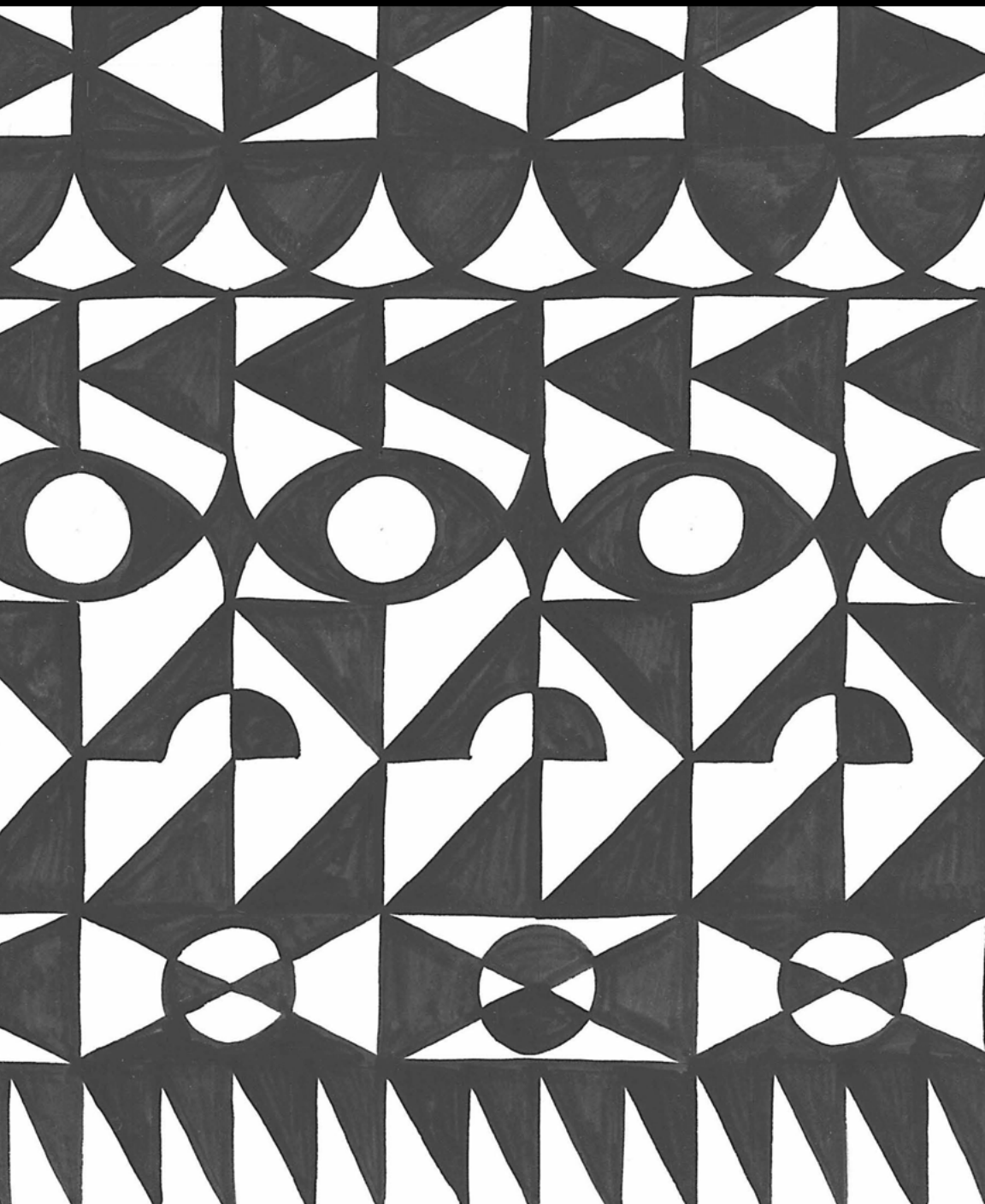
DRONE AESTHETICS
WAR, CULTURE, ECOLOGY

EDITED BY BERYL PONG AND MICHAEL RICHARDSON



Drone Aesthetics

War, Culture, Ecology

Technographies

Series Editors: Steven Connor, David Trotter and James Purdon

How was it that technology and writing came to inform each other so extensively that today there is only information? Technographies seeks to answer that question by putting the emphasis on writing as an answer to the large question of 'through what?'. Writing about technographies in history, our contributors will themselves write technographically.

Drone Aesthetics

War, Culture, Ecology

Edited by Beryl Pong and Michael Richardson

OPEN HUMANITIES PRESS
London 2024

First edition published by Open Humanities Press 2024

Print ISBN 978-1-78542-103-7

PDF ISBN 978-1-78542-102-0

OPEN HUMANITIES PRESS

Open Humanities Press is an international, scholar-led open access publishing collective whose mission is to make leading works of contemporary critical thought freely available worldwide. More at http://openhumanitiespress.org

Contents

CODA

Post-Visual Images

Yanai Toister

I. New Image-Media?

'[M]edia determine our situation', Friedrich Kittler famously argued at the turn of the millennium (Kittler 1999: xxxix). This forceful assertion is celebrated in some traditions of media studies but remains rarely considered and largely unfamiliar in most strains of visual studies (Cramer 2016: 122). This can be attributed in part to the nonoverlapping geographical distributions of both fields (continental Europe and the English-speaking world, respectively). It can also be taken to indicate a deeper sentiment: images (taken broadly) are rarely understood as nothing but media. This is especially peculiar given that in Kittler's text 'media' is mostly inscriptive (Kahn 2012) and that the history of art in the West is mostly the history of inscription protocols (thus consistently ignoring the splendour of civilisations which did without those). Thus, in Western tradition, image-media is always about the circulation and consumption of inscribed and thus durably visible images.

How does Kittler's formulation hold true for present-day visualisation forms and image formats? Herein exist types and breeds of images where inscription is almost redundant (if not lacking altogether), and transmission is the only constant. Particularly, what kind of *us* or *we* do imaging systems integrated into weapon systems, operation-room robots, and driverless cars herald under such circumstances? This chapter argues that the *our* in 'media determine our situation' now incorporates non-sentient beings – machines and computers – and that this *situation* rarely necessitates the participation, the involvement, or even the presence of sentient beings like *us*. Particularly, image transmission without image inscription makes *us* redundant. Crucially,

image ubiquity is now unthinkable without built-in camera sensors of various sorts. This is true not only in military, law enforcement, medical, and smart transport applications, but in numerous other professional and creative uses as well. It is equally true of everyday consumer devices, whether handheld, worn, or, in the near future, integrated within our bodies. In fact, the camera itself, argues Asko Lehmuskallio, has become an image sensor: one among many (Lehmuskallio 2016). The outputs from such sensors are routinely networked, their data tagged to generate huge masses of image data that are navigable in real time.

Under these rapidly changing circumstances, the already porous definition of *image* is placed under increasing pressure. If the very definition of the image cannot hold, can images still be understood by reconstructing the intentions of their human producers or the desires of their human receivers (as indeed commonly attempted in visual studies)? Once perception has been automated for artificial vision, argued Paul Virilio, the analysis of objective reality can be relegated to machines (Virilio 1994: 59). Therefore, the operations of imaging technologies can no longer be understood as being exclusively the effects of inscribed images. While these remain important, this chapter speculates on the possibility of image operations that do *not* emerge from visible representational functions (numerical code which has been rendered into an arrangement of picture elements). The image operations subject of this text perform *invisibly* or rather, play formative roles that are invisible to us humans.

II. Objective / Subjective

These recent developments shed interesting light on much earlier ones, and have the potential of rewriting the historiography of image making in retrospect. Surprisingly, the preclusion of the human from the productive creation of imagery can be located much earlier than most of us tend to think. In fact, it dates back to the genesis of photography as most assailants and some advocates of the medium argued (although not for the same purposes). Notwithstanding, the boundaries between human and machine had become undoubtedly and irreversibly blurred by the 1920s with the advent of smaller, lighter, and more mobile cameras. This is illustrated most vividly in the eye-and-camera analogy celebrated in Dziga Vertov's 1929 avant-garde film *The Man with the Movie Camera* (and repeated in Andreas Feininger's *The Photojournalist* from 1951). The marginalisation of human vision is also evident in the works of Alexander Rodchenko, Otto Umbehr and, most notably, László Moholy-Nagy – artist, designer, and celebrated master at the Bauhaus.

Moholy-Nagy argued that the camera was the beginning of an objective vision as it was, in his words, 'optically true', or objective. He further called for the 'elimination of perspectival representation', and sought to abolish the pictorial and figurative traditions that had been established by painters, and remained unchallenged for centuries (Moholy-Nagy 1969: 28). This extended

to Moholy-Nagy's own work, which often sought to approximate the worm's- and bird's-eye points of view (see Figure 15.1). He also called for picturing motion, which, when done with extreme obliques, yielded previously unimagined image trajectories (Moholy-Nagy 1928).

This approach, of being '(un)encumbered with subjective intention' (Moholy-Nagy 1969: 96), eventually became known as the 'new objectivity', and came to be associated with German photography of the 1930s. In other words, these technological and theoretical breakthroughs facilitated a hitherto inconceivable rift between the supposed objectivity of the camera and the subjectivity of the human photographer – who, we can appreciate, is becoming a mere nuisance for some systems.

Although not unfamiliar, this narrative remains unpopular, perhaps unacceptable, from the perspective of classic (that is modernist) histories of photography. Those favoured the human 'photographer-as-protagonist' theme as the keyhole through which to view the broad expanse of photography. In contrast, the history of film, and particularly Hollywood film productions – since the 1920s through to the present day, when much film production is actually post- or virtual production – celebrates trajectories based precisely on *this* narrative, the rift between objectivity and subjectivity. Consequently, when relishing action films, our pleasure and satisfaction diminish in the absence of imagery captured (or made to look as if has been captured) from the perspective of a machine: be it a surfacing submarine, an accelerating locomotive, or a free-falling aircraft.

Artist, filmmaker, and essayist Harun Farocki referred to such points of view as *phantom-subjective images* (Farocki 2004: 13). Importantly, Farocki coined this term in response to footage from the First Gulf War, which was disseminated to television audiences worldwide and remained publicly available. These grainy moving-image sequences, mostly available in black and white, were produced by cameras mounted on warheads such as laser-guided bombs and cruise missiles, capable of closing in automatically on predesignated targets, mostly infrastructural or architectural, but at times also human. Contemporary phantom-subjective points of view include those of objects crossing the outer parts of the Earth's atmosphere, a pellet moving down the digestive tract or the rear-view of a mini-SUV. Closer to our own bodies, GoPro and other wearable and mountable devices aim at yielding a similar effect of supplementing or surpassing human anatomy. This confirms Stanley Cavell's assertion that the one human wish photography has truly satisfied is the wish to *escape* subjectivity, metaphysical isolation, and finitude (Cavell 1979: 21). Numerous programmes, gaming engines, and virtual cameras satisfy that same wish. In fact, in-game photography is a site where phantom subjective imagery is a common and often a desired option. Perhaps one day, when our aspirations for spatial exploration are fulfilled, and freefall and spacewalking become commonplace, phantom-subjective points of view will have become impossible or unnecessary. Until then, our inability to overcome

Figure 15.1. László Moholy-Nagy, *From the Radio Tower*, Berlin (1928).
Source: Wikimedia Commons.

gravitational, anatomical and sensorial limitations requires phantom-subjective images. These, lest we forget, emerge from technical and technological apparatuses and always remain bound to them, not to *us*. These are nowadays redesigned with growing alienation from human subjectivity and indifference to human experiences once celebrated.

III. Operativity and/or Subjectivity

Recent imaging systems bring into being image forms and formats which are not all meaningful or even legible to humans. The systems Farocki expounds upon in his installations, films, and essays continuously track changes in the world, and adjust their trajectories accordingly by juxtaposing input from on-board camera-sensors with input from other sensors and sources. Crucially, images generated in this way are not necessarily stored for subsequent analysis by humans, and thus cannot mediate the world for them. Rather, they are mostly scripts for an immediate operation: that of determining and correcting the real-time behaviour of an object-turned-subject, or a subject that cannot be human. This new breed of images has been dubbed *operational* or *operative images*. In fact, as artists such as Trevor Paglen and Hito Steyerl have been quick to note, the vast majority of images produced today are of this sort exactly (Paglen 2016; Steyerl 2016). While operative images have been first identified in tandem with phantom-subjectivities (with the latter also seeming like the precondition for the former), operative images may also appear independently thereof.

This is arguably most noticeable in services such as Google Street View (GSV), to which several artists and scholars have directed their attention in the last decade. An early artwork is Doug Rickard's *A New American Picture*. Therein GSV is used for a virtual exploration of the back roads of America, placing emphasis on the fact that the platform is a virtually infinite archive of visual vernacularity. This project was later described as 'virtual street-photography' thereby accurately capturing the awkwardness of the transition from 'offline' to 'online' photographic flânerie with nothing but bandwidth and a Lay-Z-Boy arm-chair. Jon Rafman's project, appropriately titled *9-eyes,* in reference to the nine cameras mounted on top of GSV cars, is more interesting from the contemporary perspective because it often focuses on the transitions between image captures and the instances when they seem to fracture – seem, that is, to the human eye. As compelling as these fractures are, they are the *exception* to the new rule: seamlessness. With operative imaging systems, images forever remain unfixed and unbounded, and never come into being as *only* images. Rather, image-captures breed unending panoramas which are merged with online cartographic services in two and three dimensions. Curiously, authors who have commented on GSV have failed to note it as an example wherein operative images initially appear from within standard-subjective points of view (street view), and not phantom ones which remain an opt-in possibility. Phantom-subjectivity in GSV appears only when one attempts to relocate spatially, thus turning the still image into video and the stationary viewer-cum-user to acrobatically fly through space, often arriving at giddy bird-like perspectives. It also appears when the user attempts to relocate temporally (an ability afforded, at least unidirectionally, by a recent feature of the GSV service). The most profound artwork to utilise GSV is

probably Sylvia Grace Borda's *Farm Tableaux* (2013-2015). This is a project done in collaboration with photographer John M. Lynch and existing (that is exhibited) on and in the platform. *Farm Tableaux* attempts to 'fix' images within GSV, and thus claim artistic authorship over them, an intentionally futile endeavour. In so doing it reveals that within GSV images are always a complex ensemble of various types of data created ab initio by *multiple agents* and *agencies* distributed both spatially and temporally. The artworks described here make clear that GSV and similar services not only put our bodies to pasture, they also dull and dumb vision. In so doing they gradually raise the suspicion that our born sense of vision is a no-longer-useful form of knowledge acquisition. Moreover, vision may now be a form of acquiring only non-useful knowledge.

Operative images initially emerged with (and as a derivative of) mid-twentieth-century weapon systems and technologies. Their novelty has evolved through late-twentieth-century knowledge developed in tandem with (if not for) weapon systems and technologies, most notably machine vision and computer vision. These are required for the autonomy of drones where their use is indeed ubiquitous. When it comes to autonomous drones, the displacement of our somas is coupled with a devolution of vision, with only a dull interface for our senses. As on the ground, so too above, where eyes-closed blindness reigns and its reign affords comprehension, discrimination, and choice that are dramatically altered. Following the historical primacy of machines designed to kill (or at least pass the word of gods), other technologies have equally been made algorithmic – lock, stock, and barrel. In fact, just like drones, this *is* what they are celebrated for. Such systems are now routinely used to guide us on our morning drive, perform on our bodies when we are undergoing surgery, and protect us against all manner of domestic dangers – or at least provide warning, or, if not, documentation after the fact. These civilian settings are equally rife with epistemic, ethical, and pragmatic dilemmas. Because operative imaging systems often produce nonrepresentational images, they do away with various human decisions and actions. These are relegated to non-sentient beings whose ethical limits we do not know. A limit is always a meeting of two or more affordances, but the affordances of imaging that is not only non-representational but also nonvisual are impossible to fathom with toolkits mobilised from visual studies. Operative imaging systems can only be understood as prototypical habitats for the emergence of quasi-agentic media-mechanisms. Furthermore, such systems make abundantly clear that when mediation processes are indiscernible from their outcomes, there can never be a neat separation between autonomy and agency. When media is only potentially sensory (media as only transmission and not inscription at all) the gaps between producer, technician, and user well-nigh disappear, eclipsing the possibility of external action, operation, and knowledge.

Vision is no longer an exclusively human purview, nor is it any longer subject to our exclusive judgement and control, not even when it concerns

our own bodies and indeed our very survival. In fact, some operative systems are free to autonomously and even authoritatively register, map, interact with, control, and regulate the parameters of hitherto un-existing epistemological forms. Think of radiation therapy wherein systems such as CyberKnife combine image guidance abilities with a robotic manipulator and a particle accelerator used for the treatment or removal of benign or malignant tumours. Such systems are, quite literally, a kill robot for tumours (Friedrich and Queisner 2014). Likewise, systems used for Neuro-navigation – and this is but one example – generate images which are benignly operative in the sense that they are 'part of an operation' in which the (human) surgeon is sitting in an adjacent space or even further removed from the patient. Such systems are clearly active and transformative, arguably reconfiguring the subject-object relationship throughout their operation, with machines becoming the seeing (and decision-making) subject, and human organs the objects to be seen or ignored.

To understand how this relation has been reversed, why operative images have become not only scripts for operation but operative entities in their own right, let me offer a short history of machines inspired by Vilém Flusser (2000: 24). Early industrial machines were designed to perform simple, single-purpose mechanical tasks in a system that always included humans, who were required to contribute at least a minimum of mental power and labour. Such machines can be described as 'blind', because of their inability to adapt to unforeseen events or situations. Human presence with and near such machines provided the necessary flexibility (or 'vision'). According to most modernist histories of the medium, the photographic camera was undoubtedly one such machine, as it was completely dependent on the human photographer in order to traverse the broad sweep of all potential photographs (including those yet to be realised). In contrast, Universal Turing Machines, or computers as we now call them, are designed with the capacity to perform multiple tasks, and do so not only rapidly and automatically, but also *autonomously*. This is possible so long as such machines are given a table of instructions that defines another machine (a non-Universal Turing machine). Such adaptive machines are programmable and, to the extent they are connected to sensors or cameras, may even be understood as machines with 'quasi-seeing' capacities, perhaps even full-fledged 'seeing' machines. With this in mind, could operative imaging systems be further described as being not only quasi-, but fully agentic?

Of course, some such systems do not operate entirely on their own because the images they generate, although made to be processed by computers on the fly, are ultimately destined for viewing by the human eye, for the sake of examining the outcomes of the operation as well as improving system performance (this is arguably the case for GSV and CyberKnife). Clearly, when it comes to seeing, the world is simply too plentiful for us to expect that an 'objective' imaging system could exist. The features or parts of the world

revealed by one system are not strictly speaking the same as the features or parts revealed by another (Magnetic Resonance Imaging, or MRI, is useful for observing softer tissue than is usually revealed by Computerised Tomography, or CT, which uses X-rays). Each system and each method establishes its own 'working object', so to speak (Daston and Galison 2007). Nonetheless, when it comes to operating on human subjects, new imaging methods enact a productive displacement of our sensorium, necessary for bringing into the purview of our mind information that is naturally beyond it, information that would otherwise have eluded us. By augmenting human sensitivity, operative imaging systems expand the range of human action but also reveal its limits – the fact that, unaided, our 'dreary senses' (Nake and Grabowski 2017: 23) can only discern and rely on the analogue features of media.

Here we might do well to recall Lev Manovich's words on media (or 'new media' in his taxonomy) which in general can be said to consist of two distinct layers: a 'cultural layer' whose structural organisation 'makes sense to its human users', and a 'computer layer', whose structural organisation 'follows the established conventions of the computer's organisation of data' (2001: 45). With regard to the digital image (another ancestor of the operative one), mathematician and pioneer of algorithmic art Frieder Nake speaks of a marriage between 'subface' and 'surface' features. These can be taken as an inseparable double or as a hybrid single, but they are nonetheless two distinct processes. The surface is for us humans to experience, whereas the subface is for the computer to work with. The former is visible (or audible or palpable); the latter is nothing but symbolic coding (2001; 2008). We humans are usually aware only of the surface processes, remaining blissfully ignorant of the subface where the computer holds sway, where algorithms are the ultimate submarines, and can afford to remain forever submerged.

IV. Pseudo-Operative / Truly Operative

This then is a crucial distinction pertaining to operative images: that between promotional expressions (propaganda *for* technology) and operative images. It separates images that illustrate a function (and possible meaning) to a human receiver from ones produced exclusively for a non-sentient readership. The former may be called pseudo-operative, and the latter truly operative. They differ greatly, not only in terms of their level of abstraction but also in terms of their aesthetic qualities. Since a truly operative image is not necessarily produced for human consumption, it might not represent a recognisable object. Such an image is produced when image elements are scanned to check whether they correspond to pre-existing configurations in the database. This interplay occurs in the subface. The shifting colourful traces and outlines that appear to come alive on the surface of the pseudo-operative image simply illustrate instances of machine-based recognition, the momentary creation of transitions and correspondences between worlds.

This ephemeral image-making function is therefore perfunctory: 'a gesture of courtesy extended by the machines' (Pantenburg 2017: 49*n*4). This is illustrated in Ben Grosser's artwork *Computers Watching Movies* (2013) – a sequence of pseudo-operative images: humans (really) watching how computers (metaphorically) watch movies. A truly operative image is produced by computational sensing technologies for the consumption of computer programmes, and designed to function *without* human intervention or perception (and thus falls squarely outside the province of art).

With operative images emerges an order of the world with a universal method of articulation: image-processing software. This order is composed exclusively of simple geometric shapes: straight lines, arcs, and corners, elements in a language of edges, a segmented world that exists and that is governed by the rectangular picture frame. This new world finds its ideal expression in the autonomous electronic processing logic of the guidance (or classification) system and its agentic cybernetic capacity to constantly adjust its own situation by making micro-evaluations and minute- by-minute decisions. Put differently, although operative imaging systems can 'see' us, we cannot and have never seen operative images. Familiar representatives of the submerged algorithmic world with their arrows or dots are operative images 'decorated' by machines for the benefit of human experience – to be interpretable. A computer can process pictures, but needs no pictures to verify or falsify what it reads in the images it processes – it needs no snorkel. For the computer, the image subface (code) is enough. Computers do not need animated yellow arrows and green boxes in grainy video footage to calculate trajectories or recognise moving bodies and objects. Those marks are for the benefit of humans, to help them understand the ways of the machine. The systems that bring operative images into being interact with the world (or more precisely with a symbolic abstraction of the world with which we humans interact, as Kittler would have it), and do so with far greater efficiency than we ever could (if our standards are quantitative and not qualitative). They are in that sense, with recourse to classic photographic theory, a camera born to imitate its viewer's eye that has outstripped and replaced its model (Farocki 2003). The situation that operative images determine is a human-made situation – a 'cultural world', to which humans have no recourse (Ernst 2013).

V. Post Visual / Post Knowledge?

Three novelties set operative images apart from previous breeds of images. Firstly, they require neither human creation nor human perception. Operative images inform in the same ways they entertain – irrespective of their real functions and purposes. 'If such images possess beauty', declared Farocki, 'this beauty is not calculated' (Farocki 2003) – and beauty that is un-calculated, I clarify, remains unexperienced and unknown. On the other hand, any sampling of a spatio-temporal situation, anything that can exist as a signal, can

Figure 15.2. William Henry Fox Talbot, *Lacock Abbey in Wiltshire* (Plate XV in The Pencil of Nature) (1844). Source: Project Gutenberg.

be calculated to become an image. Thus, the fascination pseudo-operative images may engender (when true-operative images are somehow made to surface) resides mostly in their logic and precision. Their automatic and relentless capacity to evolve independently through space and time in order to attain their humanly undecipherable objectives, to mediate or interface algorithmically controlled processes: programmes and universal knowledge machines.

Secondly, in operative systems, we may concede, agency is *distributed*, as apparatuses, programmes and machines form an integrated system. Such systems often leave no residue, no permanent marking, no accessible memory, not even a voltage difference. Even to the extent that a renegade visual marking is left visible – and if we insist on maintaining that a human being has been integral in leaving it so, and further insist on designating this marking as an image – designating it as an *authored* image is detrimental to our potential understanding of imaging systems. In spite of their depictive potential, operative images are, I argue, not pictures but simply visual patterns – instructive functions as omnipresent through technology as they are in nature, wherein images are often markings but rarely pictures.

Thirdly, and more disturbingly, since this form of instruction is *purely* instrumental, it does not require aesthetic properties or culturally active assets. Operative imaging systems need not enable human perception at all.

Human perception, argues Wolfgang Ernst, is dominated by 'semiotically iconic, musically semantic, literally hermeneutic ways of seeing, hearing, and reading' (2013: 27). These make it, from the system's perspective, a nuisance. Computing machines are made for compilation and have no use for interpretation. For operative imaging systems, this is formalised into the well-defined question: How does this scene (and world) correspond to a dataset? Such systems not only 'see from memory' – they 'see' nothing but memory.

When operative images no longer require a human point of genesis, when they do not require a human point of reference, need they be visible to the human eye in the same ways conventional images are? Obviously not. This, then, is where operative images constitute a watershed moment for human culture. From Plato onwards, Western philosophy and later science have consistently acclaimed vision as the ultimate sense: the privileged form of knowledge acquisition, captured by such common phrases as 'seeing is believing'. Further, seeing was considered a form of 'knowing' *in and of itself* and practically thus indistinguishable from thinking, as in the phrase 'to see the light'. In recent decades however, vision has been replaced by sensing, ray tracing and calculation, so knowledge now runs in an 'endless loop' (Kittler 1992: 2), the end of which we cannot locate. Within this nonmetaphorical darkness, only that which can be quantified is deemed knowable. Nothing else is ever acquired. With this, expressions such as 'cognitive functions' no longer denote thinking but also processing (and no longer processing in hydrocarbons but also on silicon).

Conclusion

The operative image represents a mutation in the logic of data acquisition and management based on the development of a new relationship between worlds, as computer models increasingly overlay and override sections of concrete reality. It also represents a significant augmentation of the penetrating powers of observation that can be measured through the proliferation of these models. Thus, in many instances there is 'no real need to invade foreign space in order to collect data' (Farocki 2003): the ultimate significance of the operative image in a world order where computer models augment or altogether replace reality is their accuracy, which becomes the benchmark of human achievement and progress.

Images never cease to reorganise the relationships between humans and their technology. This was true of the first photographs and is true of operative images. This fuzzy photograph from William Henry Fox-Talbot's well-known *The Pencil of Nature* (see Figure 15.2) features a building hailed as 'the first that was ever yet known *to have drawn its own picture*' (Talbot 1839).

This notion was, for at least a century and a half, the golden standard of photography theory – an image *of* the world is formed *by* the world and remains forever bound to it. Nowadays, there is no such tangibility, no such

correspondence. The new standard is not etched in substance and has no fixed relationship to the world. With this in mind, perhaps operative images hail the dawn of a new era. The decreasing demand for human labour in the autonomous creation of images implies a diminishing visual involvement in them, which in turn brings about a redundancy of human intervention and therefore agency. In this world, the concept of the *visible* image, the image produced for the human eye, has mutated. It is now simply a by-product of other operations: an impoverished aristocrat forced to serve as tour guide on their former estate (Winthrop-Young and Horn 2012).

Works Cited

Borda, Sylvia Grace. 2013-15. *Farm Tableaux*. http://www.sylviagborda.com/farm-tableaux---google-street-view.html.

Cavell, Stanley. 1979. *The World Viewed: Reflections on the Ontology of Film*. Cambridge: Harvard University Press.

Cramer, Florian. 2016. 'When Claire Bishop Woke Up in the Drone Wars: Art, Technology and the Nth Time'. In *Across & Beyond: A Transmediale Resder on Post-Digital Pracrices, Concepts and Institutions*, edited by Ryan Bishop, Kristoffer Gansin, Jussi Parikka and Elvia Wilk, 122-34. Berlin: Sternberg Press & Transmediale e.V.

Datson, Lorraine, and Peter Galison. 2007. *Objectivity*. New York: Zone Books.

Ernst, Wolfgang. 2013. *Digital Memory and the Archive*. Minneapolis: University of Minnesota Press.

Farocki, Harun. 2000, 2001, 2003. *Eye / Machine I, II, III*.

Farocki, Harun. 2003. *War at a Distance*.

Farocki, Harun. 2004. 'Phantom Images'. *Public* 29: 12-22.

Flusser, Vilém. 2000. *Towards a Philosophy of Photography*. Translated by Anthony Mathews. London: Reaktion.

Friedrich, Kathrin, and Moritz Queisner. 2014. 'Automated Killing and Mediated Caring: How Image-Guided Robotic Intervention Redefines Radiosurgical Practice'. 50th Anniversary Convention of the Society for the Study of Artificial Intelligence and the Simulation of Behaviour, London.

Grosser, Ben. 2013. *Computers Watching Movies*. https://bengrosser.com/projects/computers-watching-movies/#:~:text=Computers%20Watching%20Movies%20shows%20what,audio%20from%20the%20original%20clip.

Kahn, Douglas. 2013. *Earth Signal Earth Sound: Energies and Earth Magnitude in the Arts*. Berkeley: University of California Press.

Kittler, Friedrich A. 1999. *Gramophone, Film, Typewriter*. Translated by Geoffrey Winthrop-Young and Michael Wutz. Stanford: Stanford University Press.

Kittler, Friedrich A. 2012. 'The World of the Symbolic – A World of the Machine'. In *Literature, Media, Information Systems*, edited by John Johnston, 130-46. London: Routledge.

Lehmuskallio, Asko. 2016. 'The Camera as a Sensor: The Visualization of Everyday Digital Photography as Simulative, Heuristic and Layerd Pictures'. In *Digital Photography and Everyday Life: Empirical Studies on Material Visual Practices*, edited by Edgar Gómez Cruz and Asko Lehmuskallio. London: Routledge.

Manovich, Lev. 2001. *The Language of New Media*. Cambridge: MIT Press.

Moholy-Nagy, László. 1928. 'Photography is Manipulation of Light'. *Bauhaus* 1: 2-9.

Moholy-Nagy, László. 1969. *Painting, Photography, Film*. Translated by Janet Seligman. London: Lund Humphries.

Nake, Frieder. 2001. 'Vilém Flusser und Max Bense des Pixels angesichtig werdend: Eine Überlegung am Rande der Computergrafik'. In *Fotografie denken: Über Vilém Flussers Philosophie der Medienmoderne*, edited by Jäger Gottfried, 169-82. Bielefeld: Kerber.

Nake, Frieder. 2008. 'Surface, Interface, Subface. Three Cases of Interaction and One Concept'. In *Paradoxes of Interactivity. Perspectives for Media Theory, Human-Computer Interaction and Artistic Investigations*, edited by U. Seifert, J.H. Kim and A. Moore, 92-109. Bielefeld: transcript.

Nake, Frieder, and Susan Grabowski. 2017. 'Think the Image, Don't Make It! On Algorithmic Thinking, Art Education, and Re-Coding'. *Journal of Science and Technology in the Arts* 9: 21-31.

Paglen, Trevor. 2016. 'Invisible Images (Your Pictures Are Looking at You)'. *The New Inquiry*. December 8. https://thenewinquiry.com/invisible-images-your-pictures-are-looking-at-you/.

Pantenburg, Volker. 2017. 'Working Images. Harun Farocki and the Operational Image'. In *Image Operations: Visual Media and Political Conflict*, edited by Jens Eder and Charlotte Klonk, 49-62. Manchester: Manchester University Press.

Rafman, John. 2008-ongoing. '9-Eyes'. https://9-eyes.com/.

Rickard, Doug. 2010. 'A New American Picture'. https://dougrickard.com/a-new-american-picture/.

Steyerl, Hito. 2016. 'A Sea of Data: Apophenia and Pattern (Mis-) Recognition'. *E-Flux* 72. https://www.e-flux.com/journal/72/60480/a-sea-of-data-apophenia-and-pattern-mis-recognition/.

Talbot, William Henry Fox. 1839. *Some Account of the Art of Photogenic Drawing, or, the Process by Which Natural Objects May Be Made to Delineate Themselves without the Aid of the Artist's Pencil*. London: R. and J.E. Taylor.

Virilio, Paul. 1994. *The Vision Machine*. Translated by Julie Rose. Bloomington: Indiana University Press.

Winthrop-Young, Geoffrey, and Eva Horn. 2012. 'Machine Learning.' *Art Forum* 51: 473-79.