International Space Station are far away from the action in the presidential race. Luckily for them, NASA and Texas understand the unique needs of space-traveling citizens, who want their votes counted" (Greenfield, 2008).

discourse of danger functions as providence and foretells a threat that prompts renewal has been conspicuous in the catalog of American statecraft" (p. 105).

Eschatology is an odd sidekick for progress mythology, but in practice the one justifies the other. Categorizing assorted phenomena and persons as "dangerous" presupposes their placement in a sequential conception of history. Strange groups of people, powerful technologies, and events don't galvanize outside of broad ideological frameworks and shared information systems. Nation states need nationalism, or a sense of "imagined community" (Anderson, 1991) to maintain a body politic. They need the excluded to define themselves, and the metaphor of the "other"-as-deviant conjures images of both body politic and political body. Writing about the U.S., Campbell (1992) argues that, "The ability to represent things as alien, subversive, dirty or sick has been pivotal to the articulation of danger in the American experience" (p. 2). We create our enemies even as technologies bring them closer.

Authoritarian Modernity: Lasswell and Kovel

British Scholar Anthony Giddens suggests that Harold Lasswell's (1962; 1935) analysis of the *garrison-state* is crucial to an understanding of authoritarian modernity. In Lasswell's formulation, modernity is both cavalcade and concentration camp. For Lasswell, modernity is technologically supervised and compressed—spectacularly consumed—but the threat of official violence menaces. Giddens assesses the significance of Lasswell's notion of the garrison-state:

> Lasswell's analysis of the "garrison-state," originally formulated in the 1930s, reverses the usual type of thesis found in the social sciences. According to him,

> in the nineteenth century industrial organization and administrative rationalization pervaded the development of the European countries and the USA. But subsequently there has developed a trend towards "military-police dominance," which threatens to expand in the impending future. (Giddens, 1985, p. 245)

Kovel (1983, 1982/1983) notices the implications of military-police dominance for media. He advances the idea that increased military-police dominance enfolds 24-hour media networks into NORAD and global broadcasting into the hydrogen bomb. By Kovel's reasoning, geography-annihilating atomic weapons, surveillance, and descriptions of the military as a justice system can all be recognized as "the logical result of an entire attitude toward the world" (p. 131).[51]

For Kovel, a result of military-police dominance is the acceleration and mechanization of strategic conflict that accompanies the conversion of the visual into the tactile. "The technocrat peers out of his tower, sends killer satellites into orbit, arms his CIA, monitors the Other, and waits to get before he is gotten" (Kovel, 1982/1983, p. 157). In Kovel's terms, when the visual becomes the tactile, acceleration and mechanization ensure that shock and awe are visceral. Bombs, missiles, bullets, and torpedoes are the palpable broadcasts that follow the stage directions and scripting of less resolute information systems: radar, cameras, wiretaps, e-mail monitoring, the evening news, Sean Hannity's radio show. Bombs in this sense are highly-condensed information vehicles designed to be quickly absorbed, get mass coverage, have high

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[51] A recent, definitive example of the military's conflation with the justice system (and in this instance the rhetorical equation of justice and an exploded bomb) is in the comments of President George W. Bush following the execution of Al Qaeda operative Abu Musab al-Zarqawi. President Bush told the White House Press Corps that U.S. forces have "delivered justice to the most wanted terrorist in Iraq" ("'Zarqawi has met his end," Foxnews.com, June 8, 2006, p. 2).

ratings, and overcome audience efforts at adaptations. They are video news releases (VNRs).

Cybernetics: Gehlen, Crary, and Robins & Webster

Gehlen's (1980) interest in the subjugation of humans by technologies takes authoritarian modernity to a subtle level. He says subjugation happens when, "we look at cybernetics, to the theory of techniques of regulation, for clues to the working of our own brains and nervous systems" (p. 11). Therein Gehlen is interested in the context of human-machine interaction (although he does not use the terms), in the compulsory cybernetic architecture (hence "cybernetics" derivation from the Greek term "kubernētēs," for "steersman")[52] and people's place in it. He is more interested in subjugation-through-cybernetics than in media representations.[53]

Crary (1999) describes cybernetics as a quest for mastery and control. By his reasoning, cybernetics encloses society in capitalist ideology, and does so even as it is presented as "user control." In Crary's estimation, media and information technologies

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[52] In *Human Use of Human Beings* (1954), and in *Cybernetics: Or Control and Communication in the Animal and the Machine* (1961/1948), Wiener mentions that kubernētēs is also the source for the English word governor. In *Cybernetics* he writes that, "In choosing this term, we wish to recognize that the first significant paper on feedback mechanisms is an article on governors, which was published by Clerk Maxwell in 1868, and that governor is derived from a Latin corruption of (the Greek word for steersman)" (p. 11).

[53] Levidow & Robins (1989) connect cybernetics to what they call the *military information society.* For them, cybernetics "involves disavowing human qualities not so easily reducible—or, rather, redefining them according to computer metaphors. Through infotech, military models of reality appeal to widespread illusions of omnipotence, of overcoming human limitations, even as they conceal our relative impotence. Computer-based models of war, work and learning can promote military values, even when they apparently encourage the operator to 'think.' In all those ways, we are presently heading towards a military information society, which encompasses much more of our lives than we would like to acknowledge" (p. 150).

increasingly interlock for the “management of attention” and to construct “conditions that individuate, immobilize, and separate subjects, even within a world in which mobility and circulation are ubiquitous” (p. 74). Media convergence enabled by digitalization is the ideological-technical one-two punch for Crary, just as it is for Debord (1994).[54] The convergence of even “apparently-harmless” consumer technologies like television and the PC render “bodies controllable and useful simultaneously, even as they simulate the illusion of choices and ‘interactivity’” (Crary, 1999, p. 75). In this framework, Benjamin’s intoxicated, surging masses are mere objects of a comprehensive guidance system, or, considering the speed of their immobility, are self-guided missiles (Kittler, 1997).

Robins & Webster (1999) detail authoritarian cybernetics as well as its implications for information war and what they call “military information culture.” Like Crary, for Robins & Webster, the:

> Cybernetic model is not…simply a neutral, technical, phenomenon. It entails a particular concept of mind, of reason, of knowledge and skill, and it forecloses alternative conceptions. It privileges mechanistic over holistic thinking; cognition over intuition; calculative over deliberative rationality.[55] (p. 181)

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[54] Both thinkers are indebted to Michael Foucault’s (1979) work on Panopticism on this point. Foucault argues that we are “in the panoptic machine, invested by its effects of power, which we bring to ourselves: since we are part of its mechanism” (p. 217).

[55] Radical thinker Hakim Bey finds a kind of gnosticism in information culture, and even in science itself. He argues that “All science proposes a paradigmatic universalism—as in science, so in the social. Classical physics played midwife to capitalism, communism, fascism and other modern ideologies. Post-classical science also proposes a set of ideas meant to be applied to the social: relativity, quantum “unreality,” cybernetics, information theory, etc. With some exceptions, the post-classical tendency is towards ever greater etherealization. Some proponents of Black Hole theory, for example, talk like pure Pauline theologians, while some of the information theorists are beginning to sound like virtual Manichaeans” (1996, p. 2). Also, “Modern science also incorporates an anti-materialist bias, the dialectical outcome of its war against Religion - it has in some sense become Religion. Science as knowledge of material reality paradoxically decomposes the materiality of the real. Science has always been a species of priestcraft, a branch of cosmology; and an ideology, a justification of 'the way things are'” (p. 1).

Tension between authoritarian calculation and democratic deliberation is at the heart of Robins & Webster's theorizations. They assert that, historically, the predominance of calculation has fueled the scientific management of society, the growth of alienating modes of capitalism, and the empowerment of hyper-efficient and networked digital computers.

Robins & Webster understand F.W. Taylor's attempts to extend the calculative rationality of early 20th century capitalism beyond the workplace (i.e. "Taylorism") in a way that is reminiscent of Mumford's discussion of monastic clockwork. However, they also see an intensified division of mental and physical labor and the construction of closed, authoritarian information systems. They describe Taylorism as the collection of production knowledge by mental labor, the creation of measurable standards, systematic planning, and the propagation of surveillance. Robins & Webster argue that capitalism's "cybernetic imagination" is the efficient coordination of calculation, command, and control.[56] These are elements of authoritarian modernity.

Like Virilio, Robins & Webster argue that World War I was a crucial moment in the "industrialization of war," (1999, p. 153) and in the erasing of distinctions between civilian and soldier. But Robins & Webster also observe that digital information systems have increased in importance to such an extent that commodities and weapons can hardly be consumed without them. In many instances, such as a car being built, advertised, purchased, driven, crashed into a free-ranging cow, and salvaged, and a

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[56] On page 124 of *Times of the Technoculture*, Robins & Webster quote Marx (1976) on this point. They write that "Taylor aimed to concentrate all 'brainwork' in his centralized 'planning department.' It was with machinery, however, that this gathering in of skill and knowledge became truly systematic. Through technology we saw 'the separation of the intellectual faculties of the production process from manual labor, and the transformation of those faculties into powers exercised by capital over labour'" (p. 548).

radar-guided missile being proposed, assembled, launched, targeted, exploded, and broadcast on CNN, commodities and weapons are themselves information systems within larger systems. They are storage and decision-making media in their own right. Robins & Webster quote military historian John Erikson to the effect that information is the fundamental attribute of military operations:

> Modern military operations are not to do with weapons. They are to do with information, command, control….Information does things. It fires weapons. It tells them where to go. The signals network is the key thing….It's not about the muscle, the strong arm of the warrior. It is his nervous system that matters. Signals and communications. (1999, p. 155)

An emphasis on electronic signals and communications, if they can even be separated in the way Erikson does, reveals the tendency to define *communication* as calculable *information* (and therein communication systems as something akin to Shannon & Weaver's SMCR model). Robins & Webster conclude that this tendency undercuts political deliberation in favor of electronic projections and automatic responses. But this thinking, when drawn into the ruminations of Benjamin and Virilio, leads to even darker corners: the drive for certainty, for the mathematical ordering of quantified variables, multiplies uncertainty at every turn. Newton's mechanical universe of active and passive—of order—produces interactive chaos in quantification (and in quantumfication). The difference between information and noise is ideology; myth is a mill that grinds information from noise. What appears as a chain of events is actually "one single catastrophe which keeps pilling wreckage upon wreckage" (Benjamin, 1968, p. 258). Progress is a storm.

Cybernetics: Wiener

Shannon and Weaver's (1949) SMCR transmission model of communication systematizes *predictability* when refined by Wiener's (1961) addition of the *feedback loop*. *Feedback loops,* as conceptualized by the radar researcher and erstwhile communication theorist, clarify connections between efficiency, predictability, and information systems. For Wiener, investigating their relationship was necessary to forecast the position of enemy aircraft with sufficient speed so that slow bullets could hit fast planes. Today's fad marketers face the same problem, as demonstrated by the firing of products and ads into places targeted groups are certain to arrive—in bathroom stalls, on parking stall stripes, at the gas pump, at the World Trade Center, and on Facebook.[57]

Wiener, Shannon, and Weaver are behind the hardware and software of cybernetics. Much of the enduring logic of cybernetics, information theory, and issues of communication and control can be traced to them or to the musings of their colleagues John von Neumann and Alan Turing (Rheingold, 2000; Wiener, 1961; Shannon & Weaver, 1949). Their everyday relevance to communication studies is in the often superficially-employed transmission model of communication, in the discourses of technological utopia or dystopia, and as a bare template on which media effects are measured. Conversely, critical scholarship has assessed their work and legacy as positivist, bourgeois, hegemonic, technologically deterministic, sexist, and sometimes at odds with dialectical materialism (Dechert, 1966). But somewhere in the melee between

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[57] In the case of the World Trade Center, the targeted group is the commercial media, and through them, their audiences.

pedestrian acceptance and critical excoriation, the immediate context of their work—problems of communication and control in human-machine communication, automata, ballistics, cryptography, and broadly, national security—has been lost in the scrap heap of anecdote and footnote. Such oversight is of, quite literally, explosive proportions.

For his part, Wiener was aware of some of the social and economic consequences of his efforts (Conway, 2005). In *Human Use of Human Beings* (1954), he was troubled that the international and intranational communication network he was developing was coming online amidst the likes of Senator McCarthy, "the blind and excessive classification of military information," and "a secretive frame of mind paralleled in history only in the Venice of the Renaissance" (p. 112).[58] He also observed the possibility of mass unemployment in the face of an increasingly technological economy, warned of the exploitation of "the new tools to the extent that they appear to yield immediate profits, irrespective of what long-time damage they can do," and feared that "We shall see a process parallel to the way in which the use of atomic energy for bombs has been allowed to compromise the very necessary potentialities of the long-time use of atomic power…" (p. 161). Wiener's a long way yet from Mumford's (1970) or Robins & Webster's (1999) critiques of what I call authoritarian modernity, but by 1946 he was disillusioned enough with the U.S. military, the beneficiaries of his labors during

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[58] In his discussion of Venice of the Renaissance, Wiener (1954) asserts a relationship between secret information, nationalism, the "other," and a mythological construction of history: "[In Venice] the extraordinarily precise news-gathering services of the Venetian ambassadors (which form one of the chief sources of European history) accompanied a national jealousy of secrets, exaggerated to such an extent that the state ordered the private assassination of emigrant artisans, to maintain the monopoly of certain chosen arts and crafts. The modern game of cops and robbers which seems to characterize both Russia and the United States, the two principal contestants for world power of this century, suggests the old Italian cloak-and-dagger melodrama played on a much larger stage" (p. 112).

both world wars, to declare, “I do not expect to publish any future work of mine which may do damage in the hands of irresponsible militarists” (Heims, 1980, p. 208).

Nonetheless, Wiener’s computation of firing tables during World War I, his toils to shoot down planes that went faster than bullets during World War II, and his contributions to communication theory are of a kind (Rheingold, 2000). All turn on the significance of precise and unremitting adjustments based on predictability. Wiener’s notion of electromagnetic feedback is similar to the thermostat: it presupposes that output associated with transmission reflects off target objects and returns in a diminished, but measurable, form. Returned transmissions, or feedback, are useful if they are attained with sufficient speed and accuracy. They enable predictions of an object’s distance and trajectory. During World War II, Wiener refined and automated the use of feedback in radar systems so that servomotors could steer artillery batteries in time to hit enemy aircraft.

Wiener understood that radar systems were apparatus of communication. He observed that, “The technique of radar used the same modalities as the existing technique of radio besides inventing new ones of its own. It was thus natural to consider radar as a branch of communication theory. Besides finding airplanes by radar it was necessary to shoot them down” (Wiener, 1954, p. 148). But he was also interested in automata, human and machine memory, other applications of feedback, and the physics of vision (Wiener, 1961).[59] In applying and expanding his concept of feedback to human vision, Wiener writes:

> Let us come at once to the eye-muscle feedbacks in man. Some of these are of purely homeostatic nature, as when the pupil opens in the dark and closes in the light….Others concern the fact that the human eye has economically confined its best form and color vision to a relatively small fovea, while its perception of motion is better on the periphery. When the peripheral vision has picked up some object conspicuous by brilliancy or light contrast or color or above all by motion, there is a reflex feedback to bring it into the fovea. This feedback is accompanied by a complicated system of interlinked subordinate feedbacks, which tend to converge the two eyes so that the object attracting attention is in the same part of the visual field of each, and to focus the lens so that its outlines are as sharp as possible. (1961, p. 134)

Wiener's observation of feedback in human sight, the interaction of pupils with light, reflexive focus, and coordinated eye movement, brims with the kind of interactivity between sight and touch that Virilio would appreciate. Wiener fills human sight with pupils' waxings and wanings, muscle twitches, and neural movements—with motilities. For Virilio, when these motilities are exploited, manipulated, and magnified in importance by accelerating technology and the demands of economics, they enable on a biological level the construal of movement as progress. For me, they become the paint brushes and pastel chalks of the art of the dashboard, even as the homeostatic body becomes the canvas (and the driver's seat, the easel). The incarcerated receiver cares not that "natural" space is collapsing, that linearity has given way to gestalt, or that touch and sight share the same lack of distance, until the speed of authoritarian

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[59] Writing more generally of *feedback,* Weiner states that "*feedback* [is] the property of being able to adjust future conduct by past performance. Feedback may be as simple as that of the common reflex, or it may be a higher order feedback, in which past experience is used not only to regulate specific movements, but also whole policies of behavior" (1954, p. 33).

modernity is revealed through collision, until the arbitrary *present* is shattered by the inertial *now.*[60]

The implications of feedback for information theory concepts such as *message* and *information*, then, are complex. Messages are objects in need of encoding and decoding, but in a more technical sense than semioticians or cultural studies researchers usually appreciate.[61] Wiener was a mathematician and physicist, and understood that the issues of transmission, control, feedback, message, and noise are basic processes of universal order and chaos. Wiener's universe was more fundamentally communicative than clockwork; it was a universe of matter, energy, and "To Whom It May Concern messages" (Conway, 2005; Wiener, 1954). He initially thought he had stumbled onto a generalized explanation for brain function and computer processing, for nerves and electronic circuits that reconceptualized humanity, society, and all of known existence.

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[60] Wiener (1961) argues that linearity is not necessary for predictability and differentiates between theories of linear and non-linear prediction. His discussion of 1940s radar as an anti-aircraft predictor in this regard is illustrative: "In the anti-aircraft predictors which I described, the linear characteristics of the predictor which is used at any given time depend on a long-time acquaintance with the statistics of the ensemble of time series which we desire to predict. While a knowledge of these characteristics can be worked out mathematically…it is perfectly possible to devise a computer which will work up these statistics and develop the short-term characteristics of the predictor on the basis of an experience which is already observed by the same machine as is used for prediction and which is worked up automatically. This can go far beyond the purely linear predictor….In various papers…we have developed a theory of non-linear prediction…" (p. xiii).

[61] Stuart Hall's (1980) famous Encoding/Decoding article is an important bridge between how the terms are used in cybernetics and how they're used by cultural theorists. He writes: "Traditionally, mass-communication research has conceptualized the process of communication in terms of a circulation circuit or loop. This model has been criticized for its linearity—sender/message/receiver—for its concentration on the level of message exchange and for the absence of a structured conception of the different moments as a complex structure of relations. But it is also possible (and useful) to think of this process in terms of a structure produced and sustained through the articulation of linked but distinctive moments—production, circulation, distribution/consumption, reproduction….This second approach, homologous to that which forms the skeleton of commodity production offered in Marx's *Grundrisse* and in *Capital,* has the added advantage of bringing out more sharply how a continuous circuit—production-distribution-production—can be sustained through a 'passage of forms' (p. 128).

He wrote “It became clear to me almost at the very beginning that these new concepts of communication and control involved a new interpretation of man, of man’s knowledge of the universe, and of society” (Wiener, 1966, p. 325). That Wiener overshot the mark takes nothing away from his highly-nuanced understanding of messages and information:

> Messages themselves are a form of pattern and organization. Indeed, it is possible to treat sets of messages as having an entropy like sets of states of the external world. Just as entropy is a measure of disorganization, the information carried by a set of messages is a measure of organization. In fact, it is possible to interpret the information carried by a message as essentially the negative of its entropy, and the negative logarithm of its probability. That is, the more probable the message, the less information it gives. Clichés, for example, are less illuminating than great poems. (1954, p. 21)

Cyberneticists like Wiener think of information as something other than merely an “object” or “content.”[62] For them, and particularly for Shannon—whose efforts to understand telephone system relays formulated a technical definition of information (Shannon, 1948; Shannon, 1938)—information is a step toward artificial intelligence. But information is still “content” in a sense. Wiener wrote, “Information is a name for the content of what is exchanged with the outer world as we adjust to it, and make our adjustment felt upon it. The process of receiving and of using information is the process of our adjusting to the contingencies of the outer environment, and of our living effectively within that environment” (Wiener, 1954, p. 17-18). In other words, information is *in-formation* (a term that conjures images of soldiers marching to battle,

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[62] Campbell (1982) relates that on several occasions Wiener enigmatically referred to information as entropy. Considering that Rudolf Clausius, author of two laws of thermodynamics, wrote that *entropy* means “transformation,” information would be inextricable from transformation (Rheingold, 1985).

commuter traffic, and the blocking of actors in a Broadway production) and *formation in*, (a term that connotes perpetual interaction between inside and outside, a constant rearrangement of received information). Pamela McCorduck (1979) describes the paradigm shift evidenced with the concentration on information. “*Cybernetics* recorded the switch from one dominant model, or set of explanations for phenomena, to another,” she discerns, and then clarifies that, “*Energy*—the notion central to Newtonian mechanics—was now replaced by *information.* The ideas of information theory, such as coding, storage, noise, and so on, provided a better explanation for a whole host of events…” (p. 42).

Accompanying the mind-scrambling prospect of endless information (Rheingold notes that Shannon discovered the universe is playing an endless game of twenty questions with itself) is the prospect that all information is best comprehended as noise and/or entropy. But is the sender-message-channel-receiver-feedback formulation only linguistic cover for a universe of noise? Phrased differently, is a communicative universe a noise bomb? As it turns out, the tendency to entropy demands the creation of information systems and puts a dialectical twist (of entropy-order) on the natural-artificial dilemma. The question of information systems’ mediation of the human experience of the entropy-order dialectic is of course the same question sans “human experience.” The vital relationship is between entropy and order, or in the language of Benjamin, dispersal and collection. As the Austrian physicist Ludwig Boltzmann observes, “Entropy is a function of the way the parts of the system are arranged, compared with the number of ways the system can be arranged” (Rheingold, 1985, p.

121). Virilio’s and Benjamin’s critiques of modernity are both aimed at the inadequacy of system arrangement and posit, respectfully, accidents and dialectical images as moments pregnant with rearrangement.[63]

Politics of the Oblique: Mobility and Motility

Virilio’s (with Lotringer, 1997) notion of space as structured according to military-industrial logic, as logistic, posits citizens and other objects as always-already anticipating conflict with “others.” For Virilio, earlier and slower technologies contributed to a unified national body, but today’s are crushing space for a body politic and dispersing individual bodies. For Virilio, today’s technologies are causing a “double movement of implosion and explosion” (Armitage, 2000, p. 134). In military terms, Virilio sees the conflation of defense and assault, the enveloping dialectic of preemptive action. But it’s not as though Virilio thinks natural space has suffered Baudrillardian obliteration.[64] In Virilio’s terms, geographical locations are “real,” but accelerated means of communication, of transportation and transmission, make their physical distances and proximities less important over time (Castells, 2000). In Virilio’s world,

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[63] This point begs Kellner’s (1999) critique of Virilio’s occasional forays into technophobia. In cybernetic terms Virilio is arguing that the current system arrangements *are not* homeostatic. But in longing for a more “natural” sensory experience where technologies are properly servile, does he not need to argue that his arrangement *is* homeostatic?

[64] In an interview with Carlos Oliveira, Virilio stated that “against the opinion of Baudrillard, I’d have to say that reality never vanishes. It constantly changes. Reality is the outcome of a predetermined epoch, science, or technique. Reality must be reinvented, always. To me it is not the simulation of reality that makes the difference, it is the replacement of a predetermined reality by another predetermined reality. I proceed from the antagonism between real and virtual reality, and I notice that that both will shortly constitute one single reality, but this will only take place through an unbelievable change that will have profound consequences for life; and these negative consequences are at the core of my writing” (Oliviera, 1995, p. 7).

Departments of State and Interior are lost in space. In Virilio's world, Departments of Time could better meet the needs of fragmented, high-speed modernity.

For Virilio, modernity and its nation states are shifting from geo to chrono-politics. Virilio believes human perceptions and movements are changing at the same time. His early (and nearly forgotten) interest in oblique architectures, architectural utopias, and disequilibrium illuminates his concerns with such shifts, and further informs his notion of logistics. He and Claude Parent designed Paris' Church of Sainte-Bernadette with a politics of movement in mind. It was the first building erected consistent with the "theory of construction on an incline" and contains no horizontal (pre-industrial era) or vertical (modern) angles (Redhead, 2004, 24; Virilio & Parent, 1996).[65] Thus, to be in Sainte-Bernadette's is to both move and anticipate movement, to gravitate to one space and then another, to discover unexpected perceptions, to feel one's body.[66]

The Church of Sainte-Bernadette draws attention to distinctions between movement and motility, dance and spasm. Virilio favors the former. In his world, the immobile but motile spastic is strapped down and twitching at the bottom of an

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[65] Parent further connects the dots between Virilio's interest in the function of the oblique, the church of Sainte-Bernadette, and Germany's Atlantic Wall bunkers. He remembered that: "It was Virilio who said that we should put a slope on the floor planes of the church…The challenge of working together on a real, concrete project inspired a fundamental breakthrough—the first application of the function of the oblique. The military bunkers dominated our early projects—the church as well as the cultural centre in Charleville. Virilio saw the bunker as the apotheosis of twentieth-century architecture" (Virilio & Parent, 1996, p. 51).

[66] David Fisher's "dynamic tower," or "moving" skyscraper that is slated to be erected in Dubai both extends and constricts Virilio's intentions. Fisher says "It's the first building that rotates, moves, and changes shape," but its movements are not meant to be sensed by occupants. (Dubai Plans Moving Skyscraper, 2008, p. 1).

electronic eggcup (or perhaps, is surfing the web), proximate to but unwilling to touch other epileptics, frozen as he drowns in a funnel of information and images. Virilio does not think everyone is a motile spastic just yet, and not all of the time, but he is nevertheless at pains to point out that the faster modernity goes, the more we, as its passengers, are strapped down and pressed into our seats. He describes business travelers as embodying, "a new form of sedentariness…in the instant of absolute speed. It's no longer a sedentariness of non-movement. It's the opposite" (Virilio & Lotringer, 1997, p. 68). His figurative automobile driver, who stands in for all modernists, increasingly experiences the world through a dromoscope (a speed camera), through a kind of film. He writes, "The excess of speed has contributed to a progressive enclosing of the driver, first behind the screen of a simple glass windscreen, then the full windshield and enclosed cabin," and eventually argues that the automobile's seatbelt, dashboard, windshield, and vector are a microcosm of authoritarian modernity's progressive "will to power" (Virilio, 2005, p. 112).[67] Yes, Virilio's a little crazy.

Therefore, when Virilio notices that, "Already now, when you come back to Paris from Los Angeles or New York at certain times of the year, you can see, through the window, passing over the Pole, the setting sun and the rising sun. You have dawn and dusk in a single window," (Virilio, 1997, p. 13) he finds the circumstance instructive but not positive. For him, dawn and dusk are *in* the window. They are technologized images experienced at hundreds of kilometers an hour, without the wind touching the

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[67] In so doing, Virilio goes further than does Schivelbusch (1986) in his description of the increasing removal of the traveler from the bumps of the horse, rattles of the carriage, and train car window as a source of panorama art.

traveler’s cheeks, and with the sounds of the jet engine. The traveler is *in* her seat, *in* her ergonomic iron maiden, and she’s too preoccupied with the arrival of objects and information—her coffee, in-flight movie, puffs of conditioned air, images out the window, airplane, herself—to contemplate that she has temporarily become an invalid in the name of progress. Aerosmith’s Steven Tyler likes to sing “Life’s a journey not a destination,” (and he’s been quoted to the point of triteness), but in Virilio’s world he’s kind of wrong. For today’s jet-setting business traveler and tele-commuter (but not, indeed, for many immigrants and migratory workers), life’s more of an arrival than a journey. Information and images hit target bodies and, in aggregate, enclose them for their orderly flow through space.

On this point, Virilio ruminates that recent technological developments have worsened human experience: interval is being replaced by interface, transportation by transmission, mobility by motility, journey by arrival (Virilio, 1997). The targets of Virilio’s criticism are often technologies that resemble what he refers to as a *vision machine,* technologies whose logic comes to light (literally) when “the real-time image dominates the thing represented, real time subsequently dominating over real space, virtuality dominating actuality and turning the very concept of reality on its head” (Virilio, 1994, p. 63).[68]

These technologies construct a virtual realm of the calculable, of data, information, and images (Kellner, 1999). Therein they contribute to “paradoxical presence, the long distance telepresence of the object or being which provides their

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[68] Armitage (1996) describes “vision things” in similar terms.

existence here and now," (Virilio, 1994, p. 63) and to modernity's obsession with forecasting.[69] In military terms these technologies contribute to the annihilation of time just as their compatriots—including the atom bomb—destroy matter and space. New forms of information war, electromagnetic surveillance, laser guidance, and other remote controls contribute to the shock and awe of push-button warfare/consumer culture.

Politics of the Oblique: Riesman

Virilio isn't interested in the sociological implications of his politics. He stays in the world of angles, movements, and gravity—of physics. Nevertheless, the Lasswell-and-Weber-influenced David Riesman is one way to bridge the two realms.[70] Riesman's *The Lonely Crowd* (1961), the most influential social commentary on post-World War II America, unreflectively uses radar to describe an emerging personality type—the *other-directed person.* According to Riesman, other-directed people were ideally suited to the incessant, incoming messages of the emerging consumer society. They both encouraged and were encouraged by the "rising expectations" and logistics of the suburbs, Interstate Highways, and push-button consumerism (Riesman, 1961, p. lviii).

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[69] Here Virilio is articulating a dynamic logic of the image: "The age of the image's *formal logic* was the age of painting, engraving and etching, architecture; it ended with the eighteenth century. The age of *dialectic logic* is the age of photography and film or, if you like, the frame of the nineteenth century. The age of *paradoxical logic* begins with the invention of video recording, holography and computer graphics…as though, at the close of the twentieth century, the end of modernity were itself marked by the end of a logic of public representation" (1994, p. 63).

[70] Riesman (1961) acknowledges Weber's influence: "We followed Max Weber's lead in seeing the Protestant Ethic as linking a Greek type of rationality to a Judeo-Christian type of this-worldly morality" (p. xxxvii).

If Riesman took up Virilio's example of driving that I mentioned above, he would be interested in different things than was Virilio. Riesman would discuss frustration that there wasn't another lane of highway instead of a consideration of its width, straightness, and separation from nature. Riesman would consider the middle and upper class drivers' ability to isolate themselves in their vehicles instead of drivers' immobilization in their seats. Riesman would identify different emotions—shame, guilt, or anxiety—as responses to a social violation like a fender bender, whereas Virilio would describe the interruption of progress in literal (that is, physical) and mythic terms.

In addition to the *other-directed person,* Riesman identifies two other types of Americans in the *lonely crowd*. The *tradition-directed* person, "feels the impact of his culture as a unit, but it is nevertheless mediated through the specific, small number of individuals with whom he is in daily contact" (Riesman, 1961, p. 24). The *inner-directed* person, "has early incorporated a psychic gyroscope which is set going by his parents and can receive signals later on from other authorities who resemble his parents" (p. 24). The already-mentioned *other-directed* person, "learns to respond to signals from a far wider circle than is constituted by his parents." Moreover, for the other-directed person, "The family is no longer a closely knit unit to which he belongs but is merely part of a wider social environment to which he early becomes attentive" (p. 25). Riesman contrasts the other-directed person with the inner-directed person by saying that, "one prime psychological lever of the other-directed person is a diffuse anxiety. This control equipment, instead of being like a gyroscope, is like a radar" (p. 25).

The rise of the other-directed person in consumer society fascinates Riesman. He sees it as correlating with the rise of mass media messages. He writes that, “the child begins to be bombarded by radio and comics from the moment he can listen and just barely read” (p. 97) and then proceeds to describe a new manner of reading that Virilio would understand as logistical. In writing about children reading, Riesman declares that:

> Perhaps the most important change [in consumer society] is the shift in the situation in which listening and reading occur. In contrast with the lone reader of the era of inner-direction, we have the group of kids today, lying on the floor, reading and trading comics and preferences among comics, or listening to ‘The Lone Ranger.’ When reading and listening are not communal in fact, they are apt to be so in feeling: one is almost always conscious of the brooding omnipresence of the peer group. (Riesman, 1961, p. 99)

To be sure, Riesman and Virilio have different projects. Riesman is interested in how American character is changing in consumerism. Virilio is interested in angles, movements, perceptions, and technologically enabled collisions. Nevertheless, both are concerned with other-directedness, incoming messages, and forecasting, and these are bridges between the two thinkers. According to Riesman, people, like children reading comic books on the floor, are increasingly putting their fingers in the wind and anticipating the thoughts, values, and judgments of others. According to Virilio, information is incoming. He sees innumerable machines, media technologies, and architectures constantly shouting “fore!” or “fire in the hole!” as they launch volley after volley of information cannonballs at everyone. I imagine Virilio inviting the children from Riesman’s example into the Church of Saint-Bernadette so they could read on the floor, slide into each other, and discover the “brooding omnipresence” of his politics of the oblique!

Politics of the Oblique: Hunter-Gatherer, Cybernaut, Warrior

The body of the soldier-citizen is Virilio's vehicle to argue that modern vision technologies displace natural modes of perception. For Virilio, modern bodies are nodes in information systems, are respondents to electronic information. They lack both the inclination for spontaneous movement and the opportunity for political deliberation. Minus the Sidewinder missiles, his description of a warrior in a media center applies just as neatly to a consumer in a living room:

> The disintegration of the warrior's personality is at a very advanced stage. Looking up, he sees the digital display (opto-electronic or holographic) of the windscreen collimator; looking down, the radar screen, the onboard computer, the radio and the video screen, which enables him to follow the terrain with its four or five simultaneous targets; and to monitor his self-navigating Sidewinder missiles fitted with a camera of infra-red guidance system. (Virilio, 1989, p. 84)

The differences between natural, geophysical reality and virtual reality are striking for Virilio. They extend into his most concrete discussions of the attributes of spaces. Victor Hugo once remarked that "the rope doesn't hang, the earth pulls," and Virilio would agree. The technologically produced "artificial skies" (Virilio, 2005; 1997)—the firmaments—of vision machines lack gravity and an earth-like fixed point, and therein telepresence defies Virilio's politics of the oblique.

Geometrically, Virilio contrasts the hunter-gatherer's physical journey in real space with the cybernaut's freefall in real time. His earth dweller is a hunter-gatherer traversing and examining objects; his cybernaut is an object in vertigo being examined by other objects. He writes of the cybernaut's experience of real time: "Unlike the *real space* perspective of geometry, the perspective of real time is no longer constrained by terrestrial weightiness; the *transaparent* horizon of the live telecast screen escapes gravitation by basing itself on the very speed of light" (2005, p. 32, emphasis mine). For Virilio, then, virtual space is a cybernetic space wherein much of natural human experience—horizons, the alternation of day and night, gravity—are absent. For him, virtual space is outer space.

There is a finer distinction between hunter-gatherer and cybernaut, and specifically in terms of the state and the conduct of war. Deleuze and Guattari (1986) note that "war is not contained within" the State because while the State "seizes and binds," war is mobile—it is carried by the nomadic warrior (p. 2).[71] In this formulation war and the State are a fundamental binary of authoritarian modernity, of imprisonment-blitzkrieg, of marketplace-battlefield. [72]

The question begged by these issues is whether or not Virilio's longing for hunter-gatherers is nothing more than his 'jonesing' for war. The combination of his valorization of physical movement and his objections to the nation-state certainly make this a possibility.[73] One can construe his politics of the oblique as an architecture for advancement: advancing soldiers, advancing tanks, advancing vectors. After all, Germany's Atlantic Wall, the bunkers and radar outposts built along the French coast to

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[71] Deleuze and Guatarri maintain that: "Either the State has at its disposal a violence that is not channeled through war—either it uses policemen and jailers in place of warriors, has no arms and no need of them, operates through immediate, magical capture, "seizes" and "binds" preventing all combat—or, the State acquires an army, but in a way that presupposes a juridical integration of war and the organization of military function. As for the war machine itself, it seems to be irreducible to the State apparatus, to be outside its sovereignty and prior to its law: it comes from elsewhere" (1986, p. 2).

[72] Giddens (1981) would insist on "enclosure" instead of "imprisonment," as it more powerfully invites discussion of the relation between the State, capitalism, private property, and migrant workers.

[73] Virilio's Roman Catholocism is a more likely, though not necessarily exclusive, explanation.

stop the Allies, did trigger his brainstorm of the possibilities of the oblique (Redhead, 2004; Virilio & Parent, 1996).

Virilio maintains that the differences between warriors and hunter-gatherers are logistical (Virilio, 2005). Deleuze and Guattari buttress his assertion by distinguishing between tools and weapons. They maintain, “A distinction can always be made between weapons and tools on the basis of their usage (destroying people or producing goods)” (1986, p. 75). However, even as they uphold that “it is not only certain that war does not derive from the hunt, but also that the hunt does not promote weapons,” (p. 76), they are obliged to concede that “either war evolved in the sphere of indistinction and convertibility between weapons and tools, or it used to its own advantage weapons already distinguished, already constituted” (1986, p. 76-77). For Deleuze and Guattari, hunters apply technologies as tools whereas warriors apply them as weapons; the difference is one of both speed and relation to the “other.” Their more expansive discussion is worth citing on this point:

> As Virilio says, war in no way appears when man applies to man the relation of the *hunter* to the animal, but on the contrary when he captures the force of the *hunted* animal and enters into an entirely new relation to man, that of war (enemy, no longer prey). It is therefore not surprising that the war machine was the invention of the animal-raising nomads: animal breeding and training are not to be confused either with the primitive hunt or with sedentary domestication, but are in point of fact the discovery of a projecting and projectile system. (Deleuze & Guattari, 1986, p. 77)

In Deleuze and Guttari’s thinking, weapons are ballistic and centrifugal in their nomadic deployment against “enemies.” They observe that the more “mechanisms of projection a tool has, the more it behaves like a weapon, potentially or simply metaphorically” (p. 75). Therein television, radio, newspapers, film projectors, radar, and missiles can all be considered weapons in so far as they project and are projected in space without necessary regard for geophysical or political boundaries (such as the borders of nation-states or cities). Conversely, for Deleuze and Guattari technologies are more tool-like when they are “more introceptive, introjective” (p. 76). In their estimation, tools, unlike weapons, can organize “matter from a distance, in order to bring it to a state of equilibrium or to appropriate it for a form of interiority” (p. 76).

In the final analysis, both weapons and tools mediate space and transform matter, but the one is more (or more obviously) dispersive and destructive and the other is more (or more obviously) collective and productive. Both remote control and interactivity are present, but “in one case it is centrifugal, in the other centripetal” (p. 76). The interplay of these forces makes the channeled movements of citizen-consumers and/or commodities through relative space economically-motivated martial art.[74]

It’s not as though Virilio thinks his natural space escapes the notion of relativity. He enthusiastically trumpets Einstein’s maxim that “We just have to accept it…there is no fixed point in space.” (Schmidt & Wichmann, 1922; Virilio & Lotringer, 1997). His politics of the accident are relativist in a tangible way. But for him, the experience of natural space is slower—much slower—and so the interruptions of collision and accident are often of a local (as opposed to a general) scope. They still exist, though; death is his accident of life and little deaths—epilepsy and picnolepsy—differentiate

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[74] Deleuze & Guattari elaborate on the relationship between hand-held weapons and martial arts, and argue that even hand-held weapons are projective: “It is true that missile weapons, in the strict sense, whether projected or projecting, are only one kind among others; but even hand-held weapons require a usage of the hand and arm different from that of tools, a projective usage exemplified in the martial arts” (1986, p. 76).

movement from stillness and consciousness from unconsciousness and make them purposeful (Virilio & Lotringer, 1997). "Epilepsy is little death and picnolepsy, tiny death…what is living, present, consciousness, here is only so because there's an infinity of little deaths, little accidents, little breaks, little cuts in the soundtrack" (p. 40).

Like many psychoanalytic theorists, Virilio's notion of consciousness is cinematic and the visual experience is "that of montage, a montage of temporalities which are the product not only of the powers that be, but of the technologies that organize time" (Virilio & Lotringer, 1997, p. 40). Considering Virilio's notion, I argue that consciousness is a work of art in Benjamin's (1968) age of mechanical reproduction. Consciousness is an archive for an idealist, for a psychoanalyst, and for a materialist historian.

Politics of the Oblique: The Battlefield of Perception

Not all little breaks, cuts, and accidents are identical. Virilio asserts that "technology doesn't give us anything more, it interrupts us differently," and then clarifies that "to be interrupted in a car is different from being interrupted while walking. The connection of the driving body with the locomotive body is a connection to a different type of speed change. Interruption is a change of speed" (Virilio & Lotringer, 1997, p. 40). In the case of far-reaching, high-speed technologies, interruptions are so fast and omnipresent that they obliterate geographic space.

When Virilio compares atomic and information bombs, war and live media coverage, he has in mind our simultaneous experience of them (Virilio, 2000; Wilson, 1994). In response to Baudrillard's declaration that the Gulf War did not exist, Virilio told Louise Wilson that, “In the case of the Gulf War we are dealing with a war which is extremely local in space, but global in time, since it is the first ‘live’ war….And this thanks to CNN and the Pentagon” (Virilio, 1994, p. 3). Rhetoric like this suggests Virilio longs for an anti-technology Sabbath. But it also suggests the battlefield as a field of perception and for cinema, radar, and other televisual machines as constructing that field.

In Virilio’s framework, televisual displays differ from earlier modes of spatial representation. Painting, stained glass, and bas relief can all represent national spaces in political ways (as can, of course, maps), and have historically complemented print media in cultivating a sense of nationalism (Anderson, 1991). But their *formal logic,* their comfortably real pictorial representation, is at variance with the tenuous formal logic of photography and cinema (Virilio, 1994). By the time of World War I, the speed and ubiquity of modern movement, collisions, and accidents could eclipse topographical representations and national identities dependent on them. World War I was the beginning of a high-speed information transmission and storage system—aircraft, camera, automobile, projector.

World War I generals could continually and remotely assemble and reassemble photos and films into a meaningful collage.[75] The soldier’s point of view was thereafter fragmented: Foot soldiers peered through the smoke from their trenches. Pilots aimed

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[75] Kittler shows how such information systems prefigure the computer: “as Paul Virilio has demonstrated, World War I put into operation all available storage media combined with early prototypes of transmission media. In turn these transmission media, technically perfected and serialized, supported World War II, but only to provoke, by further escalation since 1943, the development of computing media. Universal discrete machines settle the old question—how to make people die for others” (1997, p. 118).

their cameras from above the fray. Generals watched projections on a screen. But for Virilio the fragmentation, the explosion of World War I, was accompanied by a correlative implosion. Consciousness and war came together in cinema: "World War I was a revolution in perception…After 1914, war became a war film; there were no longer paintings of battles or maps highlighted in red or blue, but a film" (Virilio, 1999, p. 27).

Virilio maintains that "*paradoxical logic* emerges when the real-time image dominates the thing represented, real time subsequently prevailing over real space, virtuality dominating actuality and turning the very concept of reality on its head" (Virilio, 1999, p. 63). For him, even among modern technologies there's a difference between representations of past objects and activities, that is, representations of their reality at time delay (photography and cinema), and representations that indicate the real-time presence of objects. Radar, infrared surveillance, television, and other contemporary technologies can indicate the real-time presence of objects, although sometimes without representing objects' physical forms. Radar blips indicate the presence of objects, and their movements and trajectories can be calculated, but the actual objects and their contents remain largely unknown. Images of radar objects dominate the objects themselves; radar projects their telepresence even as their physical space is compressed. Radar objects are represented by their outer surfaces, and so in some sense they are always unidentified.

Information systems that allow the real-time representation of objects are an important and growing part of the authoritarian modernity through which consumer-soldiers surge. They contribute to a Tayloristic, well-calculated ordering of information and objects and allow the mythology of progress to coordinate even as it fragments (Robins & Webster, 1999). In cinematic terms, information systems are some of the lighting rigs, boom mics, and focusing equipment of the film that is modern consciousness (Virilio, 1989). For Virilio, the aggregate effect of the real-time representation of objects is the infiltration of fields of the formal and dialectical with the paradoxical, and the destabilization of previous conceptions of reality.

In this scenario, information *is* spectacle and consumer-soldiers are constantly being bombed with it. Modern perception is a battlefield with information projectiles always arriving. Virilio’s discussion of the World War I battlefield has some commonality with a more general field of perception:

> The battlefield is first a field of perception. Seeing them coming and knowing that they are going to attack are determining elements of survival. In war, you can’t be surprised, for surprise is death. The 1914 war and World War II radically modified the field of perception. Before World War I war was always waged with maps. Yves Lacoste said ‘Geography is meant to wage war.’ It happens that maps are drawn using topographical landmarks or surveys to direct artillery firing. If the 1914 war was not a total war, then at least it had totalitarian tendencies, and it destroyed all the topographical landmarks of eastern France. Thus, after every artillery battle, it was absolutely imperative to make photo-mosaics in order to get re-oriented and not massacre each other needlessly. The first planes were used not to fight but to observe from above, as the first balloons were used to photograph enemy lines. So the cinema, the photo-cinema, the photo-mosaic and the documentary were all used to wage war and favoured an expanded vision of the battlefield. In the past, in order to see the enemy, you had to climb a high point or watchtower and then you could see them coming. Later the plane and camera were used to try and locate the enemy. (1989, p. 26)

Even Virilio’s cybernaut could see the ready comparisons between *arrival and surprise, enemy and other, channel surfing and artillery battle*. In Virilio’s world, transportation, communication, and architecture have united in authoritarian modernity, and there's little for the motile somnambulist to do but twitch in his electric chair.

Virilio and Kittler

Virilio's pessimism in the face of all things technological has been noted by scholars (Redhead, 2004; Cubitt, 2001), as has his moralistic anti-statism (Crogan, 2000; Crawford, 2000; McQuire, 1999). Despite occasional admissions that "all is not negative in the technology of speed. Speed and that accident, that interruption which is the fall, have something to teach us on the nature of our bodies and the functioning of our consciousness," (Virilio & Lotringer, 1997, p. 39) at times he crosses the line into technophobia: He broadly compares media to the German occupation of France during World War II (Redhead, 2004). He argues that interactivity amounts to forced collision (Virilio, 2005). He describes technologies as tools of endocolonization (Virilio, 2005; Virilio & Lotringer, 1997). Contributing to the gloom and doom is the fact that while Virilio is a humanist, he has no sociology to speak of and has shown little interest in the possibilities of culture-based appropriations of technologies.[76] Virilio declares the eminent demise of politics, democracy, apple pie, and the body, but offers few ideas about how the situation might be improved.

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[76] One of his rare moves in the sociological direction is his discussion of what he calls "speed classes." These classes correlate with economic classes, i.e. wealthier, means-of-production-owning persons can have both faster mobility and motility and have a greater influence over the speed of society, but he never develops these ideas in terms of either political economy or identity politics. (Virilio, 1986). More recently, he has made connections between technology, speed, and music and has declared that the question of technology is one of rhythm (Redhead, 2004). There is also his provocative declaration that the origin of the war machine is the sexual coupling of man and woman, with woman being the first vector of both man and war (Virilio 2005; Virilio & Lotringer, 1997).

And what about Virilio's body-technology dilemma? It's a microcosm of his distinction between natural and virtual, but his assessments of both are based on nothing more than an unstated assumption that individual human bodies are authentic and technologies are not. There are various ways to finesse that distinction, such as through a "green materialist" take on nature's production-as- difference versus technology's production-as-sameness, or through appeals to philosophical humanism. Virilio doesn't account for either a gender-based political argument against singular consideration of the individual human body (Haraway, 1991), or an indictment of the distinctiveness of subjects and objects (Althusser, 1971). Virilio's concern with the body and its movements and with accidents and collisions, is in some fashion material; these are the bullets and battles of a military industrial complex run by capitalist technocrats.[77] But his critique of technology always-already arrives at ideals: morality through deceleration, education through stoppage, public deliberation, and geophysical locality. Those ideals constitute the natural for Virilio.

Kittler's treatment of technology corrects Virilio's excesses. Kittler finds the processes of digitalization and media convergence integral to "electronic warfare," and to people's inability to "make sense of their senses" (Kittler, 1997, p. 31, 33), but he doesn't see such developments as intruding on an authentic human body. For him, media are combining into a single communication channel (and in so doing erasing boundaries between previously distinct media and even the notion of media) and

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[77] In his 1997 interview with Lotringer he remarks that, "Speed is not considered important. Wealth is talked about, not speed! But speed is just as important as wealth in founding politics. Wealth is the hidden side of speed and speed the hidden side of wealth. The two form an absolute couple….There's a violence in wealth that has been understood: not so with speed" (p. 35-36).

completing the exteriorization of knowledge that theorists like Innis (1972), McLuhan (1962), Ong (2002), and even Plato (1973) observed with writing.[78] "A total connection of all media on a digital base," Kittler observes, "erases the notion of the medium itself. Instead of hooking up technologies to people, absolute knowledge can run as an endless loop" (Kittler, 1997, p. 32). For Kittler people are technologies, and cybernetics, while inseparable from the military, is not subjected to moral critique.

The similarities and differences between Kittler and Virilio are illustrated in their discussion of the airplane as insular media experience. As mentioned above, Virilio thinks of an airplane passenger's experience as motility, interface, arrival, and dromoscopy (speed camera). For him, passengers are trapped inside a speeding bullet/information system, albeit one with wings and a pilot. They are more than a little like the human batteries in the Wachowski brothers' *Matrix* films, but they're flying at 400 mph. For Kittler, though, interface on the airplane has additional dimensions:

> The crew is connected to radar screens, diode displays, radio beacons, and nonpublic channels. The crew members have deserved their professional earphones. Their replacement by computers is only a question of time. But the passengers can benefit only from yesterday's technology and are entertained by a canned media mixture. The passengers' ears are listlessly hooked up to one-way earphones…to the recording industry…Their eyes are glued to Hollywood movies…to the advertising budget of the airline industry….Not to mention the technological medium of the food industry to which the mouths of the passengers are connected. A multi-media embryonic sack supplied through channels or navels that all serve the purpose of screening out the real background: noise, night, and the cold of an unlivable outside. Against that there is muzak, movies, and microwave cuisine. (Kittler, 1997, p. 32)

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[78] In *Phaedrus*, Plato (1973) has Socrates indict writing for being "inhuman," for destroying memory, and for being passive (i.e. for not adapting itself to conversation).

Kittler has a more developed sense of media experience as extension of industry than does Virilio. For both, “the communication technologies of the day exercise remote control over all understanding and evoke its illusion” (Kittler, 1997, p. 30). But Kittler’s throwaway reference to nonpublic channels, to the piloting industry, invites consideration of specialized forms of media literacy as well as the remoteness of pilots from passengers and (even more so) of radar operators from pilots. For Kittler, the eminent replacement of human pilots by computers furthers such remoteness, but does so outside of passengers’ immediate experiences. In Kittler’s estimation, airline passengers absorb themselves in media to cope with their confinement and forced proximity to each other. In his estimation, they are content as destinations for other consumer technologies—sounds, images, and packages of pretzel bits. For Kittler, pilots and passengers share restricted movement, but pilots have more input in media production and a detailed sense of their position in the transportation industry.

Little imagination is required to consider *pilot* and *passenger* general modes of authoritarian modernity. Each mode exists within what Kittler calls “partially connected media systems” (1997, p. 32) and has various articulations. Despite increasingly interconnected media systems, for Kittler there are still “incompatible data channels and differently formatted data” or “individual windows for one’s sense perception” (1997, p. 33). These discrete windows of perception dovetail with Virilio’s (1989) description of the World War I information system—aircraft, cameras, automobiles, and projectors—but for Kittler it is the windows themselves that battle, and they do so predominantly amongst themselves. “True wars are not waged over people or fatherlands," he writes, "but rather between various media, communications technologies, and data streams" (1997, p. 30).

Kittler's consideration of people as technology, as "self-guided missiles," contributes to his agreement with Benjamin that the masses cannot be trusted to overthrow technocratic modernity (Comay, 2004; Kittler, 1997).[79] Kittler further realizes that "To follow Benjamin is to gather military information," and therein finds himself telling "a story of strategic command" (1997, p. 118). The broad questions at stake in Kittler's story, though, are: Can the entire world be conceived in digital binaries? Is nature a Turing (which is to say, a Universal) machine? Is the real "as Jacques Lacan would have it…what is impossible in relation to our machines and systems?" (1997, p. 25). These questions lead Kittler to conclude that "it is from the specific terms—the equations, blueprints, circuit diagrams—that technology itself provides that one must proceed, in order to see…what mechanisms determine and set the limits of our bodies, our subjectivities, our discourse" (1997, p. 25). Therefore, Kittler traces the military facets of cybernetics.

Kittler approves of technological and militaristic progress and is enthusiastic about digitalization. After noting fiber optic cables' allowance of electronic warfare, he off-handedly quips that, "Before the end, something is coming to an end. The general digitalization of channels and information erases the differences among individual

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[79] On this point, we are again trapped in Benjamin's whirlpool of eternal dialectics and/or mysticism. Pensky (2004) reminds that for Benjamin, like Virilio, "interruption is the truest revolutionary act," (p. 191), and Comay (2004) suggests that for Benjamin dialectical interruption is both necessary and necessarily beyond the masses: "To enter history is to register as a crisis for the present the shock of betrayed possibilities—thwarted futures in the past. Such a circularity defines the peculiar force of Benjamin's messianism: the redemption of the irredeemable through the impossible reawakening of vanished impossibilities within the irreversible 'one-way street' of time" (p. 149).

media. Sound and image, voice and text are reduced to surface effects" (Kittler, 1999, p. 1). Kittler is not concerned about an eschatological "end," and delights in the technological integration and synchronization that Virilio condemns. In a sense, Kittler cannot wait for Virilio's dreaded information bomb to drop. The interpretive differences between the two scholars are striking, especially considering that both believe that war is "the father of all things technical," and that the media are powerful quartermasters of society (Kittler, 1999, p. xxxvi).

Kittler is willing to push cybernetics to its limit. For him, the promise of digitalization is nothing less than erasure of "the very concept of medium," and the replacement of distinct wiring, people, and technologies with an endless loop of absolute knowledge (1999, p. 2). His discussion of Junger's war memoir is overt in this regard. He describes the dissolution of soldiers inner beings' amidst overwhelming weapons and/or media technologies, and in so doing barely conceals his construction of social activity as warfare. Conclusively, Virilio's technologically determined hell is Kittler's technologically determined heaven.

Kittler is not obviously technologically deterministic. Yes, he emphasizes technological innovation to the detriment of other potentially causative factors in many instances. But he also countenances a Benjamin-like discussion of historically specific contingencies. Sometimes, Kittler seems aware that every historical era "shows critical epochs in which a certain art form aspires to effects which could be fully obtained only with a changed technical standard" (Benjamin, 1968, p. 237).

In the next three chapters I apply the ideas of Kittler, Virilio, Deleuze & Guatarri, Mumford, and Benjamin and many of the others in this and the previous chapters to my collection of historical objects. My discussion in the coming chapters is much more visceral and explosive, as I convey the wreckage left in the wake of dialectical, authoritative modernity. I do not so much splatter scholarship on a metaphoric windshield (as I have done here) as I advance into the forgotten, confounding objects that I found in the papers of the MIT Rad Lab, and into the objects those papers led me to in turn. As I maneuver into my historical discussion, I am reminded of Virilio's citation of Napoleon, who declared that, "The capacity for war is the capacity for movement. If yesterday alacrity was the essence of war, it is necessary today to state that it has become its absolute form" (2005, p. 117). But Sun Tzu, author of *The Art of War*, has an even better finger on what I am about:

> Having collected an army and concentrated his forces, [the general] must blend and harmonize the different elements thereof before pitching his camp….After that, comes tactical maneuvering…the difficulty of tactical maneuvering consists in turning the devious into the direct and misfortune into gain. Make it appear as though you are a long way off, then cover the distance rapidly and arrive on the scene before your opponent. Hoodwink the enemy, so that he may be remiss and leisurely while you are dashing along with the utmost speed. (1981, p. 42)

The strategic movements I have made in *Geometry of Empire, Dialectical Image,* and the present chapter are now complete, and what remains is a rush of tactical deviousness and directness. My objects have seemed a long way off, but will now attack with rapidity.

CHAPTER 4: REMOTE CONTROL

Radar, like radio, was developed at sea before it took to the air. In this chapter, I present a pre-history that first locates radar in the watery—rather than ethereal—domain. I consider lighthouses, torpedoes, searchlights, war horns, death rays, robot missiles, and World War II traffic jams. I draw on my MIT Radiation Lab research and on other sources that snowballed from that research. I don’t introduce new theoretical concepts, but I do consider them in specific historical contexts. As per the previous chapters, the present goal is not to think of radar in the usual ways (which is hardly to think of radar at all) but instead is to see it and everyday realities in new and politically subversive lights (Benajmin’s *now* as opposed to his *present*). Formally, I address the questions “How does radar inform an understanding of logistical communication?” and “How is radar a feedback system and a form of remote control?”

Lighthouses, torpedoes (both naval and dirigible), searchlights, and war horns are feedback systems that extend nation states’ remote control. They help nation states identify and coordinate movements from a distance—their own, those of their enemies, and those of immigrants and nomads. They reinforce and extend nation states’ borders, and prefigure some of radar’s logistics. At the same time, they threaten those same borders and contribute to progressive-catastrophic, authoritarian modernity.[80] Torpedoes, searchlights, and the like contribute to the tensions Mumford (1964) identified as creating a “critical situation” in modernity (Mumford, 1964, p. 6).

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[80] Admittedly, lighthouses contribution to progressive-catastrophic modernity is mostly historic.

The MIT Rad Lab documents housed at the New England branch of the National Archives & Records Administration in Waltham, MA, are essential to my purposes. The MIT work relies on the previous and fitful efforts of the Naval Research Laboratory and the U.S. Army Signal Corps, efforts that began as early as 1922. Because of this reliance, the records of the MIT Radiation Lab's Historian's Office, Record Group 227, are a collection of past efforts as well as a chronicling of the various MIT projects. With the U.S.' direct involvement in World War II, the MIT Rad Lab went from a modest operation of less than 50 workers with 10,000 feet of space in the Electrical Engineering Department in November, 1940, to a labyrinthine "skunk works" of nearly 3,000 workers and almost 500,000 square feet of space in 1943 (Guerlac, 1945). And the scope of projects conducted at the Rad Lab was immense. According to Henry Guerlac of the Rad Lab Historian's Office, they included:

> A large number of new applications, for which microwave equipment is uniquely appropriate….The Laboratory has developed, with the approval and sometimes the insistence of the Services, airborne interception equipment for night fighters, airborne radar for the detection of surface craft, as well as radar for early warning against aircraft, for height-finding and ground control of aircraft, for harbor defense, for the direction of guided missiles, for anti-aircraft fire control with automatic following of the target, for blind landing of aircraft, for low-and high-altitude bombing through overcast, for navigational aids. (Guerlac, 1945, p. 2)

The work at MIT's Rad Lab was clearly preoccupied with aircraft (both planes and missiles), logistics, refining radar as a vision machine, and remote control. As Guerlac notes, Rad Lab technicians hoped radar systems would "*see action* in this war" (1945, p. 2, emphasis mine). World War II was a blitzkrieg, a lightning war, instead of a map-style storage (trench) war like World War I. During World War II, soldiers advanced through faster and more powerful transmission and calculation technologies, through radar, the vacuum tube computer, and ultimately, the atom bomb. In the larger picture, though, radar is rooted in the lighthouse, torpedo, war horn, and death ray.

Lighthouse

Lighthouses go back to at least the 3rd century BCE and the Pharos at Alexandria—one of the Seven Wonders of the World. According to lighthouse historian Peter Williams (2001), the Pharos was named after an island that stood watch over Alexandria's harbor and bore an inscription declaring it to have been built, "On behalf of all mariners to the savior gods" (Williams, 2001, p. 10). Williams further relates that, "Julius Caesar…described [the Pharos] as being 'of great height and wonderful construction,'" (p. 10) and cites German historian Herman Thiersch's research that the Pharos was:

> Built as a stepped pyramid starting from a base 350 feet (about 107 meters) square. The tower rose over 400 feet (122 meters) with a further tower—a smaller, rounder, construction—holding a fire basket on the top of the main structure. Some descriptions do not agree with this and say that the fires were in closed chambers open only toward the sea. A staircase spiraled up to allow wood to be carried up for the fire. The fire would have burned with as much smoke as flame, making a better mark by day than night. (p. 10-11)

The Pharos was logistically important. It marked the entrance to one of the Mediterranean's main trading ports, providing a constant point of orientation for ships of war and commerce. An endless stream of slaves supplied the Pharos with power—wood—and did so without a space to congregate. Slaves were always ascending or descending, always moving in a line, while the Pharos' keeper—a slave master—

occupied a point of view and played traffic cop. John Naish, in his book *Seamarks: Their History and Development* (1985), writes, “The first and probably the most important reason for” the Pharos was “defense.” Naish then suggests that the second reason for the Pharos was “prestige” or to psychologically bolster the power of Egypt. The third was “to aid navigation” (p. 16).

The Romans built similar, but smaller towers for “military and navigational use” (Naish, 1985, p. 37). The medieval English used “hill-top and cliff-top sites for signal fires,” and for national defense (p. 37). In the 13th century, the Hanseatic League, an association of trading cities and guilds based in northern Germany and extending beyond Denmark and the Netherlands, erected a system of signal poles (also called “beacons,” “markers,” or “bakes”) to help its members avoid sandbars and to suppress piracy.

Each of these systems required training on the part of ship captains and crews. The English went so far as to establish a system of licensing, registration, and fines. The English system “crystallized into sanctions against those shipping cargo in foreign vessels if an English ship was available,” and applied collected monies to the maintenance of its signal towers and buoys (Naish, 1985, p. 42). Atop signal towers, England’s keepers observed ships movements and passed on significant information—such as a ship cutting across a buoy line or moving suspiciously—to harbormasters so that fines could be amassed and naval forces directed. The English used lighthouses as simple, but orderly, information systems (Naish, 1985).

Some medieval European signal towers were additions to, or adaptations of, monasteries or churches. These often sat, majestically, atop promontories and near towns, a positioning that promoted both contemplation and an air of authority. There was also, as Naish notes, the employment of monks' as signal tower keepers. For centuries, the monks helped keep the merchants and voyagers under the bishop's mitre:

> Monastaries, such as that of St. Mathieu…were built on clifftops and concerned themselves not only with the rescue and comfort of the shipwrecked, but the salvage of wreck goods, pilotage, and possibly the erection of seamarks, profits from salvage and pilotage no doubt paying for the others. Guilds of mariners and pilots were often formed under ecclesiastical guidance and protection.[81] (p. 40)

Monks watching the seas, collecting tolls, rushing to rescue and salvage, placing beacons and buoys, and running guilds mingled the logistical and mythical. The ecclesiastical authority of the monks and their architecture bestowed power and perceived benevolence on the effort to civilize the sea. Ship captains and crews weren't simply subjects of a new form of surveillance and accountability; they were integrated within the pervasive and legitimizing logistics of medieval Christianity. The coordination between lighthouse monks and ships' strait and narrow travels preceded such maritime hymns as "Jesus, Savior, Pilot Me," and "Brightly Beams Our Father's Mercy." "Jesus, Savior, Pilot Me," made the mingling of logistics and myth plain in declarations such as "Chart and compass come from thee," and "Wondrous sovereign of the sea, Jesus, Savior, pilot me." "Brightly Beams Our Father's Mercy" claimed that, "Brightly beams

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[81] Later, Naish again comments on the importance of monasteries in establishing lighthouses, beacons, and buoys. He writes that, "The influence of the early monasteries has already been stressed: in the siting of churches at points useful to mariners, and in building stone towers on dangerous reefs, the monasteries on the Atlantic seaboard played a big part [in helping naval vessels navigate]" (1985, p. 69).

our Father's mercy, from his lighthouse evermore, but to us he gives the keeping of the lights along the shore" (Julian, 1957).[82]

Mumford (1934) underscored that medieval lighthouses, lightships (vessels that spotlighted dangers and escorted ships around sandbars and reefs), and masts were steering (cyber) technologies. When deployed, they increased the speed and safety of travel by sea. Moreover, they made extended, remote voyages less foolhardy than before:

> In the fifteenth century the two-masted ship had come into existence: but it was dependent upon a fair wind. By 1500 the three-masted ship had appeared, and it was so far improved that it could beat against the wind: long ocean voyages were at last possible, without a Viking's daring and a Job's patience. As shipping increased and the art of navigation improved, harbors were developed, lighthouses were placed on treacherous parts of the coast, and at the beginning of the eighteenth century the first lightships were put to anchor on the Nore Sands off the English coast. With growing confidence in his ability to steer, to make headway, to find his position, and to reach port, the sailor replaced the slow land routes with his water routes. (p. 121)

Mumford described a relationship between steering technologies (or technics) and movement. Three-masted ships, lighthouses, lightships, and sophisticated harbors enabled prolonged, but swift movement—spices and silk from Asia, slaves from Africa, and missionaries, soldiers, and colonists from Europe. According to Williams, when the first colonists arrived on the East Coast of North America, they immediately put steering technologies in place by marking "landing sites and embryo harbors with a daymark" (Williams, 2001, p. 27). They also "may have used a lantern [to mark harbors] at night" (p. 27).

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[82] Edward Hopper, who wrote the lyrics of "Jesus, Savior, Pilot Me" was the pastor of the Mariner's Church at New York Harbor, which was also known as "The Church of the Sea and Land" (Julian, 1957).

I should clarify that, although ancient and medieval lighthouses, lightships, buoys, and beacons anticipate radar in their steering of objects, radar is not a medieval lighthouse of more advanced means. Medieval lighthouse keepers could hear ships—and even conversations outside the window—in ways that radar readers cannot. Medieval lighthouse keepers were part of a particular kind of remote information system—a feedback system—that alerted harbormasters (and sometimes, priests and bishops) of pirates, and collected tolls and fines, but the system moved at the speed of keepers. The separation of communication and transportation that Carey (1988) extols had not yet occurred.

Superficially, the automated, electric lighthouses that emerged in the early 20th century were more radar-like than were their medieval and ancient predecessors. Automated lights swept with mechanical reliability and keepers often relayed information via radio or telephone. Williams (2001) recounts the drudgeries that beset keepers before automated lighthouses:

> For hundreds of years, the light shown by a lighthouse relied on the diligence of the keeper to ensure its maximum efficiency during the hours of darkness. He also had to ensure that the fog signal was sounded at the first signs of diminishing visibility. It was only through skilled and regular attention that the light from the early lamps burned cleanly….The revolving light required its clockwork motor to be manually wound throughout the night. Rules and regulations governed the work schedule to make sure that all these tasks were carried out….You can well imagine that any means of automating some of this drudgery would be a welcome innovation. (p. 156)

Welcome or not, automation came to lighthouses as their logistical functions—defense, navigation, and prestige—declined. Airplanes moved too quickly and were too small for even the most diligent keepers. Because of this, automated lighthouses clarified the declining utility of both lighthouses and keepers, a withering that radio and radar worsened, and GPS systems put in the grave (Williams, 2001).

Contrastingly, radar flourished as an automatic vision machine. It identified and coordinated both sea vessels and airplanes, and automation required more—not less—of its readers. The same technological advances that transformed lighthouses into museums and restaurants made radar a national necessity. Radar is rooted in naval logistics, but it adapted readily to the air.

Locomotive Torpedo

Since at least April 18, 1775, when Robert Newman made the steeple of Boston's Old North Church an optical telegraph, speed and arrival have been issues for Americans and for nation states more generally.[83] By 1805, the advance of explosive, tide-driven naval vessels called *torpedoes* would forever change how nation states understand and extend themselves through space. As Larry Smart (1959) notes:

> In 1805, Robert Fulton, in an experiment before ranking members of the British Admiralty proved the practicability of submerged explosions by blowing up the Brig DOROTHEA…. Two "torpedoes" were armed and tied to 80 foot lengths of line trailing from small [dingys]. "Each boat having a torpedo in the stern, they started from the shore about a mile from the brig, and rowed down [toward] her; the uniting line of the torpedoes being stretched to the full extent, the two boats were distant from each other seventy feet…As soon as the connecting line of the torpedoes passed the buoy of the brig, they were thrown into the water and carried on by the tide." Contemporary accounts report DOROTHEA was raised bodily into the air and broken in two.[84] (p. 97)

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[83] Revere's famous "one if by land; two if by sea" shining of lights in the Old North Church exemplifies optical telegraphy.

[84] The phrase "Damn the torpedoes!" goes back to the days before they were locomotive. Reportedly, Union Admiral David Farragut uttered it while charging the port of Mobile, Alabama during the Civil War. The torpedoes Fulton describes are "mines" in today's vernacular (Burrell, 1999).

The tide was no longer the preferred means of delivery when in 1860, Giovanni Lupis, a Captain in the Austro-Hungarian Navy, demonstrated the first locomotive torpedo, a remotely controlled device that touched off unparalleled orderings and arrangements, and eventually, created a need for radar.[85] Lupis' torpedo was simple: he attached steering ropes and a clockwork engine to a boat with trigger mechanisms on the bow, mast, and sides, and then filled the stern with explosives (Routledge, 1903). At only a knot or two, Lupis' device was a deadly marionette, but one that would never hit enemy ships that saw it coming. Naval vessels of the day could easily outrun it, and reloading the launching apparatus required an inordinate amount of time. The Lupis torpedo was most effective at night, when the sight, hearing, and diligence of enemy sailors were at their worst, and when ships were often anchored. Considering the shortcomings of Lupis' torpedo, "the Austrian authorities felt that the system of guidance was impractical and that the methods of obtaining motive power, by clockwork or steam power, were objectionable" (Burns, 1988, p. 3). Lupis' torpedo was too slow and awkward an information system; it failed to effectively gather feedback and extend Austro-Hungarian space.

But it *was* an information system, and one that disrupted enemy traffic formations such as commute (convoy), gridlock (blockade), collision (ramming and bombardment), and parking (station keeping).[86] As a literal, physical extension of Lupis'

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[85] J.R. Partington's (1999) work suggests that Lupis' device may have not been the first locomotive torpedo. He observes that Hassan Al-Rammah claimed to have designed "what has been supposed to be a torpedo" in the 13th century. He notes that it was called 'the egg, which moves itself and burns' and believes that "it was intended to move on the surface of water" (p. 46-47).

[86] There was at least one instance in which the torpedo prefigured the automobile. Kirby (1999) wrote that, "Mr. Cunningham, an American shoemaker, built rocket torpedoes and once celebrated the 4th of

arms the torpedo was an armament; the steering ropes gave him control that became more remote and tenuous as the torpedo became increasingly distant. Lupis used his eyes to see the torpedo and target, and his muscles to channel the torpedo through the waves and currents as a person-to-person (or person-to-ship) form of telecommunication. Lupis' message was *force* in the sense mentioned by Archimedes, the ancient Greek mathematician and militarist: it exerted force on the ocean as it displaced water and on its target through collision and explosion (Steele & Dorland, 2005). Subtexts of nationalism, militarism, and economics ("I can destroy your expensive capital ship with a torpedo that costs pennies on the dollar!") can also be part of torpedoes' intended message-explosions.

Still, despite his government's rejection, Lupis' torpedo was not quite dead in the water. In the early 1860s he met Robert Whitehead, a British engineer with access to sophisticated production facilities. With Whitehead's innovations Lupis' torpedo was soon faster, submersible, self-steering, could be launched quickly from ship or shore, and was a candidate for large-scale production and distribution. By 1876, torpedoes traveled at 18 knots and the British Admiralty was buying the rights to manufacture them by the thousands. An 1873 report from the British Torpedo Committee declares that "any maritime nation failing to provide itself with submarine locomotive torpedoes would be neglecting a great source of power, both for offence and defence" (Burns, 1988, p. 3). Any nation state that failed to use torpedoes would neglect the potential to buttress its border and compromise others' borders.

July by setting off one of his torpedoes up the town's main street. It shot off at high speed scaring old ladies and horses and finally came to rest in the butcher's shop where it set fire to the icebox" (p. 9).

The arrival of the Lupis torpedo accelerated the technological race: Thereafter, inexpensive, low-profile torpedo boats were designed and built to send explosive little "messages," destroyers were made to take out the torpedo boats, and torpedo nets were manufactured to protect ships at anchor. Nineteenth century torpedo nets were made of steel rings and extended to more than 20 feet below the surface of the water; like Victorian hoop skirts they kept untoward advances at a distance, but also slowed vessels down. Naval historian Russell Burns observes that, "the relatively small size of torpedo boats, apart from leading to low construction costs, made them difficult targets to observe at night. Torpedo nets could be used by ships at anchor, and until about 1880 they were the principle means of defence against nighttime torpedo attacks" (Burns, 1988, p. 5). With the nets out, the ships of 1880 only moved at about three knots, and their ability to maneuver, remain in formation, and keep up with a convoy was hampered (Watts, 1971). Torpedo nets, while protecting individual water craft and the sailors in them, compromise a battle group's orderliness and effectiveness. The mere possibility of a torpedo launch wreaks havoc with naval logistics. For potential targets, the point of view created by the lighthouse, spy glass and lookout post is no longer adequate. Threats can emerge much too quickly, with torpedoes unknown until after their detonations.

Still, the view through the looking glass serves modern attackers. It encourages psychological distance from acts of destruction and killing, distance that was difficult to maintain in the swashbuckling days of ramming and boarding, and even of simple gun fire. Cannons and deck guns are a step in the direction of torpedoes in their assembly line operation: they divide the labor of loading, aiming, and firing, and hence the cannonball always arrives, step by step, on the enemy's deck without singular responsibility. But cannons and deck guns are aimed at persons as well as vessels, and retain the trappings of interpersonal warfare. Torpedoes are aimed at masses, at ships themselves, and enemy sailors become ill-defined occupants of targets (Brown, 1999). Consider German Lieutenant Otto Weddigen's account of the first U-boat ambush of a British convoy:

> When I first sighted them they were near enough for torpedo work, but I wanted to make my aim sure, so I went down and in on them. I had taken the position of the three ships before submerging, and I succeeded in getting another flash through my periscope before I began action. I soon reached what I regarded as a good shooting point. Then I loosed one of my torpedoes at the middle ship. I was then about twelve feet under water, and got the shot off in good shape, my men handling the boat as if she had been a skiff. I climbed to the surface to get a sight through my tube of the effect, and discovered that the shot had gone straight and true, striking the ship, which I later learned was the Aboukir, under one of her magazines, which in exploding helped the torpedo's work of destruction….But soon the other two English cruisers learned what had brought about the destruction so suddenly. As I reached my torpedo depth I sent a second charge at the nearest of the oncoming vessels, which was the Hogue. The English were playing my game…. (Weddigen, 1914, p. 1)

Weddigen observed and fired on the ships. His men loaded, aimed, and launched the torpedo, but he had the thrill of command. He looked for an "effect" from a distance, for the effect of his message-explosions. He enjoyed his "game." Weddigen exemplified remote controlled warfare, warfare that would soon progress beyond the U-boat captain's quick look at a grayish, blob-like enemy to a spike on an A-scope and a blip on a PPI (figures 1.3 and 1.4).

To reduce the power of torpedoes' message-explosions, the image of the torpedo needed to precede the arrival of the torpedo, and the naval point of view needed sharper focus and greater scope. Turn-of-the- century militarists considered searchlights just the thing; unlike lighthouses they were mobile, could be enclosed in directional hoods, swiveled about, focused, angled, and otherwise adjusted (Hezlet, 1975). They weren't (and aren't) particularly useful for seeing torpedoes arriving underwater—that is, for seeing them advance through space—but searchlights were able to spot torpedo boats, which helped forecast torpedoes in time and direction.[87] The fanciful notion that searchlights were first conceived to help locate sailors thrown overboard during rough seas does not hold up under investigation. Searchlights were the business end of early warning surveillance systems built to detect torpedo boats. They were also, as Burns notes, a crucial link in the development of radar systems:

> The searchlight detection and location system has some similarities to a radar surveillance system, viz: a) the use of electromagnetic radiation and a powerful radiation source; b) the utilization of means to focus the radiation in a narrow beam to increase the radiation flux in a given direction and hence increase the detection range of the system; c) the employment of a mounting which allows the beam to be swept over a given region and which enables the bearing of an object to be determined; d) the incorporation of a sub-system within the overall system, able to detect and track a given object. (Burns, 1988, p. 6)

However, the limitations of searchlights are legion. As detection systems they are mostly useful during nighttime or inclement weather. Moreover, bright, sweeping lights tell an enemy fleet exactly where to aim. A navy might as well put up a giant, inflatable gorilla and sell used cars as make extensive use of searchlights. If the lights are placed too low, their ranges are shortened. If too high, there is a risk of passing above torpedo boats and failing to detect them. And never mind the politics of the oblique: In

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[87] F. J. Milford (1996) suggests that before advanced steering mechanisms spotting the torpedo's wake could also be useful, as it would point like an arrow back to the torpedo boat.

rough seas a ship rolls and lists, making the ideal position of searchlights anything but fixed. As a logistical medium, the naval searchlight tries to arrange objects in space so that torpedo boats remain at a maximum distance. This allows ships to react to torpedo attacks, but at the same time makes ships sitting ducks. The point of view established by the searchlight becomes an obvious point for attack. As an information system the searchlight lacks 24-hour utility and channel control (or privacy)—most anyone can receive and interpret its messages.

Radar, being outside the spectrum of visible light, remedies this situation. Just like Bentham's Panopticon that Foucault employed, radar unfastens *seeing* from *being seen*, a pairing that makes the searchlight logistically ambivalent.

War Horns

The interim between bare searchlights and effective radar systems (a period of approximately 50 years) was filled with attempts to improve the former via powerful listening devices, what I'll alternatively refer to as war horns, acoustic locators, orthophones, sound mirrors, static dishes, or static walls (Scarth, 1999). Each of these was developed and deployed according to a lighthouse-and-spyglass logic—according to a naval logic—but was also tasked with atmospheric responsibilities.

In 1880, the magazines *The Manufacturer and Builder* (The Topophone, April 1880) and *Scientific American* (Navigation in Fogs, July, 3) featured Alfred Mayer's topophone (or "sound placer"). Mayer's contraption looked like a stethoscope with two reflectors mounted on an undersized ox collar (see figure 4.1). Shortly thereafter, large devices with ranges of 20–30 miles were placed on the decks of ships and along coast lines so that the direction of emergency whistles could be ascertained in dense fog, icebergs and other navigational obstacles could be heard in time for course correction, and searchlights could be aimed tactically and intermittently at enemies.[88] A chronicle of radar's pre-history details the development and abilities of these listening devices:

> Acoustical sound detectors, giving a rough indication of direction by means of applying the binaural principle seems to have begun, at least on the allied side, with the orthophone, an extremely simple device used in the French Army in 1917. At roughly the same time an experimental acoustical detector of the reflector type was produced in England by the Anti-Aircraft Section (under A.V. Hill) of the Munitions Invention Department….Despite their intrinsic weaknesses these devices were brought to a high pitch of perfection just before [World War II]. In 1936 an error of only a quarter degree was claimed on fixed sounds, and for an airplane flying at "reasonable" heights all sound locator manufacturers quoted two-degree accuracies (The Origins of Radar, 1945, p. 3).

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[88] While sometimes icebergs are quiet, other times they are loud. Research conducted at Oregon State University found that, "Icebergs that are grounded on the seafloor often get slowly pushed by currents and wind, causing them to vibrate like a tuning fork and make a loud hum" (Media Release, 2007, p. 1).

Figure 4.1: Topophone

Professor Mayer's topophone [1880]

A sketch of Mayer from the July 3, 1880 article in *Scientific American.* His design allowed naval officers to hear distant objects when there was too much fog for binoculars. Sketch is in the public domain. (*Scientific American,* July 3, 1880, p. 8)

War horns, developed in at least one instance by a Munitions Invention Department, were passive reception systems. They detected sound waves, but didn't project them. They made their operators collection points for information, and often, the decision making processors who joined two otherwise distinct information systems—sound detectors and searchlights. But in another way they were active: they made previously unheard sounds receivable, and in so doing fashioned their producers unwitting (and unwilling) senders (or providers of feedback). War horns left eavesdropping a silent, controlled, and coordinated form of large-scale information gathering, with the whisperings of motors, cries of migrating birds, and rumblings of icebergs' salacious content. World War I's air battles rendered sound detection even more important, as the speed of warfare complicated early warning, and as war itself became remote from its coordinators. A Rad Lab historian observes that:

> Although from the point of view of the present war [World War II] aircraft played a wholly auxiliary role in the last war [World War I], its potentialities having been scarcely exploited, this threat had given rise to methods of detection that depended upon tell-tale information emanating from the plane itself. Apart from visual spotting and telephonic reporting, the chief methods depended upon the detection and amplification of information involuntarily supplied by the approaching plane. These were detection and location by means of 1) the sound of the aircraft engine, and 2) electromagnetic radiation having its source in the plane. (The Origins of Radar, 1945, p. 2–3).

War horns upgraded searchlights, a necessity as war accelerated. They relied on sound, on sensory information not compromised by the presence of the sun, and so they were equally useful day and night. When employed in conjunction with war horns, searchlights flared with a speed approaching that of a volley of musket fire, and with about the same danger of giving away a ship's position. War horn-steered searchlights popped on and off like extended flash bulbs, giving snap shots of a target's location moments before gunfire arrived. Phenomenologically, the war horn, searchlight, and deck gun are synchronized extensions of their operators' ears, eyes, and hands, respectively. Ideologically, they extend nation states' capacities for surveillance, eavesdropping, and the projection of force in time and space. Journalistically, they ensure that war is a media spectacle with flashing lights, itching ears, and the red glare of rockets.

But while war horns were useful 24–hours a day, improved the efficiency of searchlights, and did not of themselves advantage enemies by giving away ships' positions, they had their own problems. Put simply, war horns of the 1930s and 1940s "gave no range information; their performance depended on the wind, and they were quite unreliable on gusty days; and lastly their range was so short…that with the high speed of modern planes" they were too slow and limited for practical use (The Origins of Radar, 1945, p. 3). War horns extended the ears of their operators, but the points of *listening* they established lack the grid-making qualities of searchlights' points of *view*. War horns, like compasses, discerned direction but not distance. They presumed a grid whereon the proximities of various objects were logistically significant, but the distance between objects remained unknown and unknowable.

They also expanded the logistical role of wind. No longer would commanders only verify that enemy troops were downwind from discharging mustard gas, or that snipers compensated for crosswinds before shooting. The development of war horns and other acoustic locators fostered hope that technologies would be developed that could minimize wind's significance as a source of noise. In the meantime, weather forecasting was important. In the 1930s weather reports were, more than ever, factored into decisions about the movements of military ships and planes. During war, blustery days increased the likelihood of sneak attacks, and therefore demand increased readiness (Scarth, 1999). I can only guess what might have happened if someone had adapted the wind machine—the silk-covered, slatted, rotating drum that Richard Strauss used for his 1897 symphony, *Don Quixote: Fantastic Variations on a Theme of*

Knightly Character—to turn-of-the-century warfare (one thing is certain: the military would have been *literally* tilting with a wind machine).

In the 1930s, hopes for effective acoustic location were such that massive acoustic locators, called *static walls,* were built on the English coast. These walls were over 200 feet in length and dozens of feet tall (Scarth, 1999). They had greater range than war horns (perhaps exempting the Japanese' *war tubas,* the large, powerful war horns deployed to protect their home islands) because they effectively received longer wavelengths, and because they were fitted with state-of-the-art microphones that were wired to listening stations. Amplifying the detected sounds and sending them to remote listeners allowed eavesdropping networks of static walls to form, even as it isolated eavesdroppers from the spaces they monitored. Static walls were architectural demarcations of the soils of nation states—of secure homelands—but like the medieval ramparts that preceded them, they were also architectures of advance. The keep's territory extended to the range of bowshots, catapults, and spyglasses; media with greater ranges mean larger swaths of controllable territory. Static walls, with their interconnections to searchlights and anti-aircraft fire, merely incorporated detection into the physical barriers themselves.

War horns and static walls didn't live up to expectations.[89] In 1934, Britain conducted a now infamous test of its air defense capabilities, a test conducted in the face of growing anxiety over Nazi Germany (Batt, 1991). Following the test, Air Ministry

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[89] Failure had its own benefits. During World War II, these media were deployed long after they had been replaced by radar systems in order to deceive enemies' natural eyes as to a military's actual detection capabilities (Penley, 2002). These systems have been successfully used by intelligence agencies, and are currently being considered as part of a comprehensive border protection program (Lipowicz, 2007).

official H.E. Wimperis wanted to sack acoustic detection in favor of a death ray.

According to radar historian Penley (2002):

> To give time for their guns to engage enemy aircraft as they came over, the Army was experimenting with the sound detection of aircraft by using massive concrete acoustic mirrors with microphones at their focal points. Dr. H.E. Wimperis, the Director of Scientific Research for the Air Ministry, and his assistant, Mr. A.P. Rowe, arranged for Air Marshall Dowding to visit the Army site on the Romney Marshes to see a demonstration. On the morning of the test the experiment was completely wrecked by a milk cart rattling by. Rowe was so concerned by this failure that he gathered up all the Air Ministry files on the subject of Air Defence. He was so appalled that he wrote formally to Wimperis to say that if we were involved in a major war we would lose it unless something new could be discovered to change the situation. (Penley, 2002, p. 1)

At the same time, American researchers were not only trying to refine war horns, they were also attempting thermal and electromagnetic detection. In the mid-1930s, "both thermal detection and microwave radio experiments" were being conducted at the Army Signal Corps laboratories in Fort Monmouth, New Jersey ("Beat and Pulse Radio Detectors," undated, p. 3).[90] In 1938 a thermal detector was installed in a truck and was field tested. Its performance was underwhelming. The official report found that:

> With thermal detector, day and night range on the plane…was about 4,000 yards…for commercial ships leaving New York Harbor, about 8,000 yards. Angular accuracy seemed to be about two degrees on ships, not above 10,000 yards. Beyond about 7,000 yards the impression was that the response was not entirely certain and positive, although more experience and training might improve the impression. (Hulburt, 1938, p. 1)

This performance led the official observer to conclude that:

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[90] This is further evidenced by a comprehensive report on the U.S. Army's attempts to develop detection technologies in the 1930s. "Both thermal detection and microwave radio experiments were at this time carried on by the Laboratories Sound and Light Section, which also was entrusted with visual signal lamps, underwater sound ranging and Field Artillery sound ranging" ("The Signal Corps. Development of U.S. Army Radar Development Part I," undated, p.3).

> Sensitivity has been sacrificed to speed of response…a better detector for ships could be devised…[I think the] Army will not entertain further development of thermal devices for airplane location because of the better promise of radio devices and because the thermal radiations from airplanes can be screened, if necessary…. (Hulburt, 1938, p. 1)

Hulburt's prediction notwithstanding, acoustic and thermal detectors have since been deployed as foils for one another in a never-ending escalation. In an effort to eavesdrop on slower, more sedentary violations of national space, micro war horns have been placed, for example, in the nostril of a wooden eagle outside the residence of the U.S. Ambassador to Russia (Wallace et al., 2008), stationed near national borders and drug trafficking routes (Eldridge et al, 2004; Pomfret & Farah, 1998), and used to monitor conversations and international telephone calls (Risen, 2005, p. A1). The macrophones of war preceded the microphones of espionage and national security.

The Telautomatic Art

Guglielmo Marconi is often considered the inventor of radio, as though it sprang from him fully formed, like Athena from the forehead of Zeus. Such consideration fails to account for the complex interweaving of economic, technological, and social forces that enmesh all inventors, and perpetuates a complacent acceptance of technologies as applied. In Marconi's case, the focus on him as a creator-genius minimizes the fact that he plays an important role in the industrialization of invention, the adaptation of the assembly line to production, the struggles for patents and national privilege, and the rise of Mussolini's fascism (Aitken, 1976).

In the tradition of optical telegraphy, after which the Telegraph and Beacon Hills of many American cities are named, Marconi ascended hills to avoid their interfering with his transmissions. That interference could be feedback, could be used to calculate distance, position, bearing, and other radar-derived information, was only important to him later in life. In a speech to the Institute of Radio Engineers in 1922 he states:

> As was first shown by Hertz, electric waves can be completely reflected by conducting bodies. In some of my tests, I have noticed the effects of reflection and deflection of these waves by metallic objects miles away. It seems to me that it should be possible to design apparatus by means of which a ship could radiate or project a divergent beam of these rays in any desired direction, which rays, if coming across a metallic object, such as another steamer or ship, would be reflected back to a receiver screened from the local transmitter on the sending ship, and thereby immediately reveal the presence and bearing of the other ship in fog or thick weather. One further great advantage of such an arrangement would be that it would be able to give warning of the presence and bearing of ships, even should these ships be unprovided with any kind of radio. I have brought these results and ideas to your notice as I feel—and perhaps you will agree with me—that the study of short electric waves, although sadly neglected practically all through the history of wireless, is still likely to develop in many unexpected directions, and open up new fields of profitable research. (1922, p. 237)

In the age of the airplane, Marconi's observations are still "out to sea"—he's thinking of naval identification and coordination. Nevertheless, Marconi does pull together his rivals' earlier, disparate ruminations. Some of his rivals, and especially Lee De Forest and Nicola Tesla, had been publically ruminating on systems for electromagnetic detection and remote control as early as the turn of the century. They had even noted that the difference between a detector and a destructor is one of frequency and amplitude.[91] When the French battleship *Iena* exploded in 1907,

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[91] Tesla, at least, entertained the possibilities of electromagnetic detection and destruction as early as November 21, 1898. In his letter to the *New York Sun*, he talked about a "self-propelling machine, the

electromagnetic waves were considered a possible cause. De Forest thought this unlikely, but not impossible. According to the *New York Times*:

> [De Forest] recalled the experiments of Nicola Tesla with a dirigible torpedo about the time of the Spanish-American war. Tesla then considered the problem of the use of wireless telegraphy for directing torpedoes and discharging them. It was Tesla's theory that a torpedo's movements could be controlled by means of waves of electrical energy, and he made many experiments to this end, but with no practical results. At that time Tesla made the statement that in the same manner he could project a wave of sufficient intensity to cause a spark in a ship's magazine and explode it. (Mar. 19, 1907, p. 4)

Tesla's estimation of his own successes and intentions was different. In a letter to the editor of the *New York Times*, written the day of (and published the day after) De Forest's comments, he argues that:

> A report in the Times of this morning says that I have attained no practical results with my dirigible wireless torpedo. I have constructed such machines, and shown them in operation on frequent occasions. They have worked perfectly and everybody who saw them was amazed at their performance. It is true that my efforts to have this novel means for attack and defense adopted by our Government have been unsuccessful, but this is no discredit to my invention….The time is not yet ripe for the telautomatic art. If its possibilities were appreciated the nations would not be building large battleships. Such a floating fortress may be safe against an ordinary torpedo, but would be helpless in a battle with a machine which carries twenty tons of explosive, moves swiftly underwater, and is controlled with precision by an operator beyond the range of the largest gun. As to projecting wave-energy to any particular region of the globe, I have given a clear description of the means in technical publications. Not only can this be done by the means of my devices, but the spot at which the desired effect is to be produced can be calculated very closely…. (Tesla, Mar. 20, 1907, p. 6)

Beyond the fact that knowing *when* radio detection systems were operational through the words of Marconi, Tesla, and De Forest is like trying to figure out the relationship between ACORN and FEMA detention camps on Glenn Beck's marker

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motions of which are governed by impressions received through the eye." This "controlling device" could potentially make guns obsolete (Nov. 21, 1898, p. 9).

board, the differences between conventional searchlights and radar have immense logistical importance. Radar serves 24-hours a day and without the fatigue of human sight. Enemies could not detect its use without comparable equipment, and, at least in the early years, would find the task difficult even if they had such equipment. Radar extended combat beyond the range of guns and natural sight. With sufficient power it extended a nation state's reach anywhere in the world. And then there was the possibility of not only an information system, but an electromagnetic weapon, a death ray.

Death Ray

Amidst the fallout of World War I, Europeans and Americans were taken with airplanes and the means of controlling and destroying them. As would-be electromagnetic weapons, death rays are important to radar's pre-history. "The inventors of a 'death ray' multiply every day," says the May 29, 1924 *New York Times* (p. 4), with scientists from the U.S., Britain, Germany, and Russia all claiming to have developed devices that would "bring down airplanes, stop tank engines, and 'spread a curtain of death.'" Public fascination with death rays was drummed up by high-profile, crackpot inventors (and later by Boris Karloff in the film, *The Invisible Ray*). But the horrors of storage war—of soldiers as bumps in grooves—fomented genuine enthusiasm for remote, high-speed transmission weapons. Military officials with bloated post-war budgets were looking for clean killing through unproven devices.[92] The U.S. Navy was interested in inventor Grindell Matthews' death ray (*Chicago Daily Tribune*, May 28, 1924). The U.S. Army made inquiries of a German scientist who had developed "a method of producing invisible rays capable of stopping airplanes in midair and automobiles" (*Chicago Daily Tribune*, May 29, 1924, p. 5). German General Freiherr Von Schoenich fantasized about death rays and other remote weapons. According to the *New York Times*:

> General Freiherr Von Schoenich has issued a book, "The War of 1930," in which he describes how a third war between France and Germany will be carried on….German death ray machines will be uncovered on the whole French border….Thousands of French airplanes will try to fly to Germany, but most of them will be destroyed by the death ray…. (Aug. 3, 1924, p. 6)

Von Schoenich sees death rays as besting the airplane's speedy, border-compromising, remote attacks. Death rays' post-war allure was more than public obsession with scientific whimsy or hoped-for telautomatic art. Legitimate organizations like the U.S.' Committee for Scientific Survey for Air Defense put time and resources into developing an electromagnetic death ray that could "be used to strengthen present methods of defense against hostile aircraft" (Minutes, 1935, p. 1). Such devices were also a reaction to the "tides" of immigrants displaced by the war, an inclination to coordinate (and for some, to *stop*) the flow of alien bodies across nation states'

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[92] Skepticism of a sort was present in some quarters: "the versatile Lord Birkenhead leads the skeptics," wrote the New York Times, "He exclaims that an unknown amateur should stumble upon an epoch-making discovery is about as likely as that a child of five should defeat…the champion chess player" (New York Times, May 29, 1924, p. 18).

permeable boundaries.[93] The same newspapers that heralded the death ray as a national searchlight and electronic rampart crinkled and tore over nomadic invasions. Death rays were out-pointing while immigrants were in-coming. Immigrants came by plane, boat, and even the Underground Railroad (a difficult to control channel). Speaking of the latter, the September 27, 1924 *Atlanta Daily World* records that:

> Through [Sandusky, Ohio], which many years ago was the principal route for the Underground Railroad carrying escaping slaves to Canada and freedom, there now come under the dark cover of night alien citizens from Canada seeking entrance to the United States in defiance of immigration laws. The route once being used by fleeing slaves is, thus, being used in the reverse by another group seeking "a land of liberty." (*Atlanta Daily World*, Sept. 27, 1924, p. 2)

Considering post-war immigration and death rays in constellation reveals how the latter was an imagined logistical medium at the extreme. Death rays were hoped-for weapons that would accomplish many of the purposes of logistical tools (Deleuze & Guattari, 1986). They were conceived as projectors of social-electromagnetic (or variously, molecular) force that would divide populations, and with the direst consequences. Defectors were to be held *in* and immigrants *out* according to nation states' designs. Those approaching the death ray's "border" would have lost their lives in the act of attempted identity transformation (such as from "other" to "citizen"). Death rays would have made the national boundaries that Anderson (1991) correctly locates in the minds of citizens uniquely, mortally, and materially manifest.

Deleuze and Guatarri provide an example of the identity issues death rays suggest. Consider, by analogy, that death rays would have been one device among many

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[93] The most infamous and extreme example of this reaction is Hitler's designation of "International Jews" and gypsies as *lebensunwertes Leben* ("life-unworthy life").

that made Go piece–like nomads into something akin to chess pieces. Unlike Go pieces, whose identities are anonymous or collective, chess pieces have intrinsic identities, coordinated movements, and hierarchies. Deleuze and Guatarri (1986) contrast Go and chess pieces to distinguish nomads from the state-bound. They suggest:

> Let us take Chess and Go, from the standpoint of the game pieces, the relations between the pieces and the space involved. Chess is a game of State, or of the court: the emperor of China played it. Chess pieces are coded; they have an internal nature and intrinsic properties, from which their movements, situations, and confrontations derive….Go pieces, in contrast, are pellets, disks, simple arithmetic units, and have only an anonymous, collective, or third person function: "It" makes a move. "It" could be a man, a woman, a louse, an elephant. (p. 3)

Chess pieces are placed in relation to a centralizing force and point of view—the survival of the king. Go stones are nomads whose movements and identities are entirely situational. If the survival of the king is the goal of chess, the king can be seen as an emblem of progress (although not necessarily modern), the squares as its logistics, and the movement and arrangement of pieces its various progress narratives.

Considerably, in 1924 the naturalized ideology of America as a "melting pot" in the *present* was ripe for disruption by the *now* of Lupis' torpedo, Mayer's topophone, and paranoia over the Underground Railroad running in reverse. The death ray as an instrument of progress—of clean war, and even, as I'll argue below, the end of war—and hotly contested immigration legislation (*Chicago Daily Tribune*, Mar. 1, 1924; Jan. 2, 1924) were emerging because of a temporal montage of ideological indigestibles. In January of 1924, Representative Albert Johnson of Washington, the Chairperson of the House Committee on Immigration, suggested that most of the members of his committee "are of the opinion 'that mankind is literally at the crossroads' and that a majority of the people of the United States are convinced that immigration to this country must be drastically checked" (*Chicago Daily Tribune*, Jan. 23, 1924, p. 15). Johnson was adamant that "the name *melting pot* is a misnomer," and asserted that, "the countries of the world shall no longer dump upon the United States their criminals, their feeble, their aged, and their undesirables" (p. 15). These comments were uttered as scientists basked in the potential of electromagnetic detection systems (Marconi) and death rays (Tesla, Grindell-Matthews, and Wall), and as a General (Von Schoenich) boasted, in the English language press, of his intention to line the French border with death ray machines. Both keeping "others" at bay and the electromagnetic means to do so were public concerns.

The logistics of large-scale immigration were not lost on Americans, who demonstrated awareness of organized and occupied space. A March 1, 1924 letter to the editor of the *Chicago Daily Tribune* pulls the constellation of immigrants, spaces, and logistics together:

> One phase of the immigration problem seems to have escaped attention in or out of congress, namely, that which has to do with location and occupational control of immigrants. Under the law soon to be enacted those permitted to enter the country should be compelled to settle upon and cultivate lands remote from congested centers and undergo the same schooling in pioneer self-reliance that our own ancestors did. It seems to me that this is the only way to make Americans of them….Our prison, poor house, and asylum records show an amazing preponderance of foreign names, mainly from city courts. Our right to dictate location and occupation as part of citizenship is clear…. (Mar. 1, 1924, p. 8)

Returning for a moment to one of Virilio's (1986) themes, the speed of immigration was fundamental to the logistical problems of the 1920s and 1930s, and was managed through quotas, quarantines, and highway speed traps. To avert rush hour, immigrant-bearing ships were forced to wait outside the three-mile national boundary before proceeding, according to strict schedules, to quarantine centers. Shipping lines could be fined up to $200 for each immigrant brought in over quota. In 1922, immigration authorities concerned with ships' dangerous midnight "sprints" into port announced:

> A policy of strict enforcement of the immigration law, which provides that not more than 3 percent of the nationals of any country already here will be accepted….A rule at Quarantine requires that the ships shall be examined in the order they enter.[94] (*New York Times*, Jul. 1, 1922, p. 12)

Inside the U.S., speed traps accompanied automobiles from the first, and even as the unidentified driving objects (UDOs) were blamed to justify increased enforcement (Reppetto, 2004). Today's airport-screening speed traps and terrorist profiles are in this sense typical port procedures, albeit now imposed on all air travelers, and even on the act of air travel itself. The logic—the logistic—of port and quarantine has extended throughout nation states, an idea buoyed up in the letter to the editor of the *Chicago Daily Tribune* I just cited.

In 1906, legislation was proposed in New Jersey that would have treated nonresident motorists more harshly than resident motorists. This legislation would have left nonresident motorists "at the mercy of any local constable, who can arrest without warrant for exceeding the speed limit, using armored tires, and for any one of a long list of prohibitions" (*New York Times*, Feb. 21, 1906, p. 6). In 1910, Connecticut officials set

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[94] With prohibition on, rum runners and their cargo were treated similarly, albeit with a publicized quota of zero. The Oct. 12, 1924 New York Times reports that, "the war at sea to make America dry is pursued with more vigor, the result, it is assumed, of a larger and stronger prohibition 'navy' which operates under a 'censorship'" (p. XX2).

speed traps for a “certain class” of motorists—unidentified outsiders (*New York Times*, May 22, 1910, p. S4).[95] In 1922, a breakthrough electromagnetic searchlight at the Naval Research Laboratory enabled high-tech, efficient speed traps. According to a Rad Lab historian:

> In one of the early field tests on [electromagnetic detection equipment] transmitter and receiver were placed forty feet apart, and by means of the interference phenomenon employed…a Ford truck was detected at 250 feet as it moved down the perpendicular bisector of the line joining transmitter and receiver. (The Origins of Radar, 1945, p. 6)

Unlike the 1934 test of the static wall, the 1922 test of an electromagnetic searchlight was not foiled by an erstwhile milk cart. The first radar-powered speed trap was a success.

RCA

The fragments of torpedoes, dirigible torpedoes, death rays, immigration debates, fear of the Underground Railroad running in reverse, speed traps, and logistics suggest a preoccupation with the integrity of the nation state’s border and electromagnetic remote control and weaponry. They figure into the eventual development and deployment of radar, and into the expansion of a port mentality. After World War I, though, electromagnetic detection’s possibilities were mostly considered in the laboratories and speeches of inventor-promoters like Marconi. Electromagnetic

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[95] Instructions given to attendees of the 2007 meeting of the U.S. Social Forum, an organization concerned with immigrants’ rights, evidence that apparent “nonresidents” and “outsiders” continue to be subjected to rigorous speed enforcement: “Immigrants travelling by land should be aware that some local police departments aggressively enforce traffic laws against those they suspect of being undocumented immigrants as a pretense for investigating immigrant status. You should not travel significantly above the speed limit or otherwise call attention to your vehicle” (United States Social Forum, 2007, p. 3).

detection was enchanting, but was nonetheless outside most people's daily consideration.

Contrastingly, radio telephony, exploratory, point-to-point transmission and reception of messages, was a popular phenomenon and governmental concern. Unlike radar, which would be developed around electromagnetic interference—around waves that reflected back—radio telephony's value was in its atmospheric effervescence. Radio telephony began at the dawn of the 20th century, with amateur radio operators sending and receiving messages, forming clubs, and seeking messages from as far away as possible (a practice radio amateurs call "DXing" (Douglas, 1999; 1987)). Few people considered the logistics of radio telephony, though, until the Titanic disaster of 1912. According to Douglas (1999):

> Immediately after the *Titanic's* wireless operator, Harold Bride, notified stations that the ship had hit an iceberg, wireless stations all along the northeast coast of North America clogged the airwaves with inquiries and messages. Out of this cacophony emerged a message picked up by both sides of the Atlantic and reprinted in the major papers….Editors of the *London Times* and *The New York Times* were appalled to learn the next day that the message was false, and they blamed the amateurs for manufacturing such a cruel hoax. (p. 60)

Radio amateurs' endangering remote voyages was not tolerable. Congress passed the Radio Act of 1912 only months after the Titanic collision; it required radio amateurs to obtain a government license and restricted their transmissions to specified wavelengths. When World War I began in Europe, the U.S. Navy, which had overseen radio in the U.S. since Teddy Roosevelt's executive order in 1904, was concerned with radio waves' carrying security-compromising information. It prohibited all amateur radio transmissions for the duration of the War. It also, along with the U.S. army, encouraged radio amateurs to enlist so that radio could coordinate remote military operations. The U.S. military organized, professionalized, and deployed radio amateurs as part of the war effort (Douglas, 1999; 1987; Aitken, 1976).

After the War, President Woodrow Wilson rolled out a logistical foreign policy. International communication, shipping, and oil were his three "requisites of success in foreign relations" (Nebeker, 2009, p. 134). Wilson didn't like Britain's ownership of undersea cables and their manufacture and wasn't going to tolerate the British-owned Marconi company's dominance of radio (Nebeker, 2009; Aitken, 1976). When General Electric advised the U.S. government that in the near future much of its radio manufacturing would be under contract to Marconi's American operation, Franklin Roosevelt, who was then an Assistant Secretary of the Navy and Wilson appointee, took action. He "convened a meeting which led to the establishment of a U.S.-owned international-communications company. General Electric set up a subsidiary, the Radio Corporation of America (RCA), which would buy out American Marconi" (Nebeker, 2009, p. 134). RCA was so rooted in nationalistic soil that its:

> Articles of incorporation stipulated that only U.S. citizens might be directors or officers of RCA and that no more than 20% of the stock might be owned by foreigners. A press release expressed the objective of the new firm: to link the countries of the world in exchanging commercial messages. (Nebeker, 2009, p. 134).

Wilson and Roosevelt were determined opponents of British control of electromagnetic messaging and extension of the nation state. They grounded RCA's ownership in U.S. citizenship, in the American political identity. When RCA traded stock for the radio patents owned by GE, Westinghouse, AT&T, and United Fruit, it became a national trust: AT&T manufactured transmitters, GE and Westinghouse made receivers, and electromagnetic SMCRF in the U.S. was owned by Americans. Radio was not going to be the means of foreign incursion, at least not on the level of ownership and manufacturing (Aitken, 1985).

Radar is in the shadows of these events: The patents pooled in RCA and the manufacturing arrangements between GE, Westinghouse, and AT&T were exclusive and nationalistic.[96] AT&T's large-scale manufacturing of radio transmitters eventually aided the development of radar in the U.S. in that it supplied equipment that was modified for early radar experiments at the Naval Observatory in Maryland and at the Army Signal Corps laboratories in New Jersey (Baxter, 1946). Moreover, the founding of RCA was a bridge between radio's past as a Navy protectorate and its future as a commercial broadcasting medium. In the sense that radio eventually became a broadcasting medium, would-be death rays (radar) were also broadcasters. Rather than the point-to-point communication of telephony, they cast their beams broadly and received feedback from many points. Tesla claimed he could cast his death ray so broadly that he called it "teleforce." I now elaborate on its contribution to the development of radar.

Teleforce

As early as 1898, Tesla thought his wireless torpedo would allow the world's militaries to "dispense with artillery of the present type." He believed his device so immensely powerful, so instantaneous and ubiquitous, that warfare would shortly cease

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[96] RCA's patent pool was not as effective as anticipated. According to Inglis (1990), RCA only accounted for 1/6 of the total sales of radio equipment in the U.S. during its trust years.

for lack of one-upmanship. In that year, he told readers of the *New York Sun* of the impossibility of meeting his weapon with “corresponding development.” He wrote that, “It is this feature, perhaps more than in its power of destruction, that its tendency to arrest the development of arms and to stop warfare will reside” (Tesla, 1898, p. 9).[97] Tesla’s medium was the ether, a medium he considered to permeate all space, and he was convinced that nationalism would decline through interconnection in it.[98] He believed the ether would help people to “begin to think cosmically,” and that inventors would open doors to world peace. Tesla was the Deepak Chopra of weapons designers, even as he gave himself and his inventions important places in a modern progress narrative.

Tesla considered the postal service a precursor to ether-spanning devices like radio, and to his wireless torpedo and global, wireless, AC power schemes. He proffered the “mechanisms” of the postal service and mail bag as evidence of progress:

> Universal harmony has been attained only in a single sphere of international relationship. That is the postal service. Its mechanism is working satisfactorily, but how remote are we still from that scrupulous respect of sanctity of the mailbag! And how much farther again is the next milestone on the road to peace—an international judicial service equally reliable as the postal! (Tesla, 1905, p. 21)

Tesla believed pervasive and efficient mechanisms, and especially SMCRF information systems like the postal service, indicated humanity’s readiness to dispense with *weltschmerz* (world weariness) and ascend into peaceful, ethereal reality. Tesla

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[97] According to the *New York Times*, Orville Wright likewise believed the airplane would end war (July 1, 1917, p. 55).

[98] Tesla’s hopes for the ether are similar to McLuhan’s posited “electronic interdependence.” See McLuhan (1962).

posited an ideological break between the type of torpedo Lieut. Weddigen launched from his U-boat and his own wireless torpedo, between the modern mailbag and the ancient Egyptian one (Innis, 1972). But he failed to account for the role of wireless communications, such as radio and radar, in military logistics and in the construction of nature as “other.” Unlike Mumford and Wiener, Tesla didn’t reason how the military’s ownership and selective application of technology empowers a progressive-catastrophic dialectic. Tesla posited technology and world peace in a cause-effect relationship.

By 1934, the press was so taken with Tesla’s advancements that it uncritically referred to his particle beam emitter (a device that used a vacuum tube to accelerate and then propel molecules of mercury and tungsten) as both a “death ray” and a “peace ray.” The *New York Sun* connected technology, nationalism, and world peace with the “wall” rhetoric then applied to war horns:

> The beam, as described by the inventor to rather bewildered reporters, would be projected on land from power houses set 200 miles or so apart and would provide an impenetrable wall for a country in a time of war. Anything with which the ray came in contact would be destroyed, the inventor indicated. Planes would fall, armies would be wiped out and even the smallest country might so insure security against which nothing could avail. Dr. Tesla announced that he plans to suggest his method at Geneva as an insurance of peace. (July 10, 1934, p. 7)

Tesla’s peace ray had, by 1940, been transformed into “teleforce.” In ideological terms, Tesla’s teleforce was a systematic, station-based, particle-beam extension of the nation state into the atmosphere, and one suited to the menacing airplane. It was supposed to melt airplane motors from 250 miles distant and construct a ‘“Chinese Wall of Defense…’ around the country against any enemy attack by an enemy air force, no matter how large" (*New York Times*, Sept. 22, 1940, p. 10). The *New York Times* recorded that:

> This "teleforce" is based on an entirely new principle of physics….This new type of force Mr. Tesla said, would operate through a beam one-hundred-millionth of a square centimeter in diameter, and could be generated from a special plant that would cost no more than $2,000,000 and would take only about three months to construct. A dozen such plants, located at strategic points along the coast according to Mr. Tesla, would be enough to defend the country against all aerial attack. The beam would melt any engine whether diesel or gasoline driven, and would ignite the explosives aboard any bomber. (p. 10)

Not everyone was enthralled with transmission-as-destruction. In Britain, physicist-meteorologist Robert Watson-Watt was convinced that "radio-destruction" systems were not feasible, and knew better than to be drawn into Tesla's "no corresponding development" fancy. Burns writes that, "On the question of whether rapidly moving targets could be immobilized Watson-Watt assumed that bombing aircraft of the 'immediate' future would be all-metal monoplanes with cowled engines and screened ignition systems" (Burns, 1988, p. 123). Watson-Watt believed "the most attractive scheme" to project Britain into the atmosphere, "was that in which zones of short-wave radio illumination were set up through which an approaching airplane had to fly" (p. 123). His efforts led to 20 CH (Chain Home) radar stations on the British coast by the spring of 1939 (Allison, 1984).[99]

The effort to systematically and electromagnetically extend the U.S. (electromagnetics seemed more promising than Tesla's particle scheme) materialized in MIT's Rad Lab. As noted in the Lab's history, "The incentive for the development of

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[99] Allison (1984) indicates that with World War II looming, British radar researchers had more urgency than did their American counterparts.

[radar] became irresistible when the technical advances in aviation [were] almost coincidental with the deterioration of the international picture” (The Origins of Radar, 1945, p. 5). Despite hopes that radar would become a death ray, Rad Lab researchers conceived of it as a communication system that preceded and enabled a weapon system, much like the searchlights that preceded and enabled deck guns in the early days of torpedo nets. Isidor Rabi, who took a leave of absence from Columbia to become the Rad Lab’s associate director, describes radar in a way that circles back to Lupis’ communication system:

> Radar represents an extension of man’s senses and power. He sees further. He sees more clearly. He measures distance more accurately. He can transmit information more readily….Then you apply it to something. It extends your senses in dropping the atomic bomb, it extends your senses in guiding the missile. It gives you more information for navigation. (Guerlac, 1946, p. 2)

Henry Guerlac, a colleague of Rabi’s at the Rad Lab, is likewise explicit. “Radar is not a death ray,” he writes, and:

> It cannot reduce a city to ruins or hold out to a new age the promise of cheap power. But it does enable man to do an astonishing number of things he could not do before, and to do them with extraordinary precision. It has proved the most versatile instrument in modern warfare, revolutionizing one area after another. (Guerlac, 1946, p. 2)

Rabi’s assertion that the radar vision machine “sees further” and “sees more clearly,” exemplifies both the modern penchant for forecasting and a narrative of progress through technology. While radar does not literally “reduce a city to ruins,” a city becomes an incomprehensible blot on an A-Scope’s right-to-left display of distance (Figure 1.3) and invisible on a PPI’s bull’s eye (Figure 1.4). Radar-as-teleforce extends power, senses, and navigation, and sees cities only as reflections of surface and movement. It is precision in excess; a point of view for a geometry of empire.

War Dance

Radar projected a nation state's rhythm, order, and border into the air and over the sea. Radar was a necessary antecedent of both traffic coordination during World War II and the post-war development of military networks such as NORAD. During the War, the movement of supplies, troops, and bombs was of such scale that collisions and deaths by friendly fire were common. As the War progressed, *radar-as-rampart* (or *radar-as-speed bump*) was broadened to include *radar-as-traffic cop*. As the U.S. military's Committee on Air Navigation and Traffic Control confirmed in correspondence with the Rad Lab in 1944:

> The development of radar equipment in the course of this war has, in almost every instance, been in response to an urgent, specific military need. Early-warning radar systems appeared in the earliest phases of the war at a moment when direct attacks where anticipated on our shores….Application of such equipment as an aid to navigation followed as a by-product that grew rapidly in importance to overshadow its initial purpose. (Stratton, 1944, p. 1)

Flights over "the hump"—over the Himalayas from India to China—were so dangerous that simple radio beacons were used to construct multi-level "parking garages" in the sky while planes waited to touch down.[100] The comparatively free, nomadic movements enjoyed by World War I pilots—such as Lanoe Hawker's daring duels with Manfred von Richthofen (the Red Baron)—were not feasible during World

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[100] Frank Capra's 1937 film, *Lost Horizon,* was about a lost flight over "the hump." In that film, the crew of the plane finds Shangri-La.

War II. A test case for the application of radar to the logistical problems of World War II was Kunming, the capital of Yunnan province in South-central China:

> The tremendous volume of air traffic in the Kunming area had raised a serious traffic control problem some time before the termination of the war. An unprecedented amount of air traffic was concentrated in this area, the terminal area for the air supply routes to China. On days when instrument let-downs were required at Kunming airfield, bottlenecks were apt to occur over the field. Aircraft arrived frequently at the field and were apt to arrive in bunches necessitating stacking over two radio beacons. At times so many aircraft were stacked up that aircraft were forced to wait two hours before obtaining their clearance for let-down. The possibility of using radar to assist in relieving this bottleneck was suggested…. (Chu et al., 1945, p. 2)

The possibility of radar-as-traffic-cop, speed trap, and immigration coordinator was realized when radar “controllers” and beacons were deployed to create highways for the air traffic coming into and out of Kunming. This new use of radar was referred to as an “air traffic control system,” and, while SMCRF writ large, was also consistent with a politics of the oblique, with an expansion of architecture that coerced movement (Virilio & Parent, 1996). The movements of high-speed pilots and their planes were thereafter controlled in three dimensions:

> The Air Traffic Control System established in China is based on the maintenance of lateral, altitude, and time separation between aircraft. Navigation is done primarily on radio homing beacons….Aircraft progress along the various routes is recorded in the area traffic control center. Each pilot reports his time of passing over known radio beacons along his course. From this data the controllers calculate the estimated time of arrival on the aircraft over succeeding radio beacons on the basis of an assumed ground speed for the particular type of aircraft in question. Corrections in altitude are given to avert possible collisions. Aircraft awaiting a landing clearance are stacked vertically on radio beacons in bad weather, and are cleared in turn for their instrument let-down. (Chu et al., 1945, p. 1)

The advanced state of British radar allowed them to use radar beacons throughout the War.[101] These beacons were used as early auto-pilot systems and mitigated the dangerous docility of remote war conducted by somnolent, sense-deprived pilots. According to Roberts (1946), during World War II:

> [Radar] beacons placed at home airports were a valuable navigational aid to crews of Coastal Command planes returning from long and wearisome search missions over the North Atlantic, enabling them to home directly from as far as 70 or 100 miles by means of the range and azimuth information obtained….The [radar] beacons were placed not only at home airports but at points convenient for patrol activities; many a British pilot spent long hours patrolling back and forth between two ground beacons which marked the limit of his beat. An RAF song "Orbiting the Beacon" immortalizes this aspect of the war. (Roberts, 1946, p. 1)

The square dance between beacons, the coordinated response to the radar "caller," prompted song. With the noble craft of the RAF arriving and pivoting at beacons, swishing their exhaust-skirts in rhythm as their patrols cut across Britain's invisible, radar-projected tiles, the mock combat of the war dance ritual was realized as modern warfare.[102] It materialized the war dance as a defense of the nation state. But more than this, radar searchlights helped pilots adapt to the rigors of 24-hour warfare and the confines of their cockpits for hours at a time.

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[101] The British were also the first to develop radar beacons (Roberts, 1946).

[102] Slavoj Žižek identifies how the playwright Brecht saw performed ideology in the movement of Soviet tanks: "When Brecht, on the way home from his home to his theatre in July 1953, passed the column of Soviet tanks rolling towards the *Stalinallee* to crush the workers' rebellion, he waved at them and wrote in his diary later that day that, at the moment, he (never a party member) was tempted for the first time in his life to join the Communist party. It was not that Brecht tolerated the cruelty of the struggle in the hope that it would bring a prosperous future: the harshness of the violence as such was perceived and endorsed as a sign of authenticity….Is this not an exemplary case of what Alain Badiou has identified as the key feature of the twentieth century; the passion for the Real?" (2002, p. 5).

NORAD, a postwar outgrowth of both the air traffic control and national defense logistics of World War II, placed radar stations along North American coasts and the arctic to (in Tesla's terms) bestow the sanctity of the mail bag on the new frontier. The narrative for this picket of radar stations invoked both nationalism and ethnic difference. For "the first time since the *Indian wars*," wrote *New York Times* correspondent Hanson Baldwin:

> America has 'live frontiers'—frontiers of the sky and the sea—exposed to serious assault by enemy aircraft, missile firing submarines and guided missiles with nuclear warheads….The nation is spending each year an estimated $4 to $5 billion on continental defense….The electronic eye of radar—mounted on land, in planes, blimps, ships and on man-made islands in the sea—is the first element of this defensive system; it gives warning of attack and can control our intercepting aircraft. (Baldwin, 1955a, p. SM10, emphasis mine)

By 1955 the speed of "others" was such that the national boundary was imagined beyond the three-mile limit reserved for immigrants waiting for processing at Ellis Island:

> Eventually, a mid-ocean, or off-shore 'barrier,' which at the moment is still largely on paper, will be established with navy escort ships….The off-shore barriers are expected to extend in great arcs of sea and sky on both flanks of the North American continent….This complicated and elaborate system of seaward defenses, which is intended to provide interlocking and overlapping radar guard against air or submarine attack, gives us additional warning time in an age of speed and more speed; it extends seaward our heretofore shore-based 'vision.' (Baldwin, 1955b, p. SM11)

More recent efforts to sanctify the atmosphere with the efficiency and order of the postal service can be seen in Ronald Reagan's Star Wars defense plan, George W. Bush's anti-missile system (Boese, 2006), and the delivery of text messages to mobile phones. Delivering messages to mobile targets is both a militaristic and a mundane priority, a matter of intensifying and elaborating Wiener's artillery systems and firing tables.

Robot Missiles

Tesla was adamant that his dirigible torpedo functioned, and that the time would eventually be "ripe for the telautomatic art" (Tesla, Mar. 20, 1907, p. 6). That time was, if not when the Hindenburg exploded, when the Germans built V-1 and V-2 "buzz bombs" during World War II (Kennedy, 1983). Three times as many people died building V-2s than were killed as targets (22,000 as compared to 7,200), but nonetheless the V-2 was a speed weapon. It was too fast for intercepting planes, antiaircraft batteries, and the emaciated German prisoners busily constructing their own demise. At one point, the British considered rows of anti-aircraft batteries and radar to coordinate their defense. The British Missile Defense Agency nixed that idea, though, as the falling artillery shells would have caused more damage than the buzz bombs (Missile Defense Agency, 2002). In the early 1940s the telautomatic art of the V-1s and V-2s was, with the brevity of a few frames of film, projecting orange and crimson onto the landscapes of Europe. In the 1960s the telautomatic art ignited NASA's Apollo program with a rocket based on the V-2 (Neufeld, 1995).

But the dirigible torpedo is, dialectically, an intensification of a threat to the logistics of nation states. It is fast, less independent than a piloted craft, remote controlled, an act of force. Like the telegraph, the dirigible torpedo is cybernetic and separates communication from (human) transportation (Carey, 1988). Its explosions send messages of touch (thermal radiation and shrapnel), sight (electromagnetic radiation), and sound (of the torpedo and its shrapnel moving through the air) of a predetermined (short) duration. It also has a way of preserving the sender's anonymity, compelling reception, and placing receivers in a dominant decoding position (Hall, 1980). Dirigible torpedoes demand interactivity and fix points of view. As Virilio (1997) suggests, they produce destruction.

In the waning days of World War II, the U.S. army sought to produce such destruction by transforming worn out bombers into radar guided "robot missiles." These explosives-laden mailbags were like Lupis' torpedo, but without the physical connections of rope and arm. According to a once-secret military report (dated April 27, 1945):

> It now appears possible to control war weary heavy bombers fitted as robot missiles up to a distance of 1,500 miles. On 9 April and 14 April, two long range flights were made, using a B-17G as the "mother," or controlling aircraft, and a B-24L as the "baby," or robot aircraft. The flights were for distances of 1470 and 864 ground miles, respectively. FM radio control was used in conjunction with a radar beacon link. The elevator, rudder, and ailerons were controlled. No throttle control was used, once the automatic flight control equipment was set. (Weinbrenner, April 27, 1945, p. 1-2)

Such robot missiles were more than the logical transfer of the force of exhausted, but mobile aircraft to their fixed, but motile targets. They were the recreation of the pilot, navigator, and bombardier as remote managers. Mental and physical labor were cleanly divided, with control enabled by radar beacons and information collected in centralized radar situation rooms. The arduous lumbering of robot missiles was enclosed in an authoritarian information system, a feedback system with the "mother" controlling the "babies'" movements and speeds (Robins & Webster, 1999).[103] Robot missiles were produced, distributed, and consumed in a production line of "continual control." They were, like Weddigen's torpedo, aimed at an abstracted, mass target: According to a report of the above-cited April 9 flight, robot missiles were "suitable only for bombing area targets two to four miles square" (Weinbrenner, April 23, 1945, p. 2).

Robot missiles of this era were also blind. They were utterly dependent on their remote masters and electromagnetic directions, on the vision machines of searchlights and the machinations of autopilot systems. Obedient objects enclosed in the ideology of "ground-to-air control for individual bombers without visual contact" (Pickens, April 11, 1945, p. 1), robot missiles were perfectly dependent on their information systems. Moreover, they were controlled by their own feedback; their trajectories and speeds were adjusted according to information taken from them, quite literally, as a matter of course. Robot missiles, like Lupis' torpedoes, torpedo nets, searchlights, death rays, and milk carts were messages and channels in military information systems.

The blindness of World War II era robot missiles was of a different order than that of their controllers. Both were embedded in the historical trajectory of the searchlight, a trajectory of accelerating weaponry, authoritarian information systems, and progressive ideology: scientists, like Tesla, evoked ethereal postal delivery and imagined death rays. Militarists longed for the efficiency of remote, 24-hour warfare. Americans subjected themselves and would-be immigrants to new logistical controls,

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[103] According to a report of the April 9, 1945 flight, the robot missile "can be controlled to a point in space within the range of the plotting board with an average circular error of less than 500 yards and by an average heading error of less than 2 degrees…." (Pickens, April 11, 1945, p. 1).

such as speed traps and war horns. Nation states were extending themselves into the atmosphere. They were desperately depending on an electronic version of Balaam's ass, on a device that could see hidden dangers in the path of progress.

Before moving to the next chapter and a consideration of radar antennas and architecture, I close this chapter with a consideration of the major fragments I've just arranged—lighthouses, torpedoes, searchlights, and death rays. With the imagined death ray excepted, these fragments are feedback systems created to extend coordination and control and to forecast impending threats to nation states. As a mathematician and militarist, Wiener (1961; 1954) understood the importance of both messages and feedback to control and coordination. His use of the first person fits both the nation state and All-Seeing Eye:

> I control the actions of another person, I communicate a message to him, and although this message is in the imperative mood, the technique of communication does not differ from that of a message of fact. Furthermore, if my control is to be effective I must take cognizance of any messages from him which may indicate that the order is understood and has been obeyed. (1954, p. 117)

Wiener conceptualizes not only his personal communications, but also the post-Big Bang universe in such terms. For him (and for me), the universe is an all-encompassing information system, an omnipresent feedback loop. A feedback loop does not allow for discrete perceptions, for messages that are not constructed, sent, or received as part of a system. To see is to be seen and to be a process of seeing. To know the magnitude of a torpedo explosion and see the reflection of a searchlight from a hull is to know microcosms within the macrocosm.

CHAPTER 5: ANTENNA ARCHITECTURE

Radar is more than a searchlight. Even as a feedback system that remotely coordinates and controls movement—as I just considered it—radar is shaded with undeserved slight. Radar shacks, stations, and situation rooms are nodes in information networks, and they both transform information and realign its channels. They are, in a way, similar to their counterpart radio and television stations: they swath citizens in an electromagnetic blanket that both comforts and controls. But where radio and TV reinforce the narratives of economics and national progress, radar writes them in real time. Air traffic channels, shipping lanes, speed traps, and orbiting satellites write the narrative of non-emergence, line upon line, precept upon precept. Like the Oracle at Delphi, radar shacks centrally produce, store, and disseminate mythical information. But where the Oracle's Pythia was aided by frenzy-inducing gas, radar readers interpret their cathode ray and digital Rosetta Stones with militant precision.[104]

At first blush, the notion of a radar *station* is misleading; one might infer motionlessness and permanence, or a single, stable location on the electromagnetic spectrum (such as frequency for an FM radio station or amplitude for an AM radio station). Neither is necessary for a radar station, and in fact obscures my use of the term: that of *station* as a depot or way-point for courier activity in the tradition of homing pigeons, telegraph stations (both optical and wired), train stations, the post office, and the weather bureau. These stations were collection and distribution points

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[104] Mason (2006) discusses how a chasm at the Oracle site was probably a source for intoxicating ethylene or methane, but possibly carbon dioxide or hydrogen sulfide.

for information, sites of obsessive timeliness, and controllers of traffic. Schivelbusch describes how the nineteenth century railroad station's control of traffic was evident in its architecture:

> The "traffic" function found its architectural expression in a far more immediate way in the railroad station than it did in the other types of steel and glass architecture. In market halls, exhibition pavilions, arcades and department stores the traffic of goods took place in a stationary fashion, in the form of storage and display; in the railroad station, the human traffic literally poured through, actively, in the form of travelers streaming in and out of the trains. Unlike the other "traffic buildings" of this period, the railroad station appeared as a palpably industrial building, in which the railroad's industrialization of transport was perceptible to all the senses. (1986, p. 172)

Similarly, radar stations are designed for the pouring-through of feedback. Like 1950s suburban living rooms arranged around TV sets, radar architectures are built around radar screens. Radar readers need to see (and sometimes, hear) in-coming feedback in order to interpret, distribute, and store it. Readers' remoteness from the objects that produce the blips and beeps on their screens increases their efficiency, but also leaves the objects "pouring through" as mere abstractions. The technological architecture of radar stations—the range, angle, and fidelity of the antenna, the mode of representation (such as a right-to-left wave on an A-scope or a blip on a dartboard-like PPI—see fig. 1.3 and 1.4), and the reception context (readers' desks, control panels, chairs, and the controlled environment)—shape the feedback radar readers receive.

For the balance of this chapter I trace the flow of feedback through a single piece of radar architecture—the antenna. I begin with antennas and rotators before moving on to displays, situation rooms, reporting rooms, and interception cabins in the next chapter. I marshal a Rad Lab memo, secret briefing, and technical manual, as well as field reports, test results, and newsletter articles. These suggest that radar's logistical power is at least partially imbedded in the way its feedback is shaped by the material attributes and operations of its antenna. In this way, I again take up the question, "How is radar both a feedback system and a form of remote control?" before concluding with a discussion of the geometry of empire and Virilio's politics of the oblique.

Ground Control

In the introduction, I discussed radar as a phonograph. In those terms, a radar antenna is a needle that cuts the groove as it bounces to the bumps. I've also discussed radar as a visual medium, as a searchlight that is also a lens. The theoretical implication of those discussions for radar antennas is that they are both senders and receivers. In Wiener's conception, radar antennas receive feedback; they then inject it into a controlled system that constructs situations, predicts locations, and assigns identifications. Radar antennas write progress narratives on display screens and on the surfaces of objects. And they do it "live," and in real time.

Radar antennas radiate electromagnetic waves and then receive a few of the waves reflected by missiles, icebergs, immigrant-bearing ships, coal deposits, passing motorists, United Flight 93, or any object of sufficient size and density. Antennas are the raw gatherers of feedback that can be represented, interpreted, and circulated. Their every attribute—their material construction, rotation, size, placement, frequency, beam width, and shape—impacts the flow of feedback through subsequent radar architecture. Displays, radar readers, decision makers, and distribution channels all depend on the lowly antenna. Even though, technically speaking, antennas are the simplest pieces of radar gear, the inner, oracular work in radar situation rooms is not possible without them.

Despite their simplicity, antennas challenged Rad Lab researchers. The researchers designed them to perform tasks that the unaided human eye could not—see beyond "line of sight," (if only a little), see in the dark, detect objects on the battlefield and at the perimeter of the nation state, spin around 360 degrees like Linda Blair's head in *The Exorcist*—but they also needed them to be durable and predictable.[105] Researchers, military officers, and radar readers depended on antennas to provide feedback that could be accurately displayed on an A-Scope, PPI, or another, similar display. Efficient and accurate radar reception increased what Ernie Putley, one of the founding scientists at Britain's Telecommunications Research Establishment in the 1930s and a crucial link between Britain's radar efforts and the Rad Lab efforts, calls "ground control," control remote from detected objects and enabled by feedback. According to Putley, increased ground control was one of radar's main advantages over conventional forms of observation:

> Before the development of radar the ground control methods were restricted to visual observation and the use of signal lights, ground markers, flares or rockets.

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[105] Notwithstanding desires for radar to see beyond the line of sight, early radar was more or less limited to the horizon. As Kelley (1946) observed of ship-mounted radar sets: "Ship borne radar search equipments as developed during the early years of the war performed an outstanding function in detecting and identifying enemy aircraft flying at medium and high altitudes, giving ample warning and the opportunity for proper disposition of interceptors. *However, the enemy soon discovered that these ship borne equipments were limited in range by the horizon*, the range of detection being between 15 and 35 miles against bombers flying at 500 foot altitudes. Task force operations in late 1943 and the first months of 1944 indicated an urgent need for extending this range" (Kelley, Feb. 20, 1946, p. 1, emphasis mine). Such observations are the source of the popular expression "below the radar."

> When both radar and radio telephony became available it was possible to consider much more extensive ground control. (Putley, 1988, p. 162)

Henry Guerlac (1946) was the Rad Lab's associate director and author of the unpublished manuscript, "A Short History of the Radiation Laboratory." He elaborated that ground control was fundamentally about what I have described as logistics: mediated order and arrangement, and sometimes (and secondarily), representation. He traced events during World War II that drew attention to radar's unprecedented power to coordinate movement through early warning, waiting, navigating, shooting, and ultimately—control. He wrote that:

> In [radar's] original role as an aircraft warning device it enabled the Royal Air Force to defeat the day bombers and night bombers attacking London. Fighter squadrons could husband their strength and wait on the ground until the Luftwaffe took off from its bases….It became a navigational aid for ships and aircraft, guiding bombing squadrons to and from their objectives on the Continent, and by another technique down through the overcast on their return so that they could make blind landings in bad weather with safety….Radar enabled gunners on land, on ships, and in the air to shoot with accuracy hitherto only dreamed of by day, by night, or through the overcast. The substitution of radar for optical systems of fire control gave instantaneously and continuously the three coordinates one needs to locate an object in space: range, bearing or azimuth, and elevation. By means of radar, the Bismarck sank the Hood at 13 miles on her second or third salvo; and the Washington and South Dakota sank the battleship Kirishima at long range in the night action off Guadalcanal. To the air forces it offered not one but several ways of bombing invisible targets, controlling from a distance a tactical air force, and permitting close cooperation between air and ground forces. (p. 1-2)

In the next chapter, I detail how radar gave the RAF a decisive advantage during the Blitz. It helped slower, outnumbered British fighters 'get the angle' on the German invaders, and helped coordinate Britain's other anti-aircraft efforts. Presently, though, Guerlac's observation that radar locates objects in space through range, azimuth, and elevation, and that it does so with a sharpshooter's accuracy and despite natural weather conditions (like night and clouds), suggests its capacity to capture the surfaces of objects and weave them into a progress narrative. Both Putley and Guerlac understood that radar's control multiplied decision makers' options on the battlefield, and that it did so even as it restricted individual movements. Admirals could fire on the Hood when it was out of sight, and so gunners had to be all the more vigilant.

Radar's power to coordinate movement—to extend "ground control" as Putley describes it—is not limited to the immediate circumstances of declared war. *In truth, declared war is, on the level of the nation state, mass communicated, coordinated, and mortal conflict between competing geometries of empire*.[106] When it comes to radar antennas, the geometry of empire is literal. The consequence of this literalness is that radar logistics can be foiled by a receiving antenna 1/10th degree out of balance, refraction from clouds and fog, a flock of migrating swans, and the inability to direct or rotate a cumbersome antenna, among other things. The ephemerality of feedback through radar architectures means that tracking is less certain for radar stations than it is for train stations (which have tangible tracks and fixed points of destination and departure), and for post offices, (which have less flexible routes and stationary addresses). Radar assigns addresses to objects and tracks them, but in doing so it relies on transmission and reception angles and on identified objects—on an architecture that begins with the antenna.

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[106] *Declared war* should not be mistaken for *war* as discussed in Deleuze & Guatarri (1986). Where *declared war* is the fatal clash of nation state's subjects and objects in the name of a progress narrative, *war* is nomadic. War is what happens that cannot be reconciled to a progress narrative.

Sharpness

The power, size, shape, and material composition of antennas are the parameters for the flow of feedback through radar systems. If we consider that the frequency of radar transmission is determined by the frequency of the alternating current conducted through an antenna, and that its range is a function of the amps in that current, radar's connection to power is actual. We can also observe that the means of producing radar, though in the hands of scientific, military, economic, and governmental elites from the first, are realized through the attributes, materials, and arrangements of antennas. At the Rad Lab, mixing and matching power generators with antennas produced electromagnetic waves of varying length and sharpness (or width). These waves were shorter than those used for commercial radio, but different enough from one another that categorization was necessary. A secret Rad Lab briefing of the Radar Research and Development Subcommittee of the Joint Chiefs of Staff explains wavelengths and their categories:

> The radio waves used for radar are much shorter than those ordinarily used for communication, and vary in wavelength from about ten feet to about one inch. The general performance and properties of a radar set are dependent upon the wavelength used….Sets in the shortest wavelength range are called microwave sets, those in the intermediate range are referred to as medium wave sets, and the term long wave refers to sets employing the longest radar wavelengths. (Tactical Uses of Radar, July 7, 1943, p. 1)

As radar settled into established uses—such as early warning, navigation, station keeping, and fire control—pairings between wavelengths and antennas calcified. Many radar sets were not produced because they were too large to mount on a destroyer or because they rotated too slowly. These sets had no place in a narrative of democratic progress and were junked. The same secret briefing of The Radar Research and Development Subcommittee that I just cited shows that at the Rad Lab, relationships between wavelength, sharpness, antenna design, and use were naturalized. According to that briefing:

> The type of antenna used depends upon the wavelength range of the radar set. Long wave sets ordinarily employ a flat array of dipoles sometimes called a 'mattress' or a 'billboard.' Medium wave sets frequently use end-fire dipole arrays called 'Yagi' antennas. Microwave radar equipment usually uses a metallic reflector to produce a concentrated beam. (Tactical Uses of Radar, July 7, 1943, p. 1-2)

Whether of the mattress, end-fire dipole, or reflector type, radar antennas channel feedback with varying degrees of sharpness. *Sharpness* is the width of a given beam (or wave, but "beam" preserves the relationship to the railroad track) and impacts an antenna's ability to distinguish one contact from another (or a single object, such as an airplane, from a number of objects, such as a flock of swans or a squall of raindrops). Sharpness correlates with wavelength (shorter waves tend to be sharper), but this correlation is a function of the fact that excessively-large antennas are needed to sharpen medium and long waves. Sharp beams are more individualized beams, beams that see binary stars when blunt beams see only a gelatinous splotch, but they are also slower beams. Sharp beams provide a more meticulous geometry of empire than do their blunt counterparts, but they take longer to do so.[107] As George Newton, a Rad Lab feedback expert and Assistant Professor of Electrical Engineering at MIT, indicated in an inter-lab report on the merits of sharp beams for ship-mounted radar sets:

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[107] If we treat the space a radar set surveys like a pie, the difference between a sharp beam and a blunt beam is a bit like the difference between a narrow and a wide pie server. The narrow server provides more pieces than does the wide one, but also requires more time to serve the pie in its entirety.

> The desirability of a sharp radar beam…arises from the necessity of defining individual ships in a convoy or detecting ships in the neighborhood of large fixed echoes, such as might arise from islands. Since the searching is confined to the surface of the sea in this application, the usual objection to a sharp beam—increase in scanning time—is unimportant. (Military Uses of Radar, Jan. 8, 1943, p. 2)

Accurate knowledge of the sharpness of a particular antenna was necessary if readers were to skillfully operate their sets. Antenna sharpness was (and is) an important aspect of a radar set's personality; readers account for it as they interpret the images on their screens and circulate information. The difference between a large object and a cluster of smaller objects is more likely to be discerned if the sharpness of an antenna is known, and that discernment has enormous logistical implications. Because of this, odd, but extensive tests were conducted so that readers would minimize the number of unidentified objects on their screens. The following snippet from *Radar Abstracts*, the Rad Lab's official newsletter, describes a test by British engineers involving a bird and a balloon. It was typical of the extent to which radar researchers would go to know the sharpness of their antennas:

> Radar echoes from birds apparently serve as an operational nuisance the world over, so much so that the British have made a special study of how they show up on S-band and 150 centimeter coastal radar systems. Of course all of the spurious echoes can't be blamed on our feathered friends. Some are drifting balloons, sea wreckages, and long-range echoes appearing on the second or third sweep of the time base under conditions of strongly anomalous propagation. Speeds of these strange echoes vary from five to 80 miles per hour and range up to 70,000 yards. In order to find out more about echoes from birds, the British supported a dead gull from a balloon on a long string and tracked it with their AA No. 3 Mark II system. The bird was so arranged that its echo was separate from that of the balloon. The strength of its signal was comparable with that from typical, spurious echoes observed on S-band coastal stations." (*Radar Abstracts*, April 10, 1945, p. 5)

Antenna sharpness is essential to the fantasy of object-specific tracking on which radar is centered. The coordinated, serial use of radar to aim missiles and anti-aircraft fire, a use with precedence in the 19th century pairing of searchlights and deck guns, is, consistent with Deleuze & Guatarri (1986) and Virilio (2005; 1986), as it is both a tool for gathering and a weapon for hunting. If you consider antenna sharpness in the light of Mumford (1970), antenna sharpness is an authoritarian form of technics in that it ratchets up the digitalization of radar (smudges of feedback are transformed into clear, discrete representations), centralizes the flow of feedback, and accelerates that flow by reducing imprecision. You should not be surprised, then, that sharpness should aid an appreciation of a coordinated, serialized linking of radar and firearm in rudimentary (and rustic) terms.

Consider the following blend of object-specific tracking and bucolic daydream from the pages of *Radar Abstracts*:

> Geese and ducks won't stand a chance after the war if the kind of tracking mentioned in this operational report keeps up: A flock of geese was picked up on [one radar system] at 11,000 yards, appeared on [another radar system] at 9,000 yards, was tracked at 25 knots to cross our ship's course about one mile ahead. Perhaps it won't be long before somebody will rig up an automatic gadget that will track ducks and geese in flight and fire the hunter's gun when the birds are within proper range. And if the rifle had a long enough range so that the hunter could keep some distance away, the necessity for duck blinds might be eliminated.[108] (*Radar Abstracts*, July 10, 1945, p. 1)

The fogs of war, mist, and foliage make sharp beams a necessity for determining azimuth: blobs of feedback can conceal the movement of individual objects on a PPI

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[108] This longing is a precursor of today's Internet hunting. According to BBC News (2004), entrepreneur and sometimes-hunter John Underwood's website, live-shot.com, offers remote hunting on his Texas ranch for $150 a session.

(Figure 1.4) or A-scope (Figure 1.3). And while blunt beams move with the speed required to warn against incoming aircraft and missiles, they can be especially vulnerable to permanent echoes such as those from mountains, buildings, and the surface of the ocean. For example, a blunt beam would have a better opportunity than would a sharp beam to quickly notice an airplane diverging over New York City, or a Qassam rocket closing in on the Israeli city of Sderot, but would also be more likely to lose them in the labyrinth of urban surfaces. As the secret briefing of The Radar Research and Development Subcommittee of the Joint Chiefs of Staff explained:

> Direction-finding on a target is one of the most important functions of a radar set, and this demands that a sharp beam of radiation be produced by the radar antenna. The dimensions of an antenna producing a beam of a given sharpness are just proportional to the wavelength of the radar set, and it is this fact which leads to most of the differences between long wave, medium wave, and microwave sets. Usually, the limitations on antenna size imposed by available space (in the case of an aircraft or ship installation) or by the necessity of transport (in the case of ground radar) are such that the beam of a long wave or medium wave set has a breadth of 15 degrees or more. Such a broad beam makes the choice of a location for a ground radar set most important, in order to avoid excessive trouble from permanent echoes caused by hills, buildings, or other radar targets which may be in view of a radar site. Radar coverage at long range against low-flying aircraft or surface ships is, generally speaking, better at short wavelengths (i.e. with sharp beams) because of permanent echoes and because, even over the flat surface of the sea, interference takes place between the direct beam from radar to target and the beam which reaches the target by reflection at the surface of the ground or sea. This interference has the effect of lessening the performance of the set at low elevation angles. (Tactical Uses of Radar, July 7, 1943, p. 1-2)

Interference from the ocean or unexpected hills or buildings is natural, an instance of light waves' inconvenient bending. The ocean reflects radar waves, but in doing so it bends (or refracts) some of them into a gossamer bloom of frequencies. Rainstorms, clouds, and simple humidity can also interfere with radar systems in this way. When this same interference happens within the frequency range of our natural sight, it is a rainbow, mirage, genie, or the Virgin Mary descending on a sprinkler system.[109] An anonymous Rad Lab report on the merits of PPIs for harbor search details how these mirage-like refractions play with the range of radar antennas:

> It should be pointed out that refraction effects on radar beams, similar to mirage effects observed with visible light, can take place under certain atmospheric conditions. Downward bending of the beams, resulting in greater ranges than those expected from horizon considerations, seem to be more common than upward bending, especially over the surface of the sea. One station has recorded a maximum upward bending of 1/20 degree with a maximum downward bending of ½ degree. However, the fact that the effective range of the radar may be very considerably reduced by weather phenomena now unpredictable must always be kept in mind.[110] (Harbor Search Equipment, Jan. 8, 1943, p. 2).

Not only can humidity alter the range of a given antenna, humidity can wreak havoc on antennas themselves. Most of the Rad Lab developmental work was conducted in and around the MIT campus in Cambridge, MA. Cambridge is a temperate, moderately humid climate that is conducive to mechanical health and longevity (at least it is with the preventive measures taken in a well-funded facility like MIT's Rad Lab).

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[109] The Old Testament formalizes such supernatural interpretations of electromagnetic interference with its presentation of the Ark of the Covenant and Joseph's divination cup in Genesis 44.

[110] Blue (1943) a Rad Lab researcher, elaborates on these points: "Although radar 'sees' regardless of visibility, it is sometimes affected by heavy storms, fogs, or clouds. Clouds may present a false signal on the scope; storms may blanket a normal area of coverage. Refraction of radio waves may at times render a radar useless….A radar set does not provide uniform coverage out to the limits of its range. Instead, at great ranges, there are areas on the sea, or zones in the air, where a ship or plane cannot be detected. These gaps in coverage account for the variety of ranges at which different targets are first picked up by any one radar set. Coverage gaps are caused by the interference of radio waves reflected from the surface of the sea with those sent out directly from the radar. If the path of the reflected waves is greater by a full wave length than the path of the direct waves, the two beams will reinforce each other, and a target at this point will return a much stronger signal than it would if struck direct or [by] reflected waves alone. Hence targets can be detected at much greater ranges in areas where reinforcement occurs. Conversely, if the two paths of direct and reflected waves vary by one-half wavelength, the waves cancel each other; and no signal will be returned. Such areas represent the gaps in radar coverage" (p. 3-4).

When the Rad Lab's radar sets were put into service in Panama (protecting the Canal), and on warships and islands in the South Pacific, many of them came down with a tropical pox—corrosion.[111] Corrosion changes the material composition of metal, and thus modifies the frequencies at which it radiates and receives. The antennas were made of aluminum and required maintenance to minimize corrosion and preserve sharpness, but many of their connectors and couplings deteriorated too quickly for maintenance. A field report from August, 1944, on the SCR-588, a powerful, long wave radar set used for ground control in the Pacific, illustrates the problem:

> Radiating antenna of the ground control intercept unit SCR-588 has become almost useless within two weeks because of dampness. It gets out of tune due to corrosion forming on copper contacts….Efficiency of a set out of tune is decreased about 80 percent….The rotatable coupling unit suffered from moisture, despite the fact that heaters were properly deployed. Result was corrosion between insulation in the slip rings so the unit couldn't operate.[112] (*Radar Abstracts*, Aug. 2, 1944, p. 6)

Corrosion of antennas and other radar parts prompted supplementary logistical efforts. In 1944, *tropicalization* was the buzzword in the Rad Lab and in situation rooms everywhere. *Tropicalization* was to reduce the number of unidentified objects. *Tropicalization* was to reinstate antenna sharpness and set range. With *tropicalization*, radar sets could be a little more 'climate correct.' *Tropicalization* would slow the deterioration of radar's metal parts. *Tropicalization* was no simple matter, though, and

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[111] There is a direct connection between the Rad Lab and the Army Air Forces Weather Service. According to Whiton et al. (1998): "During the first half of 1943, Major J. Fletcher of the Army Air Forces Weather Service worked at the Rad Lab and, about a year later, established a program for use of weather radar within the Army Air Forces Weather Service" (p. 221).

[112] Although tropicalization was a serious, widespread issue, it wasn't the only one. From the earliest attempts to use radar for fire control there was a need to "Develop [cathode ray] tubes better able to withstand the shock of gunfire," and to " Mount receiving instruments in locations free from shock, but in easy communication with bridge and plotting room" (Griffin, Mar. 24, 1939, p. 3).

needed to be carried out before deployment. A little rust on a few antenna parts was a major encumbrance for a military-industrial complex already stretched to the limit by the War. It threatened to become a vicious, never-ending cycle of order, installation, distribution, repair, and order, that today's beleaguered Dell laptop purchasers can appreciate. According to a confidential United States Army Air Force (USAAF) report that was forwarded to the Rad Lab:

> The problem of tropicalization of all…radar equipment, both ground and airborne, is causing grave concern to USAAF maintenance people….It appears that if a complete and thorough fungi and water proofing of equipment is to be accomplished, the treatment should be done in the States….There is, at present, very little material available in [the Pacific theater] for tropicalization….A training program will have to be launched in order to produce men capable of doing a first class job….Equipment will have to be removed…packed, shipped to depots, treated, returned, and reinstalled. Without a doubt, many sets will be made un-operational by this excess handling, resulting in increased maintenance and repair…. ("Weekly Report of the USAAF Signals Liason Office," Apr. 21, 1945, p. 1-2)

At first, the weather-conjured apparitions that occasioned such logistical anxiety weren't seen as valuable feedback flowing through radar's architecture. Radar beams, like the Ark of the Covenant, train tracks, the Autobahn, and the American Interstate Highway System, were used to purify the natural through the logistical. They formed the lines in the geometry of empire. Schivelbusch's (1986) discussion of Baron Haussmann's renovation of Paris in the mid 19th century gives insight into why this is so. Haussmann discerned that Napoleon had designed the Parisian boulevards and avenues for the flow of military traffic, and that later they had been adapted for commercial, bourgeois objects.[113] He planned a Paris that was even more obviously centralized and authoritarian. Says Schivelbusch:

> The underlying authoritarian intentions do not entirely explain the drastic obviousness of Haussmannism. In the preparation and realization of his work, Haussmann used the railroad as a technological model, not subjectively but objectively. To describe the straight lines of Haussmann's avenues, Victor Fournel could not think of a better parallel than the railway line: 'To avoid any curve invisible to the eye and unnoticeable to the foot, cuts are made across the terrain, as in the case of tunnels for the railroad.' Haussmann approached Paris as a railroad engineer approaches any terrain through which a line has to be laid. (Schivelbusch, 1986, p. 182)

The hills, crags, dry creeks, and cattle tracks that affronted the ancient Hebrews, the American railroad, and totalitarian urban planners like Haussmann, are logistically equivalent to the ocean waves, clouds, and migrating birds that troubled the first radar readers (and that still trouble radar readers today). The earliest radar beams cut across the atmospheric terrain; they tried to make the curves of natural phenomenon invisible to the lookout and unnoticeable to the chaise-lounge soldier. They were channels for the carefully drawn flow of very particular feedback, of information about human and technological movement needed for national, logistical progress. A paradigm shift was necessary before the noise of nature would be ordered and modern, before radar-based meteorology would be conceived.

Radio Meteorology

Weather-spawned phantasms were incorporated into national, technological, and economic progress narratives once they were seen as important sources of

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[113] Logistical and military parallels between Haussmann's Paris, the Autobahn, and the U.S. Interstate System are extensive. See Petroski (2006) and McNichol (2006).

feedback. Meteor-logic was behind pre-radar efforts to reduce the dangers of hurricanes and icebergs, but the immediate context of World War II ensured that radar readers were primarily interested in echoes from patrolling air and water craft, or from incoming V-2 rockets. Initially, radar sets were tuned to track and coordinate the movements of humans and their machines; the valuation of natural phenomenon like storms and animal migrations that eventually emerged did so on those terms. *Weather became important to radar readers because it became more than interference. It became valuable feedback that furthered the efficient conduct of declared war.*

According to Whiton et al.’s history of the use of radar for weather forecasting (1998), by 1945 “weather officers” (a logistical title if ever there was one) were being cross-trained as radar engineers and readers in order to further the War effort. As they recount:

> During the course of World War II, weather officers received 15 months of intensive training in meteorology….One hundred graduates from that program were sent to Harvard University for four months of intensive training in electrical engineering and basic radar theory and then to MIT for three months of training on specific radar systems. Some were given special familiarization at the Rad Lab….Until 1947, Air Weather Service (AWS), formerly called the Army Air Forces Weather Service, had an explicit research mission: *if in the conduct of operations* it was found necessary to advance the state of meteorological knowledge or engineering practice or develop new techniques to apply….these radar weather officers had the background to recognize [a problem] and had the contacts at universities and laboratories, such as the Rad Lab, to help them solve [it]. *In this way, problems could be solved expeditiously and wartime operational needs met quickly.* (p. 221, emphasis mine)

A test conducted by Rad Lab researchers in 1944 helped shift the paradigm from considering weather a radar nuisance, to considering it an important source of feedback. This test demonstrated that weather information could flow through antennas and displays with unprecedented accuracy and timeliness. Researchers took photographs of a storm front over New England as represented on PPIs and A-Scopes and compared them with information provided by conventional airborne weather reconnaissance ("Meteorological Correlation with Oscilloscope Photographs," June 24, 1944). Compared with conventional weather reconnaissance, the radar-produced information was more precise in its detailing of storm size, direction, and density, and was able to be relayed through multiple channels at once (through radio, telephone, and courier). Researchers who conducted this confidential test concluded that:

> Radar echoes are obviously of extreme importance in the forecasting of detailed local weather, and a reporting system based on rapid photographic, written, or visual echo description, and made available to the forecasters concerned by any possible means of communication should be set up as soon as practicable. (p. 1)

Thereafter, technical support was available to radar readers who had been trying, in slapdash fashion, to account for weather on their displays. The Rad Lab designed and distributed sets dedicated to weather forecasting and even issued instructions to adapt sets already in the field. One such set, the AN/APQ-13, was adapted from its duties as an aid to high-altitude bombing. According to a confidential Rad Lab report, after adjusting the antenna angle on the AN/APQ-13, increasing its pulse length, and connecting the kludge of metal and wiring to an A-Scope, it would "detect the presence of severe thunderstorms to a range of 100 miles and cumulo-nimbus and well-developed convective clouds to at least 50 miles" ("Radar Weather Reconnaissance," undated, p. 1).

Adjustments of the AN/APQ-13's antenna and pulse length were adjustments to its architecture. What had previously been considered noise was transformed into feedback—into information vital to the logistics of declared war. But architectural adjustments also transformed the pilot-passenger dynamic I mentioned earlier. They transformed what Kittler calls a "technological interface" or "individual windows for…sense perception" (Kittler, 1997, p. 33). Kittler maintains that, "it is from the specific terms—the equations, blueprints, circuit diagrams—that technology itself provides that one must proceed, in order to see…what mechanisms determine and set the limits of our bodies, our subjectivities, our discourse" (p. 25). In this light, pilots, who had previously relied on their own eyes for weather reconnaissance, experienced the sight conferred by changes to their radar sets dictated by Rad Lab blueprints and circuit diagrams. A change of the power supply and a twist of the wrench, and pilots suddenly had an electronic eye to do much of their reconnaissance for them. Consider this confidential report from an F-5 pilot whose weather reconnaissance duties had him flying into the teeth of a storm:

> Attempting to fly [into the storm], I felt myself whipped around like a feather. My airspeed dropped to 100 miles per hour, so I instinctively pushed the stick forward. My airspeed decreased still more and I felt the ship stall and fall off. I remember looking toward what I thought was down and seeing the belly of a B-24. I must have gone into a dive then because my airspeed picked up to 350 miles per hour. I hauled the stick back and was able to right the ship at 300 feet and proceed, still on instruments, through the front where I rejoined the formation. (Training Intelligence Report, Feb. 3, 1945, p. 2)

Reading the account, we can almost feel the sweat in the pilot's grip. We can nearly see the apprehension in his gaze. His disorientation becomes our disorientation. His blend of instrumental and sensory information becomes our own. The high-speed, physically demanding work of weather reconnaissance required pilots to witness and, within the safety of a cockpit, experience the phenomena of their instruments and reports. But aircraft borne weather radar provided an additional cushioning distance between pilots and the sometimes jarring weather they observed, a cushioning distance akin to that of the medieval lookout peering out from the bastion at the enemy encamped beyond the clearing. As Virilio (1986) discusses in terms of the logistics of progress and foresight (of what he considers *invasion* or *advance*):

> The transparency of the clearing [around the keep, city, or military camp] means maintenance of the invader's specific right over a territory in which he claims to settle, of his power to penetrate. The erection of the hillock, then of the [keep], is another answer to the problem of mastery over dimension, the latter becoming perspective, geometry of the gaze from an omnipresent fixed point—and no longer, as it was before, from the synoptic route of the horseman….Land-clearing, the cultivation of the earth for subsistence, the receding of forest darkness, are in reality the creation of a military glacis [a gentle, artificial slope] as field of vision, of one of those frontier deserts spoken of by Julius Caesar, which, he says, represent the glory of the Empire because they are like a permanent invasion of the land by the dromocrat's look and, beyond this, because the speed of this vision—ideally without obstacles—causes distances to approach. (p. 72-73)

The adaptation of the F-5's AN/APQ-13 made its pilot less a scouting, scrambling horseman and more a lookout atop an electronic tower. Weather reconnaissance became more a matter of routine patrol and reading an A-scope and less a matter of holding onto the controls as though they were reigns on a wild horse. We need not declare the transformation of weather reconnaissance pilots from rugged, hard-charging heroes to twitching motilities nestled in electronic egg cups—and I certainly am not doing so—but the adaption of antennas to logistical applications did have an impact on movement. The movements of both planes and pilots became more systematic, predictable, and linear. In this sense, the "before radar" and "after radar" snapshots of World War II airborne weather reconnaissance suggest a genealogy of motion accompanying technological progress, even if not at the extremes Virilio would contend.

Still, there is more to be said of antennas, movement, feedback pouring through radar architecture, and Virilio's politics of the oblique, and particularly as pertaining to the difficulties of maintaining a geometry of empire through ship-mounted radar. Like other radars, ship-mounted radar is useful when the location and angle of its antenna is known to radar readers and decision makers. Without such knowledge, the information provided by radar is of little or no value, and may even be confusing. But unlike ground-based radars, where the location and angle of ship-mounted radar is stable, ship-based radars are relied on for ground control and the coordination of air and water traffic even though their point of view is not nearly as fixed. Ships roll and pitch, and in so doing wreak havoc on the reliability of their radar systems.

Roll and Pitch

The reliance of ground control radar on a fixed point of view is acute when antennas are mounted in locations that aren't hard and fast. Early ship-based radar stations needed antennas placed as high as possible—like lookouts in crow's nests— in order to maximize their range. A technical manual written by Dr. David Blue of the Rad Lab for the U.S. Navy advised that, "Since radar cannot 'see' much beyond the line of sight, the antenna should be placed as high as possible on the ship. Generally speaking, the higher the antenna, the greater the range" (Blue, 1943, p. 3). But at the same time, placing an antenna at the highest point possible subjects it to the most severe changes of angle when a ship rolls or pitches. The same Rad Lab report that instructed naval commanders to install antennas “as high as possible” declared that, “The coverage of a radar set, particularly one employing a narrow beam, can be severely and continuously altered by the motion of the ship in heavy seas” (Blue, 1943, p. 4).[114]

Figure 5.1 (below) illustrates the problem of roll and pitch for radar antennas. If we consider points “A,” “B,” and “C” as representing a ship at different points in time, and the arrows as outgoing and incoming radar waves, we can see that the ship sends and receives electromagnetic waves from different angles and distances at each point. Consequently, it receives feedback from different swaths of atmosphere, and, depending on the antenna’s rate of rotation, receives feedback from different objects in those swaths. A radar reader in this situation would see objects unpredictably appear and disappear—like blinking Christmas lights—but with no indication (other than confusion) that different swaths of space were providing feedback.

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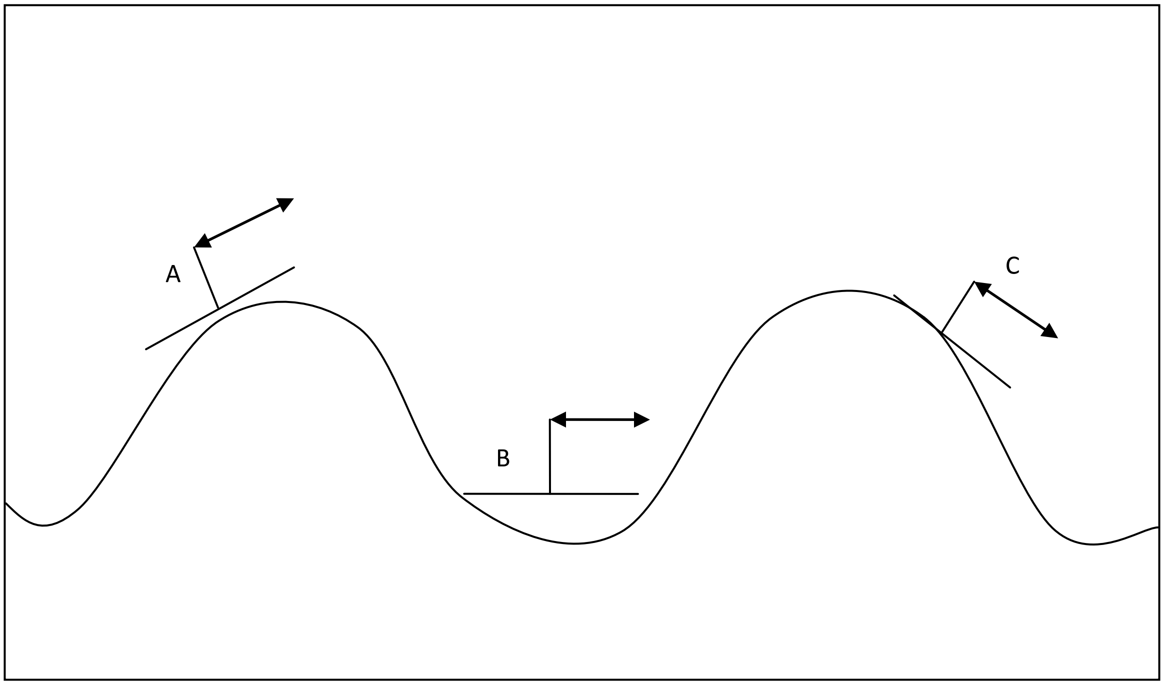
[114] Rad Lab researcher D. G. White stated the problem this way: “If high-accuracy beam control is to be had with ship borne radar, either the mount must be carried on a stabilized platform so that the azimuth and elevation of the dish can be controlled as in a land set, or a means must be provided for such adjustment of the dish around its two or three supporting axes as will counteract the changing orientation in space of its base as it moves with the roll and pitch of the ship” (1943, p. 1).

Figure 5.1: Geometry of Reception



According to Rad Lab scientist Milton White, the problem of a radar antenna shifting in space with a ship's roll and pitch led to the Rad Lab's development of *stabilizers* (White, 1943). Stabilizers allowed antennas to dip and rise in counter balance to their ships, and to do so without interfering with other movements (such as motorized rotation). The starting points for the radar stabilizer's design were *computers*—in this instance, mechanical, but automatic compensators—already used for deck guns. According to White (1943):

> It would seem, at first thought, that the necessary computers to solve [the problem of radar antenna stabilization on ships] would be exactly those which have been developed for naval gun fire control. This is fortunately true to the extent that both problems require a highly perfected stable element…. (p. 1)

But there were also important differences between deck guns and ship-mounted radar:

> Guns are stabilized only during action or alerts—a very small part of the total time at sea—and the computers and the train mechanisms of the stable element are built accordingly for occasional operation. The devices stabilizing radar antennas must withstand continuous operation….Even during an action guns are not necessarily fully stabilized continuously. If the roll of the ship exceeds 22 degrees, the stable element outputs of level and cross-level break down. This is not a serious handicap to fire control because the guns can be fired between the extremes of the roll, but radar stabilization should be continuous. (White, 1943, p. 1-2)

The initial conclusion from my discussion of roll, pitch, and stabilization is that modern warfare needs radar to be continuous, long range, and accurate. Stabilizers for ship-mounted radar were based on those used for deck guns, even as they preceded them in searchlight information systems. More comprehensively, though, *the need to establish radar as a fixed, dromocratic point of view—as a center point in a geometry of empire—demands dependable antennas*. Without dependable antennas, the sophisticated interpretation and distribution of radar feedback is impossible. Without dependable antennas, the feedback flowing through radar architecture can be confusing and even deceiving (a point I'll elaborate in the concluding chapter).

Virilio associates the ability to access a lookout's point of view with social class, and thus welds social and logistical positions. In Virilio's world, The All-Seeing Eye, radar-gun holding police officer, weather reconnaissance pilot, NORAD situation room commander, e-mail reading boss, and immigrant waiting for processing at Ellis Island all occupy social-logistical positions. "The military lookout-post offers the invader a constant view of the social environment, primary information," he writes, and then makes observations of the medieval caste system to declare that:

> Social privilege is based on the choice of viewpoint (before attaching itself to accidents of fortune or birth), on the relative position that one manages to occupy, then organize, in a space dominating the trajectories of movement, keys to communication, river, sea, road, or bridge. Whence the extraordinary diversity of social treatments in the Middle Ages, a diversity that simply represents the variety of geographical views over a "realm" that, until the nineteenth century, doesn't appear in the texts as a formal territorial entity. (1986, p. 73)

We could navigate an armada through Virilio's obfuscations of "accidents of fortune or birth" and "manages to occupy." He just doesn't have much sociology to speak of. For Virilio, "The masses are not a population, a society, but a multitude of passersby" (1986, p. 3).[115] Nonetheless, if we interpret him more narrowly we can see how it is that the positioning of radar antennas on the decks of World War II battleships had as much to do with "station keeping" and the coordination of a nation state's own forces as with enemy identification or weather forecasting. Radar gave military officers a new means of surveillance over the soldiers, ships, and equipment in their charge. Like aircraft patrolling from beacon to beacon, ships were thereafter expected to maintain precise proximities. Naval formations could be represented on a PPI with the exactness of Hasbro's Lite-Brite toy (i.e., with exact proximities). In brief, radar expanded the *general authority* of the General.

With expanded authority came expanded expectations of radar's reliability. Some sets were poorly suited to station keeping, and were taken out of production. One such set, the powerful SG-1, was so sensitive to rolls and pitches that erroneous, short-distance reflections were a nuisance in adverse weather. A field report that compiled

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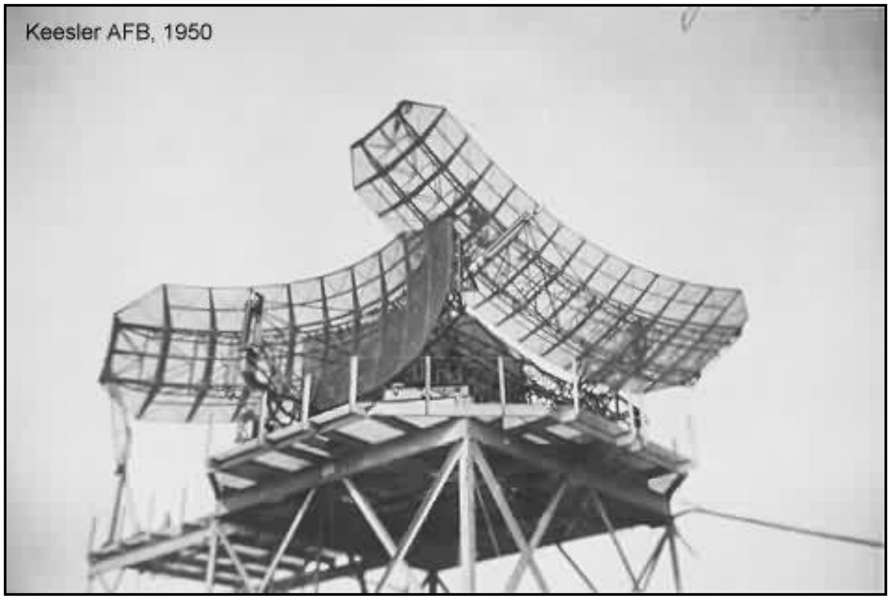
[115] Virilio goes on to say that, "The revolutionary contingent attains its ideal form not in the place of production, but in the street, where for a moment it stops being a cog in the technical machine and itself becomes a motor (machine of attack), in other words a producer of speed" (1986, p. 3).

the SG-1's shortcomings asserted that, "Trouble was encountered regularly in use of SG-1 for station keeping. Such work requires use at ranges below 1,000 yards. At this distance the ranges are not reliable, the error being about 100 yards" (*Radar Abstracts*, May 22, 1945, p. 5). That just a few years before, rough estimates of ships' locations and proximities were thought sufficient was of no consequence. The natural movements of a ship made the SG-1 a wall-eyed vision machine, and that's all there was to it.

Carousel

In addition to the challenges of beam sharpness, corrosion, and roll and pitch, Rad Lab researchers and radar readers were constantly working to control the rotation and speed of radar's wandering antenna eyes. A controlled gaze contributed to an efficient and calculable flow of feedback for display. A controlled gaze systematically predicted aircraft location, azimuth, and range. The most powerful ground and ship-based radar antennas during the 1930s and 1940s were heavy and tall and were not easily repositioned. Moving antennas in behemoth systems like the CPS-6 (see figure 5.2, below) took a lot of grunt work, and could be frustrating during testing and dangerous after deployment.

Figure 5.2: CPS-6 Radar Antenna



Pictured here from below, the CPS-6’s twin antennas allowed for height finding, but required a large, carousel-like platform in order to rotate. Photo used by permission. (Air Defense Radar Museum, 2008)

At the Rad Lab, testing the largest, most incongruous antennas was a logistical nightmare. Antennas had to be obtained or constructed by subcontractors, transported to testing grounds, assembled and taken down by support staff, and operated by researchers (who would otherwise spend their time developing new radar sets). A reasonable means for testing these gargantuan, rotating antennas was a necessity if the U.S. was to defeat the Axis powers and project itself into the atmosphere. One of the Rad Lab’s stabilization specialists, Edwin Millman, described some of the logistical challenges to testing the CPS-6. These challenges were typical of testing any large radar system:

> The first mount was set up in a stockade near building 20 of MIT in December 1944. The snow and cold made working conditions very difficult. The original program, to assemble the systems in the National Guard Hangar at East Boston, could not be followed since the Army air forces took over this hangar. After a complete search of the area around Boston failed to discover any satisfactory facilities for the complete erecting of these large systems it was deemed advisable to establish an Orlando Field Station of the Radiation Laboratory….(Millman et al., 1945, p. 1)

Eight hundred years before Rad Lab researchers struggled to test the CPS-6 in the Boston winter, prototypes to the massive CPS-6 rotators had been engineered by Arabian and Turkish soldiers. These prototypes were named *garosello* or *carosella* ("little war") by the Italian and Spanish crusaders who wrote about them. That *carosellas* were eventually transported to France, augmented, and known to the French as *carrousels*, is only part of the story of how carousels came to rotate radar systems at MIT's Rad Lab ("Tests to Determine Army Air Force Requirement for V-Beam Type Radar," July 3, 1944; Millman et al., Nov. 2, 1945).[116] According to the International Museum of Carousel Art (IMCA):

> Back in the 1100's, Arabian and Turkish horsemen played a game on horseback….The crusaders brought the game back to Europe where it became, in time, an extravagant display of horsemanship and finery that the French called carrousel. A major event of the carrousel was the ring-spearing tournament in which a man would ride his horse or chariot full tilt, lance in hand, toward a small ring hanging from a tree limb or pole by brightly colored ribbons. The object, of course, was to spear the ring. About 300 years ago, some Frenchman

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[116] The "Tests to Determine" report states that the V-beam radar, of which the CPS-6 is one model, was first mounted on a "carnival 'merry-go-round' frame" (1944, p. 1). Millman (1945) writes that, "After several months of intensive investigation of existing techniques, the V-beam ray system was chosen as having the greatest possibility of meeting…specifications. An old carnival merry-go-round was purchased and modified into a radar mount and hence the first experimental system was called the 'merry-go-round set'" (p. 1).

> got the idea to build a device to train young noblemen in the art of ring-spearing. His device consisted of carved horses and chariots suspended by chains from arms radiating from a center pole. This was probably the beginning of the carousel as we have come to know it. ("A brief history of the carousel," undated, p. 1)

As part of 20th century radar systems, carousels functioned much as they did in 17th century France. Horses, chariots, and lances preceded fighter jets, bullets, radar, anti-aircraft batteries, and bombs. The idea of running a lance into a ring was very much alive, and was even expanded: the ring was constructed electromagnetically and remotely, and the aircraft and anti-aircraft batteries were "suspended by chains"—were coordinated and controlled within information systems (such as radar and radio). Robot missiles were coordinated and controlled to such a degree that they were "lances in hand," with force, direction, and remotely dictated targets.

Desperate Rad Lab researchers scrounged up second-hand carousels, a result of the ramshackle, cash-strapped state of amusement parks during the Great Depression. Much as today, the pleasure of carousels in the 19th and early 20th centuries was in their speed and disorientation, and also in their inversion of the work day's relationship between managers, industrial machines, and workers (Benjamin, 1997).[117] The renewed acquaintance between carousel and warfare is both ironic and latently subversive in the sense that it gestures to a forgotten martial incarnation, to a former place in a progress narrative. The IMCA fails to note the pungent, Benjaminian ripeness in the carousel's

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[117] A recent affirmation of Benjamin's assertion is Huhtamo (2005). Huhtamo writes that, "The use of machines for productive purposes in factories and offices" in the late 19th and early 20th centuries, "provided a background for the appearance of other kinds of machines, meant for amusement and clarification" (p. 5).

militarized decay, and instead stitches it into the familiar narrative of economic and technological progress. According to the IMCA:

> The golden age of the American carousel lasted until the great depression of the 1930s. With the decline of amusement parks and the economy in general, used carousels satisfied the small market. The few remaining companies closed or moved on to other products. Many carousels were abandoned or destroyed. ("A brief history of the carousel," undated, p. 2)

The Rad Lab's carousels, and the subsequent adaptation of rotators to the military's needs, made even more remote the already recessed relationship between generals, military technologies, and their mobilized minions. French noblemen rode round and round in their efforts to skewer their elusive targets; during World War II, the RAF's noble dancers were no less guided by mechanical apparatus (which was a phonograph of sorts). But where the French cavaliers used carousels as training devices, *World War II military officers superimposed them on the actual field of battle*. Their goals were the usual logistical ones—order, predictability, traffic control, and systematically, a geometry of empire. Rotating radar swivels with mechanical efficiency and provides the speed, privacy, and scope of a modern, empirical point of view. It also, with display and interpretation, coordinates the flow of feedback and aggregates it into narrative *situations*, into relations of location, speed, and azimuth that are subject to decision-making authority.

Antenna rotation speed is crucial to tracking objects, constructing situations, and controlling collisions. Sequential sweeps on a PPI are used to determine azimuth and altitude of blips. If an antenna with a range of 50 miles rotates once a minute (and "blinks" for 15 seconds of that minute as the antenna is fouled), an incoming airplane going 300 miles an hour will be detected at most 10 minutes from the antenna, and might not be detected at all. If that antenna rotates once every three minutes, the same incoming airplane, even if visible, could be only 7 minutes away. Situations such as one reported in *Radar Abstracts,* emphasized the importance of speed in radar reception. In the September 26, 1944 edition*,* a U.S. Navy gunboat in the South Pacific with a rotating, pulse radar reported that:

> A strong radar contact was picked up about 3000 yards ahead….The target closed too rapidly to plot and was lost at about 400 yards. Nothing could be seen visually although it was a clear night. About two minutes later a similar target was seen on the scope at 4000 yards. It also closed very rapidly and passed down the starboard side of the gunboat. The returns resembled those given by a small escort vessel. (*Radar Abstracts*, Sept. 26, 1944, p. 5)

The aggregate effect of antennas' wavelengths, material composition, sharpness, height, and rotation is a geometry of empire that ensures the controlled, coordinated flow of feedback—of people, objects, and information—through radar architecture. In the language of Joseph Goebbels, the pilots and passengers (*das Volk*) moving according to radar's dictates are "ideal militants," or what Virilio would call a social movement. Says Goebbels, "The ideal militant is the political combatant in the Brown Army as a movement…obeying a law that he sometimes doesn't even know, but that he could recite in his sleep….Thus we have set these fanatical beings in motion" (quoted in Virilio, 1996, p. 4). But for Goebbels connecting willing followers to "movement" and being "in motion," we could recognize that Virilio has discovered the wiles of naturalized ideology and leave it at that. We could understand that for Virilio, an "ideal militant" marches in his natural ideology. As it is, there is much more at stake.

Right Angle

Virilio's relentlessly militaristic and geometric design of the church of Sainte-Bernadette can help explain what I believe is at stake. It suggests a politics of movement, a politics that critiques the practice of placing antennas as "high as possible" on ships, hills, or buildings, literally a critique of the vertical and horizontal dimensions of a geometry of empire (Blue, 1943, p. 4). Virilio refers to his politics as "the oblique function," and believes it enacts the possibilities of a "third urban order." In a 1996 interview with architecture professor Enrique Limon of New York's Pratt Institute, Virilio reminisces about the publication *Architecture Principe* and his radical architecture in the 1960s. He and his partner, Claude Parent, had attended Situationist and Autonomist lectures and were involved around the edges of the May 1968 protests in Paris. These ideas and events influenced Virilio's politics (Redhead, 2004). Virilio explains that:

> The oblique function is radically linked to urbanism because its purpose is to define a third urban order. The first urban order (villages, land population) is mainly based on horizontality. The second urban order based on verticality ended with megastructures: first the New York skyscrapers in Manhattan, then the Japanese projects to build a 2000 meter-high tower, Wright's project of a 1500 meter-high tower, etc…This is outrageous. In my opinion, the vertical order has come to an end. The idea is to lead architecture and urbanism into the third urban order, to claim that a city can expand linearly, but primarily through topology, through oriented surfaces which allow the ground not to be covered. There will be bridge structures and megastructures, but which use the oblique. So we are aiming for both a linear and oblique urbanism….The third urban order and all the *Architecture Principe* issues put the vertical city on trial. At the same time, towers were being built everywhere, on the banks of the Seine and elsewhere. The tower was the most exalted type of architecture. Our opposition to towers was absolute. Verticality was absurd because it did not allow communication. It only caused concentration, stacking. Verticality is a ghetto. When people talk about racial ghettos we reply: "Yes, there are horizontal ghettos." (Allen & Park, 1996, p. 54)

Virilio’s politics are material and concrete. They are a politics of geometry, density, and acceleration. And he is, in the simplest of terms, bent out of shape over the right angle. If there are demons in his politics they would include the Masons, their squares, and their All-Seeing Eye as well as Baron Haussmann, Gustave Eiffel, Minoru Yamasaki (who designed the World Trade Center’s Twin Towers), the mythic Tower of Babel, the Autobahn, and the Interstate Highway System. Virilio’s politics accentuate the material concreteness of the radar antenna and its geometric relationship to movement—some of the logistical building blocks of radar architecture—but do so with the same stroke that literally circumscribes economic and racialized spaces (such as ghettos).

In terms of radar antennas, Virilio’s assertion that “Verticality was absurd because it didn’t allow communication,” preserves the sense of power and occupied space that I mentioned earlier (in my example, the mausoleum vault was the most occupied space). Still, it ignores the interconnectedness of radar and other electromagnetic systems. As Virilio tells Limon, Virilio believes this ignorance is overcome by a comprehensive, Bentham-esque understanding of political space:

> A political space is a geopolitical space. “Political” means nothing. A political space applies to a piece of land, whether small (a city) or large (the nation-state). It is geopolitical in the “political geography” sense. There is a political geometry. Bentham’s Panopticon for instance is a police-state political geometry. Foucault analyzes it in *Discipline and Punish.* In Bentham’s Panopticon one man can control all the inmates from one main central spot thanks to transparency. This is geopolitics, i.e., political geometry, not political geography. A space is always political through geography and geometry. Geostrategy and war brought me to this conclusion. For the military, only strategies matter. The Gulf War was a geostrategic war. Within “geography” there is “geometry.” When you build a tower from which you control a city (the Hilton in Beirut for instance), men will fight in order to occupy and control it. (Allen & Park, 1996, p. 55)

Here Virilio provides a rationale for attacking the World Trade Center and Pentagon as well as the more horizontal terrorist ghettos along the Afghan-Pakistani border (even though he has not endorsed either). But his notion of a transparent view from the panoptic tower does not square with the logistical operations of a radar situation room: once traffic flows through material, pitching, rotating, and towering antennas it is represented on PPIs or A-Scopes and is injected into additional information systems. There, in the situation room, an entire theater of logistical operations is at work: *identification and coordination.* In the next chapter, I detail these concepts through historical detritus from the Rad Lab and argue against the idea that the empirical view—the vertical view—is transparent. I argue that the myopia of the radar vision machine allows for a disruption of the *present* with the *now,* and that radar is particularly vulnerable to its own feedback.

CHAPTER 6: MEASURES

The flow of feedback through radar architecture is the construction of knowledge at a distance. Radar antennas, displays, and stations comprise information and ordering systems: they mediate and mimic the communicative cosmos and influence experiences of space and time. In this way, radar architecture is not only akin to railway architecture in its carving out a geometry of empire, but also in its industrialization. Schivelbusch quotes French historian Peter Wexler as referring to the railway station as an industrial traffic building that is '"mi-usine, mi-palais,'" as half-factory, half-palace (Schivelbusch, 1986, p. 172). In this chapter, I describe radar, and particularly GCI (Ground Control Interception) radar, as mi-usine, mi-horloge, as half-factory, half-clock.

I have three reasons for describing radar this way. As half-factory, half-clock: 1) Radar is most clearly what Mumford (1964) describes as an authoritarian technic, 2) Radar's logistical function of *interception*, which is comprised of *identification* and *coordination*, is made clear and 3) Radar's place in the mythology of progress is most vulnerable to disruption. Each of these reasons contributes to, or is an implication of, the construction of knowledge at a distance. Each of these reasons is also undergirded by *measurement*, a fact that helps me position this chapter and the next—*countermeasure*—as dialectical, would-be foils of one another.

I first consider these reasons through several interlocuters—Mumford, Marx, Andrejevic, Robins & Webster, Schivelbusch, Carey, and Virilio. After that, I detail the rise of GCI radar and its most elaborate half-factory, half-clock, the Happidrome. Amidst the Happidrome's interception, height finding, fighter control, and fire control, Rad Lab artifacts take us on a day trip to the South Pacific and then over to Great Britain and the Blitz. Generally speaking, the PPI-reader interface and the logistics of GCI are my main focus. Specifically, I stitch the fundamental logistical function of measurement into discussions of factory efficiency, clockwork predictability, interception, and its component functions (identification and coordination). In conclusion, I say a little about the role GCI played in radar's endocolonization of citizens, and forecast its vulnerability to countermeasure.

Factory

Mumford (1964) is concerned that authoritarian technics have "no visible presence who issues commands," that, "unlike Job's God," they can neither be confronted nor defied. He further suggests that the purpose of these technics is to "displace life, or rather to transfer the attributes of life to the machine and the mechanical collective, allowing only so much of the organism to remain as may be controlled and manipulated" (p. 5-6). His perspective encourages us to see information traffic in radar architecture as objects laboring in a technocratic machine, radar readers as machine attendants, and Rad Lab researchers as engineers of their own iron cages. In simple terms, a world dominated by authoritarian technics is a factory of measurement. It is Taylor's fantasy and Marx's industrialized intensification of labor. Imagine that the factory Marx is writing about in this passage in *Capital* is both a radar station and a nation state:

> So far as divison of labor re-appears in the factory, it is primarily a distribution of the workmen among the specialized machines….The essential division is, into workmen who are actually employed on the machines (among whom are included a few who look after the engine), and into mere attendants…of those workmen. Among the attendants are reckoned more or less all "Feeders" who supply the machines with the material to be worked. (Tucker, 1978, p. 407-408)

Applying Marx's quote broadly renders information traffic flowing through radar antennas, displays, and stations as "material to be worked." It figures radar technicians and readers "workmen" and pilots, passengers, and other objects "attendants." Robins and Webster's (1999) criticisms of Taylor's management-by-measurement loom large here. According to Robins and Webster, Taylor's approach is authoritarian in that it requires:

> A massive restructuring of the relation between factory and outside world, and a recomposition of patterns of culture, leisure, consumption, social space (housing, travel)….As Bob Young and Les Levidow have pointed out, there is a tendency towards a "more directly political control over the production and reproduction of daily life, extending methods of factory discipline into the state's management of the social totality." (p. 55)

Andrejevic (2007) extends the idea of authoritarian measurement in media and technology. He does so by elaborating the classical Marxist notion of *enclosure*. In discussing the cell phone's contribution to what he calls "M-commerce"—digitally enabled commerce and information gathering that utilizes the movements of individuals—Andrejevic observes that:

> Unlike cars and TVs (at least for the moment), telephones allow for personalization and entry into an interactive network—a virtual enclosure that allows individuals to stay in constant contact with one another and with commercial and state entities interested in tracking their whereabouts. The trackability of cell phones received a big boost thanks to the legal requirement in the United States that they be equipped with GPS technology to allow their location to be pinpointed in case of emergency. This requirement, promulgated in the name of security, promises to facilitate the rationalization of consumption

> by allowing marketers to reach individual consumers when they are on the street "poised to make spending decisions…." (p. 97)

Andrejevic concludes that, "Within the electromagnetic enclosure formed by mobile phone networks, individual users trail data throughout the course of their day," and suggests that "Increasingly, we are likely to find ourselves using the telephone not to communicate with people but with automated services and databases" (p. 97). He has taken to the individual and product level what I have discussed in terms of radar's tracking of the speed and trajectory of pop culture, fashion, and commodities, and to patrol aircrafts' measured pacing between beacons during World War II. Both discussions are consistent with Schivelbusch's assertion that since the nineteenth century, "traffic determined what belonged where" (1986, p. 194).

Nevertheless, radar's display-reader interface, where readers' view blips and listen to pings, is a space where the measurements of authoritarian technics can be subverted, a space where the geometry of empire can be used against itself. Radar architecture channels traffic, but radar reader's interpretations, and particularly their privileging mechanistic, calculative cognition over holistic, intuitive, deliberation (Robins & Webster, 1999) exposes radar architecture to the manipulations of its objects. In Mumford's (1961) discussion of a new, techne-produced grid that superimposes an "invisible city" over a visible one, he allows that, "The new grid, in all its forms, industrial, cultural, urban, lends itself to both good and bad uses" (p. 642). In the next chapter, I discuss the manipulation of radar by its objects as an anti-authoritarian use. Whether such manipulation is "good" or "bad" depends on whether or not you agree with the mythos of technological progress.

Radar's logistical functions of *identification* and *coordination* emerge in the display-reader interface. These functions are not peculiar to radar. They also emerge at the junction of maps, clocks, searchlights, war horns, and global positioning systems and those who interpret them. Their importance to radar, though, is distinct because as logistical functions, they are more than *mere* functions: they are also modes of authority, and therefore, of subversion. On the macro level, I have depicted modernity as an accelerating dialectic of order and catastrophe. In effect, I have taken what C. H. Greenbow said in *An Exposition of the Danger and Deficiencies of the Present Mode of Railway Construction* (1846)*,* and have adapted it to radar. Said Greenbow:

> The wheels, rails, and carriages are only parts of one great machine, on the proper adjustment of which, one to the other, entirely depends the perfect action of the whole. And as the velocity given to the moving parts increases, so does the necessity for perfect adjustment increase also, because the imperfect action, which, at moderate speed, would only cause a *jolt*, will, when moving at high velocity, gain sufficient force to cause an overthrow. Therefore, from this cause it becomes necessary, in order to secure safety when moving at great speed, to have all the parts in contact adjusted to each other in such manner as at all times, and under varying circumstances, to preserve a true relationship one to the other, at the same time having a tendency to resist and counteract the impulses which would otherwise destroy their equilibrium, and endanger the safety of the moving body. (as quoted in Schivelbusch, 1986, p. 20)

Planes, ships, milk carts, displays, radar readers, and control rooms are measured parts of the radar machine—of the radar factory. They are adjusted to one another to minimize emergences (what Greenbow calls "jolts"), and to maximize the safety, security, and predictability of the moving body. Radar is, in this aspect, more of a tool than a weapon, as it works to efficiently arrange "matter from a distance, in order to bring it to a state of equilibrium or to appropriate it for a form of interiority" (Deleuze & Guattari, 1986, p. 76). Radar grounds would-be cybernauts, tracks hurricanes and

Canada geese, and transforms nomads wandering about the Sinai into a form of interiority, into a nation.[118] On the micro level—on the level of the radar reader—radar does this through identification and coordination.

The flow of feedback through radar architecture is more than a flow through hardware, through factory-like mechanisms, readers, and rooms. It is also a flow through the logistical software of identification and coordination. Identification and coordination contribute to radar readers' professional encoding (Hall, 1980) of electromagnetic feedback, to the "if…then" calculations they pass to others. Considered differently, identification and coordination are the dominant modes within which radar readers decode messages encoded by blueprints and architecture. Both points of view place radar readers as coders at the junction of information and narrative. Both points of view place radar readers as directly engaging the radar mechanism.

In a classic, industrial model, identification and coordination are vessels wherein electromagnetic narratives "cook." Antennas, master receivers, and displays chop and grind feedback. Feedback becomes a recipe for progress in the cauldrons, kettles, and saucepans of identification and coordination (and becomes fast food in the hands of reader-chefs and their supervisors). The display-reader interface—radar's kitchen counter if you will—is where we observe GCI's "cooking." It is where we observe GCI is a microwave oven turned inside out.

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[118] On June 12, 2009, *The Guardian* reported that in response to collisions between Canada geese and airplanes, JFK airport authorities are "installing a new bird radar system" (Goldenberg, 2009, p. D2).

Identification

Like the torpedo and searchlight that preceded it, radar is a medium of identification. It broadcasts high-frequency electromagnetic waves that reflect off any sufficiently dense object in its path. In Schivelbusch's (1986) terms, radar orders the flow of traffic, even if it does so with less absolute control than does a railway.[119] In Wiener's (1961/1948) terms, radar compels reception and feedback, or echoes, discerns them through antennas, and translates them into spikes on A-scopes or blips on PPIs. Readers assign contacts identifying numbers and ascertain their speeds and movements by observing subsequent echoes. Readers measure the size and shape of echoes and match them with a database of known air and water craft. They also receive transmissions from less powerful, but portable, IFF ("Identify Friend or Foe") transponders.

One noteworthy aspect of Rad Lab era radar in terms of identification is that while it allowed readers to know certain information about contacts, much identifying information remained unknown. Even today, radar is better at identifying vehicles and objects than it is at identifying objects (including people) that are sometimes inside them. Radar's myopic super-vision lends to the ghostly appearance and disappearance

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[119] While radar's objects are not as mechanically conjoined as are the railways, they are electromagnetically conjoined in a way that reduces much of the leeway Schivelbusch (1986) attributes to transportation on roads and canals. He writes that: "Transportation on roads and canals, as developed in eighteenth-century England by private enterprise, made both a technical and economic distinction between the *route* and the *means*….Anyone using one of these artificially created land routes or waterways did so with his own vehiclce….Route and means of transportation existed independently from one another, because individual movement of vehicles—their mutual flexibility in granting right-of-way, etc. was technically possible. The railways put an end to that liberal state of affairs. Route and vehicle became technically conjoined on the railroad: there was no leeway between the rails and the vehicle running on them, nor was it possible for one train to pull to one side when confronted by another" (p. 16-17).

of unidentified objects. It lends to a spectral flickering that resembles the "electric presence" described in early radio DXing and electronic spiritualism. Radar readers may not find radar as sublime as would a public enchanted by Oliver Lodge's radio séances, Tesla's death ray, TV shows such as *Radar Men from the Moon,* or movies like *Poltergeist* or *The Ring* (Sconce, 2000). Nevertheless, bored, overworked, half-hypnotized, and caffeinated radar readers succumb to the unknown. They wonder if their displays are spirit boards.

Readers' wonderings are justified if they are willing to accept the *mythology of progress* as "spirit." Carey's (1988) critique of SMCRF, of a geographic and transmission model of communication, reveals radar's "spirit" and sheds light on the interplay of certainty and uncertainty in identification. Carey first explains the conflation of transportation and communication that accompanied the European discovery of America:

> Transportation, particularly when it brought the Christian community of Europe into contact with the heathen community of the Americas, was seen as a form of communication with profoundly religious implications. This movement in space was an attempt to establish and extend the kingdom of God, to create the conditions under which godly understanding might be realized, to produce a heavenly though still terrestrial city. The moral meaning of transportation, then, was the establishment and extension of God's kingdom on earth. The moral meaning of communication was the same. (p. 16)

In the 16th century, *communication* between mutual "others," between Europeans and Native Americans, was a matter of *transportation*. Ships were vehicles of information, evangelism, logistical force, and bodies, and they had few rivals (architecture in the conventional sense was an exception). They were the means of collision between mutual others, but needed separation from communication systems before an invisible city, a heavenly though still terrestrial city, took shape.

Carey asserts the telegraph's separation of transportation and communication and describes how it was absorbed into a progressive mythology of Christian evangelism/apocalypticism:

> By the middle of the nineteenth century the telegraph broke the identity of communication and transportation but also led a preacher of the era, Gardner Spring, to exclaim that we were on the "border of a spiritual harvest because thought now travels by steam and magnetic wires" (Miller, 1965, p. 48). Similarly, in 1848, "James L. Batchelder could declare that the Almighty himself had constructed the railroad for missionary purposes and, as Samuel Morse prophesied with the first telegraphic message, the purpose of the invention was not to spread the price of pork but to ask the question 'What Hath God Wrought?'" (Miller, 1965, p. 52). This new technology entered American discussions not as a mundane fact but as divinely inspired for the purpose of spreading the Christian message farther and faster, eclipsing time and transcending space, saving the heathen, bringing closer and making more probable the day of salvation. (1988, p. 16)

Today, radar and other wireless communication systems have been absorbed into that same mythology. Radar constructs mythological identity, although with less certainty than is seemly for Providence. In the case of defensive, national radar systems, it means *unknown blips can be known heathens*, whether these blips represent immigrants, smugglers, a North Korean cargo ship carrying nuclear technology to Myanmar, window (foil packs deployed by hostile airplanes to confuse radar readers), or the wheel in the sky of which the bible's Ezekiel and Journey's Steve Perry are so fond.

Within the mythology of Christian evangelism/apocalypticism, Jesus and the Danish rock band Golden Earring have a power that transcends conventional radar—*radar love*. Radar love presumes *a* perfectly *knowable interior beneath the surface of an* *object, instead of one partially knowable surface within another*. When Barry Hay sings, "She sends her comfort comin' in from above, don't need no radio at all, we've got a thing that's called radar love, we've got a line in the sky, radar love," he describes a transcendent transmission—a love—that goes "in" and comforts in a way that radio cannot. Likewise, the Gospel of John presents Nathanael as unknowingly transmitting perfect knowledge of his interior to Jesus through "a line in the sky":

> When Jesus saw Nathanael coming toward him, he said of him, "Here is truly an Israelite in whom there is no deceit!" Nathanael asked him, "Where did you get to know me?" Jesus answered, "I saw you under the fig tree before Philip called you." Nathaniel replied, "Rabbi, you are the Son of God! You are the King of Israel!" Jesus answered, "Do you believe because I told you that I saw you under the fig tree? You will see greater things than these." And he said to him, "Very truly, I tell you, you will see heaven opened and the angels of God ascending and descending upon the Son of Man." (John 1:47-51)

In terms of radar identification, Nathanael and the fig tree provided feedback and Jesus was a reader with an All-Seeing Eye. Jesus' sight received more than a reflection of Nathanael's surface. It measured his soul and found no deceit! Today, radar rabbis at Israel's Ramat David Air Base see F-16s ascend and descend as the latter take off, patrol Israel's border with Lebanon, and land. These radar rabbis, these revered interpreters of objects written on ever-changing pulpit-displays, do not have radar love. They do not have its certain knowledge (although they, like all hierophants, can forget that their vision machines are not all seeing). In the first telegraph message Samuel Morse asked, "What hath God wrought?" The answer is not love, but *logistics*.

Coordination

Unlike the post office, which relies on stable, fixed addresses, radar assumes movement. Poised along national, regional, and symbolic borders, and in networks, radar is one aspect of collision-avoidance management. Moving contacts occupy different positions on overlapping radar screens and appear and disappear beneath the gaze of radar readers. Radar architecture coordinates these contacts from its sometimes immobile, but always central, point of view. Radar often tracks movements on a PPI, on an electronic, coordinate map that places the reception antenna at the center and "others" physically and symbolically closer to a margin.

As I implied in my discussion of World War II gunboats, beacons, weather forecasting, and pitch and roll, radar helps objects maneuver around and/or evade various "others." It steers naval vessels around icebergs and airplanes over lightening storms. It gives luxury automobiles electronic cushion between other vehicles and pedestrians. [120] Even pedestrians walk within the safety of radar tracking systems.[121] In all such situations, coordinating movement enables the measurement and maintenance of range, or distance, between mutual "others." At the extreme, radar's maintenance of distance gestures to European Christians' belief in their cleansing migration to America (Carey, 1988, p. 16). More mundanely, it gestures to utopian American tourism, to cleansing movements on cruise lines, points of interest that present nature and the

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[120] Toyota, BMW, and Daimler have all produced models with anti-collision radar systems designed to warn drivers if they get too close to another object and to minimize swerving in the lane.

[121] In the 1980s, New York City pedestrians could walk fancy free under de Certeau's vertical, second-urban-order gaze. Today, CPR (Cell Phone Radar) techniques are being used to track and coordinate pedestrians' movements. See Harris, Lam, Maunsell, & Burroughs (2005).

cultural “other” at a safe, commodified distance, invigorating drives in luxury automobiles, SUVs charging up mountain streams, and advertisements for such.

Coordinating movement always has military consequences. A ragged group of cars speeding down the Interstate will, in the presence of a police cruiser, even out its speed and space and resemble soldiers on patrol. Virilio (1986) claims that, “War has always been a worksite of movement, a speed-factory” (p. 141). By this, Virilio means that war is a space where coordination and chaos are interlocked. *Coordination* conjures images of the pious, post 9/11 American populace and of consumers advancing through M-commerce. *Chaos* conjures images of New Yorkers staggering through the smoke, dust, and debris of the most pandemonious commute Manhattan has ever known, of thousands of grounded flights and millions of stranded passengers. Virilio helps us see how these events are two sides of war’s worksite. He also helps us see continuity between radar, coordination, the 9/11 attacks, American’s reactions to the 9/11 attacks, and “throwing ancient weapons”:

> The essential aim of throwing ancient weapons or of shooting off new ones has never been to kill the enemy or destroy his means, but to deter him, in other words, to force him to interrupt his movement. Regardless of whether this physical movement is one that allows the assailed to contain the assailant or one of invasion, “the aptitude for war is the aptitude for movement,” which a Chinese strategist expressed in these words: “An army is always strong enough when it can come and go, spread out and regroup, as it wishes and when it wishes.” (Virilio, 1986, p. 145)

Radar increases a nation state’s, military’s, and police department’s aptitude to coordinate movement. It reduces citizens’, soldiers’ and police officers’ aptitude for individual movement. Loitering, trespassing, and speeding are anticipated and discouraged electromagnetically. Consequently, it reduces citizens’ ability to form a grassroots "army," to form what Bob Marley refers to as "movement of Jah people" in his song "Exodus."[122] It limits the strength of such an "army" by restricting its ability to move and regroup "as it wishes and when it wishes." A comprehensive, immediately enforced application of radar to restrict movement and grouping would, when deployed against American citizens, reveal the tyranny of radar's remote control. It would threaten to disrupt the *present* with the *now*. Al Qaeda's piloting buzz bombs into the World Trade Center and Pentagon on 9/11 was a demonstrated aptitude for movement, a storming of the Bastille through the air. The U.S.'s subsequent upgrade in security and air traffic architecture was a Haussmanian renovation of heavenly boulevards.

Measured movement can become coordinated movement, and coordinated movement can become controlled movement. It can become *enclosed* movement. Virilio bypasses the usual—and in my view, useful—Marxist understanding of enclosure as the process of creating private ownership for the purpose of owning the means of production and distribution and requiring the proletariat to labor and consume in controlled space. For Virilio, the economic issues are secondary. Nevertheless, Virilio criticizes the logistics of Tayloristic enclosure (and for that reason, his approach aids my exploration of radar logistics). He views enclosure through the same logistical lens he views the church of Sainte-Bernadette. Consider his description of the enclosed "factory work" of asylum inmates. He writes:

> Factory work must not escape the dictatorship of movement. It reproduces the enclosure on the spot, in an obligatory and absurd kinetic cycle, the slow death of the reject. I remember staying, about thirty years ago, on the banks of the Loire river near a state psychiatric hospital and, as a child, being surprised to see

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[122] Virilio (1986) also equates a grassroots army with social movement.

> hordes of inmates pushing carts in the dry riverbed, forced by their guards to fill them with sand and roll them farther on, only to empty them into the water and begin again. This series of aberrant movements under a burning sun continued interminably, while, from time to time, one of the wretches threw himself screaming into the Loire. (Virilio, 1986, p. 80-81)

There is a politics of movement in "wretches" throwing themselves into the Loire, or more broadly, in citizen-feeders resisting radar's remote control. Forms of resistance vary: There are frivolous media pranks, misleading military maneuvers, and attacks on radar itself. There are *countermeasures* to radars *measures* of identity, coordination, time, and space. There is also a politics of movement for radar readers, many of whom spend hours at a stretch ticking and jolting at the bottom of electronic funnels, responding to the never-ending blips and pings. Radar stations have the look, arrangement, divisions of labor, and efficiency of a factory floor. I now attend to the logistics of a distinctively instructive radar control room—the Happidrome— before sailing into the South Pacific and the Blitz. In so doing, I emphasize the display-reader interface.

Happidrome

Feedback flows through radar antennas and onto displays such as A-Scopes, PPIs, and the miles-per-hour (MPH) indicators on radar guns. These displays are mobile or fixed, networked or discrete. They are matched with antennas, and thus represent different objects, at different speeds, and for different purposes. They display measurement; they are open to calculation and interpretation. Some of them are in controlled spaces and look like reading carrels in Buck Rogers' universe. Others are in semi-private and partitioned spaces, are reminiscent of the medieval "singing booths" that monks sat in as they read the bible aloud (McLuhan, 1962). Most important to the present discussion, though, is the fact that *display-reader interfaces are spaces where progress narratives are measured and circulated.* Even though radar displays are less ubiquitous than are their TV cousins, they reinforce the Benjaminian present by providing information that helps a powerful few exercise logistical control over a mass-like many.

Technically, Happidromes were the crowning achievement of wartime efforts to create ground control through GCI. Happidromes were control centers built to make best use of the Air Ministry Experimental Station (AMES) Type 7 GCI radar, a powerful new system entrusted to safeguard Britain against the Luftwaffe. British radar historian Edward Putley ruminated about radar's limited contribution to ground control in the pre-GCI era (known as the "CH" or "Chain Home" era). He wrote that, categorically, a pre-GCI radar set:

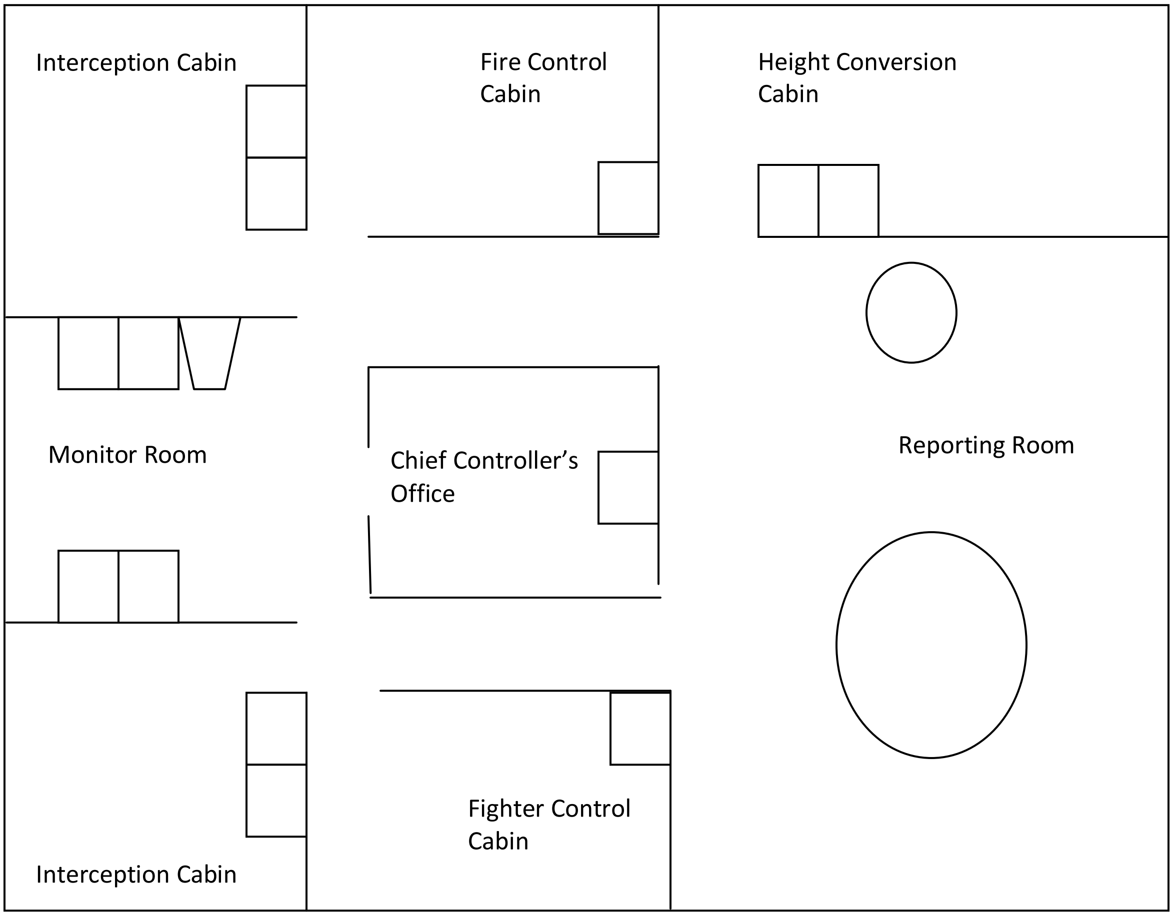
> Although very effective against massed daytime attacks…was not suitable for use against the single night bomber (or daytime sneak attacks). First, it was not sufficiently accurate to bring a fighter within visual range of its target at night, and second the operation of the complex reporting network was too slow. Finally, the original chain [of radar stations] only looked out to sea, so [it] could not deal with interceptions inland. (1988, p. 162)

Historically, Happidromes were one of the most important display spaces. As World War II spread in the early 1940s, *Happidrome*—a mash up of "happiness" and "aerodrome" (a British word for airport)—was a popular radio comedy in Britain. The radio serial told the story of earnest, tragedy-loving theater folk inadvertently producing comedies in a rundown music hall. The radar control rooms were basically the same thing, although on a larger scale, with less melodic music, and with a military purpose. Wacky engineers spackled *Happidrome* on the radar control room they were building, and the radio serial/radar control room has been a running joke ever since (Putley, 1988). More than a dozen Happridromes were eventually built in the British countryside, although most were not functioning until near the end of the War.

Contributing to the conflation of theater and military was the fact that radar Happidromes looked like theaters with a center stage for “general reporting,” and with specialized cabins (sometimes called “rooms”) set off by railings in a floor that ascended from the general reporting “stage” (see Table 6.1). Happidromes were literally *theaters of operation*. As radar stations, Happidromes were unique in that they were larger and more open and elaborate than were the simple filter rooms rigged up in radar shacks or stuffed into World War II ships. They were also uniquely British in their oblique architecture. According to Brown (1999):

> [The Happidrome’s] function required sitting in a shallow bowl with a minimum of fixed targets visible outside the bowl. This requirement is easily satisfied by England’s gently rolling countryside, but not on the American west coast, where reconnaissance had failed to find an approximation of the right surface conditions in the Pacific Northwest with things not much better in the south. (p. 223)

Figure 6.1: Happidrome



Like the ancient Greek theater of Achrida, which was built into the slopes of two hills to ensure privacy and high-quality acoustics (Storey & Allan, 2005), the Happidrome's mingling of geometry and geography was logistically motivated. Geographically, Happidromes had the oblique appearance of Virilio's third urban order and were off the beaten path. Surrounding hills blended with, protected, and camouflaged them. Of course, these hills "produced strong nearby ground returns," but beyond the hills, transmission was often strong and uncluttered (Brown, 1999).

Geometrically, Happidromes projected Britain up into the atmosphere and out over the water, and looked down on their vast protectorate. They also had "higher" sight in that their vision was at a higher frequency than was natural human sight. Logistically, they were vertical. They were towers.

Additionally, Happidromes' visions were mythically "higher" than was human sight. Happidromes lacked the singularity of the Hebrew Tabernacle and the numinous mist-ery of the Oracle at Delphi, but they were shrines in their own right. Radar architecture trafficked feedback through Happidromes, providing Hermes' "acolytes"—radar readers—with foresight. Happidromes measured feedback according to worthiness: significations of unclean, natural phenomena were, to the degree possible, discarded through discriminating reception frequencies.[123] Converters and filters purified worthy feedback before its presentation in "courts" dedicated to various divinations—*interception, fighter control, height finding, fire control*—and before its presentation in the *reporting room* for plotting and distribution. Happidromes were shrines that produced calculable bits of information with which to make progress in the War.

Amidst the explosive Battle of Britain and the subsequent Blitz, British engineer Robert Watson-Watt and his colleagues deployed and linked (via telephone) whatever GCI radars they could. Watson-Watt had been wary of the Luftwaffe since 1935, and had pressed into action every CH set that functioned (Watson-Watt, 1957). Watson-Watt networked his CH sets, but, as Putley observed, they were ineffective at night and

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[123] Weather forecasting in Happidromes was a literal but not an ideological exception to this, as it strove to prevent and minimize disruptive natural emergencies such as hurricanes and tornadoes.

pointed in one direction. The Blitz—the Luftwaffe's sneak bombings and buzz bomb attacks that occurred after the large-scale Battle of Britain, and mostly at night—only slowed after GCI radars took the field in the spring of 1941 (Brown, 1999).[124] GCI radars used electronic coordinate maps (PPIs), rotated like carousels, and, thanks to the cavity magnetron, were 1,000 times more powerful than were their CH predecessors.[125] Putley explains that GCI's power was also in its height finding:

> By the end of 1940 the first PPI had been produced…and a method for height finding had been evolved. This used two broadside antenna arrays, one above the other. Using them separately and combined in various ways, height could be determined and gaps in the vertical polar diagrams filled in. The first GCI had been built by the end of 1940, six early models being in use by January 1941. The basic development of this system was completed by the end of 1941, leading eventually to the very large [Ames] Type 7 with its elaborate "Happidrome" control room…. (1988, p. 162-164)

As Putley (1988) indicates, GCI radars' height finding worked by moving two antennas that looked like aluminum box frames (such as those used beneath a bed mattress) up and down. Only one of the antennas transmitted at a time, and they alternated transmissions, a technique known as *lobe switching*. The Happidrome had a *capacity switch* that chief controllers used to automatically set the pulse rate and the lobe switching rate, making it predictable, reliable, and efficient. With antennas at different heights, echoes were measured at different angles and thus at different

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[124] British radar historian Louis Brown thinks the arrival of GCI radars was decisive in ending the Blitz. He writes that, "May 1941 generally marks the end of the Blitz, for in that month the [ground control interception] radars began to work effectively with 102 bombers shot down that month, some during the day (30), and leaving the Luftwaffe to try their luck on the Eastern Front. The skies over England were not to be free of bombing planes until near the end of the war, but the Luftwaffe never returned again in force" (1999, p. 119).

[125] The cavity magnetron increased the power of high frequency, electromagnetic radiation about 1,000 times, and therefore increased the range of radar about 1,000 times (Watson-Watt, 1957). It also increased Britain's ability to project its mapmaking, an ability that suggests the contemporary dispute between India and China over Google Maps' designation of Kashmir (Ribeiro, Oct. 23, 2009).

distances. The height finding display (HFD) looked like an A-scope with a distance line for each antenna, but whereas an A-scope represented masses, an HFD represented distinct contacts. From that point, height finding was a matter of plugging the angles and distances into a “fruit machine”—an electro-mechanical calculator (Barrett, 2003).

GCI increased radar’s efficiency and accelerated its distribution of feedback. The Happidrome was GCI in its most refined form (at least, according to 1940s standards). Happidrome radar rotated, picked out individual aircraft, measured contact height, and displayed feedback in a space where it was quickly controlled and distributed. Technically, the Happidrome matched reception frequency and distance with a display that distinguished individual contacts from the masses. Logistically, it did so in a space where chief controllers supervised and measured feedback, radar readers, and their interactions. Virilio’s attempt to subordinate the post-World War I economy to military imperatives in *War and Cinema* (1989) has relevance to the military and industrial implications of the Happidrome’s logistical interior. He writes that, “The army is in fact the ideal form toward which a purely mechanical system of industry must trend” (p. 89).

Master Receiver

Electromagnetic waves bounced off objects and struck a Happidrome’s reception antenna, much like an object striking a tuning fork.[126] If you smack a tuning fork against a hard surface, you can see it vibrating and can hear sound waves produced by those vibrations. Tuning forks with different masses and densities will, when struck, vibrate at

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[126] As in chapter one, I rely on Hobson (2007) for my understanding of the technical issues in this discussion.

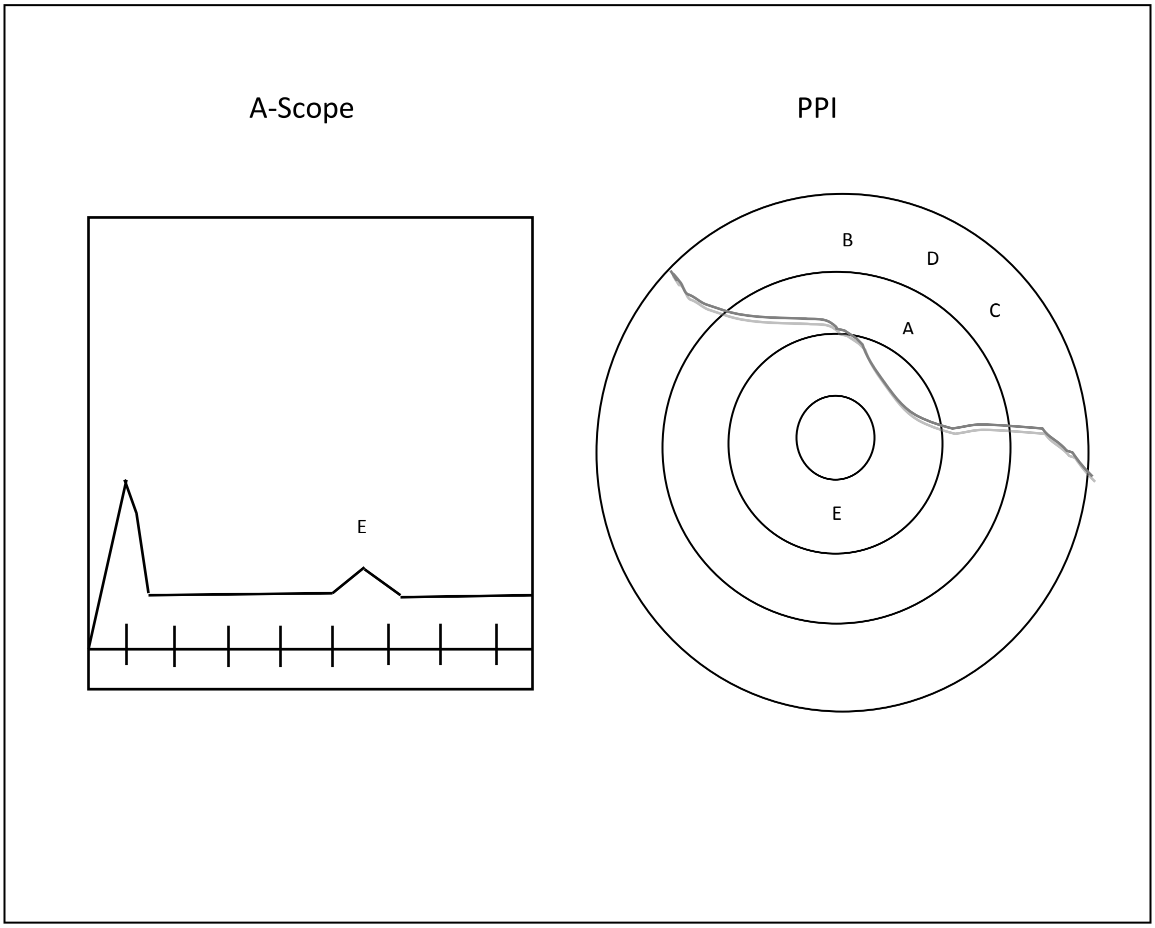
different speeds and produce different notes. In that sense, Happidrome antennas were tuning forks for light (instead of for sound). Electromagnetic waves hit them and those of sufficient strength and correct frequency produced vibrations.

These vibrations created a weak AC current that traveled through a cable to the master receiver in the monitor room (which I have represented in Table 6.1 as a trapezoid). The master receiver contained measuring devices: a *converter, rectifier, amplifier,* and a series of *filters*. The converter calculated the AC current by transforming it from analogue to digital. The rectifier translated the AC current into a DC current that fired cathode rays on PPIs. The amplifier boosted the current so it flowed to the Happidrome's farthest reaches. Filters screened out noise and unwanted frequencies. The converter, rectifier, amplifier, and filters chopped and ground feedback—they processed it—before electron guns projected it through PPIs and onto the back of readers' brains.

The *Doppler filter* measured the Doppler effect (or shift), and was a distinctive feature of GCI. Waves bouncing off moving objects fluctuate because the distance between those objects and the reception antenna has changed. If objects move away from the antenna, waves are less frequent (their frequency will be lower) and longer (than they were at the last reflection). If objects move toward the antenna, waves are more frequent and shorter. Wave changes that accompany such moves are Doppler shifts. Today, meteorologists use Doppler filters to pinpoint hurricanes. But in the beginning, they pinpointed Messerschmitts and Focke-Wulfs.

What makes GCI radar superior to CH is its increased range, matching of individual objects with Doppler shifts, display of these objects on a PPI, and automatic height finding. If electromagnetic waves that strike an antenna, induce electrical current, and fire cathode rays in a PPI are comparable to electromagnetic waves passing through a lens, striking film, and developing, GCI radars are distinct from their predecessors. They measure and represent distinct objects instead of blob-like masses. To return to my tuning fork example, GCI radars hear distinct “notes” and plot them, a measure at a time, on a PPI. CH does no better than to average the distinct “notes” into a “chord” and display them as a spike on an A-scope. Table 6.2, below, shows what PPIs and A-scopes might depict at the same moment.

Table 6.2: A-Scope and PPI



The PPI identifies “A,” “B,” “C,” and “D” as four aircraft with distinct speeds, altitudes, and trajectories, “E” as a rainsquall or snow cloud, and the coastline. The PPI continues to track the four aircraft after they pass the reception antenna. The A-scope points at six o’clock, sees only a spike at “E,” and does not know if “E” is one object or a cluster of objects. Consequently, the CH station, which only has an A-scope, is oblivious to “A,” “B,” “C,” and “D”— they are out of range and it is not facing them. The CH will not even detect “E” once it passes overhead or strays a few miles to the east or west.

Although A-scopes and CH stations have their uses, the superiority of GCI during an attack like the Blitz was immense. A master receiver that matched objects with Doppler shifts *was* remote ground control.

Clockwork Happidrome

The Happidrome's master receiver simultaneously distributed converted, filtered, and amplified feedback to interception cabins, the fighter control cabin, the height conversion cabin, the fire control cabin, the monitor room, and the chief controller's office. In a moment, I discuss the distinctive logistics of interception, height finding, fighter control, and fire control, as these are the primary constructors of identification and coordination. I also touch on the others, and the reporting room, as appropriate. First, though, I dwell on the clockwork fashion in which Happidrome radar readers saw (and sometimes, heard) feedback. I dwell on the PPI and the mise-en-scénes it presents with each sweep of the time base. In doing this, I adapt Kittler's (1999) discussion of film in *Grammophone, Film, Typewriter* and prepare the consideration of radar identification and coordination.

After detailing similarities between Marey's "chronophotographic gun" (an early movie camera) and Colonel Gatling's infamous gun, Kittler (1999) writes that:

> The history of the movie camera thus coincides with the history of automatic weapons. The transport of pictures only repeats the transport of bullets. In order to focus on and fix objects moving through space, such as people: there are two procedures: to shoot and to film. In the principle of cinema resides mechanized death as it was invented in the nineteenth century; the death no longer of one's immediate opponent but of serial nonhumans. Colt's revolver aimed at hordes of [Native Americans], Gatling's or Maxim's machine-gun…at aboriginal peoples. (p. 124)

Kittler’s description of “the principle of cinema” as focusing and fixing moving objects, shooting and filming, and mechanizing death, sketches the movie camera’s logistics. *It also sketches the logistics of another member of the cinema family—the speed camera (radar)*. To bring Kittler into the Happidrome is to bring him into the procedures of radar shooting and filming, of radar measurement. Radar frame rates can be longer than a minute per frame, a fact that makes them resemble the extended wipe transitions of 1950s sci-fi serials as one image replaces another along a distinct, second-hand-like edge. Radar attaches shot lengths and widths to antennas and receivers (instead of to lenses and film stocks). Unless a display was photographed, radar shots in the 1940s were not stored. When they were, it was usually at the moment a bomb was dropped so that Generals and researchers could measure the accuracy of both radars and bombs (Jones, 1988).[127] Radar lighting was (and is) susceptible to shadows and mirages. In the 1940s, radar sound tracks were simple mechanical signals (“pings,” just as in sonar) that represented the whispered echoes anticipated in their blueprint’s loud soliloquy. Through the speed camera, Kittler’s principles of cinema have a distinct look and sound.

Happidromes’ projection of time measurement over Britain’s landscapes, cities, and citizens stripped the varnish from any understanding of *combat around the clock*. The Happidrome’s antenna (the AMES Type 7) rotated clockwise or counterclockwise, and at any constant speed between .5 and 8 rpm. As it rotated, it bounced radio waves

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[127] Radar was adapted to radio astronomy as early as January 1946. In subsequent decades, astronomers placed radar photos in strips so they could cinematically watch, rewind, and fast forward through the movements of celestial bodies (Woodruff, 1984).

off of airplanes, ships, flak, clouds, buildings, buzz bombs, and citizens racing to the London underground or to other bunkers.[128] In 1940-1941, Edward R. Murrow's reports from the "rooftops of London" crackled with the emergent—air raid sirens blared suddenly and searchlights popped like firecrackers. When Happidromes were deployed in a big way in 1945, readers' reports had the sobriety of calculation (White, 2007). They had a detached tone befitting readers' position "above" London's rooftops.

Inside Happidromes, clockwork measurements were Tayloristic. When the Ames Type 7 rotated, clockwise, at 1 rpm, chief controllers harmonized the second hands of their watches with PPI time bases (White, 2007). As centers of Happidrome clocks, chief controllers pivoted to survey each display and reader. Controllers' centralized offices and the Happidrome's in-facing displays eased this surveillance, but if readers blocked controllers' views, controllers could walk 15 feet to the monitor room and look at the PPIs there. Chief controllers helped feedback (and other information) flow through Happidromes, and ensured that readers were as vigilant station keepers as was any Royal Navy vessel or lighthouse. Meanwhile, readers were so harmonized with time bases they reported eye ticks, blurred vision, and PPI hypnosis (Brown, 1999).[129]

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[128] The September 12, 1942 edition of the *Manchester Guardian* reported that, "Journalists were invited yesterday to inspect one of the new London Tube shelters….There are eight of these shelters, each with bunks for 8,000 people. They have been built under Tube stations, four on the north side of the Thames and four on the south" ("Under the Blitz," Sept. 12, 1942, p. A1).

[129] Radar readers' intense screen watching was a health concern from the beginning. A report from 1944 declared that: "Rumors to the effect that continued radar [A-Scope] operation is injurious to the eyes are without foundation, the OSRD and AAF radar training agencies concluded after experiments. Visual capacities of 244 radar operators were not significantly different from those of 122 non-operators" (Radar Abstracts, Sept. 12, 1944, p. 4).

In Happidromes, listening to pings was also an around-the-clock experience. Technically, pings were a simple matter: when DC current triggered cathode rays to project a blip, it also triggered a ping. A perfectly timed emergence of detectable objects and polytonal pings could, with the sweep of the turntable time base, produce a few measures of Wagner's "Walkürenritt" or Wessel's "Die Fahne Hoch" (which could also produce a PPI version of Frank Stella's severely geometric painting of the same name). In high traffic areas, pings were monotonous as every sweep of the time base brought an onslaught of them. For this reason, today's displays are either mute, only ping a few times when an object is first detected, or are otherwise subject to readers' preferences.[130] Back in the day, though, if a blueprint wanted more cowbell, it got it (Latham & Stobbs, 1996).

Rad Lab associate director Guerlac (1946) saw the connection between GCI radar and clockwork measurement when he reminisced that:

> One of the great advances in the radar art was the development of the Plan Position Indicator (PPI). When the rotating antenna was introduced and the radiation was confined to a comparatively narrow rotating beam, it became practicable to make the base along which one measures distance a radial one, with zero at the center of the tube face; and to rotate this base, like the large second hand on a wrist-watch, in exact time with the rotation of the antenna, so that it is always pointing in the same direction as the [radar] beam. The returning pulse illuminates a section of the circle, and gives the operator both the distance and the direction of targets. (Guerlac, Mar. 18, 1946, p. 5)

Like smart clocks, Happidrome PPIs ordered and arranged readers' perceptions according to minute-by-minute measurements of objects of sufficient size and density. They re-presented electromagnetic frequencies at a speed, intensity, and size the

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[130] One exception to this is radar sets that detect the presence of orbiting satellites (Latham & Stobbs, 1996).

human brain comprehended. When used for interception, height finding, fighter control, and fire control in a Happidrome, PPIs were unequaled in their ordering of objects in time and space. They were powerful protectors of the Benjaminian *present*.

Interception

In Happidromes, nowhere was the clock-like flow of feedback steadier than in interception cabins. The “interception” in “interception cabins” referred to the interception of individual echoes (feedback) from the transmitted signal, and thus to the most basic form of radar identification. Interception readers read—they measured and mapped—the AMES Type 7’s firmament. They compared PPIs with aerial photographs and passed on updates to plotters in reporting rooms. They matched geometric images with geographic and manufactured objects (Putley, 1988). Watson-Watt described what these geometric images looked like on a PPI:

> Seas, lakes, and waterways remain black…coastlines, with their cliffs, bays, and inlets, show up clearly as outline map features because they scatter radiation back to its source;…the inland landscape is a nondescript intermediate tone; and…“the works of men”—camps, hangars, and above all towns and cities—stand out brightly. (Watson-Watt, Sept. 15, 1945, p. 323)

Interception readers differentiated between city-on-a-hill “works of men” and lucent and invisible natural phenomena. They familiarized themselves with ordinary images and with flight schedules and patrol paths. Such familiarity contributed to a quick, efficient flow of feedback through cabins, Happidromes, command centers, squadrons, and convoys. According to a triumphant article in the Rad Lab’s *Radar Abstracts*, German military officials credited Allied radar developments, such as interception, for the Allies' victory. Under the headline, "Germans Admit Superiority of Allied Radar was a Decisive Factor in Assuring Victory," *Radar Abstracts* declares that:

> High German military leaders admitted officially and repeatedly that the Allies had won the radar war and that this was the determining factor in their eventual victory….The main trouble with Germany, one of her scientists declared, was that the militarists couldn't realize that this war was a technological one. But when it became apparent that the Allied scientific effort had been so successful, several thousand scientists and engineers were recalled from the army to work in laboratories. (*Radar Abstracts*, May 29, 1945, p. 1)

I agree with *Radar Abstracts'* main thrust (see Zimmerman, 2001), but the claim that "this war was a technological one," is only partly accurate. The Allies won, *at least in measure*, because of superior logistics, because of the coordination of feedback, soldiers, and citizens that GCI (and airborne) radar enabled. The Germans put resources into logistical technologies like the V-1 and V-2 and aircraft speed and fire power (Batt, 1991). Nevertheless, the flow of feedback through GCI stations and networks was comparatively faster and more extensive than was the flow of feedback—including radar information—through the Luftwaffe. It was also of a different order in that it converted the seemingly chaotic, mass-like Blitz into a traffic problem. Technology enabled Blitz-beating logistics, but logistics transformed Allied scientists and engineers into remote soldiers.[131]

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[131] Russian radar is beyond the current discussion, but it was significant, and particularly in its use of train car-based radars and searchlights. Brown (1999) writes that: "Russia's notoriously muddy roads made movement by rail essential for heavy equipment—a Freya required 28 horses for movement by typical road—and radar trains were the obvious answer, first placed in service in October, 1942. They were portable fighter control units that consisted of a Freya for early warning and two [interception radars], one to track the enemy and the other to track the interceptor so the controller could bring the two together. Some trains made good use of searchlights….As the air situation deteriorated for the Luftwaffe, the radar trains became more numerous and more important. In 1943 a radar train in the Orel-Bryansk sector took credit for bringing down about 30 planes" (p. 268).

While contributing to the efficient flow of feedback, interception readers' familiarity with PPI images and their movements also contributed to eisegesis, boredom, and routine error. Like astrologists reading boggling detail into the everyday, interception readers summoned unwarranted specificity from the depths of displays. Army Major J. D. Parker, out to inspect GCIs in the Pacific theater, became concerned about such over-interpretation. He forwarded his confidential Army Intelligence report to the Rad Lab. In it, Major Parker observed that:

> The Marines place unbounded faith in the original radar station at Henderson Field [on the island of Guadalcanal]. They told me about one classic report they got from that station. The operator not only reported the approach of enemy aircraft, but insisted his screen showed the plane was a twin-engined, single-tailed ship. This report evidently was somewhat colored by the operator's familiarity with the Japanese aircraft likely to come in. Actually, radar stations can't determine that accurately. (Parker, 1943, p. 3)

Eisegisis on the part of interception readers was a logistical problem. Whether readers were certain sea rocks were snorkels belonging to a particular class of Japanese submarine (Naval Air Combat Intelligence Report No.3, July 25, 1944), or were convinced volcanic dust was enemy convoys (*Radar Abstracts*, May 22, 1945), interception readers routinely over-interpreted and misidentified objects. This kind of mis-measurement might be acceptable if interception readers were shock jocks, political correspondents, conspiracy theorists, AIG executives, day traders, televangelists, or others who traffic in fancies. For interception readers, eisegisis beckoned disaster. Interception readers decoded representations on their PPIs, but efficient, exegetic calculation was a geometric, logistical necessity.

In 1945, the Operational Research Section (ORS) of the U.S. Army was concerned about reader errors, including over-interpretations. Instead of relying on chief controller's reports, it "went straight to the 'horse's mouth' by quizzing 159 radar navigators." The ORS was not encouraged by the quiz results. The quizzes "uncovered a multitude of the garden variety of [interpretive errors] that would not ordinarily appear in a more formal mission report." In summary, the ORS maintained that, "a great many of these [interpretive errors] were personnel errors, while a few were assessed against the gear itself" (*Radar Abstracts*, Aug. 7, 1945, p. 1). The ORS report indicted readers more than sets, engineers, humidity, or blueprints.

In 1945, the Royal Australian Air Force (RAAF) was also concerned about interception readers' interpretive errors. Over the preceding two years, RAAF had replaced some of its spotters (Cary Grant's binocular-toting character in the 1964 film, *Father Goose,* was a spotter) with interception readers. It deviated from the ORS's approach, though, in its willingness to account for readers' stupefying, watching-the-clock work. *Radar Abstracts* summarized the RAAF report by observing that:

> Working on the theory that the efficiency of operators as well as the status of the equipment has something to do with successful radar operation, the Royal Australian Air Force sent some investigators out to the lonely Southwest Pacific islands where radar men watch their scopes day and night….They found that visual conditions in both the radar and operations rooms were substandard in a great many cases. They also discovered the morale of the operators had been impaired, as manifested by boredom. (*Radar Abstracts*, May 1, 1945, p. 5)

Reading a Happidrome PPI was a single step in an information assembly line. It was a step where most information went no further than readers' brains. By design, most information didn't even register there: the speed camera's shot distance rarely varied. Its shot duration was chronometric. Its mise-en scénes had the bland consistency of sit-com living rooms. Within the confines of interception cabins, radar's predictability, efficiency, and measurement bored interception readers to error. At 20,000 feet, it fostered countermeasures. Consistent with its place in dialectical modernity, radar produced its own disruptions—its own emergencies. I say more on this in the concluding chapter.

Height Finding

In 1941, Watson-Watt and his colleagues appealed to the threat of the Luftwaffe to justify radar's sweep through Britain's cities and hamlets. Prime Minister Churchill's acquiescence to these researchers' efforts created the first national air-traffic control system (Watson-Watt, 1957). In this respect, GCI was a palpable moment in the narrative of chronological progress: its identification of air and watercraft increased the scheduling of movements and the licensing of aircraft. Eventually, individually licensed aircraft were fitted with radar IFFs that encoded a message of "this object is British," or "this object is Japanese," or the like, to the designated nation state's radar readers. In recent decades, air and (some) watercraft have been equipped with individualized IFFs that tell radar readers a craft's make and model, corporate, military, or personal owner, registration number, and flight plan (Mindell, 2002; Putley, 1988). In the 1940s, the combination of GCI's carousel looking glass, PPI, and network launched air traffic control on its flight of scheduling, security, and surveillance.[132]

GCI height finding was specifically logistical in that it extended Britain *up* into the atmosphere and *up* into Virilio's politics of verticality. GCI allowed radar readers to measure objects' heights at a glance, and therefore allowed them to quickly order objects in three-dimensional space. GCI differentiated between a V-1 buzz bomb at 3,000 feet and a B-17 at 20,000 feet occupying the same point on the x (longitudinal) and y (latitudinal) axes, even though they appeared as the same blip on a PPI. Height finding provided the Happidrome with detailed identification along the z (altitudinal) axis at a glance, and in so doing intensified radar's vertical utility. As a geometry of empire, radar's development from the carousel and rope-guided Lupis torpedo to GCI was a remote expansion of power through the x and y axes, but was less obviously an expansion through the z axis. GCI's positioning of objects on all three axes reinforced radar as an imperial grid maker and point of view.

Victor Hugo's claim that when a man is lynched, "the rope doesn't hang, the earth pulls," helps make sense of GCI in terms of height finding concepts such as *up, down, height, above, and beneath*. GCI depended on political points of view, like Great Britain, and on technical points of view, like proximity to antennas, but ultimately it depended on a *geographic* (earth mapping) point of view so that humans made sense of their information. Without a universal reference point (such as the earth), and humans

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[132] Brown (1999) confirms that Britain's radar efforts were the fountainhead of these developments. He writes that, "GCI was inherently British" and notes that American bought their first GCIs from the British, and based their MEW (Microwave Early Warning) systems on them (p. 195, 223).

as radar readers, radar becomes more metric (measurement) than graphic (mapping). If the earth no longer pulls, radar's transparent horizon situates information in endless freefall (Virilio, 2005). If the earth no longer pulls, we cannot situate ourselves to Mecca, nation state, or another centralizing, perimeter-defining point. Because the interface between display and human reader is the space where the earth pulls, it is the space to challenge radar's power.

GCI's expansion through height finding pulls back the curtain on one of its mythical advantages over natural human sight: the ability to precisely measure (or calculate) what in earlier times was called the firmament and sheol. Through height finding, GCI pushes the nation state *up* and *down.* It detects individual aircraft, watercraft, meteorites, UFOs—anything within range and of sufficient size and density. Ground penetrating radar (GPR), an emerging, specialized extension of GCI that would replace dowsing, blasts as far as 80 meters through the earth's surface to detect pipes, cables, mineral deposits, moonshine stills, archaeological sites, and treasures slipping away beneath the earth (Wright, 2009). [133] GPR-carrying dirigible torpedoes can detect land mines, and will soon bring to light underground tunnels between nation states (such as between Egypt and Israel and between Mexico and the United States), and who

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[133] Brian Wright, an expert at MALA Geoscience, one of the world's largest GPR designers, recently addressed the difficulties in using GPR to identify oil and natural gas fields. He said that, "Geological investigations are a prime application for GPR and the search for oil falls into this category. In theory, GPR signals directly 'probe' beneath the earth's surface and detect sub-surface features through reflections caused by changes in the dielectric permittivity of the ground. So in theory, GPR may be able to detect oil reservoirs as anomalies or reflections in GPR data. However, even with low frequency antennas at say 25MHz, GPR is only able to see approximately 80 meters into the ground…unless working over ice where the penetration could be several hundred meters. GPR could probably detect an oil reserve within its operating range; however, it would not be able to identify a sub-surface feather as oil rather than, say, water, ice, or some other density variation…." (Wright, 2009, p. 17).

knows what other hellish threats to the territorial sovereignty of the nation state ("Lockheed Martin Developing Ground Penetrating Radar for Tunnel Finding," July 8, 2009).

Fighter Control

During the summer of 1940, the best minds at Watson-Watt's Radio Research Station in Teddington knew the Germans did not intend to stop their westward march at France. They also knew CH did not create fighter control that would defeat the Luftwaffe. The British wanted to get the Germans out of France, and believed GCI would help them do it. As chairperson of Britain's Aeronautical Research Committee, Henry Tizard had smoothed the road for Watson-Watt's early projects. While the Battle for Britain loomed, Tizard proposed that Britain offer the U.S. a trade of GCI research for large-scale production. Neither Churchill nor Watson-Watt had confidence in the offer; isolationist American legislators had been railing against entanglement in another European war. Still, when American officials encouraged Tizard's entreaty, a meeting with President Roosevelt's newly formed National Defense Research Committee (NDRC) was arranged for September 12th (Baxter, 1946).

The British won the Battle for Britain, but the Blitz erupted on September 7, 1940. On September 11, British radar researchers' confirmed their concerns about CH as they arrived in Washington D.C. Fortunately for GCI and its PPI-powered fighter control, the NDRC meetings went well. What had been guarded interest in each nation state's radar research became full, mutual disclosure (Thomas, undated; Baxter, 1946; Watson-

Watt, 1957). Over the next three months, British researchers demonstrated their cavity magnetron and shared blueprints and test results. American researchers took their counterparts on tours of the Naval Research Laboratory, Army Signal Corps labs at Fort Monmouth, Bell Labs (where Claude Shannon would soon work on an NDRC contract), physicist Alfred Loomis' private lab, and the fledgling operation in Building 20 of MIT's Electrical Engineering Department. The British and MIT researchers admired one another's work, and arranged to set up shop and collaborate. The Blitz's early light nourished the Rad Lab (Conant, 2002).

Fighter control was a priority at the Rad Lab from the first (Guerlac, 1946). Whereas interception was concerned with individual identification, fighter control measured aircraft speeds, angles, and azimuths, and helped the RAF ambush invaders. Fighter control readers interpreted PPIs, plotted blips, passed information to chief controllers (who were often in the fighter control cabin anyway), telephoned updates to the reporting room, teleprinted reports to generals and admirals (the teleprinter was a combined typewriter-telegraph), and communicated with pilots on the radio. In all of this, fighter control readers *defended* Britain.

Still, much of the time fighter control was just as tedious as was interception. Eisegisis, boredom, and error were as likely to flourish in the one as in the other. However, when blips thought to represent German fighters and bombers appeared, fighter control became strenuous and brisk. Speaking in the fall of 1940, Churchill outlined the logistical importance of fighter control. He said:

> The use of aeroplanes, not only to attack our ships, but also to direct the U-boats onto them, is largely responsible for our losses in the Northwestern approaches.

> No effort to destroy the Focke-Wulfs should be spared. If we could employ radar methods to direct long-range fighters or ship borne aircraft to the attack we ought to be able to inflict serious casualties. (As quoted in Hodges, 1988, p. 189)

What Churchill did not say was what British fighter pilots already knew: the German's well-worn Messerschmitt BF109s and new Fock-Wulfe *Würgers* (British and American pilots called them "butcher birds") were faster, had better climb rates, and had more powerful guns than the British Spitfires and Hurricanes (Yenne, 2003; Zimmerman, 2001). If German intruders had straight shots at their targets, British defenders would never intercept them. Bowen (1988) writes that the "whole problem" with British losses in the fall of 1940 was that, "the [British fighters] were underpowered and were just not fast enough to catch the German raiders. Even in the rare event of a [British fighter] coming within firing range of an enemy aircraft, its firepower was ludicrously small" (p. 184).

GCI fighter control gave the British a decisive logistical advantage. Their fighters, while fewer in number, had tighter turning circles than did the German planes. With GCI's ability to see the German planes first, the British anticipated highways of attack. They set, as it were, speed bumps and roadblocks. They maximized the number of their fighters in the air and put them in positions to harry the Walkürenritt. They exchanged inexpensive British ordinance for expensive German aircraft. At the end of the day, GCI fighter control was a further mediation of warfare. In 1914, Otto Weddigen had relished mediated remoteness when he fired torpedoes on the *HMS Aboukir.* Almost 30 years later, GCI fighter control helped British planes destroy German air and watercraft before the latter could effectively bring their weapons to bear.

In the spring of 1945, fighter control spurred the *offensive and mobile* application of GCI. The Allies still used fighter control *defensively*—the Luftwaffe had replaced its raids of previous years with a desperate rain of V-1s and V-2s—but the British and American advance onto the Continent had stretched the stationary radars on Britain's coast (Putley, 1988). Anticipating this problem, Rad Lab and Radio Research Station researchers had created mobile versions of even the most powerful GCIs (the mobile version of the AMES Type 7 was the AMES Type 70).[134] These mobile GCIs organized bomber escorts, directed supply and ammunition drops, and helped maintain air superiority.[135] The Allies' progress demanded that motile GCI sets (think of their fixed, rotating antennas) become mobile too.

In addition to mobile GCI, the desire for *offensive* fighter control hastened the application of television technology. In the spring of 1945, increased troop movements, air traffic, and radio chatter had radar researchers considering new forms of "collision prevention and traffic control" (Television-Radar, June 5, 1945, p. 1). When Rad Lab researchers met with RCA representatives, attention turned to RCA's ionoscope (Television-Radar, June 5, 1945). The ionoscope's metal plate stored detailed images just long enough for transmission. The plan was to send PPI images to aircraft—to make

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[134] Since 1941, British and American aircraft had been fitted with an ever-growing tangle of radar gear—bombsites, surface sweepers, even fighter control—but airplane-powered radar systems were fickle and had comparatively limited ranges (Hodges, 1988).

[135] Putley (1988) writes that, "Soon after the Allied armies were established in Europe in 1944 an urgent requirement arose for a comprehensive radar unit incorporating early warning, GCI, and aircraft control. The AMES Type 70 Radar Convoy was devised. The first was sent to France in December 1944 and a second followed in May 1945" (p. 170).

Happidromes narrowcasters of fighter control TV. A report of the meeting between the Rad Lab and RCA anticipated that fighter control TV would be:

> An ingenious combination of radar and television, wherein each pilot [would] by means of television see an exact duplicate picture in his plane in space as shown on the ground radar scope—plus any special marks showing hazards, etc. of particular interest to the locality of the ground radar scope. Also, the device…[would] enable the pilot to see, on his 7-inch television screen, the position of all airborne aircraft in his vicinity and altitude regardless of visibility conditions or blind spots created by his own plane. (Television-Radar, June 5, 1945, p. 1)

Fighter control TV began narrowcasting from Happidromes and American radar stations in 1947 (Brown, 1999; Hodges, 1988). In that year, it transformed radar stations into offices of electromagnetic post, into fax centers. It immediately smoothed the emergence of the post-War, commercial airline system and the circulation of commercial and industrial goods. World War II battlefields, Virilio (1986) notes, were the logistical predecessors of the post-war marketplaces and manufacturing yards. More militarily, fighter control TV orchestrated proximity to, and occasional collisions with, the U.S.S.R. In this sense, fighter control readers were logistical counterparts to broadcast television’s red-scared program directors. They were at the interface of GCI’s authoritarian identification and coordination.

Fire Control

During World War II, Messerschmitts, Fock-Wulfes, and V-1 and V-2 buzz bombs stole to their targets in Britain. During the day, fighter planes and bombers flew low—sometimes under the radar—and struck precisely. At night, they flew with daring and struck large targets. CH provided fire control. It told anti-air and searchlight batteries where and when the Luftwaffe would receive messages. CH fire control feedback was often inaccurate, though. Even its designers damned it with faint praise. They considered it "a remarkable achievement when set against the desperation of the times" (Neale, 1988, p. 149). In the early nights of the Blitz, CH fire control had British defenders responding sluggishly to night raids. It had anti-air batteries firing late, sometimes late enough to give the RAF a "friendly" blast of information (Macintyre, 1961).[136]

In measure, CH's fire control problems were a result of its architecture and placement. The Air Ministry regulated CH placement from the first. Its 1936 regulation called for, "A site well back from the coast, with a smooth slope between it and the sea," because such a site, "gave good height-finding and good range finding." This regulation also specified:

> The chosen sites had also to be accessible to heavy engineering works; to have soil suitable for carrying 109.7 meter steel masts. They had to be convenient for electrical supplies, secure against sea bombardment, inconspicuous from the air and it was furthermore essential that they should not "gravely interfere with grouse shooting." (Neale, 1988, p. 150)

Other than the wanderings of the nomadic grouse hunter, the Luftwaffe soon realized CH site specifications. In the early days of the Blitz, there were 21 CH stations on Britain's east coast, and not more than 30 sites that were engineering accessible, inconspicuous from the air, safe from the sea, and firm of foundation. Even in ideal

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[136] Neale (1988) suggests that CH's dawdling was a result of manual plotting and an inelegant reporting procedure. He writes that, "In the early years of the war, aircraft were manually plotted by reading off range from the calibrated range scale of the display and the bearing ….The grid references were then passed by the track-teller, via high quality landlines, to the filter room." Still, he allows that, "As the war progressed, many improvements were made to the [CH] equipment and to the reporting procedure to reduce the time taken to pass information to the various control centers at times when there were many raids in progress" (p. 146-147).

locations, CH had four steel transmitters over 100 meters in height, and four wooden receiving towers over 70 meters in height (Wood & Dempster, 1961). CH architecture, like the naval searchlight of 50 years earlier, was too ostentatious for its own good. It was an obvious, fixed target for the Luftwaffe to attack or avoid.

GCI's architecture and placement contributed to its fire control. The smallest GCI antennas were only a few meters tall, wide, and deep. The largest GCI sets, the AMES Type 7s that powered the Happidromes, had a single antenna less than four meters tall, 21 meters wide, and two meters deep. Even mounted on a rotator, the mean height of the Happidrome's antenna was less than nine meters, less than 1/10 of the height of a CH transmission tower (Barrett, 2003). GCI antennas weighed less than CH antennas, and engineers built them further from roads and on more varied ground (Brown, 1999). The oblique Happidrome control room was particularly difficult to observe and target, but other GCI systems also benefitted from modest construction and flexible placement.

GCI fire control readers interpreted PPIs and told searchlights and anti-air batteries where and when to flood and fire. They accounted for sometimes-mobile searchlights and batteries, so that when the flak started to fly, targets were surprised but friendly planes and radar readers were not. In this sense, GCI fire control upgraded searchlights from torpedo boat duty (although they still had that), and subordinated them to the radar vision machine. Fire control readers combined height finding and range feedback, and transmitted it to anti-air batteries, searchlights, other radar readers, and "high command." Like hunting rifles wired to John Underwood's liveshot.com, a website that connects Internet hunters to loaded rifles, batteries often fired at fire control readers' remote commands, and sometimes against local officers' better judgment (*Radar Abstracts*, Oct. 17, 1944).[137]

Radar researchers wanted GCI fire control to evolve into *blind firing*. Blind firing would give high command, chief controllers, and fire control readers control of anti-air batteries' ranging, servomechanisms, tracking mechanisms, and triggers. The U.S. Navy was especially interested in blind firing. It saw blind firing as a way to combine fire control and automatic tracking, lessen the inaccuracies of pitch and roll, and minimize the impact of Japanese attacks. Writing of this situation, Mindell (2002) observes that:

> Well into the war the [U.S. Navy] had no automatic tracking…and no system for blind firing, where radar could direct the guns to fire automatically at night or through overcast. The new [radar stations] served to organize information and direct fighters from a central location, but they did not address the gunners facing attackers they could not see. Several projects tried to adapt existing control systems for blind firing. (p. 264)

Rad lab researchers tested a blind firing system in the spring of 1944. Their system, the Mark 56, could "search broadly for targets and automatically track at the same time, even at low angles" (Mindell, 2002, p. 268). Deploying the system was a logistical nightmare, though, and the "Mark 56 never made it into World War II" (p. 273). The U.S. military did not deploy blind firing systems until 1947. This was a long timeline for wartime development, but the Mark 56 was in place nine years before it starred in the Suez Canal crisis of 1956. In the public controversy that followed the Mark

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[137] Fire control readers mistook ground and sea echoes for incoming buzz bombs with enough frequency that *Radar Abstracts* mused , "This may be the swan song of buzz bomb tracking" (Radar Abstracts, Oct. 17, 1944,p. 6). Mindell (2002) notes this problem and declares fire control radar a "stepchild slow to win affection" (p. 264).

56’s mis-measurement of migrating swans, blind firing preceded fire control. Blind firing emerged as a progressive-catastrophic technology.

Measure

During World War II, interception, height finding, fighter control, and fire control gave GCI radar the efficiency of factory work. They measured information feeders provided them, or, more accurately, collected feedback from objects of sufficient size and density. They then wove feedback into the narrative of technological and military progress—into sacred sorties, gallant attacks, dutiful commutes, and timely reports. GCI measured the Blitz, and transformed it from an unpredictable, mass attack into a calculable traffic problem. GCI electromagnetically re-paved Britain’s heavenly and watery highways in Haussmannian fashion, effectively preventing the Nazi social movement from storming Britain consistently and forcefully. In the case of the Happidrome, chief controllers scrutinized readers’ information assembly, and could synchronize the entire effort with pocket watches.

GCI was a comprehensive form of ground control. It remotely intercepted discrete objects, and in so doing, performed the logistical functions of identification and coordination. Identification, for its part, was (and *is*, even with today’s radar) an incomplete measurement that fails to probe beneath surfaces and automated IFFs. GCI identification could not probe the depths of a Nathanael, a UFO over Roswell, New Mexico, or a United Flight 93. GCI coordination enabled the measurement and maintenance of distance between “others.” It enabled outnumbered Hurricanes and

Spitfires to limit the use of on-board radar (which would have given away their positions to the Luftwaffe), maximize their time in the air, and force the Messerschmitts and Focke-Wulfs to alter their trajectories.

However, in the latter days of World War II, radar researchers contemplated how they could actively—and not just incidentally—turn radar identification and coordination on Britain's citizens (a form of endocolonization). Consider the following report from the April 3, 1945 issue of *Radar Abstracts*:

> A function of radar that will prove valuable not only during wartime but in the years to come advanced another step recently when the British staged some promising tests with an X-band fire control set for recording in an airport control tower the positions of all aircraft and vehicles on the airport surface….Here are some of the objects seen in the tests: a moving car, a man walking along the side of the taxiing track while a stationary car was parked along the opposite side, a man on a bicycle, and a Beau-fighter taxiing. Also seen on the scope was a totem pole, whose presence was not explained. [The] British conclusion was that the set, as it stands, is not suitable for detection of movement on all of the airfield, but that results suggested that equipment could be produced utilizing the same broad principles. (*Radar Abstracts*, April 3, 1945, p. 5)

The idea of an airport control tower—a radar tower—looking down on everyday situations like bike riding, dropping off passengers at the terminal, and airport employees pulling luggage carts, is reminiscent of 16th century castles that looked down on the baileys that sustained them, Mumford's authoritarian technics, and perhaps Bentham's panopticon. Certainly, anyone who has experienced an American airport after 9/11 can catch prefigures of TSA-type measurements in the *Radar Abstracts*' description of the 1945 tests. In the next chapter, I discuss how the identifying and coordinating measures introduced by GCI, and enhanced in subsequent logistical media, have corresponding countermeasures.

CHAPTER 7: COUNTERMEASURES

Radar stations use the feedback that flows through them to identify and coordinate objects. With factory-like precision, they measure their size, shape, speed, and proximity. They plot them a measure at a time. Frequencies fire blips and pings on turntable PPIs. The music of airline schedules, *Walkürenritt,* naval convoys, and day sailors rings through radar stations and the headphones of hypnotized radar readers. Rotating radars project their clock-like measurements of time through space; highways in the sky and channels through the sea take shape for the freight-car-like flow of objects. Minute hands of Mumford's invisible city sweep over and calculate the surfaces of nation states.

Radar measurement contributed (and contributes) to the escalation of logistics and technology, much as the torpedo contributed to the searchlight, torpedo boat, new strategies for station keeping, and nighttime attacks. It contributed to *miscalculations* of radar objects, including natural phenomena like clouds, sand, migrating birds, and sea rocks, and to *countermeasures*—to objects' active manipulations of radar as a feedback system. Objects masked themselves and imitated natural phenomena, and sometimes used radar's calculated efficiency against itself to instigate the movements of armies and armadas. In this, my concluding chapter, I sketch miscalculations and countermeasures from the Rad Lab archive, consider their implications for the *now* of catastrophic countermeasures on 9/11, and draw general conclusions about logistical media.

Miscalculations and countermeasures emerge at the interface between display and reader. They leverage readers' eisegesis, habits of interpretation and procedure, and remoteness from objects and events in their manipulation of feedback. Natural phenomena contribute to miscalculations through their ephemerality, variety, affect on radar performance, or semblance to the anticipated movements of an "other" or enemy. Countermeasures actively encourage reader errors and seek to exploit radar logistics and the information networks that depend on them. In these ways, both miscalculations and countermeasures contribute to radar's progressive-catastrophic potential.

Pigeons and Bats

Before I consider natural phenomena as feedback countermeasures, I need to articulate two principles that are central to countermeasures: *the disruption of conditioned calculation and collision as logistical politics.* I am indebted to Mumford (1970; 1964), Virilio (1986), and Robins & Webster's (1999) discussion of the Luddites for these principles, although my application of them to radar is unique. To aid my articulation, I draw on two articles from *Radar Abstracts*: one that compares radar with homing pigeons and one that compares radar with bats.

A story entitled, "Pigeon Retrieving Cage, Acting as a 'Radar,' Attracts Birds to a Site They'd Never Seen Before," in the January 9, 1945 *Radar Abstracts* observes that, "Pigeons, unlike our fighter planes, have no radar to home on. But you'd think they had the way they fly to the place they're supposed to go—even if they've never been there before" (Jan. 9, 1945, p. 1). It then proceeds to describe an experiment to determine the reliability of pigeons for military communiqués:

> For six weeks before the trial, the [pigeons] were trained to seek a retrieving cage of only one type and were prevented from becoming oriented to one locality. The trial consisted of sitting a cage in Northern Ireland and then bringing the pigeons near it in a plane. They had never been within 20 miles of this site before. When released from the plane, nine out of 11 [pigeons] homed to the cage within 20 to 30 minutes. (Jan. 9, 1945, p. 1)

Like angels in Tesla's ethereal post office (see p. 145), the pigeons were conditioned objects that, while capable of flying to innumerable locations, flew right to the cage. In terms of SMCRF, they were reliable, point-to-point channels.[138] For purposes of the experiment, researchers timed and counted the pigeons. They measured them. Today, if you wanted to repeat this experiment, you could attach a descendent of radar IFF—radiofrequency ID (RFID) chips—to pigeons. UPS wants to attach RFIDs and GPS devices to its trucks so that supervisors can check their location, speed, and trajectory (Hamblen, 2008).[139]

The *Radar Abstracts* article implicitly compares fighter planes and pigeons. Without radar, the pigeons are at a disadvantage, but the parallels are hard to miss: much like the pigeons going to the familiar cage, the fighter planes, "fly to the place where they're supposed to go" because they recognize and follow beacons. The fighter

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[138] Pigeons were so reliable that in the 19th century the Rothschilds built their banking empire with them (Blechman, 2007).

[139] Andrejevic (2007) notes that RFID is being adapted to track individual commodities and the consumers who use them: "RFID tags are being miniaturized to the point that they can be incorporated into clothing without being noticeable to consumers. RFID tags, touted as the wireless version of universal product codes, are more versatile and more specific than bar codes. Their versatility lies in their ability to be scanned by radiofrequency, which means that they don't have to be visibly exposed to be read. A tag in a wallet or on a shirt label could be read by a nearby scanner" (p. 122-123).

planes (and assumedly their pilots, although they are not mentioned), are channels in a system wherein the bullets are the message (or, rather, are part of it) and the radar station shares the controls with the plane operator. Radar conditions fighter planes to recognize and follow the familiar, to patrol from beacon to beacon. Fighter planes break this routine only in the heat of battle, in the act of collision. This is some of what Kittler is getting at when he claims that computers will soon replace airplane crews (Kittler, 1997).

Disrupting radar's conditioned calculations, its measurement of objects and their trajectories and its monitoring of fights and flight paths, is one way to argue a subversive politics of logistics. Virilio (2000, 1997; 1997 with Lotringer; 1986) posits deceleration, stoppage, interpersonal deliberation, and geophysical locality as natural challenges to authoritarian modernity. I take this up in earnest in my discussions of miscalculations and countermeasures.

In the same issue of *Radar Abstracts* that features the pigeon experiment, a different article discusses how bats avoid collisions. This article could confuse the casual reader, because despite the fact that bats are sometimes described as seeing by radar, their "sight" is actually akin to sonar (bats do not use high frequency electromagnetic waves to "see;" they use high frequency sound waves to "hear"). The article discusses research conducted through the Harvard Biological Laboratories:

> What makes a bat tick? A scientist with the Harvard Biological Laboratories decided to find out….he had proven to his satisfaction that bats steer themselves away from obstacles by making use of supersonic sound. Everybody knows that bats are blind, or nearly so, and the problem was to learn what keeps [bats] from colliding with walls, ceilings, or objects in a room. A row of small wires, each a foot apart, was strung across a room from floor to ceiling. It was found that if

> either the ears or mouths of bats were plugged, they'd collide with the wires twice as often as normally. (Jan. 9, 1945, p. 1)

The Harvard scientist concluded that "Bats on a wall, preparing to fly, produced fewer than 10 cries per second, but when in flight and especially when approaching an obstacle, they emitted cries at a very high rate," as high as 50 cries per second. He used this information to advance a conclusion that has since been accepted as scientific fact: "Some characteristic of the reflected [sound] waves is believed to indicate to the bat the precise location of objects, and it then alters its course to avoid them" (p. 2).

While bats use a kind of biological sonar, their similarity to radar on a logistical level is striking. Like radar systems, bats are forecasters that depend on feedback to coordinate their movements and avoid collisions. Bats collide with objects when their early-warning systems fail, are "plugged," or when an approaching object moves too quickly. Any number of animals collide with objects for the same reasons, but bats' perceived blindness while avoiding collisions makes them noteworthy in a publication dedicated to radar. Bats avoid obstacles in a way that, to humans, looks similar to radar: bats see with a kind of invisible sight, with waves that are above un-augmented human perception.

Bats help me consider radar countermeasures. Miscalculations and countermeasures can foster, and are fostered by, the plugging of radar's feedback loop, deceptions that distort radar feedback, and movements that are too fast and unpredictable for radar (and radar readers) to calculate. In their bat-like capacity, countermeasures can subvert radar's logistical functions of identification and coordination. They can hamper its ability to control collisions, and in that sense they can challenge Benjamin's *present* with his *now*.

Miscalculation

I have mentioned how ocean waves, clouds, humidity, migrating birds and the like disrupted World War II era radar sets. Ocean waves' undulations changed the swaths of atmosphere that radar measured and triggered false blips. Ocean waves contributed to so many miscalculations that stabilizers had to be adapted from deck guns. Clouds' refraction of electromagnetic waves created phantoms, obscured targets, and even "covered" PPIs.[140] Humidity corroded antennas, warped their effective ranges, and reduced the lifespan of radar equipment. Migrating birds were mistaken for airplanes and buzz bombs. These were miscalculations in their own right (and still are today, although to a lesser degree).

Presently, I am concerned with different miscalculations. These different miscalculations were never corrected or controlled through feedback. They remained as mysterious—as incompletely calculated—as the Loch Ness Monster, Abominable Snow Man, and Saddam Hussein's Weapons of Mass Destruction. They appeared on PPIs and A-Scopes, and readers attributed them to troublesome Mother Nature, but they either disappeared or persisted in defiance of the radar sets that displayed them. Therein they disrupted radar readers' calculations and refused identification. These miscalculations

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[140] The August 18, 1945 issue of *Radar Abstracts* indicates that clouds were a severe problem for radar sets in Panama. It notes that the radar set on Panama's isthmus was especially beset by clouds: "Frequently a large portion of the PPI scope surface was occupied by rain-area echoes for long periods of time, especially when the equatorial front was over or near the isthmus" (p. 4).

haunted radar readers in a way that identified objects could not. I now sketch two of these miscalculations: a patch of sand in the Libyan Desert and an “emanating” reef in the Pacific.

From February of 1941 through May of 1943, the Germans attempted to salvage the Italian’s stalled campaign in North Africa. Field Marshall Erwin Rommel led the effort, and he was determined to outmaneuver—to logistically best—the Allied forces. He used Messerschmitts and Focke-Wulfs to forecast the movements of the British (and later, American) forces and make his own less predictable. Early on, much of the fighting was in Libya, and that meant Rommel needed detailed, constantly updated maps of the rugged desert terrain (Gilbert, 2004). He needed electromagnetic highways for the advance and retreat of his tanks and troops.

According to the November 7, 1944 issue of *Radar Abstracts*, the desert didn’t always cooperate. Apparently, a patch of sand in the Libyan desert confounded German air-to-surface radar. The fighters’ CW (continuous wave) radar sets, which indicated altitude by constantly bathing the earth in their transmissions, were inaccurate by some 20 meters over a certain patch of “non-conductive” sand. *Radar Abstracts* suggests that the Germans believe these radars were reflecting off rock beneath the sand. Moreover, when the Germans tried to leverage *Gleichschaltung* (“enforced conformity”) and pressure radar researchers from Holland’s Philips Corporation to correct the miscalculations, they discovered that the Dutch company had engaged in some logistics of its own: it had moved most of its researchers to Britain and the Dutch Antilles.[141]

Radar Abstracts gloats that:

> More than 18 months ago the Germans tried to interest Phillips in an investigation into anomalous readings obtained on [radar equipment] in the Libyan Desert. Due to the non-conductivity of dry sand, it was not unknown for [radar equipment] to respond to a reflection from rock 20 meters below the surface of the sand. (Nov. 7, 1944, p. 3)

Despite the nonchalant explanation of "non-conductive" dry sand, the Rad Lab researchers who read *Radar Abstracts,* knew something was odd. They were aware of this particular anomaly—this Bedouin Bermuda Triangle—because some Philips researchers were collaborating with Watson-Watt's Radio Research Station (Watson-Watt, 1957), but why was this sand nonconductive? Apparently, Rommel thought the logistical nuisance was a matter of poor radar performance and hoped the specialists at Philips could help. He couldn't have known that the miscalculations of altitude that distorted his maps, would, to this day, afflict radar readers and sets.

What vexed Rommel is what science journalist Giles Wright calls "The Riddle of the Sands" (Wright, July 10, 1999, p. 48). In 1932, moderns discovered the 26 million-year-old mystery of Libyan Desert Glass (LDG), when a surveyor for the Egyptian Geological Survey discovered green glass scattered over large stretches of the desert bordering Egypt and Libya (Wright, 1999). Ancients of the Pleistocene Era used LDG to make weapons, and some of King Tutankhamen's jewelry was made of the stuff (de Michele, 1997). According to Wright (1999), LDG is the purest silica glass ever found on

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[141] In 1995, Frits Philips, a member of the Philips family and Chairman of the Board from 1961-1971, received the Yad Vashem award from the Israeli Ambassador ward for saving the lives of 382 of his Jewish employees during the German occupation. Although many of these employees were everyday technicians and equipment operators, Frits insisted that they couldn't be taken away because the Eindhoven plant needed their "expertise" (Mitchman & Jan Flim, 2004).

earth and there is more than a thousand tons of it strewn across the stretches of desert that interfered with Rommel's radar.

From a scientist's point of view, the riddle of the sands is not its age (26 million years) or its composition (98% silica). The riddle is where the LDG came from and how it got there. Scientists have advanced two major theories for its origin—a meteorite crashed there, a meteorite broke up in the atmosphere—but neither is a perfect fit for the evidence (de Michele, 1997). Conspiracy theorists love LDG, as it resembles the green glass created by the nuclear test in Alamogordo, New Mexico, and embroiders tales of extraterrestrials, ancient nuclear technologies, and "pyramid power." *Logistically, though, the riddle of the sands is a masterpiece: nature disrupted Nazi radar and troop movements 26 million years in advance*. Consistent with Virilio (1997), the accident of LDG as a radar countermeasure preceded moderns' recognition of it as a significant substance. I like to think of LDG's refusal to radar's corrections and controls as the curse of King Tut's jewelry.

My second miscalculation that radar feedback never corrected or controlled lacks LDG's uniqueness. It is a miscalculation that occurs more frequently, though, and can't be relegated to a known space like the Libyan Desert. It is a difficult to anticipate countermeasure in that it is the kind of sudden, ephemeral incongruity that makes radar readers wonder and radar researchers scratch their heads. My second example, of a reef some nine meters below the surface supposedly "emanating" and creating a blip on naval radar, is remarkable in its ordinariness.

During the first half of 1944, the Allies began advancing, an island chain at a time, toward the Philippines and the Japanese home islands. Even though fire control radars were slow to deploy (see p. 231), American, British, Australian, and New Zealander navies had powerful radar systems. They deployed gunboats with early-warning radars to protect the carriers and troop transports, and that helped them win battles in the Solomon Islands, Gilbert Islands, Marshall Islands, and in New Guinea (Gilbert, 2004; *Radar Abstracts*, Sept. 26, 1944, p. 5). When the Allied navies won the nearly month long Battle of Saipan (the Mariana Islands),[142] General Douglas MacArthur, Commander of the Southwest Pacific Area Command, arrayed his ships, planes, and troops to return to the Philippines—to return to his own point of departure. I detail the logistical significance of the Battle of Saipan in a moment.

MacArthur's array for advance had fighters and patrol boats sweeping unfamiliar spaces. I can't be sure that the ship that produced the report in the October 3, 1944 issue of *Radar Abstracts* was somewhere between Saipan and the Philippines, but with the anticipated invasion of the Philippines (the invasion began on October 20, 1944), the Allied forces in the Pacific were gathered and hyper-alert for surprise attack (Weinberg, 2005; Gilbert, 2004). It was under these conditions that an escort carrier "in the Pacific" passed on a report to the Rad Lab of a ghostly blip.[143] In the report, the escort carrier's watch officer attempted to explain the phantom blip as an "emanation"

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[142] I detail the logistical significance of the Battle of Saipan on p. 236-237.

[143] *Radar Abstracts* is not a classified document and the exact ship and location have been omitted from its article.

from an underwater reef. The leader of the Rad Lab's wave propagation group rejected the watch officer's explanation:

> The watch officer who wrote the original report of the phenomenon…had raised the questions as to whether the reef possessed some special characteristic causing emanations to flow above the water's surface. Believing the [watch officer's] theory incorrect, the Rad Lab group leader submitted the following explanation: "This report on the U.S.S. _________ of the supposed underwater detection of ________ Reef is interesting, but hardly plausible. The proposed explanation involving "emanations" from the reef is difficult to support, since radar echoes arise only from configurations of reflecting surfaces above the water line. Since sea water is for all practical purposes a very good conductor, and consequently an efficient reflector, the presence of "emanations" flowing over the surface could not noticeably increase the effective radar cross section of the sea." (*Radar Abstracts*, Oct. 3, 1944, p. 8)

However difficult it is to account for unidentified objects, no serious scientist puts stock in "emanations" gibberish. The watch officer seems to think that radar can detect the reef because it is denser than the water, that radar transmissions can somehow penetrate the water, bounce off the reef, and enter the escort carrier's radar set as feedback. The leader of the Rad Lab's wave propagation group knows that theory won't hold water. If it could, there would be no need for sonar. If it could, identifying submarines would be a much simpler process. After rejecting the emanations theory, the leader of the Rad Lab's wave propagation group offered another theory:

> An explanation of how [a naval] radar on an escort carrier might have detected a point on the sea above a reef which was five fathoms below the surface was offered by the Leader of [the Rad Lab's Wave Propagation Group]….The [Rad Lab group member's] theory is that the sea probably was extremely rough and because of disturbance of normal sea currents by the reef in that immediate vicinity, [the naval radar] was able to detect this difference in roughness. (*Radar Abstracts*, Oct. 3, 1944, p. 8)

The leader of the Rad Lab's wave propagation group dismissed the watch officer's theory out of hand. From the Rad Lab leader's point of view, watch officers and radar readers were to take his “probably” as “certainty,” and were to ignore that a researcher had the leisure of conjecture. The Rad Lab group leader was not reading blips that might have been attacking! He was not laying the front lines of a geometry of empire! Moreover, what actually caused the miscalculation remained unknown to everyone. The miscalculation—whether it was a reef, rough water, the periscope of a Japanese submarine, a life raft, or a leviathan—was never corrected or controlled through feedback. It remained a mystery—incompletely calculated.

Countermeasures

Unlike miscalculations, *countermeasures* are active manipulations of feedback, and in this discussion, are objects’ active manipulations of radar as a feedback system. Countermeasures attempt to influence radar’s logistics—the identifications and coordinations constructed between displays and readers—and through these, the geometry of empire that radar helps construct. Nation states systemize countermeasures, and make them part of their quests for logistical superiority. Nevertheless, terror groups like Al-Qaeda use countermeasures to challenge nation states, and aspiring reality-TV stars launch flying saucers that force commercial flights to reroute (Simpson, Ingold, & Vaughan, Oct. 16, 2009).

Before considering 9/11 as a countermeasure, I flesh-out Rad Lab descriptions of the most important countermeasures. Countermeasures are as diverse as they are innovative. During World War II, countermeasures included *window, jamming, anti-*

radar paint and shaping, and movements designed to stop feedback or to provide deceptive feedback. I now describe each of these in turn.

Rad Lab researchers use the term *window* loosely, but *window* is nothing more than 'reflective objects that airplanes disperse into the atmosphere.'[144] More specifically, *window* is strips of specially treated aluminum foil that technicians cut to about half the length of feedback waves and pilots disperse hundreds at a time. Window can make radar readers, '"see' so many 'bombers'" that they "will have difficulty deciding which is a real bomber and which is the [window]-created decoy" (Caldwell, undated). Window relies on a paucity of natural human sight—a single lookout can discern strips of foil from approaching bombers—so pilots often disperse it at night and during inclement weather.[145]

As radar countermeasure, window manipulates feedback by jamming it with the reflections of aluminum strips. Window can misdirect radar readers and encourages them to overestimate the number of approaching aircraft. A sharp course change often accompanies an aircraft's dispersal of window, and the combination reduces the effectiveness of PPIs and can confuse fire control and height finding radar readers (*Technical Intelligence Extract*, May 21, 1945). Moreover, as a secret report on countermeasures suggests, window can make an invading force seem larger than it is. When pilots cut loose a load of window, "the radar will not track the formation [of

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[144] Window is also referred to as *chaff, rope,* or *phantom*.

[145] As the Allies closed in on Japan, the Japanese made extensive use of old technology—searchlights—to reduce the effectiveness of Allied window. Radar Abstracts reported that, "Searchlights seem to be shouldering a large share of the night defensive load over [the island of] Formosa. One Allied reconnaissance plane reported being caught in 14 searchlights for three minutes and neither the use of [window] nor evasive action seemed to do any good" (April 3, 1945, p. 7).

airplanes], but a point behind it…If a squadron drops enough [window], it will present to the radar a target equivalent to a long formation trailing behind" (Training Intelligence Report, Feb. 28, 1945).

Another method of radar jamming that Rad Lab researchers fine-tuned in MIT's Building 20 was *Electronic Countermeasures (ECM)*. ECM was (and is) the radiation of electromagnetic frequencies designed to disrupt radar and radio systems. ECM broadcasts at or near the target radar's frequency, and floods the target's master receiver and display by providing too much of it (Caldwell, undated). Because ECM is relatively light and portable and doesn't require mechanics to activate, ECM is primed for elaborate trickery. An intelligence report provided to the Rad Lab in October, 1944, suspected the Japanese had placed ECM in balloons and turned it on to confuse an American bombing raid over the Japanese city of Yawata:

> Although the flyers didn't actually see them, the photos they brought home from the 20th Bomber Command raid on Yawata, Japan, showed that large, spherical balloons were flying at high altitudes over and near the [Japanese] mainland. These balloons appeared to be carrying radar jamming devices…. (*Radar Abstracts*, Oct. 24, 1944, p. 3)

When the Allies invaded Normandy, they mixed ECM jamming with false alarms, deceptive ship movements, pitching and rolling ships, and stormy weather (Weinberg, 2005). Their mix of countermeasures and weather was too much for Germany's calculation-dependant radar readers. It exposed their measured logistics:

> Bombing and jamming of radar stations, previous false alarms, deceptive movements of ships, and the inflexible, regimented Nazi radar reporting doctrine—all of these add up to the muddling, clumsy defense put up by the Germans when the Allies invaded northern France in June….There was a series of operations rooms…and each of them controlled a group of coast-watching stations. These operations rooms seem to have been allergic to any remarks

> from stations other than actual data on range, bearing and time. (*Radar Abstracts*, Dec. 19, 1944, p. 4)

The German operations rooms commanded, controlled, and calculated their way to defeat. The Allies manipulated the German's efficient, quantitatively measured feedback with countermeasures; they exploited the fact that German commanders didn't want to deliberate with their radar readers. The German's radar measurements were so catastrophically calculated that most of their radar stations were "dependent on their operations rooms" for identification and "it was not until actual paratroop landings were taking place that [German commanders] appreciated the imminence of a landing in force" (p.4). Countermeasures, including ECM jamming, disrupted the German's conditioned calculations and helped the Allies choose their angles of attack and points of collision.

In addition to jamming countermeasures like window and ECM, Rad Lab researchers developed anti-radar paint, a paint that absorbed electromagnetic waves but hardly reflected them. The idea was to coat only select objects in the paint—military commanders weren't about to jeopardize their remote control by having many of their vehicles and facilities invisible to the radar vision machine—and to assess the possibilities of other nation states to do the same. By the autumn of 1944, the Rad Lab had developed anti-radar paint, and about six weeks after the Japanese surrender, the Rad Lab had tested it on a model submarine. According to the final report of that project, the anti-radar paint was tested:

> By coating the starboard side of a 1/3-scale model submarine with anti-radar paint…The predicted results were verified except for surfaces of small (compared to wavelength) curvature, where our results are not completely understood. It

> was definitely shown that the paint reduced the signal by about 10 db [decibels—a measurement of the strength of the signal] when the model craft was observed off broadside. (*Termination Report on Camouflage*, Sept. 20, 1945, p. 1)

A 10-db reduction in feedback strength created a logistical cascade: radar sets had a diminished ability to detect the painted objects, radar blueprints and specifications were less accurate than before, and radar readers measured their displays with increasing nearsightedness. Window and ECM concealed objects' movements and numbers, but anti-radar paint reduced its effective range. Anti-radar paint was a deeper and more subtle countermeasure than the jammers were, although nation states were not going to spread it on most of their vehicles, buildings, and other objects (that would reduce their remote control).

Rad Lab researchers' development of radar-camouflaging shape alongside anti-radar paint was, if not the origin of a logistics of stealth, an important moment in its engineering. While developing anti-radar paint, Rad Lab researchers concurrently worked to "determine the possibility of camouflaging a submarine (or other craft) against radar detection by reshaping the hull and/ or superstructure" (Termination Report on Camouflage, Sept. 20, 1945, p. 1). Their work was successful in that reflected signals from the cone-shaped objects tested were "25-35 db weaker than the signals from other objects of comparable size" (p.1). The Rad Lab's recommendation was to reshape periscopes, snorkels, and command towers. The cone is an important shape in radar's geometry of empire, a stealthy shaving of corners in the spirit of Virilio's (with Parent, 1996) oblique politics of angles, movements, and points.

The last radar countermeasure in this discussion—movement—is a kind of segue into my sketch of 9/11 countermeasures. As Deleuze & Guattari (1986) point out in their discussions of the wanderings of nomads, as Virilio (2005; 1986) asserts in his politics of mobility, motility, and speed, and as lighthouses, torpedoes, searchlights, war horns, death rays, carousels, asylum inmates throwing themselves into the Loire, and the other objects in my debris field suggest, *movement makes collision possible*. *Additionally, movement can deny radar's logistical functions of identification and coordination when it is unpredictable and cloaked in the natural.*

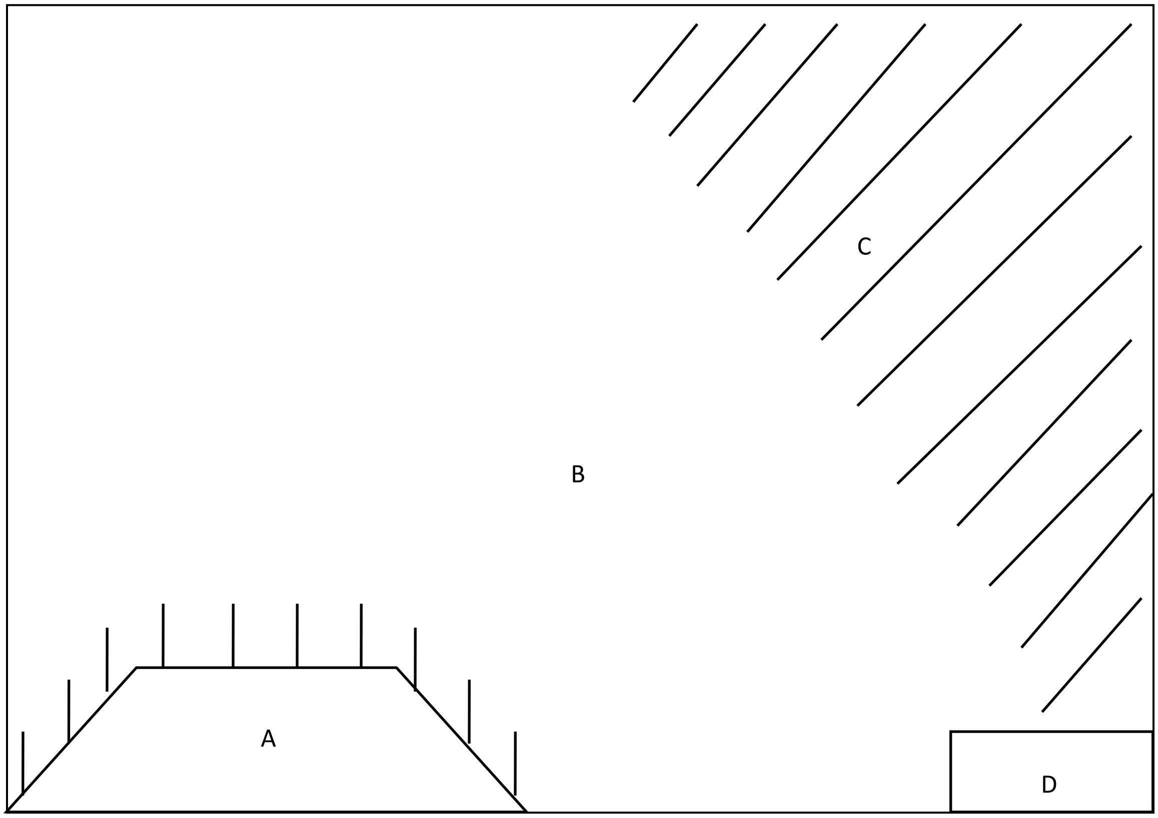
In 1945, the Japanese Navy maneuvered for every island—for every piece of the Pacific—that it could keep from the Allies. The War in the Pacific had been slowly turning against it since the logistically-titled Battle of Midway in the summer of 1942 (Gilbert, 2004). This was due, in part, to the Allies' superior early warning radars, and the Japanese Navy's inability to account for those radars in a defensive manner (Parillo, 1993). Japanese battle groups had resorted to slashing — but unsustainable — attacks, and by the summer of 1944, the Allies' logistical superiority was undeniable. On June 15, 1944, U.S. Army and Marine personnel captured the island of Saipan. With startling speed, the U.S. forces created airports that put their B-29 bombers within range of Tokyo (Weinberg, 2005).

For Japan, the U.S. seizure of Saipan and the construction of airports was a logistical disaster. Admiral Toyeda Soemu, Commander-in-Chief of the Japanese Navy, met with his ship and squadron commanders and came up with a way to exploit the Allies' radar with the hundreds of dangerous, but short distance fighter planes at their disposal. Ultimately, his efforts weren't enough to reclaim Saipan. They were, though, enough to get the attention of Allied military commanders (Weinberg, 2005). The June 5, 1945 edition of *Radar Abstracts* described how the Japanese tactics exploited the Allies radar:

> Just how much the [Japanese] know of the weaknesses of our shipborne radar systems is proven repeatedly by their air tactics….When attacking a task force off an island, for instance, the [Japanese] will fly low over the island as long as possible to take advantage of ground clutter. Since sea clutter hasn't been bothering our radars as much as that from land, the [Japanese] plane must take his chances after leaving the island. But this doesn't last for long. [The Japanese plane then climbs] quickly to the relatively blind radar area over the target area….Having soared up to this blind region, he dives down to the deck for his attack. (*Radar Abstracts*, June 5, 1945, p. 1, 3)

Figure 7.1, below, is my attempt to depict the Japanese anti-radar movements under consideration. "A" is an island, and the lines above it represent the "natural cloak" that it provides against radar, the interference with radar feedback. "B" represents the space where Japanese airplanes were most visible to radar, a space where they would climb as quickly and sharply as they could. "C" is the zone where radar doesn't see well, although it can shift with a ship's pitch and roll. When a Japanese plane arrived at "C," it would swoop down to deliver its message-explosion to the target "D" (which, in the case of a kamikaze—of a "divine wind,"—was the airplane itself). The Japanese planes' rollercoaster-like movements increased the likelihood of the collision they desired and wrested remote control from Allied radar. Although Virilio (1986) would see their movements as "advances," reliance on radar as a vision machine made them countermeasures. They were active manipulations of radar feedback.

Figure 7.1: Rollercoaster Movement



9/11

I now leap from the Rad Lab's detritus to Benjamin's *present*. I have thus far collected a variety of historical rejects—esoterica about torpedoes, carousels, death rays, 19th century urban planning in Paris, old radar equipment, Happidromes, Libyan Desert Glass, and so on. My intent in the concluding pages of this work is to apply what I've learned from these objects to a logistical understanding of the 9/11 attacks. I've learned about speed (acceleration), movement, angles, identification, coordination, collision, verticality, and remote control as aspects of radar's contribution to a geometry of empire, to authoritarian modernity. I've asserted that these can contribute to both "progress" and catastrophe.

In arguing that my efforts are consequential, I've relied on Benjamin's (1968) assertion that the *present* can be disrupted by the *now*, that historical objects that weren't absorbed into progress narratives can jostle us from sequential, ideological consciousness. Benjamin identified and coordinated such objects dialectically, that is to say, he arranged them in constellational monads that he believed would burst on the universe of consciousness with a big bang. Benjamin's language of monads, collection, and dispersal, while not necessarily an endorsement of the scientific theory of the Big Bang, is at least a poetic parallel: he describes a disruptive force that can crash ideology as all-encompassing information, as omnipresent feedback loop.

Benjamin's historical method is also a feedback loop. The wind that billows the wings of Benjamin's Angel of History, the perpetual adjustment of those wings, and the debris that remains within sight that comprises the processes of dispersion and collection, are a feedback system. At the same time, Benjamin's historical approach is to forego a sequential, "progressive" history in favor of the arrangement of fragments that disrupt our ideas of the present (Benjamin, 1968). For the sake of coherence, I have recited a few historical events—the Blitz, the founding of the Rad Lab, the founding of RCA, the development of GCI, the Battle of Saipan—fairly conventionally, although even in those instances I emphasized aspects that I hoped would estrange. I have tried to stay true to Benjamin's approach, although his many unfinished works—like the Arcades

Project (Benjamin, 1999)—seem to maintain their power, at least in part, through their very incompleteness.

9/11 is frequently discussed in ways that assume sequential American progress: 9/11 was an attack of primitives on moderns; Americans can defeat the terrorists with consumerism; terrorists hate Americans because the latter stand for freedom (these notions are critiqued in Andrejevic, 2007); Americans won't win the war on terror until they raise "the hopes and prospects of embittered children across the globe" (Benac, 2009, p. A1). Even YouTube videos that match shots of people jumping from the World Trade Center with The Weather Girls "It's Raining Men" or Tom Petty's "Free Fallin'" are discussed as either anti-American or quintessentially American. The Rad Lab fragments I've discussed inject the *now* of radar into 9/11—the now of catastrophic radar countermeasures. I now discuss 9/11 radar in terms of a failure of radar readers and their systems to identify and coordinate—to remotely control air traffic.[146] This failure was due to the miscalculations of eisegesis and out-looking, and the countermeasures of speed, invisibility, and the transformation of a plane into a robot missile.

For years, the FAA's civilian radar readers had concerned themselves exclusively with "maintaining a safe distance between airborne aircraft" (*The 9/11 Commission Report*, 2004, p. 14). They were traffic cops who worked to keep aircraft in their lanes, going acceptable speeds, and parking in the vertical "garages" that developed above busy airports in cities such as Chicago, Atlanta, Los Angeles, and Dallas. There hadn't

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[146] I do not blame the radar readers in the FAA's control centers in Boston, New York, Cleveland, and Indianapolis for 9/11. The encrusted logistics within which they worked had been hardening since the days of the Rad Lab.

been a hijacking in the United States since 1991 (n 91, p. 457), many of the FAA's radar readers had never been through one, and didn't expect to do so. Radar readers had been trained in hijacking protocol, but it wasn't an everyday concern (*The 9/11 Commission Report*, 2004).

The duties of identification—which were aided by modern equivalents of the Rad Lab's IFFs (Identify Friend or Foe radar transponders)—and coordination—avoiding mid air crashes on the ever-busy sky highways—contributed to a radar reader at the Boston Air Traffic Control center making an eisegetic error on the morning of 9/11. When American Airlines Flight 11 failed to "heed his instruction to climb to 35,000 feet," the reader was concerned it would pass too closely to another aircraft (p. 18). When Flight 11 ignored his hails and turned off its transponder, both the radar reader and his supervisor suspected an electronics problem and went about moving planes out of Flight's 11's path (*The 9/11 Commission Report*, 2004). Both were reading a traffic identity into the flight when it had become a missile.

Readers' reactions to feedback were too slow. When radar readers played back a distorted communication from Flight 11 and realized it had been hijacked, supervisors in Boston, New York, and Cleveland got on a conference call. They hoped to find the now-unidentified Flight 11 (it had turned off its transponder) on their overlapping radar screens. They assigned readers to identify Flight 11, and the Boston supervisor tried to contact the military. His first attempt to notify NORAD failed because the NORAD site in New Jersey no longer existed. It had been phased out. He then tried to contact NORAD through the FAA office in Cape Cod, but that office didn't have updated contact information. By the time the Boston supervisor reached the Northeast Air Defense Sector (NEADS) of NORAD—at the former Griffiss Air Force Base in Rome, New York—23 minutes had passed. Flight 11 collided with the World Trade Center's North Tower nine minutes later (*The 9/11 Commission Report*, 2004). *The 9/11 Commission Report* summarized these failures to identify and coordinate a remote response:

> The defense of U.S. airspace on 9/11 was not conducted in accord with pre-existing training and protocols. It was improvised by civilians who had never handled a hijacked aircraft that attempted to disappear, and by a military unprepared for the transformation of commercial aircraft into weapons of mass destruction. As it turns out, the NEADS air defenders had nine minutes' notice on the first hijacked plane, no advance notice on the second, no advance notice on the third, and no advance notice on the fourth" (*The 9/11 Commission Report*, 2004, p. 31)

As it turns out—literally—NORAD wouldn't have intercepted Flight 11 even with much more time, and couldn't have fired on the flight without authorization.[147] From its inception, NORAD, like the World War II radars that preceded it, faced outward. During the Cold War, NORAD had mostly looked at America's borders and the Soviet Union. In the subsequent years, its alert sites—its airbases with quick-scramble fighters—were used to help maintain "air sovereignty against emerging 'asymmetric threats' to the United States: drug smuggling, non-state and state-sponsored terrorists, and the proliferation of weapons of mass destruction and ballistic missile technology" (*The 9/11 Commission Report*, 2004, p. 17). Consequently, while NORAD planned to stop threats to the United States as a nation state, it "considered the danger of hijacked aircraft being guided to American targets, but only aircraft that were coming from overseas" (p. 352).

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[147] According to The 9/11 Commission Report, "Prior to 9/11 it was understood that an order to shoot down a commercial aircraft would have to be issued by the National Command Authority (a phrase used to describe the President and Secretary of Defense)" (p. 17).

NEADS scrambled two F-15s, but without radar identification there was minimal radar coordination. The NEADS ground commander had scrambled the fighters in hope that they could see what was going on, because the FAA hadn't given him any information. "I don't know where I'm scrambling these guys to," he objected. "I need a direction, a destination" (p. 20). The NEADS radar readers and fighters spent the next several minutes looking for the hijacked plane, but when they could not locate a target they followed military protocol. They avoided civilian air traffic and "were vectored toward military–controlled airspace off the Long Island coast" (p. 20). Outmaneuvered by their inability to calculate radar feedback, military procedures were unwittingly enabling the hijackings. The pigeons were unable to find the cage; Al-Qaeda was using the geometry of empire against itself.

The 9/11 hijackings were successful, in part, because of radar's inability to identify which planes had been hijacked. When three of the four planes turned off their transponders, their feedback manipulated the radar systems to an even greater degree. *The 9/11 Commission* found that:

> On 9/11, the terrorists turned off the transponders on three of the four hijacked aircraft. With its transponder off, it is possible, though more difficult, to track an aircraft by primary radar returns. But unlike transponder data, primary radar returns do not show the aircraft's identity and altitude. (p. 16)

These planes effectively became invisible to the invisible city and its authoritarian technics. They destabilized the U.S. borders, and deployed them against the effort to measure and control the situation (the F-15s had to go to a military area off the coast) (Mumford, 1961). Moreover, as the World Trade Center planes descended into the city, the radars lost them in the vertical, concrete jungle. The New York radar reader, who unfortunately, was routinely overseeing United Flight 175 when he was tasked to look for the hijacked Flight 11, was still looking for Flight 11 on his PPI minutes after it collided with the World Trade Center. There was no time to identify the hijacked flights, let alone to coordinate an effort to intercept them or get permission to shoot them down. The 9/11 attacks were not an instance of primitives taking on moderns. They were a knowledgeable manipulation of a complex feedback system.

The hijackers transformed the 9/11 flights into guided missiles, into what Rad Lab researchers called robot missiles. During World War II, robot missiles were worn out bombers loaded up with explosives and steered with radar remote controls (see p. 153-156). During 9/11, hijackers slipped beneath detection systems, piloted passenger-bearing missiles, and turned modern tools into weapons against modernity itself. According to the *9/11 Commission*, the well-reasoned procedures and protocols that projected the United States into the atmosphere contributed to the attack's effectiveness:

> In sum, the protocols in place on 9/11for the FAA and NORAD to respond to a hijacking presumed that: the hijacked aircraft would be readily identifiable and would not attempt to disappear; there would be time to address the problem through the appropriate FAA and NORAD chains of command; and the hijacking would take the traditional form: that is, it would not be a suicide hijacking designed to convert the aircraft into a guided missile" (p. 18)

The hijackers disrupted the remote pilots in the FAA and NORAD radar stations. In three out of four robot missiles, they turned off the identifying transponders. In every robot missile, they ignored the radar beacons meant to keep them proceeding from point to point, and instead followed their mythological beacons as they proceeded from point to point. They killed the pilot-passengers in the cockpits and encouraged the passengers to remain in their seats, to continue as docile cargo. They delivered their message-explosions. And their messages included the radar *now.*

Amidst 9/11's emergence, the NEADS ground commander objected to the disorienting lack of logistical information. "I need a direction, a destination," he complained to the FAA (*The 9/11 Commission Report*, 2004, p. 20). From the ground commander's point of view, there was $60 million worth of F-15s with nowhere to go. A squadron of F-15s, or 10 such squadrons, would not have made a difference. Without effective radar and RFID, pilot training, heat-seeking missiles, and the best intentions were, in a geometry-of-empire sense, *pointless*. When the *now* disrupts the *present*, procedures as routine as flight plans and orders, procedures bound to mythic notions of progress, fail to provide direction and destination.

In this instance, the ground commander's disorientation stands in for the disorientation of anyone who, during 9/11, was estranged from American progress narratives: Would-be travelers milled about airport terminals, immobile, parcel-like passengers saw box cutters in a new light, and New York City commuters discovered nomadology as they didn't care who they were or where they went as long as it was away from the World Trade Center. In Benjamin's (1968) terms, this disorientation shocked pedestrians from their trained obligation "to keep abreast of traffic signals" (p. 175).[148] In Virilio's (2004) terms, it was both implosive and explosive, both an

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[148] Benjamin notes that, "Baudelaire speaks of a man who plunges into the crowd as into a reservoir of electric energy. Circumscribing the experience of the shock, he calls this man 'a kaleidoscope equipped with consciousness.' Whereas Poe's passers-by cast glances in all directions which still appeared to be aimless, today's pedestrians are obliged to do so in order to keep abreast of traffic signals. Thus technology has subjected the human sensorium to a complex kind of training" (1968, p. 175).

immobilizing whiplash that kept passengers in their seats and terminals and a detonation that scattered New Yorkers from the World Trade Center site like shrapnel.

Logistics were speedily reasserted and national order reestablished. Before Virilio-esque rubble could even settle, let alone mature into Benjaminian ruin, President Bush had mythologized the event by declaring that no American "will ever forget this day" (*White House Transcript,* Sept. 11, 2001, p. 1). In Benjamin's historical framework, this was a declaration that Americans need not trouble themselves with the emergence of a dialectical image, with the disruption of a sense of chronological progress. By September 13, 2001, logistics were in place to control the movements—and stasis—of bodies, vehicles, and commodities. National airspace was reopened. Airports, border stations, and port security checkpoints were supplemented with additional occupying technologies and personnel (see p. 21). The FBI was working with the Immigration and Naturalization Service to detain immigration violators that matched a risk profile (*The 9/11 Commission Report*, 2004). Travelers adopted a patriotic docility that encouraged compliance with security personnel and airport traffic jams, but that also encouraged mutual monitoring (Andrejevic, 2007).

Until now, though, logistical media, and particularly radar, have not been investigated for their role in 9/11 or for their more general contribution to what I call modernity's progressive-catastrophic dialectic. *The 9/11 Commission Report* has a little to say about radar readers losing track of hijacked flights, lacking knowledge, and misinterpreting aircrafts' disappearances. For example, the radar reader in Indianapolis assigned to Flight 77 "Had no knowledge of the situation in New York," "Did not know that other aircraft had been hijacked," "Believed American 77 had experienced serious electrical or mechanical failure, or both, and was gone," and "Continued searching for the aircraft...to the west and southwest along the flight's projected path," (*The 9/11 Commission Report,* 2004, p. 24-25). Like the U.S. Army's 1945 report of reader errors (see p. 218-220), *The 9/11 Commission Report* has practically nothing to say about radar equipment, stations, or feedback, radar's interface with readers, or radar's logistical implications.

Logistical Media

These are precisely the concepts that frame my analysis of radar and the Rad Lab objects, and so I conclude by moving from a discussion of their role in 9/11 to a more general treatment. My intention is to gather my shrapnel-like answers to my research questions ("How does radar inform an understanding of logistical communication?" "How is radar a feedback system and a form of remote control?" "How do radar and radar readers create and maintain remote control?" and "How might radar be manipulated by its objects?") into one place. By doing this, I aim to say something about radar's contribution to an understanding of logistical media and about the prospects for the concept of logistical media in media studies.

In the introduction to *Gramophone, Film, Typewriter,* Kittler implies many of the fundamental ideas in logistical communication. According to Kittler:

> The Pentagon is capable of truly far-sighted planning. Only the substitution of optical fibers for conducting cables can accommodate the enormous rates and volume of bits that are presupposed, produced, and celebrated by electronic

> warfare. Then all early warning systems, radars, missile bases, and army headquarters on the opposite coast, in Europe, will finally be connected to computers, safe from an electromagnetic pulse and able to function when needed. And for the intervening period there is even the by-product of pleasure: people can switch to any medium for their entertainment. After all, optical fibers can transmit any imaginable message but the one that counts—the one about the bomb. (1999, p. 1)

Gallows humor aside, Kittler is describing an ultimate point of view (the Pentagon), several secondary points (early warning systems, radars, missile bases, and army headquarters), lines between points (optical fiber cables), high-speed information ("The enormous rates and volume of bits"), a moment before the arrival of the cumulative meaning of that information (the "intervening period"), and the cumulative meaning itself ("The bomb"). He has drawn a world with powerful points of view, high-speed information, and controlled information networks. These are first and foremost concerned with order and arrangement, and only secondarily with entertainment (and representation). They are, in a word, logistical.

My study of radar has elaborated the usefulness of the *point of view* to logistical media. I began with an often-overlooked piece of media equipment—the antenna—and described how it contributes to the order and arrangement of objects. Because radar antennas are placed as high as possible, sometimes see without being seen, can see where and when human eyes cannot, and can rotate with clockwork precision, they contribute to what Virilio calls a second urban order (Allen & Park, 1996), or to the vertical dimension of a geometry of empire. A radar antenna's blueprint, size, shape, material composition, placement, and angle construct a radar reader's point of view long before a blip appears on a PPI or a spike hits an A-scope. Antennas guide information much like tracks guide trains.

While radar antennas primarily construct a point of view, their pre-history in such macro-phonic media as war horns suggests the logistical value of *point of listening* media. Radar is sometimes augmented by audible beeps, but its grid-making measurements demand the speed of electromagnetic waves and the singular identification of sight (and despite miscalculations). A point of listening medium, such as sonar, no doubt extends nation states some 20,000 leagues under the sea. My effort here suggests that a useful place to start such a study would be with sending and receiving horns such as the tube Leonardo da Vinci reportedly stuck in the water to hear passing vessels and the underwater bells that were sometimes used to assist lighthouses (Urick, 1983).

In the quote I cited above, Kittler spoke of “conducting cables” (what I categorized as *lines*) through which information passed from one point to another. Radar depends on the lines Kittler describes, but there are others as well: lines of sight, lines of planes following beacons, lines of aircraft preparing to take off and land, lines forecasting the trajectory of an object, lines of cars driving through a speed trap, and time bases pivoting through a PPI. Just as lines helped construct Baron Haussmann’s Paris, they are crucial to radar’s place in a geometry of empire. Mythic notions of progress are even linear, although in the sense of an “intervening period” of ideology saturated entertainment.

There is also the line of radar stations—CH and GCI—that, like an electromagnetic picket, protected Britain from the Blitz. According to my analysis of objects from the Rad Lab Historian's Office, radar is a logistical medium that works well in series. Radar enlarges the spaces nation states order and arrange, and in so doing provides the means to identify and coordinate objects and extend borders. Other logistical media may not be as obviously linear as is radar, but *any medium that orders and arranges objects will intersect linearity in some fashion*. *The very act of doing so presumes, at a minimum, a sequence of disorder and order.* Like carrier pigeons, logistical media are linear even if cables, wires, string, pickets and the like are foregone.

Feedback is what makes radar tick—or blip. It travels through antennas and networks, is measured by master receivers, and is purified by filters. Reliance on feedback makes radar a speed camera, a measurer of movement, but also renders it vulnerable to miscalculations and countermeasures. Radar feedback is always information about one surface or another—the surface of a ship, oil deposit, strip of window, incoming ICBM—and is usually filtered to remove information from natural phenomenon. When natural feedback does make it onto readers' displays, it can muddle object identifications and seem supernatural. Fog, rain, reefs, whales, migrating birds, Libyan Desert Glass, and the moon over Thule cast specters onto cathode ray screens. In this sense, nature-as-logistical-foil is a theme for further research, as is the cascade of countermeasures deployed to subvert radar logistics.

Feedback enables remote control. This is, perhaps, the most straightforward of radar's contributions to an understanding of logistical media: Radar helps restrict the independent movements of air and water-craft pilots, makes its readers pilots of a sort, and contributes to what Kittler calls “electronic warfare.” Moreover, as a form of remote control, radar is clearly a medium; it mediates movements and collisions and represents both at a distance. Admittedly, while there are plenty of logistical media that do not use feedback, feedback in some form aids the ordering and arranging of objects around a particular point of view. Lupis used ropes to steer his first torpedoes. Mohammed used scroll-bearing messengers to obtain reports of his followers’ piety. Tesla’s teleforce was to have the verifiable circulations of a post office. In sum, feedback’s relationship to control is a foundational concept of cybernetics (Wiener, 1954) and should prove to be fruitful for further study.

Radar maintains remote control through measurement, through readers’ calculations of feedback. Radar information is displayed, interpreted, and distributed with an eye for speed, accuracy, and simplicity, but not, as Lyotard (1979/1984) would note, for deliberation. In this sense, radar is entangled in the tensions between technological efficiency and democratic decision making that frequently carve out space in media studies. The Happidrome, with its clockwork routines, supervisor surveillance, and factory-like distributions of labor, is a particularly strong example of calculation. Further investigation of the Happidrome could venture into gender studies (many of Britain’s radar readers were women), or into the historical development of the “situation room” space.

Finally, radar’s measurements not only enable remote control, but also enable the manipulation of radar by its objects. The banal repetition of radar reading contributes to eisegesis—too unjustifiably reading into radar displays—and thus to errors of imagination and fatigue. This is especially significant because radar readers don’t only interpret their displays, they also “write” their interpretations in their directions to others. Moreover, countermeasures such as ECM, window, and maneuvers like those used by Japanese planes at the Battle of Saipan, exploit readers’ quick calculations, subvert radar logistics, and make radar, literally, an early warning system.

In the last analysis, the concept of logistical media detonates with fresh ideas for media studies. There is room for historical research of the type I’ve done here, for collaborations between those with technical expertise and those in the humanities, and for cross-pollinations of media studies and religious studies. At the same time, I’ve grounded the concept of logistical media in thinkers that media studies scholars find familiar—Mumford, Innis, Carey, and Kittler being chief among them. All that remains is a willingness to ignore the beacons, turn off the RFID, and collide with something interesting.

GLOSSARY

AMES:	Air Ministry Experimental Station. British designation for radar research facilities and systems. Radar systems were numbered in order of their development (i.e., the first radar system was an "AMES Type 1," the second was an "AMES Type 2," and so on).
AMES Type 7:	Powerful, rotating, ground-based British radar system that enabled ground control interception. Conceptualized during the Blitz and built to make best use of the Happidrome control room.
Amplitude:	Magnitude of change in an oscillating variable. In radar, the intensity of an electromagnetic wave. For Nicola Tesla and Lee De Forest, one of the differences between electromagnetic detection and destruction.
AN/APQ-13:	High-altitude bombing radar system modified for weather forecasting. Developed at the Rad Lab.
A-Scope:	An oscilloscope on which cathode rays project each time a radar system pulses. Cathode rays project according to the radar's range, with the most distant representations projected on the right edge. Represents objects as waves. The primary display for CH and other early radar systems.
Azimuth:	Bearing or trajectory.
CH:	Chain Home radar stations and sets developed in Britain in the 1930s in anticipation of German invasion. CH sets pointed out, did not rotate, required large transmission and reception towers, used A-scopes, and were ineffective at night. Also known as pre-GCI radar stations and sets.
CPS-6:	A ground and ship-based, early warning radar system developed at the Rad Lab. The CPS-6 was so large that a carousel platform rotated it during development.

Doppler Effect:	The change in the frequency and amplitude of electromagnetic waves as they move toward or away from an observer. Scientists use the Doppler Effect to approximate the origin of light waves. Police officers use it to when they decide whether or not to give you a speeding ticket.
Doppler Filter:	A filter, usually in a master receiver, that measures the Doppler Effect. Enables the projection of individual blips and beeps on a PPI.
ECM:	The radiation of electromagnetic frequencies designed to disrupt radar and radio systems. ECM broadcasts at or near the target radar's frequency, and floods the target's master receiver and display. ECM is also called "jamming."
Fighter Control:	The measurement of individual aircraft speeds and azimuths, and radar readers' direction of aircraft.
Fire Control:	The direction of deck guns, artillery, and anti-aircraft fire. GCI radar enhanced fire control and contributed to the development of blind firing systems.
Frequency:	In radar, the number of electromagnetic waves-per-meter. Radar sets are tuned to receive feedback of particular frequencies.
GCI:	Ground Control Interception. GCI radar stations and sets were developed in the U.S. and Britain during the Blitz. GCI radars rotated, required modest antennas, used PPIs, and identified individual objects.
GPR:	Ground Penetrating Radar. A specialized extension of GCI that detects objects as many as 80 meters beneath the earth's surface.
Happidrome:	Britain's prototypical GCI control room developed during World War II. Happidromes had interception, height finding, fighter control, and fire control under one roof. Their oblique architecture helped them blend into the British countryside.

Height Finding:	The discovery of an object’s altitude through radar. GCI radars’ height finding worked by moving two antennas up and down and alternating transmission, a technique known as lobe switching.
IFF:	Identify Friend or Foe. Portable radar beacons that transmit identifying and scheduling information to radar readers. Terrorists turned off IFFs in three of the four 9/11 aircraft.
IMCA:	International Museum of Carousel Art.
Interception:	The interception of individual radar echoes (feedback). Interception is the most basic form of GCI radar identification—height finding, fire control, and fighter control all require it. Logistically, interception is comprised of identification and coordination.
LDG:	Libyan Desert Glass. LDG interfered with radar feedback in North Africa during World War II.
Mark 56:	A blind firing system based on GCI fire control and developed at the Rad Lab for the U.S. Navy. Not deployed until after World War II, the Mark 56 mis-measured migrating swans during the Suez Canal crisis of 1956.
Master Receiver:	The master receiver received radar feedback. In GCI sets, the master receiver contained measuring devices: a converter, rectifier, amplifier, and a series of filters (including a Doppler Filter).
NEADS:	Northeast Air Defense Sector. The sector of NORAD responsible for the air space in which the 9/11 flights occurred.
NORAD:	North American Aerospace Defense Command. The U.S. Department of Defense’s radar network.
Politics of the Oblique:	Virilio’s politics of geometry, mobility, motility, the body, and information. Based on situationism and autonomism, Virilio and Parent Church designed the Church of Saint-Bernadette in Paris according to its principles.

PPI:	Plan Position Indicator. Designed for use with rotating antennas, the PPI displays distinct blips on its bull's eye face. The PPI's *time base* sweeps through blips like a second hand on a clock.
RAF:	Royal Air Force.
Rotator:	A mechanical device, often including a platform, which rotates radar antennas. GCI rotators were automatic, and could rotate clockwise or counterclockwise.
SCR-588:	A ground and ship-based radar set used for ground control in the Pacific. Designed by the Rad Lab in Boston, the SCR-588 was less effective in the tropics.
SG-1:	A ship-based radar set designed by the Rad Lab. Because of its sensitivity to ships' rolls and pitches, it was not reliable for station keeping.
Sharpness:	The width of a given radar wave (or transmission). Sharpness impacts an antenna's ability to distinguish contacts and its rotation speed.
Stabilizer:	A mechanical device that helps deck guns and radar antennas compensate for the pitch and roll of ships. The earliest radar stabilizers were based on those used for deck guns.

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