OPERATIONAL IMAGES AND THE INTERPRETIVE TURN

by

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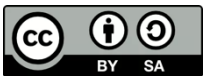

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Figure 1: NSA Information Assurance, operations patch

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Abstract

Over the past several decades, computers have allowed for the increasingly voluminous and rapid ingest of images. These images, made for machine legibility, are called "operational images," a term coined by Harun Farocki. They are made for machines, by machines; they are not made to represent an object, but are part of an operation.

Yet these operational images are only the most recent chapter in a longer history of logistical and instrumental use of images. Through the history of cartography, surveillance, and reconnaissance runs a long tale of instrumentalization, a history of calculable images primed for machine-readability. Before computers allowed for a truly "operational" image that could be harvested and interpreted independently, there were many other logistical images - only these predecessors kept humans in the operational loop.

These days, so-called deep learning allows for a new development in the operational image - not only are humans excluded, but machines are performing inscrutable assessments; they interpret images and provide conclusions while their rationales remain opaque. These images are part of an *interpretive turn.* This sort of image use is difficult to demystify, confront, and confound. To contemplate effective strategies, it helps to look at the broader context of subversion of the logistical image, reaching back to early instances of artistic intervention to help inform the present and future.

Thesis Supervisors

William Uricchio, Professor, Comparative Media Studies
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Dedication

This thesis is dedicated to all of those who helped me on the way.

For my CMS classmates, and for those who came before me and lit the path ahead.

For my advisors William and Vivek.

For my parents, Myrna and Paul, and for my wife's parents, Nina and Damian.

For Deniz and Ainsley.

For Olga.

Figures

"Writing has nothing to do with signifying. It has to do with surveying, mapping, even realms that are yet to come."

- Deleuze

"At first the camera imitates the human eye, but quickly outstrips its model… industry is abolishing work done by hand, and by eyes."[1]

- Harun Farocki

Our world is saturated in a new kind imagery, though often we cannot see it. Inside many modern machines pass countless images, parsed for information and soon discarded. They are part of a protocol and process, one performed by automated actors. They are essential in the functioning of everything from drones to speed cameras to real-time navigation systems. Harun Farocki has called these images, the currency of machine decision-makers, "operational images." In his text "Phantom Images," he provides this definition:

> "In my first work on this subject, *Eye/Machine* (2001), I called such pictures, made neither to entertain nor to inform, 'operative images.' These are images that do not represent an object, but rather are part of an operation."[2]

Artist and academic Trevor Paglen has remarked upon this encroaching reality and tried to sharpen both its definition and social implications. In his essays "Operational Images" and "Invisible Images," Paglen makes several claims about the nature of this new species of image. In the first place, he ties the operational image to computational culture - the operations are in fact calculations, performed on images ingested as information and acted upon accordingly. Because they have been captured for computer legibility, these images need not be made into

[1] Harun Farocki, *War at a Distance*, DVD (Video Data Bank, 2003).
[2] Harun Farocki, "Phantom Images," in *Public*, no. 29: New Localities (2004), 17.

light pictures for the human eye; they can exist as an electrical impulse at the level of the circuit, as stored memory, never gracing a screen. For Paglen, this is a rather terrifying prospect when it comes to uses that are less banal than, say, the facial recognition at work in a point-and-shoot camera. What happens, for instance, when these images are used to guide missiles or drones in real-time? Or to automatically enforce traffic violations and facilitate arrests? This, he tells us, is when the image takes on a sinister role, reinforcing the power dynamics at play in our global society and removing human judgement from the equation, rather than providing some independent machine arbiter of unimpeachable objectivity. And with humans increasingly irrelevant in the process of parsing and interpreting information, these operations fade from the visible realm:

> "Meat-eyes are far too inefficient to see what's going on anyway. Nowadays operational images are overwhelmingly invisible, even as they're ubiquitous and sculpting physical reality in ever more dramatic ways. We've long known that images can kill. What's new is that nowadays, they have their fingers on the trigger."[3]

It is true that a computational, or "algorithmic," turn enabled unprecedented independence by machine actors. This is what drew Farocki's attention and his documentarian impulses; this is what unsettles Paglen as he writes about the killing machines, images with their fingers on the trigger.[4] He implies that the reason images now wield untold power in our society

[3] Trevor Paglen, "Operational Images," *E-Flux*, no. 59 (November 2014), http://www.e-flux.com/journal/59/61130/operational-images/.
[4] Paul Virilio also characterizes images themselves as ammunition, supplying the front line with the needed matèriel of combat, in both *War and Cinema* and in an interview with John Armitage.

is because of a) their automation and b) their invisibility. But there are other, older instances of images that were logistical and instrumental - if not strictly "operational" - and that may be tied to similar exercises of military and state power.

Operational images belong to a longer history of logistical images, images that have been instrumentalized and are used first and foremost for their utility, not for their representational quality. Farocki identifies many of them in his films, placing the calculability of the image, and its eventual machine-readability, within a longer trajectory of mathematical and instrumental thinking.[5] To understand the rise of the machine operators of the present, it is prerequisite to understand the development, over time, of the machine-legible image.

This history stretches back, long before the advent of the computer. One crucial turning point arrived with the development of calculable grids of navigation in the 16th century, when European powers sought new means to guide and record missions of conquest. Another came with new photographic technologies of surveillance and reconnaissance in the early 20th century. In this history, "invisible" images are nothing new: there have long been images embedded in utilitarian enterprises, undergirding the logistics of states and militaries for centuries. This broader historical understanding dispels some of the mystique and opacity of present-day operational images, enabling deeper critique and subversion of the state and corporate powers using logistical images toward nefarious ends.

If images have long been deployed by these powers, logistically and instrumentally, there have also long existed attempts at subversion and exposure, attempts to resist such use of the image. The examples given by Paglen, the subjects explored by Farocki all seem to hew to a common theme: operational images are designed to locate people or objects in space with

[5] See, for instance, his explanations of architectural projections in *Images of the World and the Inscription of War.*

definitive precision, the better to exercise machine efficiency, surveillance, and targeting - the better to facilitate the interlaced functions of production and destruction identified by Farocki. This functionality has been deployed in systems of navigation, reconnaissance, aiming, and conquering. In the sciences of cartography and aerial photography, instrumental images have played and continue to play a vital role.

What has changed in recent years is both their ubiquitous use and their independence from human eyes - people are increasingly left out of the loop. Instead the machines now act on their own, making digital images in processes rendered illegible to humans.

The Interpretive Turn

Recent years have seen the introduction of cognitive neural nets (CNNs) - systems referred to as "deep learning." These complex webs pass information back and forth between different algorithms in an attempt to mimic the neurons of the brain. Some of these deep learning networks make use of operational images, parsing the information gathered for analysis and subsequent action. Distressingly, these constructs - the product of designers and programmers who have built them for instrumental goals - often lack transparency and are too complex to deliver a clear rationale for their conclusions. Here, it is appropriate to describe an *interpretive* turn, whereby the image is both parsed and acted on by autonomous computer systems, the human left outside the loop.

It is this interpretive turn that lies at the heart of what is troubling both Paglen and Farocki. There has been a transformation from logistical and instrumental images, which have a storied history and a deep connection to power structures, to the "operational" image, to the

automatically "interpreted" image, a new manifestation that vexes artists and theorists alike.[6] When humans are excluded from the act of consideration and interpretation, when "conscious intentionality"[7] is no longer part of the operation, then, as Paul Virilio has put it:

> "Once we are definitively removed from the realm of direct or indirect observation of synthetic images created by the machine for the machine, instrumental virtual images will be for us the equivalent of what a foreigner's mental pictures already represent: an enigma."[8]

Once this turn has been enacted, once such a stipulation becomes a quotidian reality, how does one make visible this invisible imagery? How can its power be resisted or subverted? If it is, as Farocki said, not meant to represent an object, then how does one take such an image and shape it for public eyes? These are some of the critical questions considered in this thesis. Paglen glibly suggests unlearning to see as humans, but his off-the-cuff remark is in fact not far from what may be required. Learning how machines both perceive and construct the visible world has been one step toward illustrating their power and presence in our daily lives - artistic practices in this vein have existed for some time.

Looking at the history of logistical images helps elucidate the process by which images eventually become fully and autonomously operationalized, even interpreted. And looking at

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[6] Thomas Keenan, for one, describes this evolution through aerial photography in his essay in Grey Room 55, "Counter-forensics and Photography."

[7] John W. P. Phillips, "Light Weapons/Darkroom Shadows: Photography, Cinema, War," in *Virilio and Visual Culture*, ed. John Armitage and Ryan Bishop (Edinburgh: Edinburgh University Press, 2013), 96.

[8] Paul Virilio, *The Vision Machine* (Bloomington: Indiana University Press, 1994), 60.

historical efforts to subvert the power of the instrumental image helps to give a broader context to the media artists, activists and theorists currently stipulating and enacting methods of resistance. The following chapters are an effort to do both.

Mercator: The Calculable Grid

This chapter considers the use of the navigational grid developed by Mercator and its effect on the representational qualities of maps. This section also chronicles the use of the grid as a guidance system, refining the accuracy of long-range weapons, with its first major deployment occurring in the First World War. Maps are representational images, but since the invention of cartographic grids there has been an invisible, logistical image driving the functionality of the map. This early instrumental image stands out, both as an image not meant for representation and as an often "invisible" image.

Moreover, the map grid was a literal substructure that would one day be inhabited and traversed by automated operators. In this sense, map grids enabled many modern instantiations of operational images, from the visual navigation programs on our phones and car dashboards to the camera-eye of a cruise missile or the self-driving car. These systems rely on images of both the physical world and the virtual overlay of the grid to complete their operations.

As an instrument of power, the navigational grid and its calculated precision was in fact designed for sailors. Mercator had no intention of his grid coming to affect and dominate the geographical maps with which schoolchildren are so familiar. Instead, he meant for it to reconcile some of the salient problems of nautical maps, to accurately record maritime voyages in relation to the land. Of course, these systems reinforced and better enabled the missions of

conquest and subjugation carried out by the seafarers of the colonial era. Similar to the modern operational image, the navigational grid tended to reify dominant power structures, and also enabled the advancement and efficaciousness of military technologies.

Aerial Photography: Loops and Legibility

This chapter looks at another of the important technological advancements of the First World War: aerial photography. Not unlike the grid, overhead photography spurred important developments in the move toward instrumental imagery and its machine-legibility, though in a different manner. It marked the beginning of iterative loops and strict rule sets to guide interpretation. While aerial photography had existed in fits and starts well before the turn of the century, it was in WWI that the rival powers each formed photographic units for reconnaissance and surveillance. Pasted into grids and updated in a piecemeal fashion, the photos of the Western Front's aerial units prefigured the iterative, informational loops of modern operational images. While not quite a closed circuit, the aerial photograph process gained paramount importance in conflicts from this point forward.

At the same time, the effect of distance on the representation and the conduct of warfare was quite profound. From the First World War, cameras and weapons of distance became the norm; weapons gave no visceral view or even notion of the enemy. Surveillance photographs taken from great heights flattened details and reduced the human element to miniscule specs. To interpret the images, specialized units were trained to read the overhead view. In his work on this subject, Farocki has repeatedly pointed to what may be overlooked or left out of these strict systems - the inflexibility of a calculated image system with explicit objectives. The

instrumentalization of images in the First World War would have profound implications in the century to come, as these iterative loops edged ever closer to automation.

Operational Images, Machine Interpreters

What happens when the image becomes fully "operative," when it no longer needs humans in the loop? This chapter looks at the schism that created the operational image - made by machines, for machines - and its break from previous logistical and instrumental uses of the image. To confront this latest instantiation of the logistical image, scholar/artists like Paglen have taken up evidentiary and forensic approaches to shine a light on the state and corporate powers that often build operational image systems. It is important, as before, to consider the underlying motivations for these instrumental systems in order to better understand and challenge them. For Virilio, this turn represented a kind of fulfillment of the "logistics of perception" – automation only signals even greater control of visible events by the military and the state.

Some of these images are made into visual representations for humans to monitor or record; many are not. For Farocki, there is a hidden menace in automation for "objective" purposes: "A missile which corrects its own course carries the threat of infallibility."[9] It is in the interest of state powers to present publics with such "infallible" image systems, but the veneer of objectivity belies constructs that are anything but egalitarian in their goals and procedures. Farocki's techniques of annotation and repetition form a kind of forensic approach, attempting to discover in the visible something that has eluded our gaze or attention; he seeks to make the

[9] Farocki, *War at a Distance*.

invisible visible, to draw out connections not readily apparent, things that are hiding in plain sight.

In his films, Farocki hints at something more sinister, something that Paglen has described at length in his text "Invisible Images." This chapter delves into the use of operational images by CNNs, and what can be considered the *interpretive turn*. What happens when machines perform complex operations that are inscrutable to humans - when the images they use to make decisions have been deciphered in an incomprehensible manner? This is the central question of this chapter.

Evidence, Resistance, Subversion

To understand how theorists and artists can intercept and reframe these images, it helps to fill in the some of the broader history of the logistical image. While the previous chapter takes up the work of Paglen and Farocki, this chapter brackets their endeavors by reaching into the past and looking toward the future for further instances of resistance and subversion by artists, theorists and activists who have sought to counter the powerful entities deploying logistical images.

Logistical and instrumental images have often elicited artistic interventions. These modes of resistance have oscillated between exposure or demystification (i.e. collecting the sort of evidence that Paglen collects) and active subversion and sabotage of the systems themselves. These projects often alluded to what would finally become necessary to confront machine actors: a tactical approach to the deployment of artistic media, media designed to break machines, show their weaknesses, and pull apart the seams of objective presentation.

Early efforts were often grounded in the anti-imperialist and anti-capitalist art movements of postwar Europe. Guy Debord, the founder of Situationist International, could not abide by the clean grid lines and fixed geometry of France's new urbanism. He and his cohort of malcontents extended their critique of consumer society to subvert and reinvent cartography. In effect, they sought to hijack the grid, decontextualizing it from "objective" urban understanding and navigation, appropriating and redeploying grids for their use in "psychogeography." Debord's counter-mapping distorted logistical images, and thus instigated a style of intervention that would retain its relevance as the century wore on.

More than half a century later, we can find many contemporary art projects that resonate with the work of both Debord and Farocki, challenging the instrumental framework of images and sensor data powering so many decisions in our society. Generally, contemporary artworks exhibit two established approaches borrowed from earlier interventions. The first is an extension of evidence-gathering that pulls at the seams of the digital image, showing the operational processes by which it is made and presented to us. The second collects byproducts and glitches of image-gathering and image-making. The work of contemporary Google Earth interventionists Florian Freier and Clement Valla occupies these two spaces, respectively. There is also a third approach, one that is directly confrontational, and involves feeding the sensors false and confusing data. The projects of Adam Harvey and Zach Blas exemplify this area of tactical confrontation. This style of intervention is relatively new, provoked by the algorithmic black boxes and deep learning actors entangled in our image culture, image processing systems that are designed to remain obscure and proprietary. Intervening in this fashion can be called *tactical media*.

To confront the operational image going forward, it is likely that a combination of all three strategies will be needed. Both demystification and active subversion are required. This is because the processes need to be revealed, *and* they need to be actively resisted. While some artists develop masks and diversionary tactics to camouflage citizens from corporate and state power, others like Paglen turn the camera-eye back on the machines, gazing up like astronomers at the night sky.

Plotting the Grid: Mercator's Logistical Image

The image first became logistical through the science of cartography. Under every modern map is a second map, a hidden chart, a latticed framework that governs interaction. It is there for navigation, to direct the user in relation to the physical environment.

Few scientific practices so immediately conjure up notions of precision and exactitude as that of cartography. The better a map represents reality at scale, the better the map. When considering the history of map making, it is common to describe a system of gradually increasing representational accuracy, developing across the years with the assistance of technological advancements and ever-more-sensitive measuring tools. Over time, through the use of map projections, a direct proportionality was attained, and the map's scale was perfected for the purposes of navigation. This narrative fits nicely with the progress of science, and aligns with the many efforts of Enlightenment Europe to calculate and quantify the elements of the natural world. Importantly, there is a representational truth to this history: that the map gradually became a clearer, more faithful picture of the world we inhabit.

"How quaint," we think, upon seeing some ancient map of the world that is largely incomplete and wholly out of proportion, "if only they knew." We chortle to ourselves, and consult our own map of the earth, convinced that the map has attained perfection. But every flattened atlas is itself a distorted map projection of one kind or another; flat paper ignores the earth's curvature. And apart from this basic, visual distortion, there are other distortions. It has long been established that maps are cultural objects, that they require a certain form of literacy to be made sense of, that they curate information in a highly purposeful manner. Underlying each map, each boundary, each line and point, is a set of decisions driven by geopolitical forces and

social norms. The fact that power runs through the history of cartography is not a novel observation. Nor is the fact that mapping was indispensable to the projects of empire and colony. Nor the observation that maps are comprised as much by what is left out as that which is included. These realities have been repeatedly illuminated, the world map deconstructed numerous times by scholars across the globe.[10]

Alongside these latent currents of power, perhaps because of them, there developed an invisible system of measurement and coordinates: a virtual data structure that came to dominate the very basis of navigation and the calculable map image. This system began as a simple, visible grid to aid sailors in their global voyages, and later evolved into a complex network of invisible coordinates that foreshadowed the development of GPS and satellite mapping.[11]

This grid system was a logistical image, the first of its kind. Spurred by the Renaissance desire to quantify and measure every earthly entity, this superimposition was borne out of the need to delineate and determine the finite nature of the earth. It was a classic sort of early Enlightenment project, elevating human understanding by means of rational perception, arresting the physical world through precise calculation. In mapping and gridding the earth, the cartographers of the Renaissance created the early images of a new sort of logistics. Their maps contain two images. One is representational, and pictures geography to give humans a grasp of the relative location and size of various territories, geographical features, landmarks, etc. The other is the grid, a projection laid out on top of the map (sometimes visibly, sometimes not), affecting its presentation to better guide humans in their efforts toward accurate navigation. The grid instrumentalizes images for utilitarian purposes, not for representation or reflection. They

[10] See *The New Nature of Maps* by J.B. Harley, *Mapping Reality* by Geoff King, and *Apollo's Eye* by Denis Cosgrove for a detailed look at the cultural values and structures of cartography.
[11] For more on the grid, pointillism, and its relationship to GPS, see *After the Map* by William Rankin.

prefigure what Harun Farocki termed *operational images*, and they are a critical piece of infrastructure in our modern world.[12]

It was in the science of cartography that some seeds were sown for the prominence of these operational images, and for their eventual use and even interpretation by machines. Indeed, calculable images like the cartographic grid would take but a few centuries to become a dominant paradigm, with seismic implications for the nature of the image and its use by machines. For anything that is calculable is also machine-readable. As a technology made by humans, to be deciphered and read by other humans, maps are a visual language, decoded by visual literacy. But ultimately, map coordinates would be read, traversed, and inhabited by automated operators, without the need for a traditional, representational map.[13] The calculable map image marked the inception of this development.

This chapter describes a critical development in the history of cartography: the imposition of the grid system and the turn toward a calculable, logistical map image. Starting from Gerardus Mercator's initial map projection and moving through the artillery grids of WWI to the U.S. government's deployment of the Universal Transverse Mercator (UTM) in the years after the Second World War, this chapter considers how the coordinate system represented a departure from representational mapping, toward an instrumentalized image primed for the computational culture of the 20th century.

[12] Paglen, "Operational Images."
[13] William Rankin, *After the Map: Cartography, Navigation, and the Transformation of Territory in the Twentieth Century* (Chicago: University of Chicago Press, 2016), 257.

Mercator's Projection

Gerard Kremer finished his studies in Louvain, Belgium in 1532. As was fashionable amongst the cognoscenti of elite Europe, he Latinized his name to Gerardus Mercator. In the years after his studies, he began to work building globes and maps, and in 1538 was the first to print North America's new moniker on his world map. Imprisoned and nearly executed by church authorities on charges of "heresy" (perhaps due to his early map of Palestine, the Holy Land), he was saved by the strong support of Louvain's authorities and was able to set up a permanent workshop in Duisburg, Germany - a tolerant locale removed from the urban centers of Belgium and its Catholic bureaucrats.[14] Mercator pioneered new globe-making techniques that allowed for easier replication; using paper and plaster to create globes on a wooden frame, his method departed from the established processes of etching into wood or metal spheres.[15]

Mercator's singular contribution to cartography, and to navigation in particular, came in 1569 with his cylindrical projection map, or as he called it, "A new and enlarged description of the earth with corrections for use in navigation."[16] As with many such innovations, Mercator sought to solve a technical problem: specifically, that sailors should be able to use a constant compass bearing to chart their course across the oceans (incidentally, the word *navigation* itself derives from the Latin *navigo*: to go by ship). Mercator himself had never been to sea - and never would. His chief motivation in creating these ruled lines was to reconcile nautical charts with geographical maps.

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[14] Nicholas Crane, *Mercator: The Man Who Mapped the Planet* (London: Weidenfeld & Nicolson, 2002).
[15] Dana Smetanová et al., "Mercator's Projection - a Breakthrough in Maritime Navigation," *Nase More* 63 (2016), 182.
[16] John Parr Snyder, *Flattening the Earth: Two Thousand Years of Map Projections* (Chicago: University of Chicago Press, 1993), 46.

Latitude and longitude lines were insufficient due to their curvature, and required the supplemental use of a sextant or similar tool of celestial navigation. Using the latitudinal or longitudinal grid for navigation would eventually create a compass bearing that spiraled along the surface of the earth - a curving path called a "rhumb" line.[17] Straightening these rhumb lines and laying them into a map, with latitude and longitude as a grid, presented two significant advantages. First and foremost, sailors would be able to plot a straight course using only a meridian line and compass. Second, and perhaps more important to Mercator himself, this new system allowed for the accurate plotting and recording of oceanic voyages in a rectilinear projection map, which let mariners and cartographers use the same map. It was this unification that he sought: "Mercator's new projection would harmonize the geography of globes and maps; the spherical with the planar; the three-dimensional with the two-dimensional."[18]

In his detailed biography of Mercator, Nicholas Crane has suggested that this epiphany occurred as a side effect of the process of globe-making: "with the geography of the world laid flat on his work-surface, prior to being glued onto the sphere, the meridians on the gores would have appeared as straight, equidistant lines… if the parallels - the lines of latitude - were straightened too, then moved further apart, the rhumbs must also straighten."[19] In this way, a conformal projection map (one that preserved angles) could be drawn up using only straight lines.

The coordinates of Mercator's system were laid out for anyone to see: a gridded matrix spaced out in exactly such a way as to make navigational diagonals. The result created distortions toward the poles, a familiar result in map projections. The accuracy of the map

[17] Crane, 204.
[18] Ibid., 205.
[19] Ibid., 205.

proved its usefulness, and it eventually became the dominant system for sea charts and navigation once sailors realized its simplicity, despite the geographic distortions.[20] It is somewhat ironic that although Mercator intended his system first and foremost for maritime navigation, it became "all too commonly used for geographic purposes," despite "the fact that Europe is portrayed about twice its true area in proportion to countries near the equator."[21]

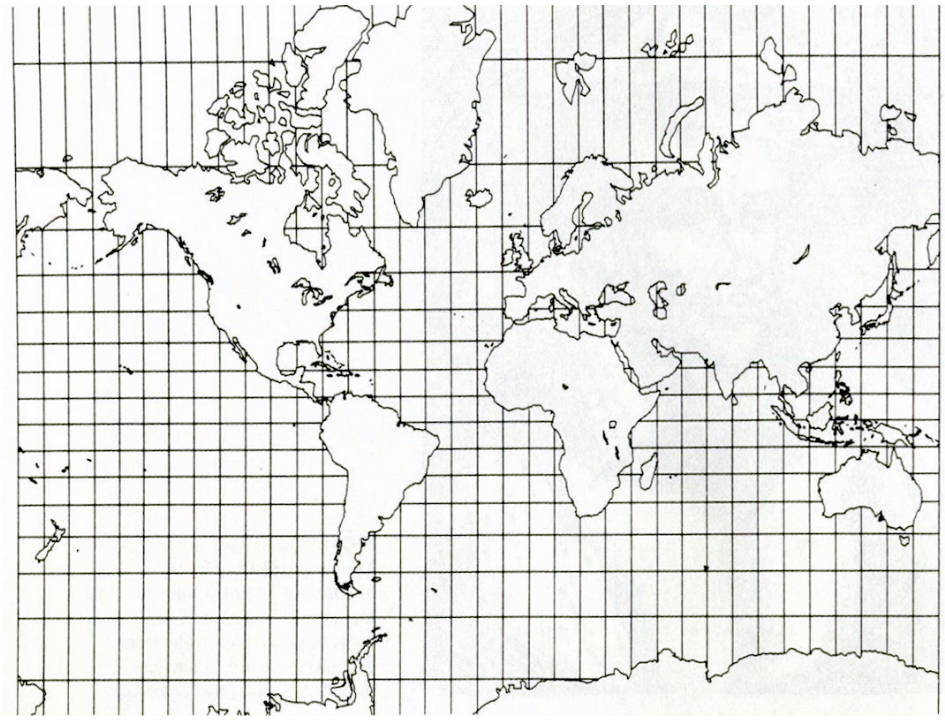

Figure 2: Mercator's projection grid

The significance of this breakthrough cannot be overstated. This was the start of a mapping standard employed today by NATO, the US government, GPS, and Google Maps.[22] It is the system by which we find our way through *almost every interactive map available to us*, and certainly those that dominate the consumer spheres of digital mapping and navigation.

[20] Ibid., 290.
[21] Snyder, 48.
[22] Smetanová et al.

Contemporary classrooms deploy Mercator maps to this day, carrying with their geographic distortions a warping of geopolitical import. Only recently have these maps seen a concerted effort at comparative analysis in public schools.[23] Mercator's legacy was assured by an innovation with a very instrumental purpose: a map image that existed to guide rather than to represent an accurate picture of the Earth: "Mercator had ruled an immutable framework for global mapping, a planar grid which would prove as timeless as the planetary theory of Copernicus. In seeking the essence of spatial truth, he had become the father of modern mapmaking."[24] His was but the first of many grids that would serve logistical ends.

As would be the case centuries later with GPS, it was not so much about having a complete picture of the land as finding one's way, and this is one feature that made Mercator's projection a logistical image. His projection was not made to represent the Earth at scale as much as it was to inform and locate subjects as they traversed its surface. It was an instrument of purpose, designed for an outcome. And what's more, it slowly became invisible. The calculable grid would provide the underlying technology for much of electronic mapping in the 20th century, becoming ever more important despite being divorced from the physical maps whence it originated. Of course, it would take several hundred years and critical developments in military technology for a grid-based system of coordinates to overtake the Earth's surface, and to become an automated network of electronic signals. To get there, the Earth had to be flattened once again during one of the great technological turning points of history: The First World War.

[23] Joanna Walters, "Boston Public Schools Map Switch Aims to Amend 500 Years of Distortion," *The Guardian*, March 23, 2017, https://www.theguardian.com/education/2017/mar/19/boston-public-schools-world-map-mercator-peters-projection.
[24] Crane, 206.

Artillery Grids of WWI

"Despite the fact that most people have, at best, only a vague awareness that these grids exist at all, they are arguably one of the most successful cartographic innovations of the twentieth century"[25]

In his book *After the Map*, William Rankin chronicles the crucial importance of the grid in the 20th century, spending significant time on its implications during WWI. When map grids became applicable to battlefield operations, they initiated an escalation in logistical image use for the ensuing century. That the grid was deployed as a piece of military technology should come as no surprise, given its historical importance in the fields of logistics and navigation. In this case, the specific military technology that necessitated the implementation of the grid was artillery. The simplicity of using straight lines on a map, thereby negating the curvature of the Earth and avoiding complex calculations, proved an essential development in the operation of big guns.

During the First World War, a miserable conflict of stagnation and trench warfare[26], soldiers were bogged down in opposing dugouts and assaults were often carried out using long range weaponry. In previous conflicts, artillery was directed by forward observation: a scout would relay back to the gunners the proximity of their hit through a field telephone. But forward observation became difficult in the context of trench warfare, in which enemy forces dug in just a couple hundred meters away from each other. And there was another problem: the artillery used to shell enemy positions had a tendency to blow up the land, and the telephone lines of the

[25] Rankin, 121.
[26] Virilio rightly points out in *War and Cinema* that despite stagnation on the ground, WWI was a conflict of unprecedented speed in the air and in the capture of images. The grid, too, ultimately proves to be a technology of speed and instantaneity.

Western Front were under constant bombardment. Communication was disrupted by the very weapons that relied on open communication lines, making it much harder to accurately shell a location on the next attempt. The militaries of WWI needed a new methodology to guide their long-range explosives. The solution was a grid, a calculable image intended not for navigation but for the precise aiming of cannon.

By placing grids over relatively small regions of the globe, artillery could be directed using simple planar geometry. Existing maps of northern France lacked both detail and accuracy, being drawn at too small of a scale and for the purposes of wayfinding rather than aiming in straight lines. So, a system for which Mercator had laid the foundation was adopted, though across an area small enough to minimize distortion. This was a grid based on Johann Lambert's map projection. Lambert was something of an autodidact savant, who by the age of 12 had begun to teach himself the particulars of math, physics, and astronomy.[27] Among his many contributions to cartography (which included the transverse Mercator projection) was a conformal conic projection, created in 1772. Mercator's original map was the "simplest conformal projection,"[28] and thus served as the basis for many derivative projections, including those of Lambert. Conformality - having no angular distortion - was indispensable to plot artillery across a flat plane. Having been "hardly used"[29] in the interceding years since its introduction, Lambert's method was adopted for the grids used by the French army. They called it the *système Lambert*, and it was used as the best logistical means for map firing. The other allied forces were quick to recommend the French system, recognizing the accuracy of "a map that would flatten the earth and allow coordination and easy calculation within a large

[27] Snyder, 77.
[28] Ibid., 157.
[29] Ibid., 78.

geographic area."[30] The grid provided by the Lambert projection was used as the basis for maps, and soldiers would use the supplemental materials of a plotting board and a so-called "trig list" of nearby monuments and beacons to triangulate their position and that of the target. As the soldier set out to aim his weapon, the paper map was but a momentary reference, while the real targeting was done on the plotting board, without a geographical representation.[31]

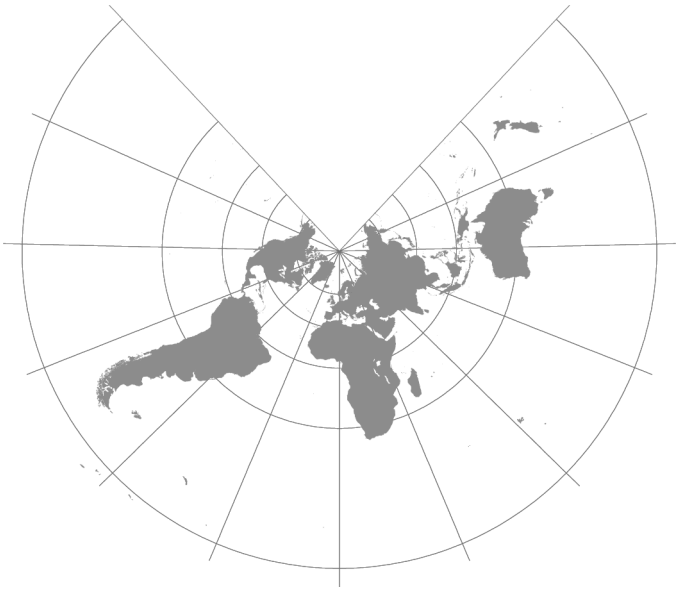

Figure 3: Lambert projection

But, when projected across larger areas, WWI grids were not widely extensible. Rankin's many figures show the degrees of distortion when each grid used in WWI is extended over the Earth. The solution to this distortion was devised years down the road, after several iterations and other universal attempts at a global grid. As the Second World War drew to a close, the US Army decided to adapt Lambert's transverse Mercator projection as a series of ellipsoids over the

[30] Rankin, 134.
[31] Ibid., 135.

entire globe. This invention was called the Universal Transverse Mercator. From the UTM there derived several other navigational standards, notably the World Geodetic System of 1984, or WGS84, the reference coordinate system for GPS. The Global Positioning System shares a lot in common with initial navigational and positional grids. It provides a full-scale overlay of coordinates on the very terrain of the Earth, a web of points constituting a logistical image that exists at scale, outside of any human's visual perception. GPS represents an outgrowth of a pointillist conceptual turn, one enabled by grids: "The invention and expansion of grids therefore signals an important turning point in the history of territory, when the logic of the map starts to transition to the logic of what French military surveyors called the 'canevas de points' - the framework of points."[32]

As a technical history, this overview of the grid demonstrates an important evolution of cartographic technologies across increasingly global and powerful instantiations. Indeed, the UTM was also designed to sight weapons, guide missiles, and coordinate efforts in the air and on the ground. But more importantly, the use of WWI grids marked the first time that soldiers used images to guide their actions and decision-making against unseen foes. As Paul Virilio points out: "If the First World War can be seen as the first mediated conflict in history, it is because rapid-firing guns largely replaced the plethora of individual weapons. Hand-to-hand fighting and physical confrontation were superseded by long-range butchery, in which the enemy was more or less invisible save for the flash and glow of his own guns."[33] It is an interesting addendum to this remark that the flash and glow of the guns provided a means of locating them for counterattack, in a process called "flash spotting." It is certainly the case that soldiers had to rely on a grid-

[32] Ibid., 123.
[33] Paul Virilio, *War and Cinema: The Logistics of Perception* (London; New York: Verso, 1989), 70.

based guide to attack an invisible enemy - mediating images were facilitating very real and rapid outcomes, and had become a part of the military's operational apparatus.

Rankin points out repeatedly in his writing that the soldiers of the First World War - and those of subsequent conflicts - "inhabited" the grid. What he means by this is that grid coordinates exist full scale, in a 1:1 experience of actual space. Navigating and positioning oneself through a coordinate system is an entirely different from traditional map literacy, which requires an appreciation of scale and the "God's-eye" view of an entire territory scaled down to a single, human-readable image: "Although the grids of World War I were certainly a cartographic technology, they did not actually represent anything at all. Instead, they were a new kind of spatial infrastructure, overlaid and installed as a new way of inhabiting geographic space. (And although representation can certainly be powerful, it cannot hit a target eight kilometers away on the first try.)"[34]

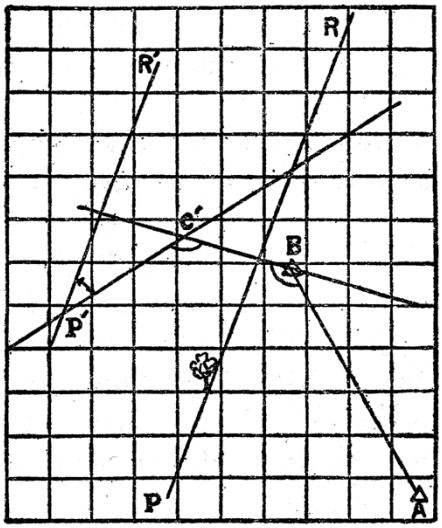

Figure 4: Artillery plotting board, teaching model

[34] Rankin, 139.

Rankin is characterizing the grid as a map technology pulling away from its initial purpose - representing geography - and taking on a new logistical function. The grid can thus be considered an instrumental image with flexible uses. His term spatial infrastructure is very telling, and alludes to a guidance system that was purpose-built but came to inform the very experience of the landscape itself. From the grid's origins as a maritime guidance system to its "inhabitable" overlay in earthly space, the logistical image dispensed with the idea of a truthful scale of geographic representation, warping the planetary surface to suit instrumental endeavors, from the ships of colonists to the artillery of gunnery crews. The grid arose to guide ships, and it was adapted in WWI to guide weaponry and even aircraft: "these grids also helped integrate a wide array of users into the same geographic system: they were used not just for heavy and light artillery, but also for aerial photography, reconnaissance, and, for Germany, even small weapons like mortars and machine guns."[35]

This moment of diversified utility in the history of mapping was just an evolution in the instrumentalization of the image, an advancement for soldiers to accurately wage war at a distance. Of course, grids and later standards like GPS also informed ways of moving and being in the world, not just for the military but for everyone in possession of a GPS receiver. And for everyone with a receiver in their pocket, the idea of a grid of coordinates is hardly noticed and rarely considered, even as they move and interact with their smartphones:

> "Grids are invisible even to most of their users, and their politics are concealed in difficult debates about map projections and the mathematics of surveying. Appreciating grids does not require a detailed understanding of all of these

[35] Ibid., 127.

technical conversations, but it does require understanding how technical decisions can regulate both the experience and the politics of space."[36]

Mercator's grid had indeed established a logistical form of the image. By the mid-20th century, the grid became a form of "global vision" based on the calculable, navigational image and accelerated by the US military. Rather than simply illustrating a territory, these images served an instrumental purpose for human operators - of movement, of logistics, of targeting. When, during WWII, the grid became an electronic constellation of coordinates, "the epistemic concerns [were] still convenience and efficiency rather than objectivity or truth."[37] One Allied system was called Gee - the term itself short for "grid" - and was deployed as a sort of inverse radar for triangulating the position of aircraft.

Perhaps Mercator himself would have found this a fitting evolution of his conformal system. After all, he never really intended his maps to be used to teach geography or represent topographical features; in the first place they were meant for navigation and efficient movement across the globe. As it turned out, such efficient routes could also be plotted, sadly, for destructive firepower. But the fact that the grid departed the map and took on its own electronic significance as a guidance system may in fact have been the most appropriate outcome.

Mercator's maps still hang in classrooms throughout the country, despite being "misleading," "deceptive," and "grossly inaccurate" for the purposes of learning geography. The reasons for this may be more about utility than pretensions toward visual truth: "as a rectangular map, it fills a rectangular wall space with more map, and clearly… its familiarity breeds more

[36] Ibid., 124.
[37] Ibid., 206.

popularity."[38] Add to this that "inaccuracies" may be read in another light: that they are not distortions, but the reflection of the power and priorities that flow through Mercator's projection.[39]

The man certainly sought a unifying system that allowed for conquest and domination. But to give Mercator his due, he also had humanistic preoccupations of his own. In his view, the map was but a tool to lift humans out of their own ignorance, transcending the limits of Earthly knowledge in an effort to better know themselves. In his *Historia Mundi,* Mercator wrote of the sciences of cartography and astronomy that they must instill a "spiritual contemplation of the heavens," serving as a vehicle to "lift up those minds which are drowned in these earthly and transitory things, and shew them the way to more high and eternal matters."[40] A peer and fellow Flemish cartographer, Abraham Ortelius, emblazoned a similar ethos across the top of his *Typus Orbis Terrarum*, with an inscription with reads:

> *For what human affairs can seem important to a man who keeps all eternity before his eyes and knows the vastness of the universe?*

However, the fact remains that the grid he invented provided the basis for many efforts of military coordination and conquest. The logistical image became weaponized; it became an essential component of war and a sighting mechanism for efficient killing machines. The navigational uses of the grid ultimately helped planes to get off the ground and locate targets. It

[38] Snyder, 157.
[39] The distortions of various map projections have been addressed as emblematic of the colonial worldview time and again, particularly in *The New Nature of Maps* and *Mapping Reality*.
[40] Denis E. Cosgrove, *Apollo's Eye: A Cartographic Genealogy of the Earth in the Western Imagination* (Baltimore: Johns Hopkins University Press, 2001), 154.

was also during WWI that another image technology took to the skies: the camera. Once aloft, the photographic image would become the next province of the logistical image, with deep ramifications for the rest of the century.

Looping toward Automation: Aerial Photography and Interpretation

Some twenty years after the First World War, grids would take to the skies as radio navigation systems, guiding and facilitating the next global conflict. But before the Great War had concluded, another form of the logistical image got off the ground: the photograph. While navigational grids established their prowess in aiming artillery, the airborne camera served up a new means of positioning troops and materiel. Combining two quintessential technologies of the modern era, the camera as an airborne surveillance device rewrote the conditions of warfare. Providing new notions of reconnaissance, positioning, and perspective, the gathering and interpretation of aerial images comprised an essential role for the air forces of all major WWI combatants.

Aerial photography created an "instrumental image."[41] These pictures from on high were part of a protocol, a gathering of essential information to be parsed, interpreted, and swiftly acted upon. In the same way that the grid began as a tool of navigation and took on an increasingly essential role in military operations, the photograph, once aloft, began an ascent in both its altitude and logistical role. Used both as a tool for mapping and for strategic analysis, the overhead photo was part of a larger logistical loop between images and actions, in which humans played an essential interpretive role. But this loop grew tighter over time, logistical efficiency demanding a gradual exclusion of the human interpreter.

From above, the photograph would also reshape the ways that soldiers understood and interacted with the planetary surface. This foreshadowed the ubiquity of satellite views that

[41] Allan Sekula, *Photography Against the Grain: Essays and Photo Works, 1973-1983* (Halifax: Press of the Nova Scotia College of Art and Design, 1984), 33.

would inform public imaginings of foreign locales by the century's end, notably with technologies like Google Earth. An act of interpretation was required by these men of the First World War, which in turn required specialized training and a new understanding of the possibilities of the image. Devoid of a horizon line, the bird's eye view required a new type of image literacy, and new methods for extracting information.

In some ways, and despite obvious limitations of resolution and granularity, these images were considered "objective" in nature. They were concrete referents, imprints of light whose veracity was unquestionable. That is, until it fell to certain operations units to create camouflage, to produce artifacts in the image or obscure others, complicating the act of interpretation as a loop developed between surveillance and counter-surveillance, between the visible and the invisible, the overt and the camouflaged.

And as photo after photo arrived at airbases across the Western Front, their rapid replacement and temporal succession marked the first steps toward real-time loops, constantly refreshing the information of the battlefield. This process also generated an image overabundance, each photograph not meant to be considered as an individual object, but as part of a flow of images, each updating, surpassing, and outdating its predecessor. Each referent was soon irrelevant; its impermanence recognized as a limitation of its utility. It was in this manner that overhead photographs prefigured the digital patchwork of surveillance, from satellites to CCTV.

The overhead view, particularly in the context of military operations, has repeatedly drawn the attention of artists and theorists alike. Harun Farocki and Paul Virilio have both dedicated a sizeable share of their work to interrogating these machines of distance and the representational conundrums they create. Themes of image instrumentalization have run through

the body of Farocki's film oeuvre, from *Images of the World* to *Eye/Machine.* Virilio has meanwhile been writing about what he calls "the logistics of perception" since the 1980s. What Farocki and Virilio both realized, somewhat obviously, is that images are not harmful, but their deployment can be. There are no objective images, but images can certainly have objectives. Their work draws attention to that which is not readily apparent in an image; upon close inspection, the picture itself can often reveal some of the logic that drives its generation and use. Farocki's work is almost forensic in nature, and provides some early approaches to recontextualizing imagery that often appears banal. In the case of overhead photography, issues of distance, targeting, and the dehumanizing of the battlefield are paramount concerns.

Farocki traces the development of warfare at great distance, and his historical digging, tracing and blueprinting provides an exemplary method that can be applied to the photographic image, to interrogate its status as a piece of information in a chain of events. When images are reduced to geometric data, they become machine-readable. Many new media artists working today take a similar approach, presenting images in a fresh context, reframing and reconsidering how and why they were created.

This chapter chronicles how the aerial image became part of a protocol and process, a mechanical assembly foreshadowing the digital operational images to come. In devising interpretive schemes and piecemeal mapping strategies, the aviators and field offices of the First World War edged the machine-image closer to its machine-readable future. As the fodder of war, these developments were powerful; this chapter focuses on their wartime consequences, from logistical workflows to the very perceptions of the battlefield. Behind the trenches of France, trained analysts interpreted the flat, vertical photographs. But they set in motion a decidedly operational concept: that images could be parsed for essential information, used and discarded.

They laid the groundwork for the operationalization of images, making prescribed calculations and reductive value judgements, setting the stage for machines themselves to do the reading and parsing. This chapter also considers the historical efforts of Harun Farocki, who routinely unearthed and scrutinized the manufacture of instrumental imagery.

Surveilling the Western Front

While soldiers in the trenches of WWI struggled to advance by a few meters, the skies above them played host to a battlefield unprecedented in speed and scope. Aircraft arced across the horizon, and became romanticized in military history: pilots with superhuman flight skills, fighting aces, the jousting knights of the heavens. These mythologies grew out of one of the singular technologies of the war, one which added unprecedented speed and agility to combat.

Complemented on the ground by the practices of grid-guided artillery, airplanes reflected the same principles of conflict at great remove, with an enemy often unseen. Combat formed but one facet of their mission. For the first time, great numbers of airborne cameras were deployed to record the enemy. As the photograph took to the skies, its evidentiary powers recognized by the supreme commands of each military, it took on an instrumental quality and became part of the war apparatus.

Photography had in fact entered military service before the First World War, but was primarily used for documentation and historical records. Although there are early indications that Nadar deployed balloon photography for the military, its success was limited as was its use. There were several field tests during the American Civil War, but nothing that really got off the

ground, so to speak.[42] As Allan Sekula deftly summarized in his essay *Steichen at War*: "The First World War was the first occasion for the intensive use of aerial photography for 'intelligence' purposes. The previous half-century had yielded combinations of balloons and draftsmen, balloons and cameras, rockets and cameras, and, absurdly enough, pigeons and cameras."[43] It took the airplane to accomplish what other methods of aerial photography could not do: provide a reliable, targeted image controlled by a human operator, with a fast enough turnaround to be of practical value in assessing the conditions of the battlefield.

Although the airplane could generate new images at rapid speeds, with a human sighting the frame, there were issues which had not been present in the case of, say, the relatively stable hot air balloon. Airplanes moved fast; they vibrated and shook; their altitude could be up to several thousand feet in the early days of aviation.[44] The engineers of the Allied forces worked to address these issues, refining the craft of aerial photography and changing many of the basic capabilities of cameras and film stock in the process. Initially, pilots had to take cameras mounted on pistol grips or rifle stocks into the air, sighting and photographing at fairly imprecise angles over the side of the fuselage: "Pistol cameras were cradled by hand and pointed out windows, producing exposures that, for all their detail, were neither perspectivally nor geographically precise. Camera shutters froze shut, and human fingers chapped and bled. Emulsion iced over, and exposed plates were ruined before development."[45]

But the adoption of airborne surveillance had developed an "aura of inevitability by 1914" despite its early inaccuracies, and successive feats of photographic engineering pushed the

[42] Hanna Rose Shell, *Hide and Seek: Camouflage, Photography, and the Media of Reconnaissance* (New York: Zone Books, 2012), 89.
[43] Sekula, 34.
[44] Shell, 89.
[45] Ibid., 89.

technology forward.[46] All of the Allied air forces created special photographic units to handle the process and strategies of aerial surveillance. The handheld camera was soon supplanted by one mounted beneath the aircraft, cradled in a stabilizing mount on springs. Rapid, propeller-driven plate change for the cameras, special emulsions to defeat adverse conditions and produce clear exposures at higher altitudes, and high-speed shutters to reduce shake and blur made overhead photography a fully viable reality.[47] So it was that "two globalizing mediums, one of transportation and the other communication, were united in the increasingly rationalized practice of warfare… A third medium of destruction, long-range artillery, was quickly added to this instrumental collage, making possible bombardment - as well as image recording - at a great distance."[48]

Faithful correspondence to a map and to accurate geolocation were seen as crucial. In those rudimentary experiments with balloons, for instance, Union observers in the American Civil War developed a relay system by telegraph from the air; observations were reported by referencing a map grid, and the soldiers on the ground could mark a duplicate with objects of military import. This system was of course tethered, running electrical wire through the balloon cables (wireless telegraphy would not be invented for a couple decades), and could therefore be thought of as a high observation post rather than a machine for active reconnaissance. But the soldiers of the First World War likewise employed the updated grids of their era to locate photographs in physical space, relying on their evidentiary qualities to place the enemy in a drawn map. Aerial photography, once upgraded, proved adequate to the task, particularly once engineers devised a method in 1915 to "place a lens on the back of aerial cameras that recorded

[46] Ibid., 89.
[47] Sekula, 36.
[48] Ibid., 34.

the direction of the compass needle directly onto the negative… a precision crucial for mapping, modeling and analysis."[49]

Figure 5: Hythe Mk. III, a "chronophotographic rifle"

Beginning in 1916, the year of the Battle of the Somme, the Royal Flying Corps and the Royal Naval Air Service recognized the "decisive role of aerial photographs in determining British strategy" and by 1917 were suggesting "that all pilots be trained in aerial photographic practice."[50] The practice of aerial photography followed this schema: airplanes would head out over the front, bringing back their cache of images for processing. These images would be

[49] Shell, 92.
[50] Ibid., 91.

developed and placed into an organized grid, laid out in a patchwork that could be updated and replaced piecemeal as new images from the front came in. This system - a "photomosaic" style of mapping[51] - created a relatively accurate collage of pictures to represent broad swaths of territory. Photographers tried to achieve similar altitudes, light conditions, aperture, shutter speed and focal length during each sortie in order to produce consistent shots. Their goal was to "simulate, or at least approximate, laboratory conditions,"[52] bringing home shots with as little variation as possible.

The success of this system from a mapping standpoint may lead to the conclusion that "the aerial photograph was a record, prima facie, and a mosaic of indexical signs of the real."[53] But the truth was more complicated than the "raw data" presented by these indexical signs. For all its pretenses to the sort of "mechanical objectivity" outlined by Daston and Galison, the aerial photograph faced numerous interpretive challenges by human operators which required a more flexible style of reading more akin to the notion of "trained judgment": a concurrent shift in the scientific community of atlas makers who believed "objective" truth often required some interpretive intervention, "not hesitating to enhance images or instrument readings to highlight a pattern or delete an artifact."[54]

Clearly, the overhead photograph had already been enhanced and refined in a number of ways to meet specific conditions. Interpreting the myriad pictures of the French and German countryside presented another obstacle to fully instrumentalizing the image.

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[51] Ralph E. Ehrenberg, "Up in the Air in More Ways Than One: The Emergence of Aeronautical Charts in the United States," in *Cartographies of Travel and Navigation*, ed. James R Akerman (Chicago: University of Chicago Press, 2006), 241.
[52] Shell, 99.
[53] Ibid., 92.
[54] Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2007), 46.

Interpreting the Bird's Eye View

Placing images in a grid, and overlapping them to create a collage, could clear up the location of the photograph. But after that, it was the content that mattered, and the various air forces found themselves facing difficult interpretive conundrums.

For one thing, the aerial photograph presented a bird's eye view to the interpreting teams, a flattened vertical perspective that carried with it the obliteration of any horizon line. As Hito Steyerl has mentioned, this departure from a "traditional sense of orientation" lacks the illusory anchor of linear perspective and suffers the "loss of a stable horizon."[55] While cartographers had long *imagined* this top-down perspective, the airplane allowed for its facsimile, captured by camera. Simply put, the eye had to be retrained to recognize features of the landscape and human activity from an entirely new angle. Without the simple distinction between foreground and background, these two-dimensional images were little more than a single plane of abstraction: "By eliminating the horizon the aerial photograph produces and all-over visual field that… is primarily apprehended as opaque form. In this way, aerial photographs can seem as distant and blankly non-figurative as abstract painting, as if the vertical vantage that makes the aerial view possible has collapsed and left just the flat plane of the image."[56]

Simply put, these early overhead images were all but illegible to the soldiers of 1916. This was remedied, in part, through instruction: "Visual training, so called, taught soldiers how to see critically and skeptically and thereby be better able to arrive at information reliable enough

[55] Hito Steyerl, "In Free Fall: A Thought Experiment on Vertical Perspective," *E-Flux*, no. 24 (April 2011), http://www.e-flux.com/journal/24/67860/in-free-fall-a-thought-experiment-on-vertical-perspective/.
[56] John Beck, "Strangers to the Stars: Abstraction, Aeriality, Aspect Perception," in *Virilio and Visual Culture*, ed. John Armitage and Ryan Bishop (Edinburgh: Edinburgh University Press, 2013), 47.

to inform strategic military decisions and save lives."[57] Stereoscopic photography and the reintroduction of horizontal shots also gave soldiers supplementary information to the overhead shot. It was this pursuit of "truth," that the "deformations of the medium" were gradually accounted for, with planes harvesting their material in the "hours of oblique sunlight, in order that the location of shadows might distinguish convexity from concavity,"[58] in order that topography might be more obvious.

Having made some amends for perspectival issues, another deception reared its head: camouflage. The interpreters were engaged in a cat-and-mouse game of surveillance and counter-surveillance, of visibility and invisibility, never quite knowing what they were looking at. This further degraded the quality of objectivity presented by photograph, leaving it up to the interpreters to say what was actually what. Their job was a largely comparative one, reconciling a timeline of photos and searching for telltale shifts and realignments. To make this job easier, they examined their mosaic maps with stereoscopes to accentuate the signs of concealment.[59] They had to look for differences of essential objects, comparing photographs in a series. In order to identify these objects successfully, the photograph had to be reduced to a set of information with an expressly empirical goal. Sekula writes:

> "The meaning of a photograph consisted of whatever it yielded to a rationalized act of 'interpretation.' As sources of military intelligence, these pictures carried an almost wholly denotative significance. Few photographs, except perhaps medical ones, were as apparently free from 'higher' meaning in their common

[57] Shell, 94.
[58] Sekula, 35-36.
[59] Shell, 99.

usage. They seem to have been devoid of any rhetorical structure. But this poverty of meaning was conditional rather than immanent."[60]

The image itself could never have its multifarious meanings, contexts, and potential uses eliminated. But in the operations of WWI, the photographs were stripped down to a logistical purpose, because "the act of interpretation demanded that the photograph be treated as an ensemble of 'univalent,' or indexical, signs, signs that could only carry one meaning, that could point to only one object. Efficiency demanded this illusory certainty."[61] So it was that codes were developed for identifying such signs, to translate some of the uncertainty from the two-dimensional map into certainty about a three-dimensional referent, before returning the image to a flattened grid:

> "A triangle stood for a dump; a circle with a central dot stood for a trench mortar. A terrain was reduced to a set of coded topographic features, 'grounded' by the digital logic of the grid. With the development of camouflage, a low-level language game evolved in which the indexical status of the sign was thrown into question, thereby inflating the suspicions of the photo-interpreter."[62]

The logic of the grid was indeed a digital one, and the photograph was part of a binary process: yes or no, 1 or 0. Interpreters were forced to consider the image's qualities as set of indicators, and nothing more. And with photographs pouring in at staggering rates, this illusory

[60] Sekula, 35.
[61] Ibid., 35.
[62] Ibid., 35.

efficiency was a necessary step to make the image into something practical, instrumental, and relevant to the mechanics of warfare. Sekula has noted that as many as 1500 prints could be processed in an hour by a 20 worker team - large efforts requiring strict organization of labor.[63] With an apt system of interpretation in place (apt for the job at hand), the instrumentalization of the aerial photograph was complete. Stripped to their most utilitarian use value, the photographs were part of a protocol and process more than anything else. This serial and industrialized approach to the production of images at unprecedented rates made the aerial photograph logistical; it was also a harbinger of digital images and real-time surveillance loops.

Industrial Loops, Tremors of "Real-time"

"This circular loop of communication and representation configured control by working and reworking details as 'covers' and 'mosaic' compositions in order to generate a form of 'genuine knowledge', the possibility of truth through representation."[64]

"The camera-recording of the First World War already prefigured the statistical memory of computers, both in the management of aerial observation data and in the ever more rigorous management of the simultaneity of action and reaction."[65]

Sekula and others have recognized the process by which images were ingested, interpreted, and acted upon as a sort of assembly line in which humans played the critical

[63] Ibid., 37-38.
[64] Caren Kaplan, "Desert Wars: Virilio and the Limits of 'Genuine Knowledge,'" in *Virilio and Visual Culture*, ed. John Armitage and Ryan Bishop (Edinburgh: Edinburgh University Press, 2013), 76.
[65] Virilio, *War and Cinema*, 71.

reviewing role - both in the design of their information-gathering machines and in the act of looking over the fruit of the machine's vision. Sekula has referred to this as "virtual assembly-line image production"[66] while Thomas Keenan has called it "actionable evidence… linked in a network or a chain with a set of actors and agents that respond to them."[67] These evidentiary photographs were of course collected to be used more than looked at or regarded, and filled a material role in the production line of wartime recon.

But beyond their Fordist tendencies as objects of industrial efficiency, the continual feed of pictures spoke to a new order in image production and visual culture: that of the real-time loop, the live feed, the digital patchwork of refreshing views. The demands of efficiency had reduced the image as much as possible: "efficiency not only demands certainty, however illusory it might be, but makes the illusion real by automating or mechanizing their processing."[68] Having distilled the informational potential of the photograph for its military value, John Beck writes that "highly trained interpreters [could] parse representations of an environment that [had] been collapsed and denatured for them alone." This made a "closed loop… between mode of representation and its legibility," replacing any notion of a natural landscape with "functional spatial arrangements."[69] The logic of reconnaissance demanded an image that had been encoded with certain referential goals, ready-made to be interpreted as part of this mechanized loop, then discarded once an updated version arrived on the scene. It is inside this closed loop, this "mechanized process" of locating and destroying enemy forces, that "meaning, severely constrained, was a means to an immediate material end."[70]

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[66] Sekula, 36.
[67] Thomas Keenan, "Counter-Forensics and Photography," *Grey Room*, no. 55 (April 1, 2014), 60.
[68] Ibid., 61.
[69] Beck, 47.
[70] Sekula, 36.

Between the sheer number of images arriving for analysis and their temporal ephemerality, the work of the photographic units begins to look a lot like a modern, closed circuit – a live stream. Sekula concludes that this apparatus was indeed "the premonition of video surveillance."[71] Although WWI photographic grids and mosaics experienced considerable lag time, they were imbued with a sense of presence, immediacy and liveness. Each frame within the grid could be updated and amended as soon as a fresh photo was available. Indeed, the gridded assemblages of photographs resemble modern satellite mapping paradigms like Google Maps, which are not live but give an impression of witnessing the world *as it is*, while in fact containing many indexical moments and a collage of referents over time. Then as now, the fact remains that the "value of aerial photographs, as cues for military use, depended on their ability to testify to a *present* state of affairs."[72] The pictures recorded "bear witness to a particular, limited situation, recording it so as to enable operations in it."[73] That is to say, military operations. The same could be said of modern mapping imagery used today, guiding the banal tasks of navigation, orientation, and situatedness, as well as the controlling gaze of surveillance, tracking, and monitoring.

Since modern electronic surveillance systems, live streams, and television are not *really* delivered instantaneously, they are just a refined and seamless version of the early photographic loops, presenting information that has already happened, but is also happening now (in your living room). In "The Illusions of Zero Time," Virilio claims that this speed of optical cables, that of light itself, is the last "insuperable barrier"; "the televised event certainly takes place, it nonetheless makes us aware of its ultimate limit, that of the absolute speed of light… The unity

[71] Ibid., 35.
[72] Ibid., 34.
[73] Keenan, "Counter-Forensics and Photography," 60.

of time and place is split between the transmission and reception of the signals – here and there at the same time – thanks to the wizardry of electromagnetic interactivity."[74] This illusion of presence, this testimony to a live state, had already begun with maps; it was accelerated in WWI toward its eventual and (possibly) insurmountable impediment of the speed of light and of vision itself.

Figure 6: American soldiers construct a photomosaic map

During WWI, it was still obligatory to keep the human in the loop. Trained interpreters played an indispensable role, one that could not be replaced by any technology of WWI. They were training to read machine images, and were embedded in a mechanistic process. The process

[74] Paul Virilio, "The Illusions of Zero Time," in *Virilio and Visual Culture*, ed. John Armitage and Ryan Bishop (Edinburgh: Edinburgh University Press, 2013), 28-29.

sent planes out over the front, snapping hundreds of photographs. These in turn would be developed and reviewed for their content, marked and numbered for their salient features, and added to the gridded boards on the walls of command centers. When new photos came in, they too would be interpreted and the difference in new information determined. Inside this loop, in a process Keenan refers to as "decoding and recoding of the images,"[75] humans played the most critical role: they determined what the content of the photograph was, the interpretive act in a mechanical process in which both speed and accuracy were of paramount importance.

The instrumentalization of the photograph means the creation of an image that may be calculated, quantified for its present or not present signs - in effect, the conditions for machine readability. Ultimately, the promise of such a system was in fact to eliminate the human interpreter entirely, either by building interpretive functions into the very registration and collection of the picture, or, ultimately, by automating the interpreter. As Keenan artfully illustrates in his review of Sekula's queries: "The ideal goal of such an interpretive machine would be to incorporate the 'reading' of the image into the very technology that generates it in the first place, to produce images that arrive before the eye bearing their own translation into the terms required for intervention . . . and then to link that directly to the means of intervention."[76] Computers, with their algorithmic capabilities and (eventually) "deep learning" interpretive functions, would be needed to complete this puzzle.

The photographic loop of WWI was a wide and slow loop, but it began a tightening of information flow, smaller concentric circles getting closer and closer to real time: "In its machinery, its mechanical reading, it tends toward a system in which the loop between production, interpretation, and reaction can be further and further reduced and closed, to a point

[75] Keenan, "Counter-Forensics and Photography," 61.
[76] Ibid., 62.

where the image would no longer require reading in anything like the sense we currently mean."[77] It is easy to see how the photographic assembly line can be compared to modern processes of interpretation that remove the human from the equation; mechanical readings will give way to algorithmic analysis. Within the century, humans would be training machines to read images themselves. And eventually, to act on them as well.

Reframing the Battlefield: The "Logistics of Perception"

"From the commanding heights of the earliest natural fortifications, through the architectonic innovation of the watch-tower, and the development of anchored observation balloons, or the aerial reconnaissance of World War I and its 'photographic reconstruction' of the battlefield, right up to President Reagan's latest early warning satellites, there has been no end to the enlargement of the military field of perception."[78]

The techniques of reconnaissance at work in WWI provided image logistics that foreshadowed the modern operation image: something constantly updated, plastic in meaning, and interpreted by a calculated and precise reading. At the same time, the view from above reconfigured the terms for interacting with the battlefield, and the enemy. Virilio has pointed to the fusion of the camera and the gunsight as a "camera-weapon" which brings media technology and military technology together in a powerful new configuration. This mode of sighting, generated in what he calls the "first mediated conflict in history,"[79] played a critical role in the

[77] Ibid., 63.
[78] Virilio, *War and Cinema*, 69.
[79] Ibid., 69.

distancing of the soldier from the very act of war. Sekula, too, understood this facet of what he called the instrumental image, writing of the erasure of unwanted perspectives by the camera-weapon: "While the airplane lent itself to material penetration and control, the camera served mainly in a cultural and ideological campaign."[80] Aerial photography would of course change the way that soldiers saw the enemy, flattening not just topography and horizon but the inhabitants of the frame as well.

The military view from a distance produced an alienating effect due to its shift in perspective. But the tightly regulated technology that represented war - in the case of WWI, aerial photographs - made some ways of seeing and perceiving possible, while negating others. In the airborne reconnaissance systems of the Western Front, there germinated an "evolution from the sites of war as field of perception to the operation of perception itself as techno-culture." Part of this move to the *logistics of perception*, as Virilio calls it, had to do with the two logistical image systems deployed to great effect in the Great War:

> "Two technologies in particular assist the separation of the possible and impossible into configurations of control; the analogue reconnaissance photograph and the operational map. Both observational image and map mediate the new space and time of World War I by creating enhanced viewing practices based on the hybrid 'chrono/camera/aircraft/weapon'."[81]

For Virilio, WWI also inaugurated a new means of combat: to locate one's foe and wage war on an adversary, sight unseen. First came the ability to view the enemy at such a great

[80] Sekula, 34.
[81] Kaplan, 75.

distance that identification was reduced to a rudimentary human/not human binary, and destruction was assured just by obtaining a line of sight. Then gridded space and the precise calculation of distance enabled highly accurate shelling from far away. Finally, only pictures were used, to create images of the enemy in a world in which "direct vision was now a thing of the past."[82] Ultimately, the location and destruction of a target would happen without really setting eyes on the individual(s) in question. WWI did not fully realize this potential, but it set in motion the mechanisms that assured it realization. Later, during the Gulf War, another crucial turning point for Virilio, the sighting mechanisms would be aired on CNN, and the public was drawn into the same entranced encounter as the pilot - from a healthy, sterile distance. The public would eventually inhabit the very means by which the war was waged.

Virilio was not the only one disturbed by these pictures. Around the same time that he wrote *War and Cinema*, Harun Farocki began a series of film projects that traced many similar concerns through a forensic, documentary analysis of long-range views and machine vision. This work led him to an analysis of industrial image-making. And ultimately, to a new term: operational images.

War at a Distance

"Then, pictures into measurements. Today, measurements into pictures."[83]

Throughout his career, Farocki produced considerable work on the changing implications of the image in the 20th century, particularly as it aligned with the technologies of combat. Both

[82] Virilio, *War and Cinema*, 11.
[83] Harun Farocki, *Images of the World and the Inscription of War*, DVD (Video Data Bank, 1988).

in theoretical texts and his essay films, he used repetition and text suggestively to ponder the impact of logistical imagery on our material world. Each work expounds some element of its counterpart: the texts describe the films and the films exhibit the text. Beginning with his 1988 film *Images of the World and the Inscription of War*, he set about appropriating a number of logistical images, reframing them, granting them the heft and consideration that they deserve.[84] His efforts provided some historical context for the wartime generation of images - for whom, and for what, they were captured and read, and how the perception of soldiers was impacted.

The inquiry opens with a wave machine, an automated device that oscillates to make artificial waves for scientific investigation. A monotone narrator has this to say about the waves: "When the sea surges against the land irregularly, not haphazardly, its motion binds the gaze without fettering it and sets free the thoughts."[85] The film then follows an essayistic course, taking as its point of departure architectural projects of the mid 1800s in which measurement and precise calculation could be accomplished from afar using photography. The theme is one of alienation caused by sight and distance; Farocki illustrates how visual perspective could be used to determine the size of an object; obtaining measurement through photography would prove a "safer" approach. Haltingly, the narrator reveals, through repetition and close readings of photographic objects, the slippery logic and elusive meanings of aerial photographs. "Enlightenment, Aufklärung," she states with clinical remove, "that is a word in the history of ideas… In German, Aufklärung also has a military meaning: reconnaissance, flight reconnaissance."[86]

[84] This work was continued in later films, notably *Eye/Machine* (2001) and *War at a Distance* (2003).
[85] Farocki, *Images of the World.*
[86] Farocki, *Images of the World.*

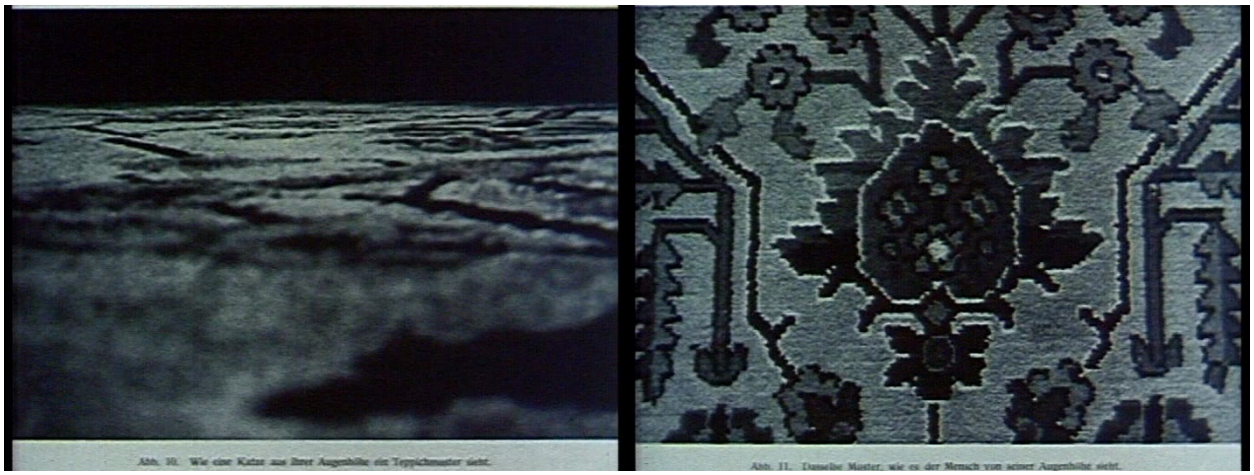

Figure 7: Stills from *Images of the World* - a cat's and a human's perspective of a carpet

Both distance and the objective of reconnaissance affect how an image is read, and *Images of the World* underscores this fundamental point. Photographs taken during an industrial bombing raid in Silesia capture Auschwitz; the photographic analysts, not looking for concentration camps, do not find it. Even when the CIA identifies the site much later, their analysis does not occur at a human scale. Trying to reinsert human beings into the frame, Farocki reminds his viewers of the traces of human life rendered unimportant or inessential by the parsing of the image. Foot tracks in the snow at Auschwitz; a barracks; an execution wall; a gas chamber. Through their objective lens, the wartime analysts identified many objects, but not human activity. Distance can create a profound alteration of context. For instance: Farocki presents an image of a rug, from a very low horizontal perspective, as a cat would see it. The image is devoid of its easily recognizable patterns from on high; it is a clever reversal to demonstrate a simple fact, one that circles back to questions of legibility and interpretation:

"Human beings must learn anew to recognize the pattern of the Earth from the perspective of the air."[87]

Farocki had a canny grasp on the "logistics of perception," describing the term before it was coined, in so many words. He illuminated the ways in which process and protocol leave critical information unchecked. The more an image is instrumentalized, the less it can say. He sought to imbue his found footage with a new voice, presenting seemingly banal images and recovering something of their information that may be hidden, yet hiding in plain sight. As Keenan remarks:

> "One does not simply see an image… its light is always shadowed by something that does not belong to the perception or intuition of the visible (which is to say, finally, to the aesthetic). Of necessity there could never be enough seeing to saturate an image. *Images of the World* fixes on what is not there to be seen, on what could never be seen, not because of some invisibility but rather because of a sort of blindness built into sight; it attends to what is not of the order of sight, to another light or an oversight in the image. Which is to say, it takes these images as inscriptions, to be read and not just to be seen or looked at."[88]

This passage strikes at the heart of the matter in Farocki's documentary, almost forensic approach: the difference between seeing and perceiving, and between perception and apprehension. What is obvious at first glance may be superficial; logistical images often need a

[87] Farocki, *Images of the World.*
[88] Thomas Keenan, "Light Weapons," in *Harun Farocki: Working on the Sight-Lines*, ed. Thomas Elsaesser (Amsterdam: Amsterdam University Press, 2004), 204.

closer look. It also touches on how the image itself is an interpreted document - a formulation of light etched onto celluloid - and a function of distance, speed, light, and of course purpose.

Farocki's approach strikes this stance: it provides not just critique, but a countershot. In this way, he occupied a crucial role that Sekula, for one, would have greatly admired. Sekula was less concerned with destroying the myth of photographic realism (and the mirror myth that photos lie) than with illuminating the circumstances of its registration; "rather, photographic evidence must be considered in terms of the forum or the debate into which its testimony is entered, what he calls in his Steichen essay its 'conditions' and what he calls in 'Dismantling Modernism' its 'presentational circumstances.'"[89]

Farocki also unearths what at the time was a relatively new technology, fairly isolated in use: adaptive interpretation, performed by machines, as in the case of the course-correcting cruise missile. Once physical labor has been automated, the automation of other human capabilities is sure to follow. Sight will be automated, and so too will interpretation. There are practical concerns - too many images are gathered for humans to evaluate. So a machine will do it: "More pictures than the eyes of the soldiers can consume. A program is being developed that automatically identifies people in vehicles on infrared photographs."[90] These remarks were the beginning of a project that would extend through the rest of Farocki's life - from *Images of the World* to *Eye/Machine* to *War at a Distance.* In the course of making these films, Farocki would identify a rupture in the automation of logistical images, enabled by computers: he would define the operational image.

[89] Keenan, "Counter-Forensics and Photography," 65.
[90] Farocki, *Images of the World.*

Operational Images, Machine Interpreters

Logistical images existed long before the computer. As part of a process and protocol, these images were reduced to their most functional purpose, leaving out all but the most actionable information. As technologies of speed and immediacy progressed - namely, the airplane and the camera - logistical pictures were embedded in feedback loops, circling their way closer and closer to real-time. But in the midst of this loop, there was always a human interpreter - an individual trained in the reading of images, in the art of making legible the overhead view, the photograph snapped at a great distance.

Computational culture transformed these logistical images into Farocki's operative images: their intake and analysis could be automated by computers. This was a new type of image, one that need not grace human eyes for verification. Operational images are "not for edification, not for reflection"[91] - they are the product of an algorithmic turn that allows for their rapid reading and analysis. What operational images *do* represent is an acceleration in the logistical use of images. The speed of modernity so aptly described by Virilio is at work in the rapid calculations of computer-driven image analysis. Computers did not enable the *invisibility* of operational images - after all, the means by which images are registered and employed has been quite often invisible throughout the history of logistical images (film exposures, radio grids, etc.). But this acceleration of image-harvesting and capture necessitated a new group of automated actors in the form of machines.

Humans, being too slow to analyze the vast number of images recorded by technologies of surveillance and reconnaissance, were displaced in many of their analytical capacities by

[91] Harun Farocki, *Eye/Machine I, II and III*, DVD (Video Data Bank, 2001).

machines. Adopted for many industrial endeavors, the algorithmic parsing of images allowed for faster and faster data processing. Computers allowed the number of images generated automatically to grow exponentially; they likewise enabled the rapid analysis of these images. Only computers could keep up with the vast number of images generated daily.[92] On the production line, the human role shifted to that of a supervisor who rarely intervenes; closed circuits and machine perspectives are "images to monitor the predetermined."[93] Yet people are still "in the loop" in many of these accelerated cases. An assembly line still requires humans to monitor and assess its accuracy, despite its robotic arms and machine eyes. Nonetheless, the loop has been constricting, drawing tighter. Self-driving cars do not require human intervention - so long as they can drive with precision. Corrective functions are introduced; missiles take flight and correct their own paths to a target.

The operational image shares salient characteristics with its broader logistical family. To name a few arenas of such images: license plate readers, cruise missiles, ISS modules, assembly lines, facial detection. What these systems share with their predecessors is their base purpose: locating and manipulating objects in space. At first blush they are quite similar to early instrumental images, grounded in the science of cartography, the grid, and the indexical image; they are precisely located in a mapped terrain. But this relatively new preponderance of computer-analyzed images in fact is a reciprocal arrangement to earlier navigational pictures: rather than assisting human operators in locating themselves in space and in relation to objects, these new operational images exist to locate objects and humans, positively identifying them for a computer. The question of location has long been solved through standards like UTM and GPS,

[92] Lev Manovich, "Automation of Sight: From Photography to Computer Vision," *manovich.net*, 1997, http://manovich.net/content/04-projects/014-automation-of-sight-from-photography-to-computer-vision/11_article_1997.pdf, 9.
[93] Farocki, *Eye/Machine.*

systems that computers can readily harness to know exactly where an object (or person) lies. Or, as has been stated by Trevor Paglen, "we no longer look at images - images look at us."[94] This is directly borrowed from Paul Virilio's text *The Vision Machine*, in which he quotes the famous Bauhaus artist Paul Klee as having said, some years ago, and before the advent of the computer, "now objects perceive me."[95]

The Interpretive Turn

The computer actor performs two decisive functions. One is operational; it is the automated analysis of images within fixed parameters, driving a predetermined outcome. The other is something more nebulous, more complex, and more troubling. It is the automation of interpretation itself, the use of flexible machine learning systems that are themselves contingent and adaptive, and whose rationale may not be legible or even extractable. This second function looms large, and while it has not yet taken over in any kind of ubiquitous sense, the companies and state actors employing this new technology envision an increasingly important role for their deep learning systems. This is evident in the advertising copy of many modern firms, whose claims for machine learning capabilities in the analysis of images verge between impressive and alarming.

Operational images may include human-readable processes and outputs: for example, the functions of a facial recognition algorithm or a self-driving car, which have clear parameters for image ingest, analysis, and subsequent action (notably in the reading of lines in an image).

[94] Trevor Paglen, "Invisible Images (Your Pictures Are Looking at You)," *The New Inquiry*, December 8, 2016, https://thenewinquiry.com/invisible-images-your-pictures-are-looking-at-you/.
[95] Virilio, *The Vision Machine*, 59.

However, the operational image's fully automated valence has been expatiated in recent scholarship: it can be part of a convolutional neural net (CNN), part of the process of so-called "deep learning" networks. In this situation, the image can be analyzed, its contents acted upon without a delivering a rationale to human intermediaries. This is what can be called the *interpretive turn*, a moment that is changing the way that image operations and logistics are governed and utilized.

This moment has engendered many a dystopian prognostication, hinted at not just by the likes of Paglen but by Virilio as well - this forms but the latest phase in a slow encroachment by military and state actors in the logistics of perception, to the point where the image is rendered illegible due to its machine-made/machine-read nature. Under this machinic paradigm, full automation, devoid of human intervention, is inevitable.

Through a close reading of Farocki, Virilio and Paglen, this chapter traces the emergence of the operational image and its slide toward automated interpretation. While most contemporary operational images are *not* part of a neural net or deep learning system, these novel software constructs are gaining ground in the world of logistical images. Recent advertising copy from a number of companies touting broad machine learning capabilities point to this incursion. The increased prevalence of neural net actors raises a number of ethical questions: when humans can be entirely excluded from the process of interpretation and review, what are the implications? How are power structures reified, and how is a veneer of objectivity maintained throughout this process? These are some of the overarching questions this chapter addresses.

Farocki's Eye Machines

"Similarly, there are no pictures that do not aim at the human eye. A computer can process pictures, but it needs no pictures to verify or falsify what it reads in the images it processes."[96]

Farocki's work on the circulation of operational images maintained an evidentiary quality, a style similar to his earlier film *Images of the World*. He recontextualized the image as he had before, and traced its operations in a repetitive fashion. With *Images of the World*, he had made some preliminary observations on the military role of machine vision and its automation. His subsequent work, *Eye/Machine*, built upon his previous theories and insights, while simultaneously addressing the growing presence of operational images in everyday life and technology.

Eye/Machine dispenses with voiceover, instead annotating the images with text. The film was created for an installation, and features multiple images within the frame. The black areas are intermittently punctuated by phrases that point to the operations of the pictures on the screen. The video begins with a shot from the Gulf War - a smart bomb finding its target, shown twice in slightly overlapping frames; a suicide camera, correcting its own course. From the eye of the smart bomb targeting system to the more nebulous overhead views of shopping carts and parking lots, Farocki recontextualizes the imagery with commentary like this:

> "Images from flying projectiles, images from suicide cameras. These images lack plasticity. The human scale was missing. Without reference to everyday

[96] Farocki, "Phantom Images," 21.

experience the images failed to grip. These images are devoid of social intent. They are not for edification, not for reflection."

The pixelated street for a self-driving car that exists anywhere, the targeting data of missiles on anonymous bridges and critical infrastructure in Iraq - only Farocki's text and voiceover place the viewer back in the image once more, locating and grounding it in the physical location of its provenance. In the map, the view from above, and the machine gaze, there is a flattening, an eradication of perspective and understanding. Indeed, these operational images create ambiguity and, devoid of human actors or context, are vague in their site-specificity. In his essay Phantom Images, Farocki wrote that "it must be noted that in these 1991 Gulf War images, no people can be seen. The battlefield is uninhabited. When you see an entire roll of such images you cannot help but think that the war will continue on well after humanity has disappeared from the face of machines."[97]

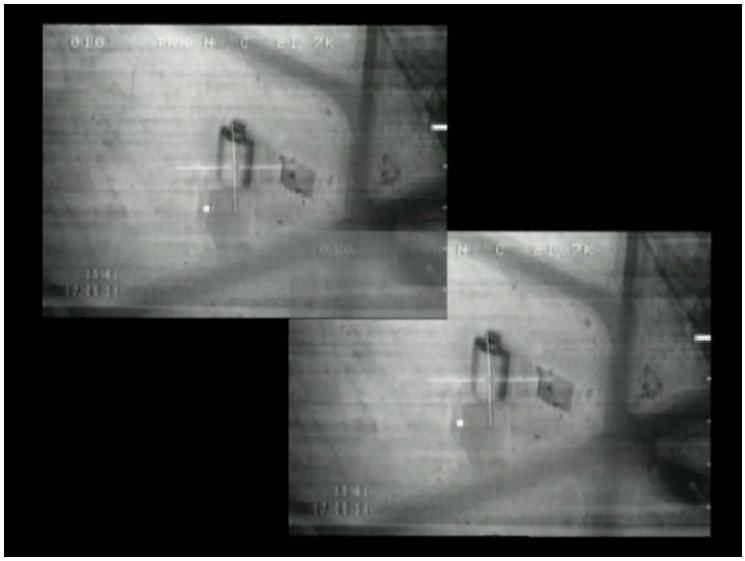

Figure 8: Still from *Eye/Machine*

[97] Ibid., 15.

In *Eye/Machine*, Farocki slowly builds a case for the influence of machine actors, showing time and again the smart bomb camera, the self-driving car, and the assembly line, all from the perspective of the detached, machinic gaze. With each successive technology, each iteration, he returns to underscore the relationship between production and destruction: the assembly line's camera-eye harkens back to that of the missile's camera; the void of the aerial battlefield recalls the emptiness of the factory floor; the self-driving car reconciles the physical world as seen through a camera with stored geographical data, much like the cruise missile. For its part, the cruise missile relies on a real-time system of analysis and correction: "the apparatus HIL, short for 'hardware in the loop,' is a machine that tests the flight path of rockets as they travel towards their target and corrects their course, independently navigating their flight to their strategic objective."[98] Like a self-driving car, the system searches for familiar lines and contours, performing on-the-fly acts of recognition and adapting its course, turning lines from green to red when an object is positively identified, "rather like a somewhat slow-moving mind that underlines in red a thought that seems to be correct."[99] Inelegant, effected with fragmentary clumsiness, "these sensory automatons are supposed to replace the work of the human eye."[100]

What redeeming value can be gleaned from Farocki's meditation on the automated interpreter, the end user of the operational image? Humans can create systems that reduce the image to a sort of yes/no legibility. But before, there was a human intermediary to interpret and act upon the information presented. Machines, acting independently, will see only what they are instructed to see, and nothing more. This cold gaze (a kind of "blindness") was an area of fascination for Farocki since the late 80's, when he first hinted at these systems and the power

[98] Ibid., 17.
[99] Ibid., 17.
[100] Ibid., 17.

they would soon wield. In *Eye/Machine*, the tone is decidedly sinister. Farocki's intervention builds important evidence regarding the influence of operational images in daily life, showing the visual mechanisms by which they function. And in doing so, "Farocki demonstrates that our naive anthropocentric notions of vision and the visible are obsolete in today's world."[101]

Automated Analysts

In his description of machine actors, Farocki certainly pointed to the ever-closing loop in which humans are relegated first to supervisors and eventually - in some an easily foreseeable future - discarded from the interpretive process entirely. From assembly lines to license plate readers to facial detection to drones, the modern instrumentalized image is an intrinsic part of logistical endeavors the world over. Not surprisingly, much of the early efforts to automate the perception and reading of images came from the state and military, with the NSA and CIA driving early efforts at character and speech recognition, essential components of mechanical translation. This was initiated by the agencies' desire to snoop with greater efficiency on Russian communications, flagging keywords and phrases for review by agents.[102]

Machine vision works through a perspectival, geometric process. The computer "sees" images by tracing lines in an object, detecting edges and contours. At first this processing was limited to individual images, but soon enough - as early as the 1970s - computers were performing basic analytic tasks, sorting and comparing images through subtractive processes that sought to identify differences: "The techniques of image processing, which can automatically

[101] "War Vision," *San Francisco Cinematheque,* accessed July 17, 2017, http://www.sfcinematheque.org/war_vision_two_by_harun_farocki_03_04_2004/.
[102] Manovich, "Automation of Sight," 8.

increase an image's contrast, remove the effects of blur, extract edges, record differences between two images, and so on, greatly eased the job of human photoanalysts."[103] Lev Manovich writes that these machines were first employed by the National Photographic Interpretation Center, which had reached an overwhelming intake level of satellite pictures. Human analysts were no longer up to the task, but computers were - and they only got faster at their jobs. At first the machines were used to simply flag new information: objects changed and the computer pointed analysts to the differences. But soon, the analysis itself could be built into the software:

> "The combining of image processing with pattern recognition made it possible in some cases to delegate the analysis of photographs to a computer. For instance, the technique of pattern matching used to recognize printed characters can also be used to recognize objects in a satellite photograph. In both cases, the image is treated as consisting of two-dimensional forms. The contours of the forms are extracted from the image are then compared to templates stored in computer memory. If a contour found in the image matches a particular template, the computer signals that a corresponding object is present in a photograph."[104]

These days, there are many comparative systems at work, sorting images into classes of objects; they are known as linear classifiers. Trained on vast image databases like Imagenet, these programs allow machine vision to perform at very high levels of accuracy, averaging images from millions of pictures to determine a given object's identity. This process has gotten better and better at positively identifying the content of pictures, particularly with the advent of

[103] Ibid., 10.
[104] Ibid., 10.

convolutional neural networks. These computers refer information through a complex web of decision-making processes to determine the value or identity of an object:

> "The earliest layers of the software pick apart a given image into component shapes, gradients, luminosities, and corners. Those individual components are convolved into synthetic shapes. Deeper in the CNN, the synthetic images are compared to other images the network has been trained to recognize, activating software 'neurons' when the network finds similarities."[105]

One concern here is that these systems are given a veneer of objectivity by their designers while they in fact compound the power structures of our society. Paglen lists off a number of examples, with the case of a company called Vigilant Systems standing out in particular. Their company offers live machine vision for fixed locations and police cruisers; the cameras scan and read license plates using optical character recognition (OCR) and compare the numbers and letters against a database of delinquent offenders. They can then immediately alert the police to apprehend the vehicle. If the offender has unpaid fines, the cop will give the individual two options: immediate payment or arrest. In this arrangement, "municipalities are incentivized to balance their budgets on the backs of their most vulnerable populations, to transform their police into tax-collectors, and to effectively sell police surveillance data to private companies."[106] Power has long flowed through operational imagery, and this is just the latest instantiation. But with increased "invisibility" of the images themselves - buried in databases and never made visible for human eyes - it can be much harder to elucidate and critique their operations. Like

[105] Paglen, "Invisible Images."
[106] Ibid.

maps, grids, and overhead surveillance, "machine-machine systems are extraordinarily intimate instruments of power that operate through an aesthetics and ideology of objectivity, but the categories they employ are designed to reify the forms of power that those systems are set up to serve."[107]

A second concern is that "deep learning," algorithmic systems can provide adaptive and contingent models for reading and detecting images, which includes the ability to detect and mitigate false data and efforts at obscurity or camouflage. For Paglen, this is a kind of point-of-no-return. Now, he claims, computers can have complex adaptive capabilities that allow them to detect fakes, skirt red herrings, and train on "adversarial" images deliberately crafted to fool their parameters. The key to continued subversion is not just artistic interventions, but a rethinking of the endemic nature of machine images in everyday life. Yet Paglen's own projects align with ongoing efforts to reveal the operations of machines, infrastructure, and traces of state and corporate power hiding before our very eyes. Furthermore, there are multiple means by which operational images can be deconstructed; methods of intervention from bygone eras must meet with new techniques for subversion in an era of "invisible images" and deep learning. Techniques must of course be adapted; the back-and-forth game in Hanna Rose Shell's *Hide and Seek* must continue in perpetuity, only now, the game pits human against machine. Or, in Paglen's words, "the point here is that if we want to understand the invisible world of machine-machine visual culture, we need to unlearn how to see like humans."[108]

[107] Ibid.
[108] Ibid.

"Sightless Vision"

Before this takeover, and given that machine vision actually dates to the 1960s, there were a number of prescient texts and works that pointed to our contemporary predicament. Beginning in the 1980's, Virilio outlined his concerns as the image drifted away from human-oriented representation and toward political and industrial utility. After the Gulf War, he saw a turning point in the use of automated killing machines: smart bombs and cruise missiles were now ubiquitous features of warfare, with their own targeting mechanisms featured on cable news broadcasts. Manovich has written that the Gulf War first exhibited the West's ability to wage - and win - war through the use of imaging technologies; the conflict's outcome "was largely predetermined by Western superiority in the techniques of perspectival representation."[109]

For Virilio, this spelled but the latest chapter in the "logistics of perception" - an automated turn that would further enable the control of visible events by the military and the state. In his book *The Vision Machine,* written in 1994, Virilio considers the changing implications of the image when more and more computers generate and analyze an ever-growing number of pictures, images, and sensor data. Some of it is visible to the naked eye, and some is not. Most importantly, these images of infrared enemies, thermal targets and laser-guided bombs represented a schism in the representations of war, replacing the reporter with a direct view of the visual mechanisms of annihilation, along with it an assurance of technical superiority. The future that Virilio had already written about in *War and Cinema* - the finite limits of weaponry as

[109] Lev Manovich, "The Mapping of Space: Perspective, Radar, and 3-D Computer Graphics," *manovich.net*, 1993, http://manovich.net/content/04-projects/003-article-1993/01-article-1993.pdf, 1.

the speed of light - came alive: “The Gulf War was the combat of surveillance against camouflage, visibility against invisibility, human eye against computer eye.”[110]

But again, these images were created for humans to see, for purposes of verifiability, corrections, and the assurance of complete destruction. Virilio expands on his predictions in *The Vision Machine*, and correctly assesses that the future of image-driven operations will be primarily a challenge of speed. The ability to parse images, to ingest them with rapid ease and provide analyses and subsequent action - this would be the next phase in the logistics of perception, and the ultimate phase of the operational image:

> “‘Vision machines’ designed to see and foresee in our place… These synthetic-perception machines will be capable of replacing us in certain domains, in certain ultra high-speed operations for which our own visual capacities are inadequate, not because of our ocular system's limited depth of focus, as was the case with the telescope and the microscope, but because of the limited depth of time of our physiological 'take'.”[111]

Virilio worried fitfully about the future “automation of perception,” about the “sightless vision” used when a computer and a video camera form a closed loop. Their hidden decision-making process is a walled-off world: “Having no graphic or videographic outputs, the automatic-perception prosthesis will function like a kind of mechanized imaginary from which, this time, we would be totally excluded.”[112] Indeed, it has come to pass. But the systems behind

[110] Ibid., 1.
[111] Virilio, The Vision Machine, 61.
[112] Ibid., 60.

these operations have effects; they leave behind evidence. Often, these technologies make their way into the public domain in the form of consumer software and electronics. Sometimes they are even the stuff of television broadcasts, as in the case of the Gulf War. It is here that they can be deconstructed and reflected upon, and even used as adversarial tools in the questioning of centralized power.

Paglen's Forensics

Where Farocki has repeatedly used found footage sourced directly from machines as his evidence, Paglen has used other means to gather and analyze the forensic details of machine operations. In multiple lectures, panels, and public appearances, Paglen has referred to his role as an "astronomer, trying to learn about some of the universe's more exotic features indirectly,"[113] peering into the night sky for some collateral evidence of activities hidden from the naked eye.

He has completed many projects that train the gaze of the camera back on the infrastructure of highly secretive, classified operations by the United States. From the existence of secret air bases in the deserts of the American Southwest to the cataloguing of spy satellites in his project "The Other Night Sky," Paglen obsessively searches for the traces, vestiges, and visible evidence that is left behind for ordinary citizens to observe and identify. Some of this evidence is vague, blurry, and almost indecipherable. Some of it is in sharp relief, with its motives hidden. While Farocki sought to give infrastructural context to machine-generated images, Paglen looks for the infrastructural evidence of secret sensing operations. In a panel titled "Art as Evidence" at Transmediale 2014, Paglen gave this rationale for his practice:

[113] "Trevor Paglen - Transmediale 2014 Keynote: Art as Evidence," YouTube video, 23:03, posted by "transmediale," January 31, 2014, https://www.youtube.com/watch?v=SDxue3jGAug.

> "Coming back to this pole of abstraction that my work always is going towards… for me this abstraction of everyday life comes from learning how to notice the ways in which everyday objects and environments have become militarized or weaponized, and the meanings of everyday objects in the visible world have become suspect… We don't have to look any further than the everyday objects that we live with, every day."[114]

In the same talk, he shared the improbable traces of secret SIGINT missions and units, which ironically have unique patches, to be worn on the uniforms of their operatives. Stranger still is the iconography of the patches, which appropriate symbolic meaning from the domains of science fiction, fantasy, occultism, and freemasonry.

In addition to pointing out both the obscure and the obvious, Paglen has recently worked to construct art projects that visualize the invisible. In a project with Obscura Digital titled "Sight Machine," Paglen worked with programmers to create a visualization of how facial detection works. The team used "actual off-the-shelf artificial intelligence surveillance algorithms"[115] to generate visual representations of the machines at work. Their target was a live performance by the Kronos Quartet, with the resulting images projected behind the musicians as they played. Lines trace contours, circles identify salient objects, and familiar yellow boxes bound faces. The project was made with many of today's standard toolkits for computer vision, like Tensor Flow

[114] Ibid.
[115] "Trevor Paglen's 'Sight Machine,'" *Obscura Digital,* accessed July 18, 2017, http://obscuradigital.com/work/trevor-paglens-sight-machine/.

and Torch. But to make the mechanics of such software visible was in fact difficult - many of the systems utilized lower frame rates, and latency presented an obstacle:

> "These AIs — whether for facial recognition, object identification or threat detection — are designed to communicate with their machine counterparts, not to provide human-readable output. Making that possible in realtime required Obscura's systems engineers to maximize throughput in a Herculean research and development effort."[116]

In building the project, Paglen wanted to make a strong visual representation of the "enormously powerful optimization tools" embedded in our world, calling their very optimization - their drive for efficiency - into question. It is again a case of producing a body of evidence that speaks to otherwise hidden operations; in an interview on the project, Paglen rightly asks: "whose interests are they going to optimize the world in?"[117]

Figure 9: Trevor Paglen and Kronos Quartet, "Sight Machine" performance

[116] Ibid.
[117] Ibid.

Algorithmic Parsing vs. Deep Learning

Computers enable the operational image and its rapid algorithmic analysis. They also enable complex learning networks, adaptive systems that can change and hone their own accuracy and capabilities. In a way, Paglen expanded the definition of the operational image with the addition of these deep learning interpreters. Farocki had already laid some of the groundwork for this interpretive shift, pointing to it time and again in his films on the operational image. Algorithmic parsing of an image - by a self-driving car, for instance - hints at the possibilities of interpretation, but it is in neural nets that the operational image undergoes an automated act of reading that is hard to scrutinize. For one thing, as Paglen claims, these CNNs do not necessarily provide a *modus operandi*, but rather a conclusion presented as objective while the human-engineered design and priorities remain clouded. This opacity is a real problem for attempts to analyze these analytic machines. The budding sophistication of these deep learning systems poses difficult questions for the future of the image and for possible interventions. Not only can the image reside as sensor data, never rendered out for human eyes, but its very design and operations become invisible as well.

Operational images are embedded in algorithmic processes, but historically, these processes have been relatively transparent and easy to categorize and understand, as Lev Manovich so adeptly summarizes in his writings on machine vision and computational culture. Tarleton Gillespie also provides a useful outline of what these programs can do in his essay "The Relevance of Algorithms." In the first place, they rely on databases to even function; that is, on information rendered machine-readable and machine-intelligible. An image, for instance, must be reduced to pixels, coded in terms of position and RGB color value. Algorithms are in fact

quite rigid, and thus it is hard to think of them as "interpretive" structures. There are clearly delineated categories, groups that "will be treated with reverence by an approaching algorithm."[118] Basically, the algorithm can sort items, create hierarchies, and compare values. Just as with instrumental readings of photographs, instrumental uses of data will naturally leave out that which is deemed irrelevant, and will do so without hesitation. Algorithms are task-specific:

> "Algorithms need not be software: in the broadest sense, they are encoded procedures for transforming input data into a desired output, based on specified calculations. The procedures name both a problem and the steps by which it should be solved. Instructions for navigation may be considered an algorithm, or the mathematical formulas required to predict the movement of a celestial body across the sky."[119]

Information is coded as a data set, then decoded according to a set of parameters. Gillespie also voices concern over the perceived "objectivity" of algorithmic processes, echoing Paglen's adamant exhortations: "though algorithms may appear to be automatic and untarnished by the interventions of their providers, this is a carefully crafted fiction."[120] It is in the interest of the provider, he writes, to provide an articulation of algorithmic objectivity - but these systems are not devoid of value judgments.[121]

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[118] Tarleton Gillespie, "The Relevance of Algorithms," in *Media Technologies: Essays on Communication, Materiality, and Society*, ed. Pablo J. Boczkowski, Kirsten A. Foot, and Tarleton Gillespie (Cambridge, Massachusetts: The MIT Press, 2014), 171.
[119] Ibid., 167.
[120] Ibid., 179.
[121] For more on computational categories as value systems, see Bowker and Star, *Sorting Things Out* (2000).

When machines can pass information back and forth between multiple algorithms, as is the case with neural networks, *interpretation* becomes an appropriate term; these computers use "a machine-learning technique that draws on the way networks of neurons in the brain adapt to new information"[122] But these systems are often opaque and lack accountability. In "The Dark Secret at the Heart of AI," Will Night warns that we must "find ways of making techniques like deep learning more understandable to their creators and accountable to their users. Otherwise it will be hard to predict when failures might occur—and it's inevitable they will."[123] In the same article, Knight refers a self-driving car produced by Nvidia, one that does not drive according to a saved instruction set, but rather using a deep learning process that had *taught itself* by observing a human at the wheel. While the parameters of these learning systems are defined by engineers, their internal processes can be difficult to examine. Companies deploying deep learning refer to a kind of profound intelligence that can solve human problems with the efficiency of calculators and the complex reasoning of homo-sapiens.

To elucidate this slide toward ever-more-automated interpreters and underscore its consequences, it helps to consider the promises and predictions made by those companies who flaunt their machine learning prowess and unprecedented ability to identify objects. Outfits like FindFace, Camio and Smartvid.io all tout their ability to achieve unprecedented accuracy and efficiency with deep learning. NTechLab, the company that made FindFace, will "create algorithms as intelligent as humans and as efficient as machines." to positively identify individuals in a crowd.[124] Camio uses deep learning coupled with video surveillance to create

[122] Rachel Metz, "Camio Uses Neural Networks to Identify People, Packages, and Cats in Surveillance Footage," *MIT Technology Review*, accessed July 29, 2017, https://www.technologyreview.com/s/540396/using-deep-learning-to-make-video-surveillance-smarter/.
[123] Will Knight, "The Dark Secret at the Heart of AI," *MIT Technology Review*, accessed July 15, 2017, https://www.technologyreview.com/s/604087/the-dark-secret-at-the-heart-of-ai/.
[124] "NTechLab - Augmenting Intelligence," accessed August 5, 2017, http://ntechlab.ru.

delivery alerts for the voracious online shopper, and "learns what you care about from the way you use it, so it gets smarter over time, continuously improving your daily summaries and alerts."[125] Meanwhile, Smartvid.io makes similar claims, deploying networks of cameras that scan industrial work areas, training themselves to recognize problems and to alert supervisors so that they may enforce "safety, quality, and productivity"[126] on the job site. It is easy to imagine how enforcement can be automated, too, and all under the presupposition that the machines have correctly ascertained a situation in their infallible impartiality, all without producing any kind of legible rationale. As Farocki reminds us, "The pattern of recognition and object tracking of seeing bombs threatens with infallibility. Paul Virilio's comment that these images are aimed at us sounds like a self-fulfilling prophecy."[127]

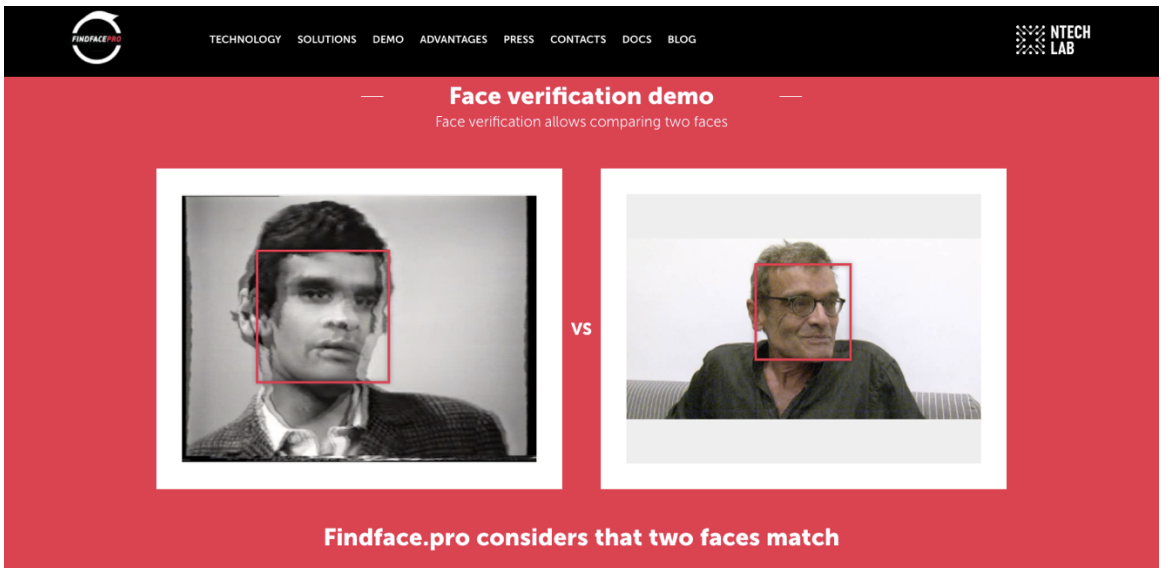

Figure 10: Findface.pro considers that the two faces match

[125] "Camio Features" *camio.com*, accessed August 8, 2017, https://www.camio.com/features/.
[126] "Smartvid.io - Industrial Photo and Video Management Using Machine Learning," accessed July 29, 2017, https://www.smartvid.io.
[127] Farocki, "Phantom Images," 16-17.

These are indeed the kind of systems that so alarm Paglen, and that Farocki points to repeatedly in his work. The two of them have both endeavored to make the invisible systems behind operational imagery visible, to use the images captured by machine actors or to create visual outputs of what a machine "sees." Together, their artistic practices point to style of intervention that is evidentiary and forensic. The scope of such interventions is of course much larger than just these two; other styles have been adopted in the past and will be required in the future to confront this new crop of byzantine software constructs. Undertaking a broader survey of subversive action against logistical and operational imagery may help light the path forward, drawing the invisible out of the dark.

Studies in Subversion: Haussmann to Google Earth

When objects depart from the realm of the visible, away from the human-observable, acts of recuperation are required to bring them to light once more. This is what both Farocki and Paglen have done through their artistic and theoretical practices. But when the images are not only elusive, but internal to a machine process that immediately uses and discards them, the task of the evidentiary artistic gesture becomes much more difficult and complex. Add to this the fact that deep learning systems can use images in new and inscrutable ways, performing internal acts of interpretation under the guise of objectivity. To intervene and demystify these processes is a great challenge to visual artists and theorists, as the automation of interpretation is often a closed loop, without points of entry. This is the essence of Paglen's alarmist yet poignant article "Invisible Images": these days, many images are never visible to us, or even accessible, and these images are the currency in an economy of machine-driven decisions. Naturally, this reality creates great consternation for those trying to pose new methodologies for intervention.

To construct some predictions for future efforts, it helps to reach into the past, farther than Farocki, to discover earlier attempts at subversion and disruption. Accordingly, this chapter describes a number of artistic interventions that have responded in kind to the increased power of logistical and instrumental images, placing the work of Paglen and Farocki in a broader context.

In the postwar era, one of the most famous subversive art collectives arose in France. First called Lettrist International, they eventually changed they moniker to Situationist International. Their leader, Guy Debord, is known for working across art forms, including film and literature, but it is his work in geography - or, to use his term, *psychogeography* - that stands out as a direct intervention in logistical imagery. Rather than using abstract tools of measurement

and empirical data to drive navigational practices, the human sensorium was used to map locations throughout a city. Debord's work was reflected in the alternative mapping practices of academics from MIT and Clark University, who likewise felt urban planning to be far too ossified and rigid, and tried to aggregate and represent experiential data from multiple human navigators.[128]

These counter-mapping strategies proved an important intervention in conventional cartographic practices, deploying alternative cartographies for humanistic readings of the cityscape; this was a phenomenological method to urban understanding. There are some lessons to be learned from the Situationist approach to disrupting the power of images, for their interventions were early answers to the instrumental image, and its uses in urban planning and the tight control of space. Indeed, the Situationists were reacting against an entire way of life suggested by gridded maps and their role in the project of modernism, with its clean lines and sterilized notion of urbanism. Theirs is an attempt at decontextualizing, a way to disrupt invisible grids of guidance and limitation that rely on finite calculability, replacing them with a project that had at its heart openness, contingency, and chance encounters.

Their work provides an early example of intervention with instrumental images - unmasking them and bringing them out into the open. Demystifying the apparently rational objectivity of the map, pulling at its seams and the motivations of its creators, and presenting alternative scenarios was the goal of the counter-mappers. Given that many logistical images - from the grid onward - were developed primarily to facilitate military action only adds to the urgency of their exposure by artists. The need to locate people and objects in space is obviously a

[128] Denis Wood, "Lynch Debord: About Two Psychogeographies," *Cartographica* 45, no. 3.

critical function of any controlling or governing entity; as such it should come as no surprise that police and militaries have sought continuously to find new methods to this end.

This ethos of unmasking has not diminished over time - it pervades the work of Farocki and Paglen, and can be found today in modern counter-mapping strategies. And contemporary efforts are not limited to counter-mapping. As the province of logistical and operational imagery has expanded, so too have the diverse responses from artists across the globe. They seek not only to counter-map or to provide evidence, but to challenge the latent power of machine vision and its voracious ingest of images the world over. Some approaches are more or less a continuation of well-established artistic strategies, like those of Debord and Farocki. One is new, borne out of the digital age and its machine interpreters. These categories are as follows:

1. **Forensics/evidence**

   Deployed by Farocki, Paglen, and others, this mode of resistance takes visible images and deconstructs them, framing them in context or demystifying the process of which they are a part.

2. **Glitches/artefacts**

   Modern systems of image-generation and mapping often leave behind artefacts that have been gathered by artists, perhaps most notably in Google Earth. Added to this are efforts to force glitches through manipulation of the system, often through the intentional

corruption of data. This is primarily a software-based intervention, only because these glitches and byproducts are typically of a digital nature.

3. Tactical media[129]

When images become part of the internal processes of machine vision and interpretation, a direct confrontation with the sensors that gather the data is required. There are many ways to combat gathering efforts; some salient contemporary projects resist facial recognition and detection, or deploy them in counter-surveillance efforts.

The projects that typify these approaches, particularly in the last category, serve as guiding lights to reveal and actively subvert the many operational images at work today. Outlined above are strategies both new and old, and it is likely necessary to employ them all if efforts at subversion are to be successful. This is because some operational images have continued unchanged, within the public's view and means of acquisition, while many others have faded from the realm of the visible along with the algorithmic processes that govern their actions. There is a common theme to the last category of interventions: as individuals, *we* must be camouflaged, while it is the power structures driving these images that deserve an unwavering gaze.

Reaching back to Debord and looking ahead to the future, this chapter fills in something of the broader range of logistical image interventions. It is an attempt to provide a concrete

[129] I am using this term in a more specific sense than the tactical media of groups like Critical Art Ensemble. Incidentally, their work aligns very much with the work of SI, creating "hit-and-run" situations in a tactical fashion.

overview with an eye to the diverse means by which the operational image may be confounded and disrupted going forward.

New Maps for Old Landscapes

The history of logistical images runs quite deep, facilitating not just calculations and a drive toward efficiency, but the machinations of human ambition and the exercise of power. Because the grid is a hugely important logistical image, and because it provided some of the calculable substructure for current operational images, it is worthwhile to spend some time on a great act of subversion against the gridded landscape and geometric city planning: the interventions of Situationist International, led by Guy Debord.

While grids themselves may have been invisible or illegible to the general public, the power of maps and guidance systems in informing the public imagination was not lost on everyone. Around the same time that the first satellites were flung into low Earth orbit, the French lettrists (soon to be situationists) began formulating new approaches to urban geography. Disturbed by the clean grid lines of modernism and the stratification of space they entailed, Guy Debord and his contemporaries began to consider new means of interacting with city landscapes. In his *Critique of Urban Geography,* Debord writes:

> "Historical conditions determine what is considered 'useful' Baron Haussmann's urban renewal of Paris under the Second Empire, for example, was motivated by the desire to open up broad thoroughfares allowing for the rapid circulation of troops and the use of artillery against insurrections. But from any standpoint other

> than that of facilitating police control, Haussmann's Paris is a city built by an idiot, full of sound and fury, signifying nothing. Present-day urbanism's main problem is ensuring the smooth circulation of a rapidly increasing number of motor vehicles."[130]

Debord diagnosed a problem: in building the *grands boulevards*, Haussmann had erected little more than a utility for the purposes of military movement, and an enduring monument to impress upon the public the grand power of the French state. In the process, he had left the same public bereft of a mindful interaction with the very landscape they inhabited. Not content to blame the alienating cityscape on Haussmann alone, Debord fulminated against the perceived arrogance of Le Corbusier, who he and Asger Jorn labeled a cop, "nicknamed him Le Corbusier-Sing-Sing after the notorious prison," and critiqued at length a totalitarian modernism that sought "to design not just the fabric of the city but the social, spiritual, and economic minutiae of everyday life."[131] The Ville Contemporaire, for example, was a nonsensical entity founded on a "vision of people at ease in an ideal urban landscape, a place where the struggle with nature, with the body, with space, and with class had inexplicably come to an end."[132] The problem was the rigid planning of urban spaces, and the images of rational utility that drove their planning, construction, and navigation. "Urbanism," Debord wrote "renders alienation tactile."[133]

In the search for a means of subversion, Debord arrived at the term psychogeography as a new cartographic approach: "Psychogeography could set for itself the study of the precise laws

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[130] Guy Debord, "Introduction to a Critique of Urban Geography," *Situationist International Online*, accessed July 3, 2017, http://www.cddc.vt.edu/sionline/presitu/geography.html
[131] Simon Sadler, *The Situationist City* (Cambridge, Massachusetts: The MIT Press, 1998), 50.
[132] Ibid., 77.
[133] Guy Debord and Asger Jorn, *Mémoires* (Copenhagen: Permild and Rosengreen, 1959).

and specific effects of the geographical environment, whether consciously organized or not, on the emotions and behavior of individuals."[134] Critically, Debord did not see the project as something that endorsed the randomness of the Surrealists ("imbecilities") but rather a new mode of urban interaction with its own rules and criteria designed to bring unseen elements of the cityscape to the foreground. The idea was to subvert the present model of urban habitation and mobility, while proposing a conscious, purposeful wandering in its place:

> "Among various more difficult means of intervention, a renovated cartography seems appropriate for immediate utilization. The production of psychogeographical maps, or even the introduction of alterations such as more or less arbitrarily transposing maps of two different regions, can contribute to clarifying certain wanderings that express not subordination to randomness but complete insubordination to habitual influences (influences generally categorized as tourism, that popular drug as repugnant as sports or buying on credit)."[135]

Debord seemed to grasp, somewhat intuitively, that the mental image of the city imposed by modern maps was itself a determining factor in how Parisians experienced movement through the city and its disparate neighborhoods; that the discipline of geography "deals with the determinant action of general natural forces, such as soil composition or climatic conditions, on the economic structures of a society, and thus on the corresponding conception that such a society can have of the world."[136] To disrupt this, a new sort of geographical survey would have

[134] Debord, "Critique of Urban Geography."
[135] Ibid.
[136] Ibid.

to be undertaken, "to draw up the first surveys of the psychogeographical articulations of a modern city."[137] Cities, of course, are fluid places, full of contingency, chance, and what Debord called "ambiances," areas of the city that possessed a certain pull on individual subjects, an intensity that made certain locales either appealing or repelling, an "attraction of the terrain."[138] Of course, these ambiances were left out of conventional cartography. The antidote to an urbanism of alienation was psychogeography, and the means of conducting a new survey was what Debord termed the *dérive*, or drift.

The drift was the means by which a subject could coast through a city, drawn from one locale to another by certain ambiances, not by the statist constructs of work and leisure. It was a simple wandering on the one hand, but on the other was an experiment in which the drifter traced and recorded their routes for later reflection and reconstruction. The word *dérive* has a nautical origin, as well as a place in military tactics; it was a sort of reconnaissance mission to theorize the future structure of a situationist city.[139] In is an interesting repurposing of terms, using the language of navigation and imperialism to reformulate a humanistic approach to the landscape. The nautical metaphor of the drift only added to its fluid and fluctuating approach, leaving the drifter out to sea at the whims of the tides and currents: "Chance is a less important factor in this activity than one might think: from a dérive point of view cities have psychogeographical contours, with constant currents, fixed points and vortexes that strongly discourage entry into or exit from certain zones."[140]

[137] Guy Debord, "Theory of the Dérive," *Situationist International Online*, accessed July 3, 2017, http://www.cddc.vt.edu/sionline/si/theory.html.
[138] Ibid.
[139] Sadler, 81.
[140] Debord, "Theory of the Dérive."

Bending the grid

By creating guidelines for the drift and its pathways between different nodes in the city, Debord and Jorn sought to create a new, collective map, creating an aggregated document of many subjects' relative experiences and drifts. One result of such intermingled planning and spontaneity was *The Naked City*, a document that put forward a new chart, a redefined and newly proportioned map of the city that reflected its ambiances and drifts. To make the map, Debord and Jorn literally cut into pieces a standard map of Paris, the *Guide Taride*, illustrating it with arrows to "link the different unities of ambiance."[141] In dismembering the map and redistributing its zones according to their relative power for the drifter, Debord and Jorn attacked the gridded matrixes of cartography and indexing: "The disturbed grid lines of Guide Taride, still visible in the fragments composing *The Naked City*, emphasized the incompatibility of Cartesian logic with the real experience of the city."[142] At the same time, and somewhat hypocritically, Debord admired metro maps that had been made to show the routes of various undergrounds. His reason was simple: that the subway routes had many curves and together formed a web-like structure under the city; subway maps actually broke with the above-ground boundaries of the metropolis, and probably reminded Debord of the meandering arcs and swerves of psychogeography.

The situationists and their forerunners (lettrists, COBRA, etc.) "despised the rationalist grid, so beloved by Piet Mondrian and Le Corbusier, as a metaphor for the regulative practices of the state." Indeed, the rationalist constructs of a planned urban grid of constricting right angles, combined with the assembly line-like building materials of reinforced concrete columns (also in a grid shape) supporting hundreds of standardized, identical units - these rigid forms constituted

[141] Sadler, 88.
[142] Ibid., 84.

the "bête noire" of situationism. But herein lay the paradox of psychogeography: it certainly rejected rational fixities and idealized notions of the city and the terrain, but at the same time sought to build new conventions in the science of mapping. It was an effort to reflect on paper the "social geography [that] theorized space as a product of society."[143] The goal was actually fairly straightforward: "In short, the situationist maps described an urban navigational system that operated independently of Paris's dominant patterns of circulation."[144] Finding this balance between subjective experience and a new, objective mapping lay at the very heart of the project of psychogeography.

Figure 11: *The Naked City*

[143] Ibid., 92.
[144] Ibid., 88.

This approach was not limited to the relatively small group of situationists and their Parisian abodes. By 1960, across the Atlantic at MIT, the theories of cognitive mapping and social geography had already been written on extensively by Kevin Lynch, a professor in urban studies and planning. In his book *The Image of the City,* Lynch expounded on the varied images that city-dwellers create to navigate and understand the landscape:

> "Moving elements in a city, and in particular the people and their activities, are as important as the stationary physical parts. We are not simple observers of this spectacle, but are ourselves a part of it, on the stage with the other participants. Most often, our perception of the city is not sustained, but rather partial, fragmentary, mixed with other concerns. Nearly every sense is in operation, and the image is the composite of them all."[145]

Perhaps it is only a propitious coincidence that Lynch deploys such an essential situationist term - spectacle - in his opening paragraphs. In any case, it is an entirely appropriate overlap in terminology. Geographer Denis Wood has detailed the emergence of psychogeography in the United States, including a course taught at Clark University in the late 60's, reporting that the professors were "wholly unaware" of Debord's formulations, and were instead influenced by Lynch's work at MIT. They too were interested in the human body as a sort of surveying instrument, and were inspired by the alternative maps of Boston produced by Lynch as a result of interviews with some 30 residents, "part of an effort to come to grips with the visual quality of American cities by studying the mental images of them held by their

[145] Kevin Lynch, *The Image of the City* (Cambridge, Massachusetts: The M.I.T. Press, 1960), 3.

inhabitants... that these maps were in some way mental maps gave them an auratic power that Lynch had surely never anticipated."[146] When Wood was working on his master's at Clark, he embarked on a series of psychogeographic mapping efforts, using the mental impressions of cities sourced by a number of teenagers as the data for his charts. Using a standard grid for London, he then manipulated the distance between the points based on sketches of the city provided by the teenagers, who had roamed around as tourists for a few days. Musing on the relationship between the situationists' geography and that of Lynch and the Clark geographers, Wood remarks that "both sciences accepted, in fact celebrated, the necessity of using human beings to measure salient dimensions of the environment. Cities, they both seemed to take for granted, as human artefacts for human living, needed human instruments to measure them."[147]

The human experience of a given city, as the situationists and other psychogeographers insisted, is a product of fragmented, terrestrial notions of space, bound up in the temporal and cultural realities of the human experience. The pretensions to the objectivity of maps were rightly questioned; but more importantly, Guy Debord and his contemporaries subverted the power structures that ran through the map and through the grid, attempting to demystify these hegemonic influences in urban planning and spatial representation, while substituting a new system of fluid and subjective impressions of the city. As Denis Wood commented, this was supposed to be a mix of the scientific and the personal; a blend of different approaches to replace wholesale the current tenets of a rigid urbanism. Debord did not see his project as simply deconstructing the existing power structures of the map, but proffering a new urban ideal to displace the staid conventions of alienation: "A future urbanism will undoubtedly apply itself to no less utilitarian projects, but in the rather different context of psychogeographical

[146] Wood, 191.
[147] Ibid., 195.

possibilities."[148] For Debord, it was important to insist that his project was also one of utility - but of utility to the drifter. One way to do this was bending the grid - an image so rigid and rational that it seemed to forbid such manipulation.

Demystifying the Instrumental Image

Just as the navigational map provided so much utility for the sailors of the Renaissance, but not the greatest picture of the Earth for a fifth grader in social studies, a city designed for the efficient movement of troops may not feel best suited to the sort of human relationships that develop between neighborhoods and discrete urban ambiances, each with different levels of emotional power. As Giuliana Bruno points out in her book *Atlas of Emotion*:

> "Although domination is one aspect of cartography, situationist cartography demonstrates that cartographic thinking need not always be colored by the impulse to conquer or by the language of power and its tendency to unify. As we have seen in the development of emotional cartography across time, cartography can be an essential tool in the exploration of moving subjects and their differences."[149]

[148] Debord, "Critique of Urban Geography."
[149] Giuliana Bruno, *Atlas of Emotion: Journeys in Art, Architecture, and Film* (New York: Verso, 2002), 268.

The images of the city stipulated by Corbusier led to alienating excesses. Subsequent generations of architects took the lessons of architectural modernism too far, building massive developments of ruled lines and square concrete.

In bending the grid, and attempting to unseat traditional cartography in the process, Debord and Jorn created a model for appropriating and subverting logistical images. The first step in the process was to demystify the map's power relations. The second was to open the map to the myriad subjectivities of individual subjects, reminding the viewer that each city's landscape is a patchwork of collected memories and mental images, all in flux, shifting with the urban tides. Appropriating the map's grid and obliterating its scale and efficaciousness in the management of space, the situationists provided a blueprint for the interrogation of operational images in the decades to come. And while their project reacted against fixity and inserted contingency, the operational images of the 20th century would be used in very flexible systems, include real time loops, shifting inputs and outputs, and dynamic means of construction. For the operational image and its budding automated interpreters, new lines of attack would be required.

Counter-mapping in Google Earth

While Paglen's "Sight Machine" effort helped create visualizations of everyday computer vision algorithms, a different Paglen-initiated project culled from the depths of web browsers certain satellite pictures not meant to be seen. In 2015, in response to a call by Paglen to photographically document the surveillance infrastructure of Germany, the artist Florian Freier created "Cached Landscapes," a quilt-like board of satellite photos gathered from his own browser cache of various signals intelligence sites in Germany. This act of recovery shows a

number of locales "researched and published by Paglen" earlier that same year. Freier explains: "While the automatically collected images of the browser cache are clearly documenting every step we are doing on the internet, for the human eye the algorithmically cropped and poorly sorted files transform into an abstract grid without any further information."[150]

The browser automatically tracks and stores information about websites visited, including the images present in Google Maps. Freier noted that the images of each location are broken up and stored in an apparently haphazard fashion - an order that has a computational rationale but that looks utterly nonsensical to humans. By gathering the images of secret bases and presenting them as mosaics of overhead surveillance, Freier draws attention to the ways in which companies like Google track and store an individual's data automatically. His is an artistic process that seeks to make visible some of the traces of algorithmic operationality, presenting for the public eye the means by which software companies store and track images. It also restores context to otherwise banal satellite photographs, removing a layer of abstraction and performing an act of counter-surveillance.

In another attempt to show the operational logic of mapping software, the artist Clement Valla collected errors in Google Earth, following both a kind of Glitch Art tradition as well as a gathering of data artefacts like Freier. His project "Postcards from Google Earth" involved a protracted search for areas in which terrain mapping algorithms appear to break down, where the seams become visible and the cracks in the digital artifice appear. Google Earth uses texture mapping to create its illusions of three-dimensional geography, draping satellite photographs over topographical wireframes. Usually this process creates satisfying - if not entirely photoreal - picture of the Earth's surface and its human-built features. But sometimes, the software performs

[150] Florian Freier, "Cached Landscapes," accessed July 18, 2017, http://www.florianfreier.de/cachedlandscapes/.

its texture mapping and generates bizarre results: “Depth cues in the aerial photographs, like shadows and lighting, were not aligning with the depth cues of the 3D model.”[151]

Figure 12: A *Postcard from the Void*

Crucially, Valla determines that this outcome was not, in fact, any kind of error. Though they carry the veneer of a glitch, the warped and twisted roadways of “Postcards from Google Earth” are in fact “the absolute logical result of the system.”[152] They draw attention to the very mechanics of Google Earth, and to the ways the image has been automated and operationalized: “They reveal a new model of representation: not through indexical photographs but through automated data collection from a myriad of different sources constantly updated and endlessly combined to create a seamless illusion; Google Earth is a database disguised as a photographic

[151] Clement Valla, “The Universal Texture,” *Rhizome*, accessed July 18, 2017, http://rhizome.org/editorial/2012/jul/31/universal-texture/.
[152] Clement Valla, “Postcards from Google Earth,” accessed July 18, 2017, http://www.postcards-from-google-earth.com/.

representation.""[153] In deconstructing this process of data-gathering and subsequent image-generation, Valla points to automated constructs colliding at full speed: the grid, the satellite camera, the texture mapping software.

The above counter-mapping projects are interventions in a critical area of contemporary operational images. The operative framework of Google Maps is one that directly affects many millions of users on a daily basis; unlike military imaging and guidance systems, Google Maps has relatively benign implications for most of its virtual inhabitants. But like these systems it is also an arena for the contingent and shifting relationships between humans and digital, machine-generated pictures of the world. As Hoelzl and Marie have pointed out in *Softimages*:

> "GSV images are a paradigmatic and particularly powerful example of what Harun Farocki has called 'operative images': images that 'are part of an operation.' In the case of GSV, operation which is not restricted to user navigation, but which is part of a larger circular operation of data exchange, with the users' trajectories feeding back into the database. This 'reverse operativity' reveals the more problematic side of the algorithmic turn: For if *we* are operating GSV images, *they* are at the same time operating *us*"[154]

And what if the images in question are outside even these acts of appropriation, generating no visible artefacts, glitches, or databases to illuminate their operations? What if they reside in a

[153] Ibid.
[154] Ingrid Hoelzl and Rémi Marie, *Softimage: Towards a New Theory of the Digital Image* (Bristol, UK: Intellect Books, 2015), 84.

literal or figurative black box? For these systems a more aggressive approach is required, one that turns the object of surveillance back on the camera eye.

Tactical Media

"The world changes by direct manipulation of perception and because it is now dominated and organised by automated images that operate independently of conscious intentionality."[155]

When the actant shifts, when humans are removed from the loop and the interpretive process, when the images generated are no longer made visible for our "meat-eyes" - this is the moment when a new tactics of subversion is called for. It is a moment in which "machines rarely even bother making the meat-eye interpretable versions of their operational images that we saw in *Eye/Machine*."[156] Instead of using, appropriating, gathering, gleaning, and decontextualizing, a new strategy of direct confrontation is called for, one that stares down the sensor and its parsing processes.

Writing about Alan Sekula in *Grey Room*, Thomas Keenan has said that he in fact despised a humanizing reframing, seeing such efforts as futile and indulgent, long on sentiment and short in results. This, Keenan says, begs the question: "Are there tactical operations with images, images that can do something else, that resist both the masking of domination, on the one hand, and the compensations of compassion, on the other? I think the answer from Sekula is a qualified yes."[157] So what does this approach look like? How does one find this third way to

[155] Phillips, 96.
[156] Paglen, "Operational Images."
[157] Keenan, "Counter-forensics and Photography," 65.

resist domination without paying lip service to a kind of liberal sentimentality? The reframe should instead be tactical, directed, an issue of *counter-forensics*: "With the term, [Sekula] refers to nothing less than the adoption of forensic techniques as a practice of 'political maneuvering,' as a tactical operation in a collective struggle, a rogues' gallery to document the microphysics of barbarism."[158] Some of this work has been done in the evidentiary and forensic approaches of artists acting as media *flâneurs* or *glaneurs*. But a further tactical approach is required to meet the demands of a kind of "collective struggle" against machine surveillance, the automated parsing of the likeness of individuals, and the scanning of a battlefield for human elements with little regard for humanity.

Figure 13: *Not a Bug Splat*

[158] Ibid., 69.

Projects like "Not a Bug Splat" rewrite the object of the machine gaze, manipulating it directly, cognizant of the overhead operations of satellites and information caching. Showing the drone operator the face of one of many "collateral" victims, blown up on a gigantic photograph spread across a field in Pakistan, the artistic gesture is written into the memory of not only the autonomous flyer's operator but the satellite picture of the same geographical location. While this project feeds the camera with a certain alternative data, it is an image directed at human interpreters and intermediaries. What of the machine interpreter? What, for instance, would a fully automated drone make of such an image? Likely, nothing. When the computer is trained only to see what it is looking for, all other symbols are obliterated. For this contemporary case, an image carefully crafted to scramble and disorient the very symbols the machine is searching for must be deployed.

The artist Zach Blas has made a stab at creating such objects with his "Facial Weaponization Suite," a collection of nonsensical masks crafted by aggregating the facial data of participants, "resulting in amorphous masks that cannot be detected as human faces by biometric facial recognition technologies."[159] Blas recognizes that such technologies in fact propagate inequalities already systemic to our society, crafting masks with titles like "Fag Face" (an aggregate of the visages of queer men). By collecting and averaging the faces of many participants, Blas alludes to a collective struggle at play and resists the fractured individuality mandated by the surveillance state: "These masks intersect with social movements' use of masking as an opaque tool of collective transformation that refuses dominant forms of political representation."[160] He strives to create a series of images that work toward an anti-operational

[159] Zach Blas, "Facial Weaponization Suite," *Zach Blas*, accessed July 18, 2017, http://www.zachblas.info/works/facial-weaponization-suite/.
[160] Ibid.

goal, effectively blocking the harvesting of facial data by machines. Blas' effort is technically effective - his participants faces are completely obscured and therefore illegible by traditional cameras - but it is principally an act of public protest, a show of solidarity against surveillance. Blocking the camera with a mask works, strictly speaking, but it is not a gesture engaged with the actual mechanics of facial detection.

For that, we must look to projects like those of Adam Harvey, who has developed a tool called "HyperFace Camouflage." His goal is to essentially feed machine vision false positives, red herrings that draw the detecting algorithms away, distracting them with digital images themselves based on facial training sets: "HyperFace works by providing maximally activated false faces based on ideal algorithmic representations of a human face. These maximal activations are targeted for specific algorithms. The prototype above is specific to OpenCV's default frontalface profile."[161] The goal of the project is actually to redirect an algorithmic machine eye away from the human subject and toward a much clearer "face," taking a page from traditional tactics of camouflage to minimize the difference between figure and ground. With HyperFace, the "figure" of the human subject is minimized in comparison to the "ground" of "false face regions," designed to attract the algorithm. The computer will search for the highest degree of confidence in attaining facial recognition, so, as Harvey puts it, "give it what it wants."[162] Unfortunately, going incognito in the contemporary world amounts to much more than protecting one's browsing habits - direct manipulation of the physical world seems one of the best and perhaps the only way to truly confound the operational imaging systems that act under their own interpretive rules. This will also inevitably become a perpetual game of cat-and-mouse;

[161] Adam Harvey, "HyperFace Camouflage," accessed July 19, 2017, https://ahprojects.com/projects/hyperface/.
[162] Ibid.

of hide-and-seek.

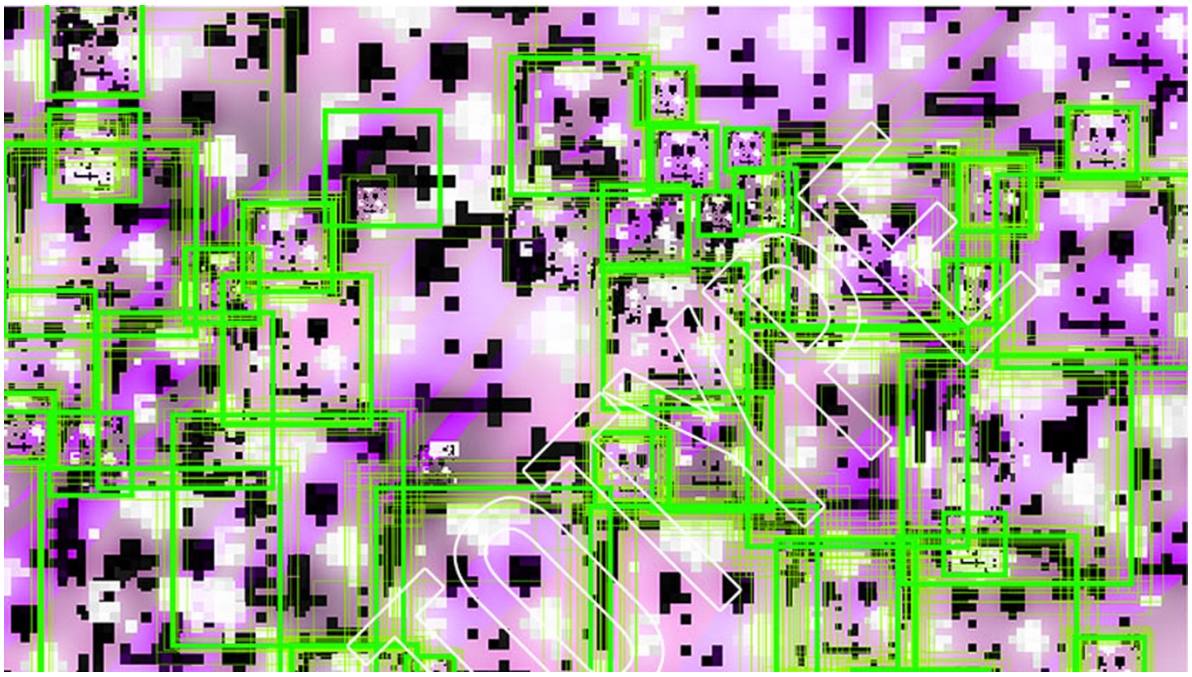

Figure 14: *HyperFace* camouflage

Fresh Projects for Fast Machines

"The only 'objective' truth that photographs offer is the assertion that somebody or something - in this case, an automated camera - was somewhere and took a picture. Everything else, everything beyond the imprinting of a trace, is up for grabs."[163]

All these projects, in one way or another, confront the machine eye, asking what role we are comfortable with computers having in our lives, as they relentlessly gather, process, and act

[163] Sekula, 57.

upon the visible world. We cannot see the processes by which machines detect our faces, the ways that the images travel through the process of positive identification. For that, we rely upon the renderings of artists, the collection of evidence, and the deployment of tactical media to resist the wanton harvesting of unique identifiers. This last area of resistance is the hardest to achieve and to continually refresh, but it is likely the most important.

We now live in an era of automated operational images, devoid of a human intermediary, and backed by technologies that are emblematic of state and corporate power. They require a host of subversive actions to draw them out into the open. Paglen's "Invisible Images" article carries a tone of despair, an undercurrent of off-the-grid resignation. How can we hope to fight such systems but by discouraging a march toward optimization, efficiency, and total surveillance, removing our personal images from circulation?

But just as "the grid" itself could be challenged and the overhead photograph reframed, the machine eye can be confronted with deliberate disinformation and camouflaged objects. Models of subversion and counter-surveillance must be as flexible and contingent as the adaptive systems they hope to challenge, while always drawing attention to the power structures at play. It is clear that operational images may be read and interpreted in a variety of ways for a variety of means; there is no "correct" reading, only the design of the system that ingests the image in the first place. Challenging those designs may mean acts of sabotage to frustrate the gathering of evidence, evidence used in the unseen operations of machinic analysis.

Conclusions

The preceding pages have constructed a prehistory for the operational image, intimating how logistical images edged ever closer to machine-readability through calculable grids and real-time, updating systems. From the cartographic grid there evolved a means to travel and target by image alone; the skies of WWI saw the birth of a looping, ever-evolving form of surveillance images. But in the midst of these changes were humans exercising a form of trained judgement to interpret and act upon the image. Today, machines can automate not just the capture of instrumentally selected data, but its interpretation and subsequent course of action as well. And within certain areas of deep learning, computer systems are incapable of providing the details of their own internal rationale.[164] These systems are granted a veneer of objectivity and empiricism, which can prove a dire miscalculation, as Farocki and others have shown time and again.

Going back to Mercator and the calculable map image, the first chapter describes the grid, an important development in logistical imagery. The chapter disaggregates the calculable, machine-readable grid from the representational image of the map, showing how the two forms of image diverged in the science of cartography. The grid also proved an important development for the aiming and positioning of weapons in WWI, a conflict that also saw the rise of aerial photography. This is the subject of the second chapter, which looks at the instrumentalization of the image in warfare, the so-called "logistics of perception," and the logistical image as part of an interpretive loop. Finally, the third chapter details how the operational image is a distinct and recent instantiation of the logistical image: images made by machines, for machines. The chapter also considers the ramifications of deep learning CNNs on the interpretation of imagery,

[164] Knight, "The Dark Secret at the Heart of AI."

technologies whose internal rationale is withheld from publics and sometimes inscrutable to its own designers; this may be called the *interpretive turn*.

The third and fourth chapters also detail the structure of response from artists and cultural theorists to, hopefully, posit methods for subverting the current state of the operational image. While Guy Debord and the situationists waged a campaign to decontextualize the rationalized images of the city, Harun Farocki sought to provide additional context and reframe wartime images into their historical context. He sought to show what was hiding in plain sight, to make the invisible visible. Trevor Paglen has picked up this thread as well, with his visits to black ops sites and reverse-surveilling of surveillance infrastructure.

This sort of forensic historical approach is still a viable template to interrogate the structures and uses of operational images. It allows us to see what is hiding in plain sight, to take objects like linear classifiers and make them a part of public understanding and discourse. It is an important reversal of the machine gaze, a contemplation of our new host of machine images. As the sheer volume of images has outstripped our society's capacity to view them, this evidentiary method of image analysis is still paramount, but it must be supplemented by new tactics. Images are made today by machines, for machines - this is not a problem of the images themselves, but of the budding interpreter designed to act in a human's stead.

One option is to feed our image machines false data; to camouflage our faces and confound automated recognition, as in the work of Zack Blas and Adam Harvey. They wish to slow down and derail processes of ingest and interpretation; after a fashion, they create more "inefficiency," as Paglen has urged. In the spirit of Debord, they attempt to undermine the operational ease of state actors and technology companies, positing contemplation in place of

increased speed and precision. But their role has moved from that of Debordian provocateur to digital saboteur.

We will need to deploy as many strategies as possible as the machine image sinks deeper into complex interpretive systems, human constructs that obscure the use of the image and confound its very legibility. A combination of demystifying, gathering evidence, and tactically resisting the harvest of images-as-data - all these strategies are needed to bring the operational image back into our field of view and understanding.

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