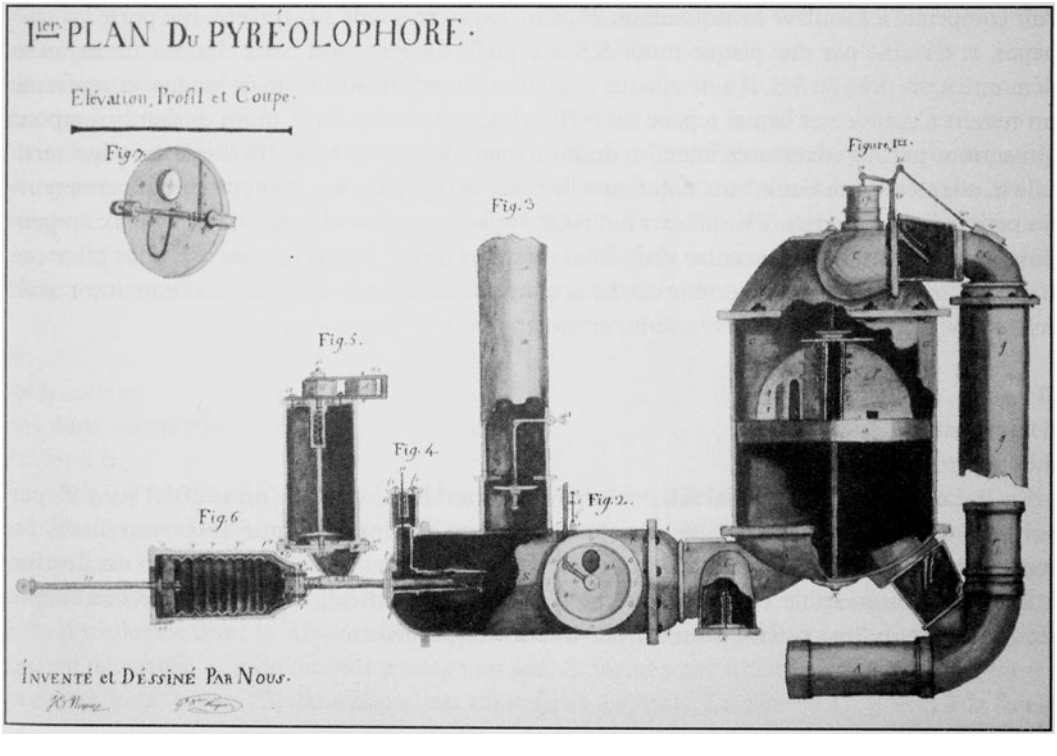
Claude Niépce and Nicéphore Niépce. ***First Plan of the Pyréolophore*****, 1806.**



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Editors' Introduction: The Aerial Image

EMILY DOUCET, MATTHEW C. HUNTER, AND NICHOLAS ROBBINS

Writing about air in the wake of 2020 is nothing if not overdetermined. The horrifying phrase "I can't breathe" uttered by Black Americans murdered in police custody has galvanized global outrage against systemic racism.[1] COVID-19 has exacerbated racialized injustice even as it has domesticated the aerosolized terror of contagion.[2] Drone strikes; weaponized chemical clouds; carcinogenic miasmas and fossil-fuel smogs bringing death through the air to the world's most vulnerable: all have haunted academic consciousness.[3] COVID-19 and its rituals of masking, handwashing, and social distancing render airborne danger ubiquitous, material, endless.

Writing as art historians about the aerial image after 2020 is, thus, as impossible as it is passionately necessary. In *The Marvelous Clouds* (2015), John Durham Peters introduces a sprawling meditation on air, fire, and other elements by refreshing the familiar tag "in medias res." We, too, write about air from within it, and do so at a moment of turbulent confusion. There is no distance—no recourse to that "aerial perspective" advanced by Leonardo da Vinci and his followers—from which to make air resolve into an orderly politico-intellectual agenda. What this issue attempts instead is an assembly of tools and provisional questions by which to pose the problem more clearly.

Photographic Hydrocarbons

Aerial images are often compressed into a canonical category: aerial photography. Yet air's status as a scientific object, optical medium, and juridical space equally shapes the image from within.[4] A prehistory of the aerial image that is not (yet) could take the aerial photograph at its word, returning to the history of photography's uneven emergence within the chemical medium of air. Materials now familiar as the motive force of fossil-fuel capital might make unfamiliar appearances in that reappraisal of photography's elemental history. But how would such a story go?

In 1807, brothers Claude Niépce and Nicéphore Niépce obtained a *brevet* of ten years' duration from the Napoleonic state for a boat engine dubbed the Pyréolophore. The engine operated on the proposition that fuel evenly distributed through air in a closed chamber would yield significant energy when violently combusted.[5] The

Niépces' engine was a sophisticated device. Visible at left in their patent drawing, bellows pumped air into a firing chamber where fuel was dispensed from a vertical hopper. Ignited by a flaming asbestos wick, the pulverized fuel exploded to drive up the main piston or "ventilator." Managed by an intricate valve system, each stroke of the counterbalanced ventilator forced compressed air into a pipe projecting from its summit while restoring atmospheric air to the engine for the next firing. "Fire-wind-carrier" as its Greek etymology proclaimed, the Pyréolophore pushed a vessel through water by jets of compressed air. The engine worked, albeit slowly. Experimental tests performed in Paris by the Académie des Sciences produced twelve to thirteen strokes per minute.[6]

Air was essential to the device. A key advantage of the three-hundred-pound, tabletop-size Pyréolophore over the steam engines improved by James Watt, Matthew Boulton, and other rival British industrialists—so declared chemist Claude Louis Berthollet and mathematician Lazare Carnot as they assessed the Niépces' engine in December 1806—was that it obviated the need to heat large quantities of water to boiling temperature to generate steam. Dilating atmospheric air rather than heating water saved fuel. However, replenishing the air in the Pyréolophore's combustion chamber after each stroke presented a stern engineering challenge. Even the breath of surrounding observers could hamper it. The engine stopped firing when crowded by human onlookers who inhaled and absorbed the surrounding oxygen. Only when nearby windows and doors were opened did the engine resume its action. "Asphyxiated by mephitic gas," Berthollet and Carnot observed, it was as though the engine had been "reanimated by pure air."[7]

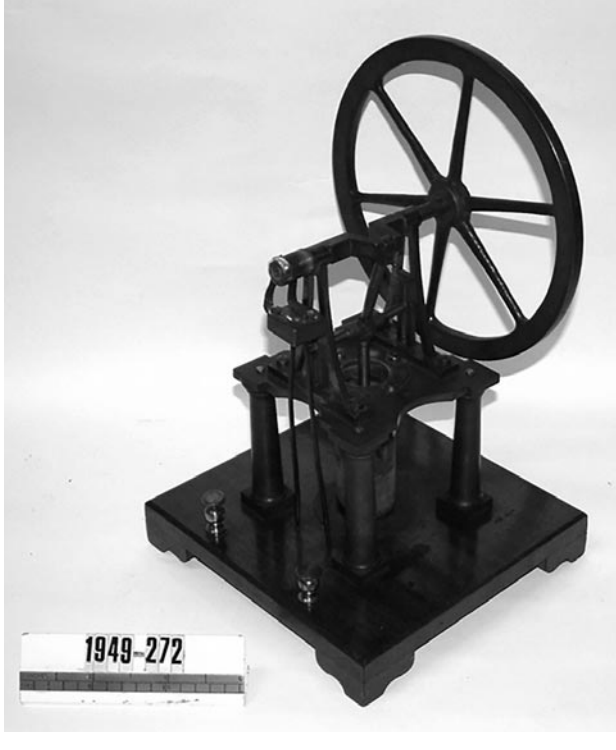
The Niépces' "romantic machine" was vulnerable to aerial pollution.[8] It was also designed to burn fuels engineered from a family of hydrocarbons long known to produce aerial contaminants. In their 1806 *brevet* application, the Niépces specified a fuel made from four parts pulverized coal or charcoal mixed with one part resin. Solid asphalt would likely have been superior to the resin, they acknowledged: it possessed greater chemical "affinity" with the fuel while containing significant proportions of hydrogen.[9] The Niépces' research base at Chalon-sur-Sâone in central-eastern France was near to major asphalt mining operations established in the mid-eighteenth century at Pyrimont, Seyssel, and other sites in the Rhône Valley.[10] A bituminous hydrocarbon, asphalt and its derivatives soon figured in the brothers' experiments beyond the Pyréolophore. By early 1817,

Below: Sample of bitumen, n.d. Musée Nicéphore Niépce, Ville de Chalon-sur-Saône.

Opposite: William Henry Fox Talbot in collaboration with Sir Charles Wheatstone and William Thomas Henley. Electrolytic gas engine, ca. 1840–1842.

Nicéphore Niépce was marveling at the inflammable properties of liquid asphalt available inexpensively from mines at Seyssel.[11] Light-sensitive and highly explosive, "Asphaltum or Bitumen of Judaea" promptly entered Nicéphore Niépce's efforts to replicate on pewter plates the new printing technique of lithography. Asphalt proved crucial to the "heliographic" image-making process described in late 1829 as Niépce entered into formal partnership with J.-L.-M. Daguerre. As previously prepared for the Pyréolophore's fuel, light-sensitive asphalt was to be pulverized. It was then mixed with essential oil of lavender, and spread over silvered plates to evaporate excess liquid in the open air and thereby fix a previously fleeting image.[12]

Inflamed in air to propel a boat by jets of air, the Niépces' hydrocarbons were instrumental to what would come to be called photography.[13] Reciprocally, engineers in the second half of the nineteenth century looked to photography's explosive chemical infrastructure as they designed vehicles capable of traveling through the air. "An engine worked by gun-cotton," so claimed English inventor Matthew Piers Watt Boulton in *On Aërial Locomotion* (1864), "might closely resemble the steam-engine. A suitable quantity of the gun-cotton (or other similar substance) being introduced into a chamber near the cylinder, and there ignited, the gas thus generated would rush into the cylinder, and work the piston, just as is now done by steam."[14] Grandson of James Watt's partner, Matthew Boulton, Boulton fils was outlining principles for aviation using heavier-than-air crafts. Having obtained four patents in 1864 alone for aeriform fuels in combustion engines, Boulton secured those aeronautic rights as he waged an acrimonious, multiyear inquiry into the putative, eighteenth-century invention of photography by his grandfather and Watt.[15]



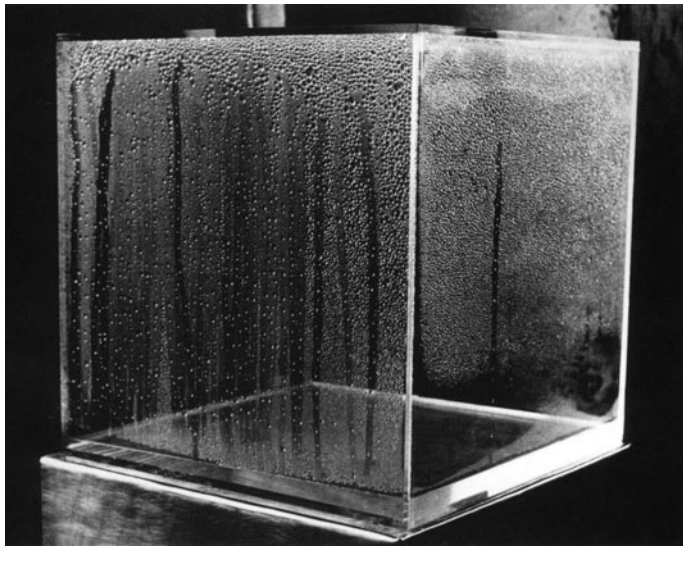
But the gun cotton that Boulton preferred as aircraft fuel also then served as a key catalyst for advanced photographic technique. First synthesized in the 1830s, gun cotton or nitrocellulose was crucial to the wet-collodion photographic process popularized by Frederick Scott Archer in 1851. Dissolved in ether and alcohol, gun cotton became collodion.[16] It was combined with silver and potassium iodides, then poured over a glass plate and dipped into baths of silver nitrate to dramatically decrease the time required for photographic exposure. Yet, none other than the patriarch

of British photography, William Henry Fox Talbot, had established gun cotton in the Victorian engine-making imagination some five years earlier. Updating principles of the "electrolytic gas engine" that he built in collaboration with Charles Wheatstone and William Thomas Henley, Talbot affirmed in a patent of 1846 that the explosive best detonated to drive his engine's piston was "commonly known by the name of gun cotton, prepared with nitric and sulphuric acids."[17]

Thus, hydrocarbons, first inflamed in air to propel a boat by jets of compressed air (while releasing carbon dioxide into the atmospheric air), acquired a "photographic" function.[18] Replaced by synthetic combustibles capable of burning in the absence of atmospheric air, photography's chemical apparatus was then mined to move combustion engines into the air.[19] Beyond affirming various theses of Paul Virilio or literalizing Walter Benjamin's adage that technological acceleration turns "the artwork into a missile," a prehistory like this one would render the aerial image inseparable from narratives of fossil capital, enfolding art history and its objects back into the larger politics and problematic of combustion.[20] Rather than air incidentally occupying the privileged point of view from which Edward Burtynsky and his slick photographic ilk can "document the scale of anthropogenic activity on the surface of the planet," the braided histories of engine-propelled crafts and the photographic technics they convey would be returned to the representational problem with which they are enmeshed: global heating.[21] The subject of aerial toxicity would be inseparable from the airborne means and media by which it is now so blithely visualized.

Of Air

Such connections have usually remained obscure. The point becomes apparent when academic and artistic engagements with air are juxtaposed to benchmarks in postwar environmental legislation. Consider Hans Haacke's *Condensation Cube* as first exhibited in 1965. Chemically treated water was introduced into a plexiglass cube. Warmed inside the cube, the water precipitated as it met cooler air beyond the object's transparent boundary. The resulting condensation gave the sculpture its title as the cube became a thermostat, an indicator of the fluctuating temperature of the surrounding gallery. Haacke was hardly alone among 1960s artists in treating the controlled air of the "white cube" as a manipulable medium. So attest



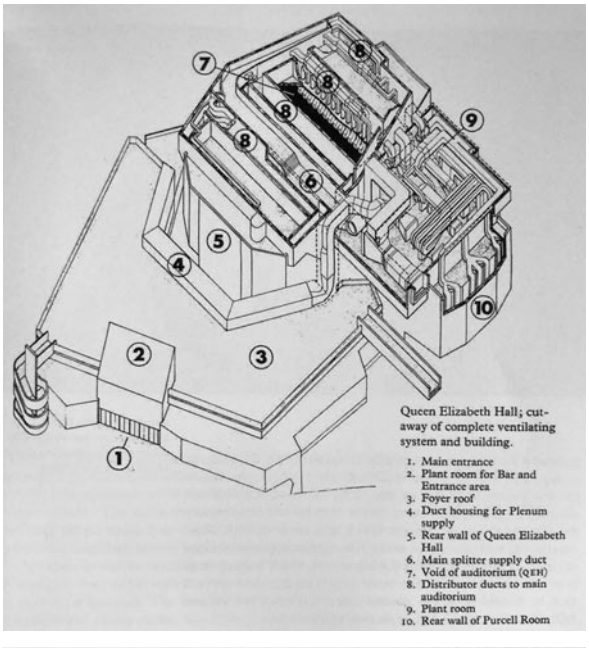
Below: Hans Haacke. *Condensation Cube*, 1963–1965.

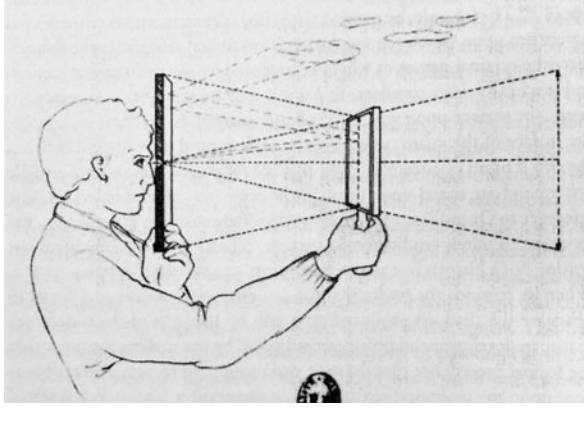
Opposite, top: Ventilation system of Queen Elizabeth Hall, London. From Reyner Banham, *The Architecture of the Well-Tempered Environment* (1969).

Opposite, bottom: Brunelleschi's perspective experiment. From Hubert Damisch, *A Theory of /Cloud/* (1972).

the "primary atmospheres" produced by the room-size installations of James Turrell and Robert Irwin or Art & Language's *Air-Conditioning Show* of 1966–1967.[22] Appearing some ten years after the Air Pollution Control Act of 1955 (the earliest federal legislation in the United States to reckon with the national scale of airborne pollution), air figured as an artistic element porous to, and integral within, the systems around it.[23]

Air would contemporaneously shape architectural history's turn away from the independent "object" of architecture toward the analysis of interrelated systems. Ventilation and climate control were central to the account of modernist architecture presented in Reyner Banham's *The Architecture of the Well-Tempered Environment* (1969).[24] Banham focused attention on how buildings' internal infrastructures produce "habitable environments," concerns that had been largely ignored in architectural history's more generic engagement with "space."[25] In Banham's account, only in the 1960s—thus, following the United Kingdom's landmark 1956 Clean Air Act, the first effective legislation against the pervasive smogs in that country—did architects begin to turn built structures inside out to emphasize their relational, circulatory functions, as in the externalized air ducts for London's Queen Elizabeth Hall.[26]

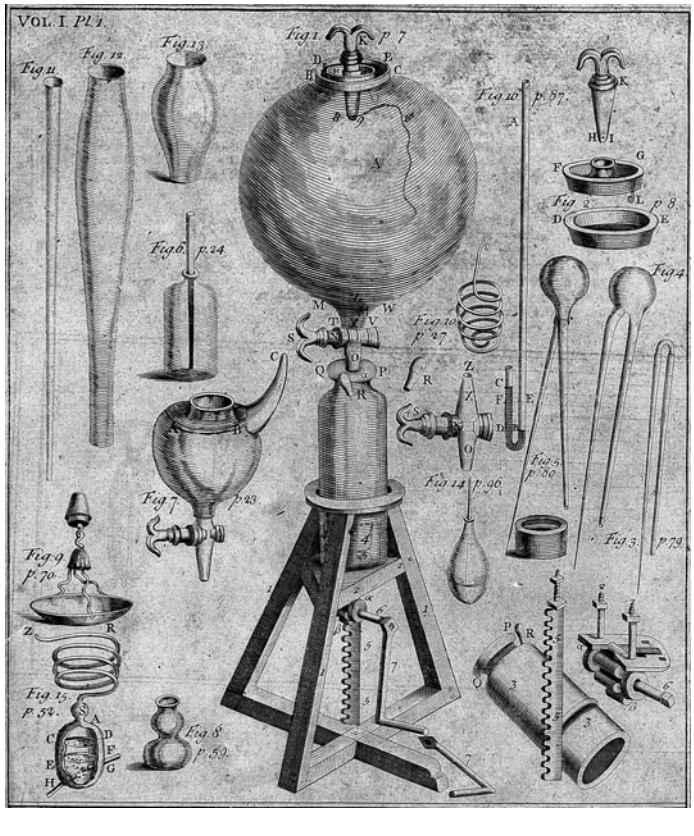




Just two years after the administration of renegade ecologist Richard M. Nixon founded the Environmental Protection Agency (EPA), Hubert Damisch published *A Theory of /Cloud/* (1972).[27] In that alternate genealogy of Western painting, Damisch identified air as the wrench in the works of Renaissance perspective. Filippo Brunelleschi's instrument for demonstrating his new perspectival technics trained the observer's eye on a fictively dimensional architectural space rendered in paint. But, as Damisch argues, the "aerial element" of the scene could be inserted into the visual structure only by means of burnished silver mirrors that reflected the sky itself. This seeming "subterfuge," which places air outside of painting's powers of rendering, "reveals perspective as a structure of exclusions" on which its very "coherence" depends.[28] To fully give in to painting's aerial dimensions was to dissolve the guarantees of

perspective that made pictures into units of stable information.[29]

Renaissance painters were not alone in struggling to suppress air. As Luce Irigaray would claim in 1983, air—the medium of human sustenance, the "groundless ground" of metaphysical thought—had been conspicuously repressed by Western philosophy.[30] But air had already destabilized territory. Signed by dozens of Eurasian and North American nations in 1979, the Convention on Long-Range Transboundary Air Pollution outlined protocols for cooperation in combating airborne pollutants, chemicals that transgressed sovereign borders and entangled diplomatic procedures.[31] By 1985, the control of air became the centerpiece for a classic study blurring the boundaries between the social history and philosophy of science. In *Leviathan and the Air-Pump* (1985), Steven Shapin and Simon Schaffer would revisit the celebrated experiments made inside the evacuated receiver of Robert Boyle's air pump.[32] But the air pump leaked. "This is not at all a trivial and merely technical point," Shapin and Schaffer argue. "The capacity of this machine to produce matters of fact crucially depended on its physical integrity."[33] Thomas Hobbes had used the pump's leakiness to attack experimental knowledge itself. Writing in the year in which the widening atmospheric puncture above Antarctica catalyzed the Vienna Convention for the Protection of the Ozone Layer, Shapin and Schaffer cast Hobbes as a deft critic of experimental philosophy's menace to sovereign power. Authoritative knowledge threatened to leak dangerously out of the air pump's social epistemology.[34]



Robert Boyle's air pump. From *The Works of the Honourable Robert Boyle* (1772).

More recently, scholarship has emphasized the imbrication of race with air's mapping of power/knowledge. Christina Sharpe's *In the Wake* (2016) articulates a pervasive "climate" of anti-Blackness—a totalizing atmosphere of terror and surrounding violence, including that of environmental and medical racism.[35] Sharpe's account is echoed in state-sponsored apprehensions of air: a 2018 report from EPA scientists quantifies the increased risk of Black Americans for exposure to airborne pollution from fossil fuels and other emissions.[36] Against such institutionalized asphyxiation, Sharpe calls for artistic practices that can put "breath back in the Black body in hostile weather."[37] This project of "aspiration" resounds in Kevin Beasley's *A View of a Landscape: A Cotton Gin Motor* (2012–2018). Beasley purchased and restored a General Electric motor that had originally powered a cotton gin on an Alabama farm from 1940 to 1973. He installed it in a tightly sealed, soundproof chamber. The engine runs at full tilt. Unlike Berthollet and Carnot choked by the Niépces' Pyréolophore, Beasley's viewer experiences an unsettling, airless silence. In the adjacent gallery, the sounds of the motor's combustion are remixed to create an audiovisual milieu. The emanations of the engine are repurposed to produce an ambient space designed as much for performance, dance, and other live practices as for being and breathing otherwise.[38]

Top: Kevin Beasley. *A View of a Landscape: A Cotton Gin Motor*, 2012–2018. Installation view, Whitney Museum of American Art, New York.

Bottom: Kevin Beasley. *A View of a Landscape: A Cotton Gin Motor*, 2012–2018. Installation view, Whitney Museum of American Art, New York.

From Above

Against this hazy, art-historical view of air stands a clear disciplinary vista. Its name is "aerial photography." In 1937, the Museum of Modern Art's inaugural photography exhibition included a special section dedicated to the topic. Curator Beaumont Newhall foregrounded photographer Edward Steichen's experience directing the photographic division of the U.S. Air Force during World War I. "Faced with the problem of getting maximum detail with the poor material then at hand," Newhall claimed, Steichen's aerial photography oriented his shift toward detail and object photography in the interwar period.[39] Corporate aerial surveys and photographs of aerial bombardment: all figured in Newhall's 1937 exhibition,

marking the multiple trajectories of the aerial photograph in subsequent scholarship.[40] Writing years later in *Airborne Camera* (1969), Newhall offered the global summary. Widespread acculturation to the aerial view had helped unseat the "anthropocentric vision of established perspective."[41] Aerial imaging was a tool for the triumph of pictorial abstraction.

Newhall's accounts of aerial photography intersected with the shifting analysis of the air from a very anthropocentric perspective: that of the nation-state.[42] In the wake of WWI and the new prominence of aerial warfare, the 1919 Paris Convention Relating to the Regulation of Aerial Navigation granted nations "complete and absolute sovereignty" over the airspace above their territory. This position was reasserted in an international agreement signed in December 1944, near the end of WWII.[43] That air was a domain of power was clear to Allan Sekula in his well-known riposte to Newhall's modernist narrative. Sekula foregrounded aerial photography in his critical framework of the "instrumental image."[44] Aerial photographs, Sekula argued in 1975, could be called on to serve a variety of narratives: "Anything from the opinions of experts, the history of a battle, the history of photographic techniques, the history of flight, dissertations on the role of air power in the First World War, to digressions on the French countryside and tales from the trenches might be expected."[45] The vertical politics of aerial photography's juridical role has more recently been deployed in

international human rights cases, such as those launched by the Forensic Architecture research agency based at Goldsmiths.[46] Likewise, artist-researchers including Harun Farocki, Hito Steyerl, and Trevor Paglen have situated the view from above as a critical problem.[47] Moving in an expanded terrain of research on images outside the domain of art, such projects have reoriented modernist conceptions of the aerial photograph toward airborne media and the technical systems they serve.[48] Commensurately, aerial photography has ceded analytic place to the aerial image.

The systems that mobilize aerial images are anything but politically neutral. Pressured by the postwar United States, the sovereignty exercised by nation-states over airspace has shifted toward deregulation and free-market governance.[49] Although drones (formally, unmanned aerial vehicles or UAVs) have been in use for reconnaissance since the early twentieth century, the proliferation of aerial jurisdictions since the 1990s has enabled increasing numbers of unmanned craft to be employed for purposes ranging from forest management and pizza delivery to military surveillance and targeted killings; more than fourteen thousand drone strikes have been perpetrated by the United States alone.[50] Caren Kaplan calls public and media concern with the expansive use of drones a veritable "drone-o-rama."[51] Scholarship has followed suit. In their survey of the field, Kaplan and Lisa Parks outline how interdisciplinary interest in UAVs has been catalyzed by the intersecting

Opposite: Installation view of *Photography 1839–1937*, curated by Beaumont Newhall, 1937. Photographic Archive. The Museum of Modern Art Archives, New York.

Below: Installation view of *Photography 1839–1937*, curated by Beaumont Newhall, 1937. Photographic Archive. The Museum of Modern Art Archives, New York.

technological, political, and social dimensions of "life in the age of drone warfare." Describing the "everywhere war" that such technologies enable, contemporary scholarship has zeroed in on the "matrix of military violence" that facilitates propagation of aerial images in modern warfare.[52]

The legality of drones is adjudicated by triangulating use-of-force laws, international humanitarian codes, and human-rights law.[53] States have moved hastily into this legal grey zone. Building on 1980s U.S. Supreme Court decisions, which ruled that warrantless aerial surveillance does not breach the U.S. Constitution's Fourth Amendment, law enforcement has developed increasingly widespread tactics of aerial reconnaissance—surveying Black Lives Matter protests throughout the summer of 2020 as but one instance.[54] Conversely, activist groups have developed tactics to contest control over aerial image production.[55] A DIY kite/aerial photography kit developed by Public Lab works with open-source software to generate maps from crowd-sourced aerial imagery.[56] Recognizing the power of such aerial imagery during confrontations over the Dakota Access Pipeline at Standing Rock in 2016, the U.S. Federal Aviation Administration instituted a temporary no-fly zone over the area. Civilian drone operators (including the Indigenous media platform *Digital Smoke Signals*) filmed police violence against activists from above—footage later used as evidence against police action.[57] Across national and global scales, aerial images have thus become crucial vectors for the analysis of the air/power nexus.

IIIII

The essays in this issue of *Grey Room* center particularly on nineteenth-century European industrial modernity as a period in which the "aerial image" came to command such epistemico-political purchase. The histories of the aerial image presented here attempt to conjoin hazy histories of atmosphere (air seen from within) with the clearer, disciplined trajectory of the aerial view (air seen from without). They suggest how air itself began to assume new material and figurative forms in the nineteenth century—shapes that come into view between the increasingly malevolent, thickened atmosphere of industrial modernity and the progressive colonization of the air by military and technological imaginaries. Tracing potential routes back through the history and historiography of aerial images, they suggest qualifications to triumphalist narratives—or triumphalist critiques—of the aerial image. Political and social pressures emerge not as a fixed context but as materially imbricated in the aerial image's being in ways that are messy, capacious, and unresolvable.

Amy Knight Powell's essay traces the history of the Western

easel painting's attempts to breathe—to be open to the world that surrounds it—against histories of the air's shaping of nationalist, gendered ideologies of subjecthood. Absent the ability to bring art and life together, painting was threatened with suffocation. Nicholas Robbins's essay on the British surveyor and entrepreneur Thomas Hornor takes air as a structuring material element of the panoramic apparatus. Hornor's efforts to regulate nineteenth-century London's increasingly polluted air, linked to the dream of aerial transparency presented in the panorama, foundered on air's fundamentally unregulatable identity. In his essay on Charles Joseph Minard's 1870 map of Napoleon's Russian campaign, Richard Taws suggests that this aerial, diagrammatic view of war and its human costs is less stable than its subsequent canonization in histories of the "infographic" would suggest. The cartographic flows inscribed by Minard's graphic method were shot through by catastrophe, displacement, and the destabilizing effects of recursive history. Emily Doucet's investigation of the photographic and archival practices that subtended Félix Nadar's efforts to foster the science of aerostation considers how the air became a space of highly mediated possibility for technological invention. Yet such a story, in Nadar's case, might end not in a triumphalist narrative of possession over the sky but in partial, melancholy failure and obsolescence.

Once upon a time (namely, the London stage in 1676), it was possible to laugh at the idea of air as a matter of substance. "I employ men all over *England*, Factors for Air, who bottle up Air, and weigh it in all places, sealing the Bottles Hermetically"—so declares Thomas Shadwell's buffoonish experimental philosopher, Sir Nicholas Gimcrack, satirizing either Boyle or Robert Hooke, the air pump's engineer. "That vault," Shadwell's deluded enthusiast assures as he points to a cabinet, "is full of Country-Air."[58] The audience laughed (as did Charles II, the Royal Society's nominal patron) because the proposition of weighing and keeping nothing seemed so absurd. But air is not nothing. Even as it strays to the margins of visibility—and thus evades venerable technics of art history—air became inescapably real in 2020. Its chemical, political, and epidemiological weight continues to unfurl in terrifying ways. Element, medium, and perspective, air and the aerial image make for messy subjects. To reconcile scholarship on images "of air" and "from air," as this issue does, is thus to plan for the world in which the intellectual jurisdictions of flight, fuel, and image-making appear no longer clouded in their connections but are made matters of concerted political inquiry.

Notes

The editors of this special issue thank the editors of *Grey Room* and the anonymous referees for their critical feedback on this project. The essays in this issue developed from a conference held at Yale University in 2019. We thank Jessica Horton, Maria Loh, Lynda Nead, Chitra Ramalingam, Alison Syme, and Jennifer Tucker for sharing their work at the conference. Thanks also to Amy Knight Powell and Richard Taws for contributions then and in these pages. We are pleased to acknowledge the guidance and support of Jennifer Raab, Paul Sabin, Martina Droth, Tim Barringer, and Deborah Coen.

1. This movement is not bound by the events of 2020; it builds on traditions of organizing well beyond the contemporary moment. On the lethal histories of asphyxiation by the police, see Mike Baker, Jennifer Valentino-DeVries, Manny Fernandez, and Michael LaForgia, "Three Words. 70 Cases. The Tragic History of 'I Can't Breathe,'" *New York Times*, June 29, 2020, https://www.nytimes.com/interactive/2020/06/28/us/i-cant-breathe-police-arrest.html.

2. Faheem Ahmed, Na'eem Ahmed, Christopher Pissarides, and Joseph Stiglitz, "Why Inequality Could Spread Covid-19," *The Lancet: Public Health* 5, no. 5 (2020): 240; and S. Ali, S. Stranges, and M. Asaria, "Covid-19 and Inequality: Are We All in This Together?," *Canadian Journal of Public Health* 111, no. 3 (2020): 415–16. For a bracing counterpoint, see Elizabeth Wrigley-Field, "US Racial Inequality May Be as Deadly as Covid-19," *Proceedings of the National Academy of Sciences of the United States of America*, August 24, 2020, https://doi.org/10.1073/pnas.2014750117.

3. See Lisa Parks and Caren Kaplan, eds., *Life in the Age of Drone Warfare* (Durham, NC: Duke University Press, 2017); Peter Sloterdijk, *Terror from the Air*, trans. Amy Patton and Steve Corcoran (Cambridge: Semiotexte and MIT Press, 2009); and Richard Misrach and Kate Orff, *Petrochemical America* (New York: Aperture, 2012).

4. See Eva Horn, "Air as Medium," *Grey Room*, no. 73 (Fall 2018): 6–25.

5. Their 1806 patent specification stipulates, "Nous imaginâmes que s'il [l'air atmosphérique] se trouvoit pénétré brusquement dans un vase clos par la flamme d'une substance éminemment combustible, réduite en poussiere très-fine, et disséminée dans toute la capacité de ce vase, il déploîrait alors, une énergie beaucoup plus grande." (We imagined that if atmospheric air were to be violently penetrated in a closed vessel by the flame of a highly flammable substance, reduced to a fine powder and distributed throughout the vessel, it would deploy a much greater amount of energy.) "Notice sur le Pyréolophore," in *Niépce: Correspondance et papiers*, ed. Manuel Bonnet and Jean-Louis Marignier (Saint-Loup-de Varennes, France: Maison Nicéphore Niépce, 2003), 269. For the engine's operating principles, see Horst O. Hardenberg, *The Niepce Brothers' Boat Engines* (Warrendale, PA: Society of Automotive Engineers, 1993).

6. [Claude Louis Berthollet and Lazare Carnot], "Rapport de Lazare Carnot sur le Pyréolophore," presentation to the Académie des Sciences on 15 December 1806, reproduced in *Niépce: Correspondance et papiers*, 295.

7. "La machine étoit pour ainsi dire asphyxiée par le gaz méphitique et ranimée par l'air pur." (The machine was, so to speak, asphyxiated by the mephitic gas and reanimated by pure air.) "Rapport sur le Pyréolophore," in *Niépce: Correspondance et papiers*, 294.

8. "The exemplary machines of the romantic era, powered by steam, electricity, and other subtle forces," historian of science John Tresch states, "could be seen to have their own motive force within them." John Tresch, *The Romantic Machine:*

Utopian Science and Technology after Napoleon (Chicago: University of Chicago Press, 2012), 12.

9. Of their fuels, the Niepces write: "Celui que nous proposons est un mélange de quatre parties de houille ou charbon de terre, et une partie de résine commune, le tout réduit en poudre très fine par le moyen de l'eau. N'ayant pu nous procurer de l'asphalte solide, nous ignorons s'il seroit dans le cas de remplacer la résine; cependant nous le présumons, et c'est à désirer, attendu qu'il reviendroit probablement à meilleur compte, et qu'il auroit plus d'affinité avec le charbon de terre. Celui ci contient de hydrogène en abondance." (What we propose is a mix of four parts coal or charcoal, one part common resin, all ground to a fine powder by means of water. Unable to secure solid asphalt, we are unsure if it could have replaced the resin in this case. However, we presume so and this would be desirable; it would likely be cheaper and it would have a greater affinity with the charcoal. Asphalt contains an abundance of hydrogen.) "Notice sur le Pyréolophore," in *Niépce: Correspondance et papiers*, 271.

10. See F.W. Simms, *Practical Observations on the Asphaltic Mastic, or, Cement of Seyssel . . .* (London: John Weale, Architectural Library, 1838), 2–3. See also Jeffrey T. Schnapp, "Three Pieces of Asphalt," *Grey Room*, no. 11 (Spring 2003): 5–21.

11. For a discussion of combusting and sourcing "un peu d'asphalte solide, connu sous le nom de *bitume du Judée*" (a bit of solid asphalt, known by the name of *bitumen of Judaea*), see Nicéphore Niépce to Claude Niépce, 23–24 January 1817, as reproduced in *Niépce: Correspondance et papiers*, esp. 503–5.

12. Nicéphore Niépce, "Notice sur l'héliographie" (24 November–4 December 1829), in *Niépce: Correspondance et papiers*, 922.

13. For technical analyses of Niépce heliographs identifying the presence and function of asphalt, see D. Stulik, A. Kaplan, and H. Khanjian, "The First Scientific Investigation of Niépce's Images from UK and US Collections: Image Layer and Image Formation," *Imaging Science Journal* 61, no. 8 (2013): 602–28.

14. Matthew Piers Watt Boulton, *On Aërial Locomotion* (London: Bradbury and Evans, 1864), 6.

15. See Matthew C. Hunter, *Painting with Fire: Sir Joshua Reynolds, Photography and the Temporally Evolving Chemical Object* (Chicago: University of Chicago Press, 2019), 131–78.

16. See also Estelle Blaschke, "From Microform to the Drawing Bot: The Photographic Image as Data," *Grey Room*, no. 75 (2019): 68.

17. William Henry Fox Talbot, "Obtaining and Applying Motive Power," patent no. 11,475 (1846; signed by Talbot on 3 June 1847), 2.

18. For the Niépces' celebration of the Pyréolophore's production of carbon dioxide (*gaz carbonique*), see "Notice sur le Pyréolophore," in *Niépce: Correspondance et papiers*, 270.

19. On this feature of nitrocellulose, see Heather Heckman, "Burn after Viewing, or, Fire in the Vaults: Nitrate Decomposition and Combustibility," *American Archivist* 73, no. 2 (Fall/Winter 2010): 483–506.

20. Andreas Malm, *Fossil Capital: The Rise of Steam-Power and the Roots of Global Warming* (London: Verso, 2016). See also Timothy Mitchell, *Carbon Democracy: Political Power in the Age of Oil* (London: Verso, 2013); and On Barak, *Powering Empire: How Coal Made the Middle East and Sparked Global Carbonization* (Berkeley and Los Angeles: University of California Press, 2020). For the atmospherics of medium in Benjamin's thought, see Antonio Somaini, "Walter Benjamin's Media Theory: The *Medium* and the *Apparat*," *Grey Room*,

no. 62 (Winter 2016): 6–41.

21. Sophie Hackett, "Far and Near: New Views of the Anthropocene," in *Anthropocene: Burtynsky, Bacihwal, De Pencier* (Toronto: Art Gallery of Ontario, 2018), 23.

22. See Dave Hickey, "Primary Atmospheres," in *Primary Atmospheres: Works from California 1960–70* (New York: David Zwirner; Göttingen: Steidl, 2010), 7–15; and Michael Baldwin, "Remarks on Air-Conditioning: An Extravaganza of Blandness" (1967), in *Conceptual Art: A Critical Anthology*, ed. Alexander Alberro and Blake Stimson (Cambridge: MIT Press, 1999), 32–34.

23. The 1955 act allocated federal funds for research, though legislation restricting pollution was left to individual states. See Arthur C. Stern, "History of Air Pollution Legislation in the United States," *Journal of the Air Pollution Control Association* 32, no. 1 (1982): 48–49. On Haacke, see Luke Skrebowski, "All Systems Go: Recovering Hans Haacke's Systems Art," *Grey Room*, no. 30 (Winter 2008): 54–83.

24. Rayner Banham, *The Architecture of the Well-Tempered Environment* (London: Architectural Press, 1969).

25. Banham, 20.

26. Banham, 234–64. On the aesthetic and cultural dimensions of smog and smoke abatement in postwar Britain, see Lynda Nead, *Tiger in the Smoke: Art and Culture in Post-War Britain* (New Haven, CT: Yale University Press, 2017). Banham's work has informed several other works on the history and politics of heating, ventilation, and air conditioning. See, for example, Michael Osman, *Modernism's Visible Hand: Architecture and Regulation in America* (Minneapolis: University of Minnesota Press, 2018); Reinhold Martin, "Risk: Excerpts from the Environmental Division of Labor," in *Climates: Architecture and the Planetary Imaginary*, ed. James Graham (New York: Columbia Books on Architecture and the City; Zurich: Lars Müller Publishers, 2016), 349–59; Eva Horn, "Air Conditioning: Taming the Climate as a Dream of Civilization," in *Climates: Architecture and the Planetary Imaginary*, 233–41; and Daniel A. Barber, *Modern Architecture and Climate: Design before Air Conditioning* (Princeton, NJ: Princeton University Press, 2020).

27. Stern, 55–57; and Hubert Damisch, *A Theory of /Cloud/: Toward a History of Painting*, trans. Janet Lloyd (1972; Stanford, CA: Stanford University Press, 2002).

28. Damisch, 121–24.

29. Damisch, 25–26. For a recovery of an earlier art-historical mobilization of "air"—one signifying precisely the social milieu of the artwork's coming into being—see Margareta Ingrid Christian, "*Aer, Aurae, Venti*: Philology and Physiology in Aby Warburg's Dissertation on Botticelli," *PMLA* 129, no. 3 (2014): 399–416.

30. Luce Irigaray, *The Forgetting of Air in Martin Heidegger*, trans. Mary Beth Mader (1983; London: Athlone Press, 1999).

31. "United Nations: Convention on Long-Range Transboundary Air Pollution," *International Legal Materials* 18, no. 6 (Nov. 1979): 1442–55. On the formation and efficacy of this agreement, see Jørgen Wettestad, "Designing Effective Environmental Regimes: The Case of the Convention on Long-Range Transboundary Air Pollution (CLRTAP)," *Energy and Environment* 10, no. 6 (November 1999): 671–703.

32. Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton, NJ: Princeton University Press, 1985).

33. Shapin and Schaffer, 29.

34. Bruno Latour, *We Have Never Been Modern*, trans. Catherine Porter (1991; Cambridge: Harvard University Press, 1993), 18–20. For Latour's subsequent reflection on how scholarship analyzing the constructed, consensual nature of science has been co-opted to undermine confrontation with climate change, see Bruno Latour, "Why Has Critique Run Out of Steam? From Matters of Fact to Matters of Concern," *Critical Inquiry* 30, no. 2 (Winter 2004): 225–48.

35. Christina Sharpe, *In the Wake: On Blackness and Being* (Durham, NC: Duke University Press, 2016), 102–34.

36. See Ihab Mikati et al., "Disparities in Distribution of Particulate Matter Emission Sources by Race and Poverty Status," *American Journal of Public Health* 108, no. 4 (April 2018): 480–85.

37. Sharpe, 113. In this formulation, Sharpe draws on the history of the spirometer, a device used to measure supposedly racialized capacities for breath, as well as the role of climate in shaping regimes of enslaved labor (111–12). See also Lundy Braun, *Breathing Race into the Machine: The Surprising Career of the Spirometer from Plantation to Genetics* (Minneapolis: University of Minnesota Press, 2014).

38. See Christopher Y. Lew, "Low End Theory," Whitney Museum of American Art, 2018, https://whitney.org/essays/kevin-beasley. Others of Beasley's performances and installations draw specifically on records and reworkings of breath. In Beasley's performance at MoMA, *I Want My Spot Back* (2012), for example, he tried to "extract the low frequencies" of Notorious B.I.G.'s breath as captured on his recordings. See Kevin Beasley, interview with Jenny Schlenzka, *Mousse* 41 (December 2013–January 2014), http://moussemagazine.it/kevin-beasley-jenny-schlenzka-2013/.

39. Beaumont Newhall, *Photography 1839–1937* (New York: Museum of Modern Art, 1937), 71.

40. On surveying, see Marionne Cronin, "Northern Visions: Aerial Surveying and the Canadian Mining Industry, 1919–1928," *Technology and Culture* 48, no. 2 (April 2007): 303–30; and Matt Dyce, "Canada between the Photograph and the Map: Aerial Photography, Geographical Vision, and the State," *Journal of Historical Geography* 39 (2013): 69–84. On aerial bombardment, particularly in relation to architecture, see Lucia Allais, *Designs of Destruction: The Making of Monuments in the Twentieth Century* (Chicago: University of Chicago Press, 2018); and John Harwood, "The Other End of the Trajectory: Danger Zones," *Grey Room*, no. 54 (Winter 2014): 80–106. On the place of aerial photography in the social sciences (including urban planning), see Jeanne Haffner, *The View from Above: The Science of Social Space* (Cambridge: MIT Press, 2013).

41. Beaumont Newhall, *Airborne Camera: The World from the Air and Outer Space* (New York: Hastings House, 1969), 9. See also Angela Lampe, ed., *Vues d'en haut* (Metz: Centre Pompidou Metz, 2013); and Mark Dorrian and Frederic Pousin, eds., *Seeing from Above: The Aerial View in Visual Culture* (London: I.B. Tauris, 2013).

42. The aerial view is central to James Scott's account of "seeing like a state." James Scott, *Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven, CT: Yale University Press, 1998).

43. "Convention on International Civil Aviation Done at Chicago on the 7th Day of December 1944," https://www.icao.int/publications/Documents/7300_orig.pdf. On the history of aviation regulation leading up to the Chicago agreement, see Waqar H. Zaidy, "'Aviation Will Either Destroy or Save Our Civilization':

Proposals for the International Control of Aviation, 1920–45," *Journal of Contemporary History* 46, no. 1 (2011): 150–78.

44. See Allan Sekula, "The Instrumental Image: Steichen at War," *Artforum*, no. 4 (December 1975): 26–35. The essay was later reprinted in Allan Sekula, "The Instrumental Image: Steichen at War," in *Photography against the Grain: Essays and Photo Works, 1973–1983* (Halifax: Press of the Nova Scotia College of Art and Design, 1984), 32–55. On Sekula, see Benjamin J. Young, "Sympathetic Materialism: Allan Sekula's Photo-Works, 1971–2000" (Ph.D. diss., University of California Berkeley, 2018); and Marie Muracciole and Benjamin J. Young, eds. "Special Issue: Allan Sekula and the Traffic in Photographs," *Grey Room*, no. 55 (Spring 2014).

45. Sekula, "The Instrumental Image," 39.

46. Eyal Weizman, *Forensic Architecture: Violence at the Threshold of Detectability* (Princeton, NJ: Princeton University Press, 2017).

47. Farocki explores this concept in films such as *Images of the World and the Inscription of War* (1988) and the *Eye/Machine* trilogy (2001–2003). See also Hito Steyerl, "In Free Fall: A Thought Experiment on Vertical Perspective," *e-flux*, no. 24 (2011); and Trevor Paglen, "Operational Images," *e-flux*, no. 59 (November 2014), https://www.e-flux.com/journal/59/61130/operational-images/.

48. Since approximately 2010, there has been a profusion of exhibitions bringing together contemporary artists with a dark fascination for the drone and the surveillance arm of the military-industrial complex. See, for example, Svea Bräunert and Meredith Malone, *To See without Being Seen: Contemporary Art and Drone Warfare* (Chicago: University of Chicago Press, 2016). See more broadly, Walead Beshty, ed., *Picture Industry: A Provisional History of the Technical Image 1844–2018* (Arles: SAS Luma, 2018).

49. For an overview of this trajectory, see Christer Jönsson, "Sphere of Flying: The Politics of International Aviation," *International Organization* 35, no. 2 (Spring 1981): 273–302.

50. Parks and Kaplan, 3–4. For a "snapshot" of the numbers of unarmed UAVs currently in use in the United States, see Federal Aviation Administration, "UAS by the Numbers," last modified September 29, 2020, https://www.faa.gov/uas/resources/by_the_numbers/. On the international use of armed UAVs, see a report from the UK-based nongovernmental organization Drone Wars, "Who Has Armed Drones?," last updated July 2020, https://dronewars.net/who-has-armed-drones/. On the number of drone killings, see the Bureau of Investigative Journalism, "Drone Warfare," https://www.thebureauinvestigates.com/projects/drone-war.

51. Parks and Kaplan, 1. For an influential early essay, see Jane Mayer, "The Predator War, What Are the Risks of the C.I.A.'s Covert Drone Program?," *New Yorker*, 26 October 2009.

52. Parks and Caplan, 2–3; and Derek Gregory, "The Everywhere War," *Geographic Journal* 177, no. 3 (September 2011): 238–50. Gregory's work in historical geography has been particularly influential for studies of drone visualities. See Derek Gregory, "From a View to a Kill: Drones and Late Modern War," *Theory, Culture and Society* 28, no. 7–8 (2011): 188–215; and Derek Gregory, "Drone Geographies," *Radical Philosophy* 183 (January/February 2014): 7–19. Mary Favret has explored this phenomenon in an earlier period, see Mary A. Favret, *War at a Distance: Romanticism and the Making of Modern Wartime* (Princeton, NJ: Princeton University Press, 2009). On the imbrication of the aerial image in modern warfare more broadly, see also Caren Kaplan, *Aerial Aftermaths: Wartime from Above* (Durham, NC: Duke University Press, 2017).

53. Claudia Candelmo, "Drones at War: The Military Use of Unmanned Aerial Vehicles and International Law," in *Use and Misuse of New Technologies: Contemporary Challenges in International and European Law*, ed. Elena Carpanelli and Nicole Lazzerini (Cham, Switzerland: Springer International Publishing, 2019), 93–112.

54. Jay Stanley and Catherine Crump, "Protecting Privacy from Aerial Surveillance: Recommendations for Government Use of Drone Aircraft," American Civil Liberties Union, December 2011, https://www.aclu.org/report/protecting-privacy-aerial-surveillance-recommendations-government-use-drone-aircraft; John Pavletic, "The Fourth Amendment in the Age of Persistent Aerial Surveillance," *Journal of Criminal Law and Criminology* 108, no. 1 (2018): art. 4; and Zolan Kanno Youngs, "U.S. Watched George Floyd Protests in 15 Cities Using Aerial Surveillance," *New York Times*, 19 June 2020, https://www.nytimes.com/2020/06/19/us/politics/george-floyd-protests-surveillance.html.

55. Caren Kaplan, "Atmospheric Politics: Protest Drones and the Ambiguity of Airspace," *Digital War* (2020); and Sarah Tuck, "Drone Vision and Protest," *photographies* 11, no. 2–3 (2018): 169–75.

56. For one such collaboration, see Hagit Keysar, "A Spatial Testimony: The Politics of Do-It-Yourself Photography in East Jerusalem," *Environmental Planning D: Society and Space* 37, no. 3 (2018): 523–41.

57. Sara Rafsky, *Eyes in the Sky: Drones at Standing Rock and the Next Frontier of Human Rights Video* (Brooklyn, NY: Witness Media Lab, 2017), https://lab.witness.org/projects/drones-standing-rock/. See also Jessica Horton, "Drones and Snakes," *Art in America*, October 2017, 104–9.

58. Thomas Shadwell, *The Virtuoso: A Comedy, Acted at the Duke's Theatre* (London: T.N. for Henry Herringman, 1676), 65. For the period reception, see Shapin and Schaffer, 70.