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Proxies

The Cultural Work of Standing In

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Notes

CHAPTER 1

1. Hans Vaihinger, *The Philosophy of "As If;"* trans. C. K. Ogden (New York: Harcourt Brace, 1924), 93.
2. Russell W. Glenn, Jody Jacobs, Brian Nichiporuk, Christopher Paul, Barbara Raymond, Randall Steeb, and Harry J. Thei, *Preparing for the Proven Inevitable: An Urban Operations Training Strategy for America's Joint Force* (Santa Monica, CA: RAND Corporation, 2006); Geoff Manaugh, "Yodaville," *BLDGBLOG*, December 6, 2015, <http://www.bldgblog.com/2015/12/yodaville/>.
3. Mark Bowden, *Black Hawk Down: A Story of Modern War* (New York: Signet, 1999); *Black Hawk Down*, dir. Ridley Scott (Los Angeles: Columbia Pictures, 2001).
4. The report was commissioned by the Office of the Secretary of Defense and US Joint Forces Command.
5. Glenn et al., *Preparing*, xv (emphasis added).
6. If we think of Yodaville as an instrument in the exercise of empire, it is redoubled when we acknowledge that the Yuma Proving Ground's proximity to the US-Mexico border is a bulwark of the US occupation of that highly militarized boundary. As Audra Simpson and Lisa Ford have both argued, the layering of rationality onto a practice of make-believe is central to the logic of settler colonialism. By treating the nation and its borders as a rational and legal entity, colonial powers retrospectively justify the dispossession of territory. Audra Simpson, "The Ruse of Consent and the Anatomy of 'Refusal': Cases from Indigenous North America and Australia," *Postcolonial Studies* 20, no.1 (2017): 18–33; Lisa Ford, *Settler Sovereignty: Jurisdiction and Indigenous People in America and Australia 1786–1836* (Cambridge, MA: Harvard University Press, 2010).
7. Geoffrey C. Bowker, *Memory Practices in the Sciences* (Cambridge, MA: MIT Press, 2005).
8. The territory designations are taken from the map available at www.native-land.ca. As the site states, these designations are not meant as official/legal boundaries. Indeed, as mapmaking was crucial to European colonization and occupation, the history of boundary-drawing

is an extension of that colonial project. Here, the named territories and the reservation are offered as context for the specific emplacement of Yodaville within the history of US imperial occupation.

9. Sara Ahmed, *Strange Encounters: Embodied Others in Post-Coloniality* (London: Routledge, 2000), 132.
10. Madeline Akrich. "The De-Description of Technical Objects," in *Shaping Technology/Building Society: Studies in Sociotechnical Change*, eds. Wiebe E. Bijker and John Law (Cambridge, MA: MIT Press, 1992), 205–224; Michel Callon, "Society in the Making: The Study of Technology as a Tool for Sociological Analysis," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, eds. Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch (Cambridge, MA: MIT Press, 1987), 83–103.
11. Greg Downey, "Virtual Webs, Physical Technologies, and Hidden Workers: The Spaces of Labor in Information Internetworks," *Technology and Culture* 42, no. 2 (2001): 209–235; Paul Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010).
12. Marilyn Strathern, *Reproducing the Future: Anthropology, Kinship, and the New Reproductive Technologies* (London: Routledge, 1992), 33.
13. Andrew L. Russell, *Open Standards and the Digital Age: History, Ideology, and Networks* (Cambridge: Cambridge University Press, 2014), 16.
14. Paul Du Gay, Stuart Hall, Linda Janes, Anders Koed Madsen, Hugh Mackay, and Keith Nagus, *Doing Cultural Studies: The Story of the Sony Walkman* (London: SAGE, 2013).
15. Mary Douglas, *How Institutions Think* (Syracuse, NY: Syracuse University Press, 1986).
16. I have simplified the causality here. Humans never act, for Latour, out of a simple desire to use technology to achieve a single, unalloyed goal, but rather in a nonreducible network of relationships with other humans and nonhumans. See Bruno Latour, "Mixing Humans and Nonhumans Together: The Sociology of a Door-Closer," *Social Problems* 35, no. 3 (1988): 298–310; Bruno Latour, "On Technical Mediation," *Common Knowledge* 3, no. 2 (1994): 29–64.
17. Latour, again: "The speedbump is not made of matter, ultimately; it is full of engineers and chancellors and lawmakers, commingling their wills and their story lines with those of gravel, concrete, paint, and standard calculations." Latour, "On Technical Mediation," 41.
18. Langdon Winner, "Do Artifacts Have Politics?" in *The Whale and the Reactor* (Chicago: University of Chicago Press, 1986), 19–39; Trevor J. Pinch and Wiebe E. Bijker, "The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other," *Social Studies of Science* 14, no. 3 (1984): 399–441.
19. Virginia Eubanks, *Automating Inequality* (New York: St. Martin's Press, 2018); Sasha Costanza-Chock, *Design Justice: Community-Led Practices to Build the Worlds We Need* (Cambridge, MA: MIT Press, 2020); Ifeoma Ajunwa, Kate Crawford, and Jason Schultz,

- “Limitless Worker Surveillance,” *California Law Review* 105, no. 3 (2017): 735–776; Frank Pasquale, *The Black Box Society: The Secret Algorithms That Control Money and Information* (Cambridge, MA: Harvard University Press, 2015); Stop LAPD Spying Coalition, “Location-based Policing: New LAPD Technologies, Same Racisms,” September 5, 2019, <https://www.citywatchla.com/index.php/2016-01-01-13-17-00/los-angeles/18377-location-based-policing-new-lapd-technologies-same-racisms>.
20. Lorraine Daston and Peter Galison, *Objectivity* (Brooklyn: Zone Books, 2007), 21–22.
 21. Robert Kohler, *Lords of the Fly: Drosophila Genetics and the Experimental Life* (Chicago: University of Chicago Press, 1994); Karen Ann Rader, *Making Mice: Standardizing Animals for American Biomedical Research, 1900–1955* (Princeton, NJ: Princeton University Press, 2004); Nathan Ensmenger, “Is Chess the Drosophila of Artificial Intelligence? A Social History of an Algorithm,” *Social Studies of Science* 42, no. 1 (2012): 5–30; Greg Siegel *Forensic Media* (Durham, NC: Duke University Press, 2014).
 22. Daston and Galison, *Objectivity*.
 23. Steven Shapin, “Cordelia’s Love: Credibility and the Social Studies of Science,” *Perspectives on Science* 3, no. 3 (1995): 261.
 24. Shapin, “Cordelia’s Love,” 262 (emphasis in original).
 25. Thomas Kuhn, *The Structure of Scientific Revolutions*, 3rd ed. (Chicago: University of Chicago Press, 1996), 189.
 26. Michael Polanyi, *The Tacit Dimension* (New York: Doubleday, 1966); Natalie Melas, *All the Difference in the World: Postcoloniality and the Ends of Comparison* (Palo Alto, CA: Stanford University Press, 2007).
 27. Kuhn also introduced the term “disciplinary matrix” to explain how a network of social relationships could bind communities together. Thomas Kuhn, “Second Thoughts on Paradigms,” in *The Essential Tension: Selected Studies in Scientific Tradition and Change*, ed. Frederick Suppe (Chicago: University of Chicago Press, 1977), 293–319. See also John Forrester, “If p , Then What? Thinking in Cases,” *History of The Human Sciences* 9, no. 3 (1996): 1–25; Kuhn, *Structure of Scientific Revolutions*.
 28. Michelle Murphy, *The Economization of Life* (Durham, NC: Duke University Press, 2017), 24.
 29. Shannon Mattern, “Maintenance and Care,” *Places Journal* (November 2018), <https://placesjournal.org/article/maintenance-and-care/>.
 30. Gabrielle Hecht, “Interscalar Vehicles for an African Anthropocene: On Waste, Temporality, and Violence,” *Cultural Anthropology* 33, no. 1 (2018): 109–141.
 31. Lauren Berlant, “The Commons: Infrastructures for Troubling Times,” *Environment and Planning D: Society and Space* 34, no. 3 (2016): 393–419.
 32. Cait McKinney, *Information Activism: A Queer History of Lesbian Media Technologies* (Durham, NC: Duke University Press, 2020), 22.

33. Jacqueline Wernimont, *Numbered Lives: Life and Death in Quantum Media* (Cambridge, MA: MIT Press, 2019), 163.
34. Ari Luotonen and Kevin Altis, "World-Wide Web Proxies," *Computer Networks and ISDN Systems* 24, no. 2 (1994): 2 (emphasis added).
35. Markus Krajewski, *The Server*, trans. Ilinca Iurascu (New Haven, CT: Yale University Press, 2019); Fenwick McKelvey, *Internet Daemons: Digital Communications Possessed* (Minneapolis: University of Minnesota Press, 2018).
36. Susan Leigh Star and Karen Ruhleder, "Steps toward an Ecology of Infrastructure: Design and Access for Large Information Spaces," *Information Systems Research Information Systems Research* 7, no. 1 (1996): 111–134; Geoffrey C. Bowker, Karen Baker, Florence Miller, and David Ribes, "Toward Information Infrastructure Studies: Ways of Knowing in a Networked Environment," in *International Handbook of Internet Research*, eds. Jeremy Hunsinger, Lisbeth Klastруп, and Matthew M. Allen (Dordrecht, Netherlands: Springer, 2010), 97–117; Lisa Parks and Nicole Starosielski, eds., *Signal Traffic: Critical Studies of Media Infrastructures* (Urbana: University of Illinois Press, 2015); McKinney, *Information Activism*.
37. Thomas A. Stapleford, *The Cost of Living in America: A Political History of Economic Statistics, 1880–2000* (Cambridge: Cambridge University Press, 2010), 101.
38. Stapleford, *Cost of Living*.
39. In the mid-1990s, adjustments to the CPI took into account (in the case of cars) "improved corrosion protection, improved warranties, sealing improvements, stainless steel exhaust, longer-life spark plugs, improved steering gears, rust-resistant fuel injection, clearcoat paint, and more." Katharine G. Abraham, John S. Greenlees, and Brent R. Moulton, "Working to Improve the Consumer Price Index," *Journal of Economic Perspectives* 12, no. 1 (1998): 31.
40. Michael J. Boskin, Ellen L. Dulberger, Robert J. Gordon, Zvi Griliches, and Dale W. Jorgenson, "Consumer Prices, the Consumer Price Index, and the Cost of Living," *Journal of Economic Perspectives* 12, no. 1 (1998): 5.
41. Mayo Moran, "The Reasonable Person: A Conceptual Biography in Comparative Perspective," *Lewis & Clark Law Review*, 14 (2010): 1233.
42. The reasonable person's siblings come from John Gardner, "The Many Faces of the Reasonable Person," *Law Quarterly Review* 131 (2015): 563–584; "select group . . ." from *Helow v. Advocate General*, 1 WLR 2416 at 2417–2418 (2008).
43. Ellison Kahn, "A Trimestrial Potpourri," *South African Law Journal* 102, no. 1 (1985): 184–190.
44. Moran, "The Reasonable Person."
45. US Equal Employment Opportunity Commission on Harassment, <https://www.eeoc.gov/laws/types/harassment.cfm> (emphasis added).
46. Robert S. Lynd and Helen Merrell Lynd, *Middletown: A Study in American Culture* (New York: Harcourt, Brace, Jovanovich, 1956); *Middletown in Transition: A Study in Cultural Conflicts* (Boston: Houghton Mifflin Harcourt, 1982).

47. Sarah E. Igo, *The Averaged American: Surveys, Citizens, and the Making of a Mass Public* (Cambridge, MA: Harvard University Press, 2008), 55–56.
48. As Igo writes, in 1923, Lynd tried to explain his reasons for only including US-born whites in the Middletown studies: “The reason for this is obvious: since we are attempting a difficult new technique in a highly complicated field, it is desirable to simplify our situation as far as possible.” *Averaged American*, 56.
49. Igo, *Averaged American*.
50. Elihu Katz and Paul F. Lazarsfeld, *Personal Influence: The Part Played by People in the Flow of Mass Communication* (Piscataway, NJ: Transaction Publishers, 1955), 335.
51. Katz and Lazarsfeld, *Personal Influence*, 339.
52. See Ensmenger, “Is Chess the Drosophila of Artificial Intelligence?” specifically page 6 and his comparison of artificial intelligence research to Robert Kohler’s history of the use of *D. melanogaster* in genetics research.
53. Bowker et al., “Toward Information Infrastructure Studies.”
54. I have mostly, here, focussed on entrenched proxies in technical, bureaucratic, and academic settings. But their presence is pervasive. While I discuss the artistic appropriation of proxies in chapter 6, Alice Christensen has reminded me of their appearance in literature, as well. Recall, for instance, the clerk (a “Prokurist”—a kind of legal proxy) in Franz Kafka’s *Metamorphosis* who visits Gregor Samsa, and as proxy for his parents and boss, demands an explanation, “I am speaking here in the name of your parents and of your chief, and I beg you quite seriously to give me an immediate and precise explanation.” Kafka chooses an actual legal proxy to stand in for the world *out there* at the threshold to Samsa’s bedroom. Franz Kafka, *The Complete Stories*, ed. Nahum N. Glatzer (New York: Schocken, 1971), 97.
55. The term “fixed point” comes from the field of mathematics, but here, I am evoking the way that it is used to describe invariants in the process of developing a standard (a topic discussed at much greater length in chapter 2), in which fixed points become the hardened bases of a system of measurement and comparison. For a useful description of the scientific processes and debates behind setting fixed points, using the case of developing standardized thermometers, see Hasok Chang, *Inventing Temperature: Measurement and Scientific Progress* (Oxford: Oxford University Press, 2004).
56. Martha Lampland and Susan Leigh Star, *Standards and Their Stories: How Quantifying, Classifying, and Formalizing Practices Shape Everyday Life* (Ithaca, NY: Cornell University Press, 2009), 14.
57. From George William Francis, *The Dictionary of the Arts, Sciences, and Manufactures* (London: W. Brittain, 1846) (emphasis in original).
58. Stuart Hall, “New Ethnicities,” in *Stuart Hall: Critical Dialogues in Cultural Studies*, eds. Kuan-Hsing Chen and David Morley (London: Routledge, 1996), 441–449.
59. Stanley Cavell, “The Uncanniness of the Ordinary,” in *In Quest of the Ordinary: Lines of Skepticism and Romanticism* (Chicago: Chicago University Press, 1994), 172.

60. Berlant, "The Commons," 394.
61. Here, I am building on the work of others, including Mara Mills, Cait McKinney, Laine Nooney, and Jonathan Sterne, who offer ways of thinking of nonlinear media histories that do not efface the place of human bodies in technological cultures. See Mara Mills, "Do Signals Have Politics? Inscribing Abilities in Cochlear Implants." in *Oxford Handbook of Sound Studies*, ed. Trevor Pinch and Karin Bijsterveld (New York: Oxford University Press, 2011), 320–346; McKinney, *Information Activism*; Laine Nooney, "A Pedestal, a Table, a Love Letter: Archaeologies of Gender in Videogame History," *Game Studies* 13, no. 2 (2013), <http://gamestudies.org/1302/articles/nooney>; Jonathan Sterne, *MP3: The Meaning of a Format* (Durham, NC: Duke University Press, 2012).
62. In this way, proxies often function in a mediating role similar to quantum media, as described by Jacqueline Wernimont in *Numbered Lives: Life and Death in Quantum Media* (Cambridge, MA: MIT Press: 2019).
63. John Durham Peters, "Witnessing," *Media, Culture & Society* 23, no. 6 (2001): 709; Carrie Rentschler, "Witnessing: US Citizenship and the Vicarious Experience of Suffering" *Media, Culture & Society* 26, no. 2 (2004): 296–304.
64. This quote is from the June 18, 1999, issue of the paper. The article "Bombs Away at Yodaville," written by James W. Crawley, was digitized and uploaded to a Geocities site with the improbable URL of www.geocities.com/pentagon, which at the time was the home page containing information and resources on military operations on urbanized terrain. If you want to read the whole article, you might be able to view it here: <https://web.archive.org/web/20020207204247/http://www.geocities.com:80/Pentagon/6453/index.html>.
65. On the construction of testing scenarios, see Donald Mackenzie, *Inventing Accuracy* (Cambridge, MA: MIT Press, 1990); Trevor Pinch, "'Testing—One, Two, Three . . . Testing!': Toward a Sociology of Testing," *Science, Technology, & Human Values* 18, no. 1 (1993): 25–41.
66. Glenn et al., *Preparing for the Proven Inevitable*; Christine Hoekenga, "3:10 to Baghdad," *High Country News* (March 31, 2008), <https://www.hcn.org/issues/367/17605>. These place names are also repeated in Microsoft PowerPoint slides from the US Military.
67. On immersion, military training, and simulation, see Lucy Suchman, "Configuring the Other: Sensing War through Immersive Simulation," *Catalyst: Feminism, Theory, Technology* 2, no. 1 (2016): 1–36.
68. "Iraq War Ratchets up Work at Yuma-Area Bases," *Tucson Citizen*, March 23, 2006.
69. Pinch, "Testing," 26.
70. It is worth mentioning that Yuma, Arizona, and the surrounding desert has also been a frequent filming location, since the earliest days of the American film industry. The desert has stood in for other terrestrial deserts as well as the desert planet Tatooine in the Star Wars film, *Return of the Jedi*.

71. Glenn et al., *Preparing for the Proven Inevitable*, 38–39; Susan Leigh Star, “The Ethnography of Infrastructure,” *American Behavioral Scientist* 43, no. 3 (1999): 377–391.
72. Richard Schechner, *Between Theatre and Anthropology* (Philadelphia: University of Philadelphia Press, 1985); Richard Schechner, *Performance Studies: An Introduction* (New York: Routledge, 2002); Rebecca Schneider, *Performing Remains: Art and War in Times of Theatrical Reenactment* (London and New York: Taylor & Francis, 2011).
73. Vaihinger, *The Philosophy of “As If.”*
74. Vaihinger provides this example of fictions as arbitrary-but-necessary reference points: “Here we may also include all the arbitrary determinations found in science, such as, for example, the meridian of Ferro, the determination of the zero point, the selection of water as the measure of specific gravity, of the movements of the stars as an index of time. In all these cases certain points of reference are taken and lines similar to co-ordinates drawn in different directions for the determination and classification of phenomena.” *The Philosophy of “As If,”* 23–24.
75. Vaihinger, *The Philosophy of “As If,”* 15 (emphasis added).
76. Anthony Appiah, *As If: Idealization and Ideals* (Cambridge, MA: Harvard University Press, 2017), 3.
77. Vaihinger argues that fictitious means predominate in disciplines that must manage “a large number of quantities that oscillate around an ideal point (e.g., meteorology and statistics),” *The Philosophy of “As If,”* 224, n2.
78. William Stanley Jevons, *Principles of Science: A Treatise on Logic and Scientific Method* (New York: MacMillan, 1874), 422.
79. Theodore Porter, *The Rise of Statistical Thinking, 1820–1900* (Princeton, NJ: Princeton University Press, 1988), 52; Lambert Adolphe Jacques Quetelet, *A Treatise on Man and the Development of His Faculties*, ed. T. Smibert, trans. R. Knox (Cambridge: Cambridge University Press, 2013).
80. Georges Canguilhem, *The Normal and the Pathological*, trans. Carolyn R. Fawcett (Brooklyn: Zone Books, 1989); Lennard J. Davis, *Enforcing Normalcy: Disability, Deafness, and the Body* (London and New York: Verso, 1995); Michael Warner, *The Trouble with Normal: Sex, Politics, and the Ethics of Queer Life* (New York: Free Press, 1999).
81. Ian Hacking, *The Taming of Chance* (Cambridge: Cambridge University Press, 1990).
82. Canguilhem, *The Normal and the Pathological*; Hacking, *The Taming of Chance*.
83. See, for instance Aimi Hamraie’s history of design thinking, and the discussion of Henry Dreyfuss’s user designs based on statistical averages. Aimi Hamraie, *Building Access: Universal Design and the Politics of Disability* (Minneapolis: University of Minnesota Press, 2017); Henry Dreyfuss, *The Measure of Man: Human Factors in Design*, 2nd ed. (New York: Whitney Library of Design, 1967).
84. Hacking, *The Taming of Chance*.

85. Hacking, *The Taming of Chance*, 108.
86. Davis, *Enforcing Normalcy*; Hamraie, *Building Access*.
87. Lawrence Busch, *Standards: Recipes for Reality* (Cambridge, MA: MIT Press, 2011).
88. On the idea that things that are felt to be real are real in their effects, see the Thomas Theorem, first articulated by William I. Thomas and Dorothy S. Thomas in *The Child in America: Behavior Problems and Programs* (New York: Alfred A. Knopf, 1928); see also Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences* (Cambridge, MA: MIT Press, 1999). Vaihinger was aware of the similarity of his theory to pragmatism, writing:
- Pragmatism, too, so widespread throughout the English-speaking world, has done something to prepare the ground for Fictionalism, in spite of their fundamental difference. Fictionalism does not admit the principle of Pragmatism which runs: 'An idea which is found to be useful in practice proves thereby that it is also true in theory, and the fruitful is thus always true'. The principle of Fictionalism, on the other hand, or rather the outcome of Fictionalism, is as follows: An idea whose theoretical untruth or incorrectness, and therewith its falsity, is admitted, is not for that reason practically valueless and useless; for such an idea, in spite of its theoretical nullity may have great practical importance. (*The Philosophy of "As If,"* viii)
89. Bose et al. showed in 2011 that injury and fatality rates between people categorized as male versus female showed that “the odds for a belt-restrained female driver to sustain severe injuries were 47% higher than those for a belt-restrained male driver involved in a comparable crash.” Dipan Bose, Maria Segui-Gomez, and Jeff R. Crandall, “Vulnerability of Female Drivers Involved in Motor Vehicle Crashes: An Analysis of US Population at Risk,” *American Journal of Public Health* 101 (December 2011): 2368–2373. See also Caroline Criado-Perez, *Invisible Women: Exposing Data Bias in a World Designed for Men* (New York: Harry N. Abrams, 2019).
90. While the goal of Bose et al. was to demonstrate sex-specific disparities in injury prevention, we should resist the urge to sort people along dichotomous, sex-specific categories, and instead see the body-specific ways that a reliance on an anthropomorphic model based on so-called averageness has injurious outcomes for many people. Bose et al., “Vulnerability of Female Drivers.”
91. Bowker and Star, *Sorting Things Out*; John Dewey, *The Essential Dewey*, ed. Larry A. Hickman and Thomas M. Alexander (Bloomington: Indiana University Press, 1998).
92. Bowker and Star, *Sorting Things Out*, 290.
93. Hamraie, *Building Access*; Rosemary Garland Thomson, *Extraordinary Bodies: Figuring Physical Disability in American Culture and Literature* (New York: Columbia University Press, 2017).
94. Judith Butler, “Performative Acts and Gender Constitution: An Essay in Phenomenology and Feminist Theory,” *Theatre Journal* 40, no. 4 (1988): 519–531.

95. Friedrich Nietzsche, *The Portable Nietzsche*, trans. Walter Kaufmann (New York: Penguin Books, 1982), 47.
96. Charles Goodwin, "Professional Vision," *American Anthropologist* 96, no. 3 (1994): 606–633.
97. For some recent, like-minded work on gendering as a process within technological cultures, see Wendy Chun, *Programmed Visions: Software and Memory* (Cambridge, MA: MIT Press, 2011); Jennifer S. Light, "When Computers Were Women," *Technology and Culture* 40, no. 3 (1999): 455–483; Amy Adele Hasinoff, *Sexting Panic: Rethinking Criminalization, Privacy, and Consent* (Urbana: University of Illinois Press, 2015); Lisa Nakamura, "Indigenous Circuits: Navajo Women and the Racialization of Early Electronic Manufacture," *American Quarterly* 66, no. 4 (2014): 919–941; Rena Bivens, "The Gender Binary Will Not Be Deprogrammed: Ten Years of Coding Gender on Facebook," *New Media & Society* 9, no. 6 (2017): 880–898; Mar Hicks, *Programmed Inequality: How Britain Discarded Women Technologists and Lost Its Edge in Computing* (Cambridge, MA: MIT Press, 2017).
98. Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences*, trans. A. M. Sheridan (London: Routledge, 2002[1970]).

CHAPTER 2

1. Carolyn Marvin, *When Old Technologies Were New: Thinking about Electric Communication in the Late Nineteenth Century* (Oxford: Oxford University Press, 1988).
2. The NPL is the national measurement institute in the United Kingdom and a crucial part of the country's national measurement infrastructure.
3. Michael de Podesta, "The Measure of Science: Redefining the Kilogram," presentation, the Royal Institution, London, October 22, 2018.
4. This particular kilogram lasted 130 years, but the idea of a physical mass standard in the metric system persisted for almost 220 years.
5. de Podesta, "The Measure of Science."
6. de Podesta, "The Measure of Science."
7. de Podesta, "The Measure of Science."
8. Although the Planck constant did not previously have a fixed value (only a value that included a standard uncertainty), the new instructions for "realizing" kilograms required three sufficiently precise measurements (5 parts in 10^8) of the Planck constant using a watt balance. Once the three measurements were obtained, they were averaged out to create a new, fixed value of the Planck constant, with no standard uncertainty. Philippe Richard, Hao Fang, and Richard Davis, "Foundation for the Redefinition of the Kilogram," *Metrologia* 53, no. 5 (2016): A6.
9. Terry Quinn, *From Artefacts to Atoms: The BIPM and the Search for Ultimate Measurement Standards* (Oxford and New York: Oxford University Press, 2011), 341.

10. David Turnbull, "The Ad Hoc Collective Work of Building Gothic Cathedrals with Templates, String, and Geometry," *Science, Technology, & Human Values* 18, no. 3 (1993): 315–340.
11. Émile Durkheim, *The Elementary Forms of Religious Life*, trans. Karen E. Fields (New York: Free Press, 1995[1912]).
12. Lawrence Busch, *Standards: Recipes for Reality* (Cambridge, MA: MIT Press, 2011). See also Martha Lampland and Susan Leigh Star, eds., *Standards and Their Stories: How Quantifying, Classifying, and Formalizing Practices Shape Everyday Life* (Ithaca, NY: Cornell University Press, 2009).
13. Ludwig Wittgenstein, *Philosophical Investigations*, part 1, §108. Many thanks to Nick Couldry for pointing me to this passage (the emphasis is added).
14. Mary Douglas, *Purity and Danger: An Analysis of Concepts of Pollution and Taboo* (New York: Routledge, 2002).
15. Douglas, *Purity and Danger*, 2.
16. Lisa Gitelman and Virginia Jackson, "Introduction," in "*Raw Data*" *Is an Oxymoron*, ed. Lisa Gitelman (Cambridge, MA: MIT Press, 2013), 7.
17. In their account of Irving Fisher's attempts to represent economic models, Mary Poovey and Kevin Brine excavate the laboriousness of data cleaning. Mary Poovey and Kevin Brine, "From Measuring Desire to Quantifying Expectations: A Late Nineteenth-Century Effort to Marry Economic Theory and Data," in Gitelman, "*Raw Data*" *Is an Oxymoron*, 61–88.
18. Jean-Christophe Plantin, "Data Cleaners for Pristine Datasets: Visibility and Invisibility of Data Processors in Social Science," *Science, Technology, & Human Values* 44, no. 1 (2019): 52–73.
19. Douglas, *Purity and Danger*, 2.
20. Bob Woodward and Carl Bernstein, "Funds Laundered," *Washington Post*, July 11, 1974.
21. Bob Woodward and Carl Bernstein, *All the President's Men* (New York: Simon & Schuster, 1974), 46–47.
22. The *Oxford English Dictionary's* definition of "(money) laundering" is as follows: "To transfer funds of dubious or illegal origin, usu. to a foreign country, and then later to recover them from what seem to be 'clean' (i.e. legitimate) sources. The use arose from the Watergate inquiry in the United States in 1973–4." It should be noted that though etymologies of "money laundering" identify the Watergate scandal as the first appearance, my research shows that the term was not only already in circulation before the scandal, it actually appeared in print in reference to the Mafia before it appeared in reference to Watergate. See James M. Markham, "Mob-Influenced Businesses Would Fill a List from A to Z, Officials Here Say," *New York Times*, August 19, 1972.
23. Lana Swartz, *New Money: How Payment Became Social Media* (New Haven, CT: Yale University Press, 2020).

24. Geoffrey C. Bowker, *Memory Practices in the Sciences* (Cambridge, MA: MIT Press, 2005).
25. Douglas, *Purity and Danger*, 2.
26. Matt Ford, "Use It or Lose It?" *Atlantic Monthly*, May 30, 2017.
27. J. Christian Adams, *A Primer on "Motor Voter": Corrupted Voter Rolls and the Justice Department's Selective Failure to Enforce Federal Mandates*. Heritage Foundation, September 25, 2014.
28. Adams, *A Primer on "Motor Voter"* (emphasis added).
29. Michelle Murphy, *Sick Building Syndrome and the Problem of Uncertainty* (Durham, NC: Duke University Press, 2006), 19.
30. Craig Robertson, *The Filing Cabinet: A Vertical History of Information* (Minneapolis: University of Minnesota Press, 2021); Craig Robertson, "Learning to File: Reconfiguring Information and Information Work in the Early Twentieth Century," *Technology and Culture* 58, no. 4 (2017): 955–981.
31. Robertson, *The Filing Cabinet*, 51.
32. Ruth Schwartz Cowan, *More Work for Mother* (New York: Basic Books, 1983).
33. Stephen Prince, *Classical Film Violence: Designing and Regulating Brutality in Hollywood Cinema, 1930–1968* (New Brunswick, NJ: Rutgers University Press, 2003); Tarleton Gillespie, *Custodians of the Internet: Platforms, Content Moderation, and the Hidden Decisions That Shape Social Media* (New Haven, CT: Yale University Press, 2018); Sarah T. Roberts, *Behind the Screen* (New Haven, CT: Yale University Press, 2019).
34. Raiford Guins, *Edited Clean Version: Technology and the Culture of Control* (Minneapolis: University of Minnesota Press, 2008).
35. Rena Bivens, "The Gender Binary Will Not Be Deprogrammed: Ten Years of Coding Gender on Facebook," *New Media & Society* 19, no. 6 (2017): 880–898.
36. On content moderation and user experience, see Ysabel Gerrard and Helen Thornham, "Content Moderation: Social Media's Sexist Assemblages," *New Media & Society* 22, no. 7 (2020): 1266–1286; Gillespie, *Custodians of the Internet*; Roberts, *Behind the Screen*; Sarah Myers West, "Censored, Suspended, Shadowbanned: User Interpretations of Content Moderation on Social Media Platforms," *New Media & Society* 20, no. 11 (2018): 4366–4383. On the policing of sex work online, see Kendra Albert et al., *FOSTA in Legal Context* (July 30, 2020), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3663898.
37. T. L. Cowan, "Digital Hygiene: A Metaphor of Dirty Proportions," <http://www.drecollab.org/digital-hygiene-a-metaphor-of-dirty-proportions/>.
38. Daniela Agostinho and Nanna Bonde Thylstrup, "'If Truth Was a Woman': Leaky Infrastructures and the Gender Politics of Truth-Telling," *Ephemera* 19, no. 4 (2019): 745–775.
39. Thomas P. Hughes, "The evolution of large technological systems," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, eds.

- Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch (Cambridge, MA: MIT Press, 1987), 51–82.
40. For a tiny slice of this literature, see Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences* (Cambridge, MA: MIT Press, 1999); Busch, *Standards*; Laura DeNardis, *Protocol Politics: The Globalization of Internet Governance* (Cambridge, MA: MIT Press, 2009); Laura DeNardis, *Opening Standards: The Global Politics of Interoperability* (Cambridge, MA: MIT Press, 2011); Alexander R. Galloway, *Protocol: How Control Exists after Decentralization* (Cambridge, MA: MIT Press, 2004); Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880–1930* (Baltimore: Johns Hopkins University Press, 1983); Lampland and Star, *Standards and Their Stories*; Thomas S. Mullaney, “The Moveable Typewriter: How Chinese Typists Developed Predictive Text during the Height of Maoism,” *Technology and Culture* 53, no. 4 (2012): 777–814; David Noble, *America by Design* (New York: Knopf, 1982); Andrew Russell, *Open Standards and the Digital Age: History, Ideology, and Networks* (Cambridge: Cambridge University Press, 2014); Amy Slaton and Janet Abbate, “The Hidden Lives of Standards: Technical Prescriptions and the Transformation of Work in America,” in *Technologies of Power* (Cambridge, MA: MIT Press, 2001): 95–144; Susan Leigh Star, “The Ethnography of Infrastructure,” *American Behavioral Scientist* 43, no. 3 (1999): 377–391; Nicole Starosielski, *The Undersea Network* (Durham, NC: Duke University Press, 2015); Jonathan Sterne, *MP3: The Meaning of a Format* (Durham, NC: Duke University Press, 2012); JoAnne Yates and Craig N. Murphy, *Engineering Rules: Global Standard Setting since 1880* (Baltimore: Johns Hopkins University Press, 2019).
 41. Russell, *Open Standards*.
 42. Elizabeth Cullen Dunn, “Standards without Infrastructure,” in *Standards and Their Stories: How Quantifying, Classifying, and Formalizing Practices Shape Everyday Life*, eds. Martha Lampland and Susan Leigh Star (Ithaca, NY: Cornell University Press, 2009), 119.
 43. Hasok Chang, *Inventing Temperature: Measurement and Scientific Progress* (New York: Oxford University Press, 2004).
 44. For more on the scientific-historical dimensions of precision (and, for instance, its contrast with accuracy), see M. Norton Wise, ed., *The Values of Precision* (Princeton, NJ: Princeton University Press, 1997); Busch, *Standards*; Ken Alder, “Making Things the Same,” *Social Studies of Science* 28, no. 4 (1998): 499–545.
 45. This particular conundrum comes from a discussion with Jonathan Sterne.
 46. Hans Vaihinger, *The Philosophy of “As If,”* trans. C. K. Ogden (New York: Harcourt Brace, 1924).
 47. Busch, *Standards*.
 48. Busch, *Standards*.
 49. As DeNardis writes about interoperability: “Think of the 19th-century development of a standard gauge interconnecting railroads across the vast expanse of North America or, more

- than a century later, the standardization that allows us to exchange e-mail across different types of applications and hardware devices.” DeNardis, “The Social Stakes of Interoperability,” *Science* 337, no. 6101 (2012): 1454.
50. Tarleton Gillespie, *Wired Shut: Copyright and the Shape of Digital Culture* (Cambridge, MA: MIT Press, 2007); DeNardis, *Opening Standards*.
 51. Dean Spade, *Normal Life: Administrative Violence, Critical Trans Politics, and the Limits of Law* (Durham, NC: Duke University Press, 2011).
 52. Lampland and Star, *Standards and Their Stories*.
 53. Lampland and Star, *Standards and Their Stories*.
 54. Bowker and Star, *Sorting Things Out*.
 55. Nancy Fraser, *Justice Interruptus: Critical Reflections on the “Postsocialist” Condition* (New York: Routledge, 1997).
 56. Geof Bowker, “How to Be Universal: Some Cybernetic Strategies, 1943–70,” *Social Studies of Science* 23, no. 1 (1993): 107–127.
 57. Kathryn M. Olesko, “The Meaning of Precision: The Exact Sensibility in Early-Nineteenth-Century Germany,” in *The Values of Precision*, ed. M. N. Wise (Princeton, NJ: Princeton University Press, 1995): 103.
 58. James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven, CT: Yale University Press, 1998), 4.
 59. See Olesko, “The Meaning of Precision,” in particular 117–118.
 60. Sanford Fleming, *Time-Reckoning for the Twentieth Century* (Washington, DC: Smithsonian, 1889); Stephen Kern, *The Culture of Time and Space, 1880–1918* (Cambridge, MA: Harvard University Press, 1983). For more discussion of fixed units based on the measurement of time and the utopian dreams of such a standard, see Dylan Mulvin, “The Media of High-Resolution Time: Temporal Frequencies as Infrastructural Resources,” *The Information Society* 33, no. 5 (2017): 282–290.
 61. Max Planck, “Über Irreversible Strahlungsvorgänge” [On Irreversible Radiation Processes], *Annalen der Physik* 306, no. 1 (1900): 121.
 62. These instructions, including the supplies, estimated times, and figures, are based on G. Girard, “The Washing and Cleaning of Kilogram Prototypes at the BIPM,” *BIPM Internal Report* (1990). “Rather handsome, but not specular” is from Richard Davis, “Recalibration of the U.S. National Prototype Kilogram,” *Journal of Research of the National Bureau of Standards* 90, no. 4 (1985): 265. I have added certain stylistic emphases to this text.
 63. Quinn, *From Artefacts to Atoms*.
 64. Specifically, “one of these is kept by the Director of the BIPM, one is in the possession of the President of the CIPM and the third is held by the Archives de France.” Richard Davis, “The SI Unit of Mass,” *Metrologia* 40, no. 6 (2003): 300.

65. In the 1980s, three keys were required to launch a Trident (nuclear) missile from a US Navy submarine. But Hollywood settled on two keys long ago. See, for instance, *The Hunt for Red October*, dir. John McTiernan (Los Angeles: Paramount, 1990). See also Gerald Marsh, "Skirting Human Error: The Navy's Missile Launch System," *Bulletin of Atomic Scientists* 43, no. 1 (1987): 38.
66. Stuart Davidson, "A Review of Surface Contamination and The Stability of Standard Masses," *Metrologia* 40, no. 6 (2003): 324–338.
67. Ken Alder, *The Measure of All Things: The Seven-Year Odyssey and Hidden Error That Transformed the World* (New York: Free Press, 2002); Ken Alder, "Revolution to Measure: The Political Economy of the Metric System in France," in *The Values of Precision*, ed. M. Norton Wise (Princeton, NJ: Princeton University Press, 1995): 39–71.
68. Joint Committee for Guides in Metrology (JCGM), *International Vocabulary of Metrology*, 3rd ed. (2008), 241, https://www.bipm.org/utils/common/documents/jcgm/JCGM_200_2012.pdf.
69. David Freedman, Robert Pisani, and Roger Purves, *Statistics* (New York: W. W. Norton, 2007), 98.
70. National laboratories, which are government agencies responsible for maintaining scientific, technical, and sometimes consumer standards, are responsible for checking their standards against those kept by international bodies. They also disseminate mass standards to lower positions on the hierarchy.
71. Maurice Crosland, "The Congress on Definitive Metric Standards, 1798–1799: The First International Scientific Conference?" *Isis* 60, no. 2 (1969): 226–231.
72. Alder, *The Measure of All Things*.
73. Alder, *The Measure of All Things*, 21 (emphasis added).
74. Alder, *The Measure of All Things*, 19; Alder, "Revolution to Measure," 41.
75. Alder, *The Measure of All Things*, 20.
76. Scott, *Seeing Like a State*, 30.
77. Robert P. Crease, *World in the Balance: The Historic Quest for An Absolute System of Measurement* (New York: W. W. Norton, 2012).
78. Quinn, *From Artefacts to Atoms*.
79. Johnson & Matthey was the assayer and refiner of the Bank of England. See Davis, "Recalibration."
80. Quinn, *From Artefacts to Atoms*.
81. From the BIPM's frequently asked questions about the international prototype of the kilogram, http://www.bipm.org/en/bipm/mass/faqs_mass.html.
82. Peter Galison, *Einstein's Clocks and Poincaré's Maps: Empires of Time* (New York: W. W. Norton, 2003).

83. *Comptes Rendus des Séances de la Première Conférence Générale des Poids et Mesures, Réunie a Paris en 1889* (Paris: Guathier-Villars et Fils, Imprimeures-Libraires, 1890); Craig Robertson, *The Passport in America: The History of a Document* (New York: Oxford University Press, 2010).
84. There was some debate over which French governmental office was worthy of having custody of the key. *Comptes Rendus*.
85. Jacques Derrida, "Declarations of Independence," *New Political Science* 7, no. 1 (1986): 10.
86. Bureau International des Poids et Mesures (BIPM), *SI Brochure: The International System of Units (SI)*, 8th ed. (Paris: Stedi Media, 2006), 112.
87. Quinn, *From Artefacts to Atoms*.
88. Georges Canguilhem notes that in France in the 1930s, "normalization" was used in place of "standardization," as if the two had always been interchangeable. The IPK puts this elision into practice by making all nonprototype kilograms inherent deviations. *The Normal and the Pathological*, trans. Carolyn R. Fawcett (Brooklyn: Zone Books, 1989), 247.
89. Prior to its redefinition in 1960, the definition of length was based on the Prototype Meter. It is now based on the length of light traveling in a vacuum in a certain fraction of a second.
90. Ludwig Wittgenstein, *Philosophical Investigations* (Oxford, UK: B. Blackwell, 1953), §50.
91. Nathan Salmon, "How to Measure the Standard Metre," *Proceedings of the Aristotelian Society* 88 (1987): 193–217. Charles Peirce also turned to physical standards in explicating his science of signs: "A yard-stick might seem, at first sight, to be an icon of a yard; and so it would be, if it were merely intended to show a yard as near as it can be seen and estimated to be a yard. But the very purpose of a yard-stick is to show a yard nearer than it can be estimated by its appearance. This it does in consequence of an accurate mechanical comparison made with the bar in London called the yard. Thus it is a real connection which gives the yard-stick its value as a representamen; and thus it is an *index*, not a mere *icon*." *Philosophical Writings of Peirce*, ed. Justus Buchler (New York: Dover Publications, 1955), 109 (emphasis in original).
92. Natalie Melas, *All the Difference in the World: Postcoloniality and the Ends of Comparison* (Stanford, CA: Stanford University Press, 2007).
93. Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham, NC: Duke University Press, 2007), 19 (emphasis in original).
94. Barad, *Meeting the Universe Halfway*, 19.
95. Comité International des Poids et Mesures (CIPM), *Procès-Verbaux des Séances de 1882* (Paris: Gauthier-Villars, 1883); Quinn, *From Artefacts to Atoms*.
96. Quinn, *From Artefacts to Atoms*.
97. Girard, "The Washing and Cleaning of Kilogram Prototypes"; Quinn, *From Artefacts to Atoms*.

98. Davis, "The SI Unit of Mass," 303.
99. BIPM, *SI Brochure*, 112.
100. Peter Cumpson and Sano Naoko, "Stability of Reference Masses V: UV/Ozone Treatment of Gold and Platinum Surfaces," *Metrologia* 50, no. 1 (2013): 27–36; P. J. Cumpson and M. P. Seah, "Stability of Reference Masses I: Evidence for Possible Variations in the Mass of Reference Kilograms Arising from Mercury Contamination," *Metrologia* 31, no. 1 (1994): 21–26.
101. Andrew Barry, "Materialist Politics: Metallurgy," in *Political Matter: Technoscience, Democracy, and Public Life*, eds. Bruce Braun and Sarah Whatmore (Minneapolis: University of Minnesota Press, 2010), 90.
102. Crease, *World in the Balance*, 207.
103. Steven Jackson and David Ribes, "Data Bit Man: The Work of Sustaining a Long-Term Study," in "*Raw Data*" *Is an Oxymoron*, 163.
104. Quinn, *From Artefacts to Atoms*, 173.
105. Bruno Latour, "Mixing Humans and Nonhumans Together: The Sociology of a Door-Closer," *Social Problems* 35, no. 3 (1988): 300.
106. Thomas Gieryn, "What Buildings Do," *Theory and Society* 31, no.1 (2002): 35–74.
107. Trevor Pinch, "'Testing—One, Two, Three . . . Testing!': Toward a Sociology of Testing," *Science, Technology, & Human Values* 18, no. 1 (1993): 25–26.

CHAPTER 3

1. See "The Lenna Story," <http://www.lenna.org/>.
2. This is the story as told to Peter Nowak in *Sex, Bombs, and Burgers: How War, Pornography, and Fast Food Have Shaped Modern Technology* (Guilford, CT: Rowman & Littlefield, 2011), 173 (emphasis added).
3. Jamie Hutchinson, "Culture, Communication, and an Information Age Madonna," *IEEE Professional Communication Society Newsletter* 45, no. 3 (2001): 1 (emphasis added).
4. Susanna Paasonen, Kylie Jarrett, and Ben Light, *NSFW: Sex, Humor, and Risk in Social Media* (Cambridge, MA: MIT Press, 2019).
5. Eve Kosofsky Sedgwick, *Between Men: English Literature and Male Homosocial Desire* (New York: Columbia University Press, 1985).
6. Lauren Berlant, *The Queen of America Goes to Washington City: Essays on Sex and Citizenship* (Durham, NC: Duke University Press, 1997), 59.
7. Here, I am adapting Simidele Dosekun's "spectacular femininity" to highlight the conspicuous ways that heterosexual masculinity is performed and transformed into a spectacle for the consumption of other men. Simidele Dosekun, *Fashioning Postfeminism: Spectacular Femininity and Transnational Culture* (Urbana: University of Illinois Press, 2020).

8. Nathan Ensmenger, *The Computer Boys Take Over* (Cambridge, MA: MIT Press, 2010); Nathan Ensmenger, “Beards, Sandals, and Other Signs of Rugged Individualism: Masculine Culture within the Computing Professions,” *Osiris* 30, no. 1 (2015): 38–65.
9. Jacqueline Wernimont, *Numbered Lives: Life and Death in Quantum Media* (Cambridge, MA: MIT Press, 2019); Paul Dourish, *The Stuff of Bits: An Essay on the Materialities of Information* (Cambridge, MA: MIT Press, 2017); Matthew Kirschenbaum, *Mechanisms: New Media and the Forensic Imagination* (Cambridge, MA: MIT Press, 2008).
10. Lisa Gitelman and Virginia Jackson, “Introduction,” in “*Raw Data*” Is an Oxymoron, ed. Lisa Gitelman (Cambridge, MA: MIT Press, 2013), 3.
11. Kathryn Henderson, “The Visual Culture of Engineers,” *Sociological Review* 42, no. 1 (1994): 196–218.
12. Li Cornfeld, “Babes in Tech Land: Expo Labor as Capitalist Technology’s Erotic Body” *Feminist Media Studies* 18, no. 2 (2018): 205–220; Cait McKinney, *Information Activism: A Queer History of Lesbian Media Technologies* (Durham, NC: Duke University Press, 2020); Amy Adele Hasinoff, *Sexting Panic: Rethinking Criminalization, Privacy, and Consent* (Urbana: University of Illinois Press, 2015); Sharif Mowlabocus, *Gaydar Culture* (London: Ashgate/Routledge, 2010); Kate O’Riordan and David J Phillips, eds., *Queer Online: Media Technology and Sexuality* (Bern, Switzerland: Peter Lang, 2007).
13. Hortense J. Spillers, “Mama’s Baby, Papa’s Maybe: An American Grammar Book,” *Diacritics* 17, no. 2 (1987): 67; Wendy Hui Kyong Chun, *Control and Freedom: Power and Paranoia in the Age of Fiber Optics* (Cambridge, MA: MIT Press, 2006); Safiya Umoja Noble, *Algorithms of Oppression* (New York: NYU Press, 2018); Lisa Nakamura, *Digitizing Race: Visual Cultures of the Internet* (Minneapolis: University of Minnesota Press, 2008).
14. On the materiality of gendered power and its intersection with professionalization, see Cynthia Cockburn, “The Material of Male Power,” *Feminist Review* 9, no. 1 (1981): 41–58.
15. Sara Ahmed, *Queer Phenomenology: Orientations, Objects, Others* (Durham, NC: Duke University Press, 2006), 40 (emphasis added).
16. Paul Du Gay, Stuart Hall, Linda Janes, Anders Koed Madsen, Hugh Mackay, and Keith Negus, *Doing Cultural Studies: The Story of the Sony Walkman* (London: SAGE, 2013); Lorraine Daston, ed., *Things That Talk* (Brooklyn: Zone Books, 2004).
17. Marilyn Strathern, *Reproducing the Future: Anthropology, Kinship, and the New Reproductive Technologies* (London: Routledge, 1992), 33.
18. Charles Goodwin, “Professional Vision,” *American Anthropologist* 96, no. 3 (1994): 606.
19. Goodwin, “Professional Vision,” 626.
20. Goodwin’s work has traveled far and wide in the study of the embodied practices of professional vision. See, for instance, the work of Janet Vertesi, who documents the construction of professional vision within the Mars Rover program. She clarifies that “professional

- vision” is not only a matter of what one does with one’s eyes; rather, it is a range of inter-related practices through which meaning is created through learned skill and embodied technique. *Seeing Like a Rover: How Robots, Teams, and Images Craft Knowledge of Mars* (Chicago: University of Chicago Press, 2015).
21. Jacob Gaboury, “Image Objects: An Archaeology of 3D Computer Graphics, 1965–1979,” PhD dissertation, New York University, 2015; Ann-Sophie Lehmann, “Taking the Lid off the Utah Teapot towards a Material Analysis of Computer Graphics,” *Zeitschrift für Medien- und Kulturforschung*, no. 1 (2012): 169–184; Michael Baxandall, *Painting and Experience in Fifteenth-Century Italy: A Primer in the Social History of Pictorial Style* (Oxford: Oxford University Press, 1988).
 22. Here is an elegant example of how this happens: The Lena image has two Wikipedia pages, one for the centerfold and one for the test image. Depending on the day and the backstage debates among editors, the image will sometimes appear on the test image page (because it is fair use) but not on the centerfold page. See <https://en.wikipedia.org/wiki/Lenna>.
 23. Jonathan Sterne *MP3: The Meaning of a Format* (Durham, NC: Duke University Press, 2012); Dourish, *The Stuff of Bits*.
 24. Dylan Mulvin and Jonathan Sterne, “Scenes from an Imaginary Country: Test Images and the American Color Television Standard,” *Television & New Media* 17, no. 1 (2016): 21–43.
 25. David Salomon, *Data Compression: The Complete Reference* (London: Springer, 2007), 517.
 26. Shea Swauger, “Software That Monitors Students during tests Perpetuates Inequality and Violates Their Privacy,” *MIT Technology Review* (August 7, 2020), <https://www.technologyreview.com/2020/08/07/1006132/software-algorithms-proctoring-online-tests-ai-ethics/>.
 27. The experience, and explanation for this conflict, is described at-length by Sasha Constanza-Chock in a description of “traveling while trans.” Sasha Costanza-Chock, *Design Justice: Community-Led Practices to Build the Worlds We Need* (Cambridge, MA: MIT Press, 2020).
 28. David G. Lowe “Object Recognition from Local Scale-Invariant Features,” *Proceedings of the Seventh IEEE International Conference on Computer Vision*, 2 (1999): 1150–1157.
 29. Nick Seaver, “Algorithms as Culture: Some Tactics for the Ethnography of Algorithmic Systems,” *Big Data & Society* 4, no. 2 (2017): <https://doi.org/10.1177/2053951717738104>.
 30. Ruha Benjamin, *Race after Technology: Abolitionist Tools for the New Jim Code* (Cambridge, UK: Polity, 2019).
 31. Simone Browne, *Dark Matters* (Durham, NC: Duke University Press, 2015); Benjamin, *Race after Technology*; Joy Buolamwini and Timnit Gebru, “Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification,” *Conference on Fairness, Accountability and Transparency*, PMLR 81 (2018): 77–91. In addition, see the work of the Algorithmic Justice League (<https://www.ajl.org>).
 32. Browne, *Dark Matters*.

33. Stuart Hall, "The Whites of Their Eyes: Racist Ideologies and the Media," in *Gender, Race, and Class in Media*, eds. Gail Dines and Jean M. Humez (Thousand Oaks, CA: SAGE, 1995), 18–22; Meredith Broussard, *Artificial Unintelligence: How Computers Misunderstand the World* (Cambridge, MA: MIT Press, 2018); Nakamura, *Digitizing Race*.
34. Lewis Gordon, "Is the Human a Teleological Suspension of Man?" in *After Man, towards the Human: Critical Essays on Sylvia Wynter*, ed. Anthony Bogues (Kingston, Jamaica: Ian Randle, 2006), 242.
35. Richard Dyer, *White: Essays on Race and Culture* (London: Routledge, 1997), 103.
36. Richard Dyer, "White," *Screen* 29 (Fall 1988): 44.
37. Nakamura, *Digitizing Race*.
38. Benjamin Wilson, Judy Hoffman, and Jamie Morgenstern, "Predictive Inequity in Object Detection," *arXiv preprint:1902.11097* (2019), 2–3.
39. John R. Feiner, John W. Severinghaus, and Philip E. Bickler, "Dark Skin Decreases the Accuracy of Pulse Oximeters at Low Oxygen Saturation: The Effects of Oximeter Probe Type and Gender," *Anesthesia & Analgesia* 105, no. 6 (2007): S18–S23.
40. Anna, C. Shcherbina, et al., "Accuracy in Wrist-Worn, Sensor-Based Measurements of Heart Rate and Energy Expenditure in a Diverse Cohort," *Journal of Personalized Medicine* 7, no. 2 (2017): 3–14.
41. For more discussion of the racial coding of technology and its violent outcomes, see Benjamin, *Race after Technology*.
42. Lorna Roth, "Looking at Shirley, the Ultimate Norm: Colour Balance, Image Technologies, and Cognitive Equity," *Canadian Journal of Communication* 34, no. 1 (2009): 111–136; Mary Ann Doane, "Screening the Avant-Garde Face," in *The Question of Gender*, eds. Judith Butler and Elizabeth Weed (Bloomington: Indiana University Press, 2011): 206–229; Genevieve Yue, "The China Girl on the Margins of Film," *October* 153 (2015): 96–116; Mulvin and Sterne, "Scenes from an Imaginary Country"; Susan Murray, *Bright Signals* (Durham, NC: Duke University Press, 2018).
43. Yue, "The China Girl."
44. Yue, "The China Girl," 99.
45. Coincidentally, Lena Forsén worked as a Shirley model as well as posing for *Playboy*. Linda Kinstler, "Finding Lena, the Patron Saint of JPEGs," *Wired* (January 31, 2019), <https://www.wired.com/story/finding-lena-the-patron-saint-of-jpegs/>.
46. Roth, "Looking at Shirley," 112.
47. Murray, *Bright Signals*; Jonathan Sterne and Dylan Mulvin, "The Low Acuity for Blue: Perceptual Technics and American Color Television," *Journal of Visual Culture* 13, no. 2 (2014): 118–138.
48. Mulvin and Sterne, "Scenes from an Imaginary Country."

49. The image, along with this quote, can be found in Gordon Comstock, "Jennifer in Paradise: The Story of the First Photoshopped Image," *The Guardian* (June 13, 2014), <https://www.theguardian.com/artanddesign/photography-blog/2014/jun/13/photoshop-first-image-jennifer-in-paradise-photography-artefact-knoll-dullaart>.
50. See also Philip W. Sewell, *Television in the Age of Radio: Modernity, Imagination, and the Making of a Medium* (New Brunswick, NJ: Rutgers University Press, 2014); Brian Winston, *Technologies of Seeing: Photography, Cinematography and Television* (London: British Film Institute, 1997); Murray, *Bright Signals*.
51. Dyer, *White*, 94.
52. Roth, *Looking at Shirley*; Dyer, *White*.
53. Roth, *Looking at Shirley*, 121–122 (emphasis in original).
54. Personal correspondence from David Myers.
55. Anna Lauren Hoffman, "Terms of Inclusion: Data, Discourse, Violence," *New Media & Society* (September 2020), <https://doi.org/10.1177/1461444820958725>.
56. bell hooks, "Eating the Other: Desire and Resistance," in *Media and Cultural Studies: Keyworks*, eds. Meenakshi Gigi Durham and Douglas Kellner (Malden, MA: Wiley, 2012), 308.
57. The images discussed here only scratch the surface of the ways that images are used as standards and stand-ins, which could be extended to include everything from ambiguous images used in psychological testing to the stock image industry; see Peter Galison, "Image of Self," in *Things That Talk* (Brooklyn: Zone Books), 257–294; and Paul Frosh, *The Image Factory* (Oxford, UK: Berg Publishers, 2003), respectively.
58. See *A Century of Excellence in Measurements, Standards, and Technology: A Chronicle of Selected NBS/NIST Publications 1901–2000*, ed. David R. Lide (Washington, DC: US Department of Congress, 2001).
59. Frank Rosenblatt, "The Perceptron: A Probabilistic Model for Information Storage and Organization in the Brain," *Psychological Review* 65, no. 6 (1958): 386–408.
60. Aziel Rosenfeld, "From Image Analysis to Computer Vision: An Annotated Bibliography, 1955–1979," *Computer Vision and Image Understanding* 84, no. 2 (2001): 298.
61. Janet Abbate, *Inventing the Internet* (Cambridge, MA: MIT Press, 1999), 36; Lisa Gitelman, *Always Already New* (Cambridge, MA: MIT Press, 2006); Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006).
62. Lawrence G. Roberts, "Picture Coding Using Pseudo-Random Noise," *IEEE Transactions on Information Theory* 8, no. 2 (1962): 145–154.
63. Because she was a child when she posed for these images, I am not naming her in this work or reproducing the images here.
64. William K. Pratt, "A Bibliography on Television Bandwidth Reduction Studies," *IEEE Transactions on Information Theory* 13, no. 1 (1967): 114–115.

65. Lawrence G. Roberts, *Machine Perception of Three-Dimensional Solids* (New York: Garland Publishing, 1980).
66. "TAKE ME, I'M YOURS: The Autobiography of SAIL," <http://infolab.stanford.edu/pub/voy/museum/pictures/Alllab/SailFarewell.html>. With thanks to Nathan Ensmenger for making me aware of this letter's existence.
67. Chris Garcia, "Robots Are a Few of My Favorite Things," *Computer History Museum*. June 17, 2015, <https://computerhistory.org/blog/robots-are-a-few-of-my-favorite-things-by-chris-garcia/?key=robots-are-a-few-of-my-favorite-things-by-chris-garcia>.
68. Because this reminiscence suggests that the model did not consent to being monitored by other men throughout the lab on a CCTV system, I am choosing not to provide a link to the images here.
69. Robin Lynch, "Man Scans: The Matter of Expertise in Art and Technology Histories," *RACAR* (Spring 2021, forthcoming).
70. "About SIPI," <https://minghsiehece.usc.edu/groups-and-institutes/sipi/about/>.
71. The IPTO was founded in 1962, at which point ARPA became a prime funder of computer science in the United States. SIPI, then called "USC-IPI," was funded by Contract number F08606-72-C-0008, Order number 1706 with ARPA's IPTO. As Amy Slaton and Janet Abbate note, the ARPANET node at USC, housed at the nearby Information Sciences Institute, was the "biggest and most heavily used ARPANET site." Amy Slaton and Janet Abbate, "The Hidden Lives of Standards: Technical Prescriptions and the Transformation of Work in America," in *Technologies of Power*, eds. Michael Thad Allen and Gabrielle Hecht (Cambridge, MA: MIT Press, 2001), 131.
72. William K. Pratt, *Digital Image Processing: PIKS Scientific Inside* (Hoboken, NJ: Wiley-Interscience, 2007), xvii.
73. "About SIPI."
74. William K. Pratt and Harry C. Andrews, *Transform Processing and Coding of Images* (Los Angeles, SIPI, 1969), 1.
75. Pratt and Andrews, *Transform Processing*.
76. William K. Pratt, *USCEE Report #411: Semi-annual Technical Report Covering Research Activity during the Period 3 August 1971 to 29 February 1972* (Los Angeles: SIPI, February 1972), i.
77. Ivan Sutherland, "Oral History Interview with Ivan Sutherland" (Minneapolis: Charles Babbage Institute, University of Minnesota Digital Conservancy, 1989), <http://purl.umn.edu/107642> (emphasis added).
78. *A Century of Excellence in Measurements*.
79. The "Girl" image still appears in recent editions of Pratt's *Digital Image Processing* and *Introduction to Digital Image Processing* (Boca Raton, FL: Taylor & Francis, 2014).
80. William Pratt, *USCIPI Report #660: Semi-annual Technical Report Covering Research Activity During the Period 1 September 1975 to 31 March 1976* (Los Angeles: SIPI, March 1976).

81. This is as far as I can determine from reading every digitized SIPI report. It's possible that there are unavailable reports that would predate this publication.
82. Gitelman, *Always Already New*, 97; on the historiography of computing and the dominance of a "Silicon Valley Mythology," see Joy Lisi Rankin, *A People's History of Computing in the United States* (Cambridge, MA: Harvard University Press, 2018), 2.
83. Abbate, *Inventing the Internet*.
84. Abbate, *Inventing the Internet*, 175 (emphasis added).
85. Robert E. Kahn, "Oral History Interview with Robert E. Kahn," (Minneapolis: Charles Babbage Institute, University of Minnesota Digital Conservancy, 1989), <http://purl.umn.edu/107380>.
86. As Abbate notes in *Inventing the Internet*, IPTO leadership was very adept at construing a military justification for their work by often recharacterizing what was "research" and what was "development," depending on what they thought Congress wanted to hear.
87. Hanna Rose Shell, *Hide and Seek: Camouflage, Photography, and the Media of Reconnaissance* (New York: Zone Books, 2012).
88. Nowak, *Sex*, 173.
89. Nowak, *Sex*, 173.
90. Hutchinson, "Culture, Communication, and an Information Age Madonna," 1.
91. The full entry is located at "Lenna," *The Jargon File*, <http://www.catb.org/jargon/html/L/lenna.html>.
92. For instance, in 2012, researchers in Singapore received widespread attention for printing a copy of the Lena image that measured only 50 micrometers across, the smallest image ever printed. "Playboy Centrefold Photo Shrunk to Width of Human Hair," <http://www.bbc.com/news/technology-19260550>.
93. Linda Williams, *Hard Core: Power, Pleasure, and the "Frenzy of the Visible"* (Berkeley: University of California Press, 1989).
94. US Supreme Court, *Miller v. California*, 413 U.S. 15 (June 21, 1973).
95. Cynthia Enloe, *Maneuvers: The International Politics of Militarizing Women's Lives* (Berkeley: University of California Press, 2000).

CHAPTER 4

1. Sunny Bains, "Nude Image Creates Feelings of Exclusion," *Electronic Engineering Times* (May 26, 1997): 45.
2. On the concept of "professional vision," see chapter 3 of this book and Charles Goodwin, "Professional Vision," *American Anthropologist* 96, no. 3 (1994): 606–633.
3. USC-SIPI Image Database, <http://sipi.usc.edu/database/>.

4. Jamie Hutchinson, "Culture, Communication, and an Information Age Madonna," *IEEE Professional Communication Society Newsletter* 45, no. 3 (2001): 1.
5. Quoted in Howard Rheingold, *The Virtual Community: Homesteading on the Electronic Frontier* (Cambridge, MA: MIT Press, 2000), 136.
6. See also Bruno Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts* (Princeton, NJ: Princeton University Press, 1979).
7. Hutchinson, "Culture, Communication, and an Information Age Madonna"; Peter Nowak, *Sex, Bombs, and Burgers: How War, Porn, and Fast Food Shaped Technology as We Know It* (New York: Viking).
8. One of the earliest articles where the image is labeled with the name "Lena" concerned a technique for improving the quality of satellite television's NTSC-coded images. In this article, the image is described as "the woman in the hat (Lena)." Kerns H. Powers, "Techniques for Increasing the Picture Quality of NTSC Transmissions in Direct Satellite Broadcasting," *IEEE Journal on Selected Areas in Communications* 3, no. 1 (1985): 61.
9. Brian J. Thompson, "Editorial: Copyright Problems," *Optical Engineering* 31, no. 1 (1992): 5.
10. Thompson, "Editorial," 5 (emphasis added).
11. The image appears on the covers of the July 1987 and April 1990 special issues on image processing, as well as appearing in articles published in those issues.
12. Thompson, "Editorial," 5 (emphasis in original).
13. Janelle Brown. "Playmate Meets Geeks Who Made Her a Net Star," *Wired* (May 1997), <http://archive.wired.com/culture/lifestyle/news/1997/05/4000>.
14. David C. Munson, "A Note on Lena," *IEEE Transactions On Image Processing* 5, no. 1 (1996): 3.
15. Munson, "A Note on Lena," 3.
16. In this tally, I counted total reproductions: if there was a sequence of four images showing four different steps of a process or contrasting different processes, that counted as four reproductions. I wasn't trying to count discrete tasks that used the Lena image, but rather to do a rough accounting of the image's dominance of the population of images in this one important journal.
17. On prototypical whiteness, see chapter 3 of this book and Simone Browne, *Dark Matters* (Durham, NC: Duke University Press, 2015); Richard Dyer, *White: Essays on Race and Culture* (London: Routledge, 1997); Lewis Gordon, "Is the Human a Teleological Suspension of Man?" in *After Man, Towards the Human: Critical Essays on Sylvia Wynter*, ed. Anthony Bogues (Kingston, Jamaica: Ian Randle, 2006), 237–257; Brian Winston, *Technologies of Seeing: Photography, Cinematography and Television* (London: British Film Institute, 1997).
18. Hutchinson, "Culture, Communication, and an Information Age Madonna," 5.

19. Clare Hemmings, *Why Stories Matter: The Political Grammar of Feminist Theory* (Durham, NC: Duke University Press, 2011).
20. Munson, "A Note on Lena," 3.
21. Munson, "A Note on Lena," 3.
22. Munson, "A Note on Lena," 3.
23. What the readership of *Image Processing* may not have known was that this controversy was playing out in the midst of a debate within feminist communities over pornography and sex work. The feminist "sex wars" or "porn wars" began in the 1980s and created schisms in American and European feminist politics. Antipornography feminists viewed porn and sexual practices like bondage and discipline, dominance and submission, sadism, and masochism (BDSM) as inescapably oppressive extensions of a patriarchal form of domination; meanwhile, pro-sex and sex-positive feminists fought for the recognition of sex work as legitimate and dignified labor and advocated for the liberatory and subversive potential of some forms of porn. However, this is something of an oversimplification. See Hemmings, *Why Stories Matter*; Rachel Corbman, "The Scholars and the Feminists: The Barnard Sex Conference and the History of the Institutionalization of Feminism," *Feminist Formations* 27, no. 3 (2015): 49–80.
24. Munson, "A Note on Lena," 3.
25. Munson, "A Note on Lena," 3 (emphasis added).
26. Rosenberg also maintains a website devoted to the Lena/Lenna image. <http://www.lenna.org>. As quoted in Hutchinson, "Culture," 6.
27. Wendy Hui Kyong Chun, *Control and Freedom: Power and Paranoia in the Age of Fiber Optics* (Cambridge, MA: MIT Press, 2006), 12–13.
28. Chun, *Control and Freedom*.
29. Cait McKinney, "Crisis Infrastructures: AIDS Activism Meets Internet Regulation," in *AIDS and the Distribution of Crises*, eds. Jih-Fei Cheng, Alexandra Juhasz, and Nishant Shahani (Durham, NC: Duke University Press, 2020), 162–182.
30. Amy Adele Hasinoff, *Sexting Panic: Rethinking Criminalization, Privacy, and Consent* (Urbana: University of Illinois Press, 2015), 130.
31. Sarah Banet-Weiser, *Empowered: Popular Feminism and Popular Misogyny* (Durham, NC: Duke University Press, 2018); Jessie Daniels, "Cloaked Websites: Propaganda, Cyber-racism and Epistemology in the Digital Era," *New Media & Society* 11, no. 5 (2009): 659–683.
32. *Reno v. American Civil Liberties Union*, 521 U.S. 844 (US Supreme Court, 1997).
33. Rebecca Tushnet, "Power without Responsibility: Intermediaries and the First Amendment," *George Washington Law Review* 76, no. 4 (2008): 986–1016.
34. Recording Industry Association of America (RIAA) (n.d.), "Resources & Learning," <https://www.riaa.com/resources-learning/about-piracy/>.

35. This was prior to the Digital Millennium Copyright Act (1998), which did provide some safe harbor rights to websites that hosted third-party content.
36. United States District Court, Northern District of Ohio (Eastern Division), *Playboy Enterprises Inc. v. Russ Hardenburgh, Inc.*, 982 F. Supp. 503 (November 25, 1997).
37. Although platforms today make claims about the scale and accuracy of their automated content moderation, a significant portion of the labor of determining these elements continues to be done manually (and note that image classification was a topic of the earliest studies in which the Lena image was used to test at SIPI). Sarah T. Roberts, *Behind the Screen* (New Haven, CT: Yale University Press, 2019).
38. Amy Hasinoff has shown how, in the context of the nonconsensual sharing of intimate images, property rights have become useful though problematic tools in the fight to protect privacy and reduce harm. Hasinoff, *Sexting Panic*.
39. Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006).
40. Judith Butler, *Bodies That Matter: On the Discursive Limits of "Sex"* (New York: Routledge, 1993), 139.
41. Martha Lampland and Susan Leigh Star, eds., *Standards and Their Stories* (Ithaca, NY: Cornell University Press, 2009); Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences* (Cambridge, MA: MIT Press, 1999).
42. Sara Ahmed, *Willful Subjects* (Durham, NC: Duke University Press, 2014), 143.
43. William K. Pratt, *Digital Image Processing: PIKS Scientific Inside* (Hoboken, NJ: John Wiley & Sons, 2007).
44. For instance, see Janet Abbate, *Recoding Gender: Women's Changing Participation in Computing* (Cambridge, MA: MIT Press, 2012); Amy Sue Bix, *Girls Coming to Tech!* (Cambridge, MA: MIT Press, 2014); Nathan Ensmenger, *The Computer Boys Take Over: Computers, Programmers, and the Politics of Technical Expertise* (Cambridge, MA: MIT Press, 2010); Jacob Gaboury, "A Queer History of Computing," *Rhizome*, February 19, 2013, <https://rhizome.org/editorial/2013/feb/19/queer-computing-1/>; Mar Hicks, *Programmed Inequality: How Britain Discarded Women Technologists and Lost Its Edge in Computing* (Cambridge, MA: MIT Press, 2017); Jennifer S. Light, "When Computers Were Women," *Technology and Culture* 40, no. 3 (1999): 455–483; Whitney Pow, "Outside of the Folder, the Box, the Archive" *ROMchip* 1, no. 1 (2019), <https://romchip.org/index.php/romchip-journal/article/view/76>; Christina Dunbar-Hester, *Hacking Diversity: The Politics of Inclusion in Open Technology Cultures* (Princeton, NJ: Princeton University Press, 2020).
45. Hicks, *Programmed Inequality*, 12.
46. Donna Riley and Gina L. Sciarra, "'You're All a Bunch of Fucking Feminists': Addressing the Perceived Conflict between Gender and Professional Identities Using the Montreal Massacre," *Proceedings of 36th ASEE/IEEE Frontiers in Education Conference* (2006): 19.

47. Wendy Hui Kyong Chun, "Unbearable Witness: Toward a Politics of Listening," *differences: A Journal of Feminist Cultural Studies*, 11, no. 1 (1999): 119.
48. Joan W. Scott, "Multiculturalism and the Politics of Identity," *October* 61 (1992): 12.
49. Ellen Spertus, "Why Are There So Few Female Computer Scientists?" MIT Artificial Intelligence Laboratory, 1991; Janet Cottrell, "I'm a Stranger Here Myself: A Consideration of Women in Computing," *ACM SIGUCCS User Services Conference* 20 (1992); Marianne Winslett, ed., *Final Report of the Committee on the Status of Women Graduate Students and Faculty in the College of Engineering*, University of Illinois at Urbana-Champaign, 1993; Karen A. Frenkel, "Women and Computing," *Communications of the ACM* 33, no. 11 (1990): 34–46; Barbara J. Grosz, ed., *Report on Women in the Sciences at Harvard*, Harvard University (1991); *Report of the MIT Committee on Family and Work*, Massachusetts Institute of Technology (1990).
50. Rebecca Slayton, "Revolution and Resistance: Rethinking Power in Computing History," *IEEE Annals of the History of Computing* 30, no. 1 (2008): 96–97; Dunbar-Hester, *Hacking Diversity*.
51. Spertus, "Why Are There So Few Female Computer Scientists?" 1.
52. Spertus, "Why Are There So Few Female Computer Scientists?"
53. It is important to note, however, that while there were (and continue to be) significant gender and racial disparities within the engineering and computer science programs at American and Canadian universities, the larger labor chain of technological production is heavily staffed by racialized women. Gender imbalance is a problem that afflicts elite universities and technology firms, but this focus can often conceal the larger systems of production and consumption, in which women and racialized populations manufacture computers and electronics, perform maintenance and repair work, and process e-waste. Dunbar-Hester, *Hacking Diversity*; Lisa Nakamura, "Indigenous Circuits: Navajo Women and the Racialization of Early Electronic Manufacture," *American Quarterly* 66, no. 4 (2014): 919–941.
54. Spertus, "Why Are There So Few Female Computer Scientists?" 24.
55. Spertus, "Why Are There So Few Female Computer Scientists?"; the Carnegie Mellon University report is quoted in Spertus, "Why Are There So Few Female Computer Scientists?" 25–26.
56. Banet-Weiser, *Empowered*.
57. Meredith Broussard *Artificial Unintelligence: How Computers Misunderstand the World* (Cambridge, MA: MIT Press, 2018), 69.
58. Broussard, *Artificial Unintelligence*, 69; As Fred Turner writes,

The first *computer* hackers emerged at MIT in 1959. They were undergraduates who clustered around a giant TX-0 computer that had been built for defense research and then donated to MIT. Within several years, these undergraduates were joined by a variety of Cambridge-area teenagers

and MIT graduate students and began working with a series of computers donated by the Digital Equipment Corporation (DEC). By 1966 most of these young programmers gathered on the ninth floor of Technology Square, in Marvin Minsky's Artificial Intelligence (AI) Laboratory. (*From Counterculture to Cyberculture*, 133 [emphasis in original]).

See also Gabriella Coleman, *Coding Freedom* (Princeton, NJ: Princeton University Press, 2012); Dunbar-Hester, *Hacking Diversity*.

59. For more on the history of the Media Lab and its culture, see Molly Wright Steenson, *Architectural Intelligence: How Designers and Architects Created the Digital Landscape* (Cambridge, MA: MIT Press, 2017).
60. Minsky died in 2016. In a recently unsealed deposition, Virginia Roberts Giuffre accused Jeffrey Epstein and Ghislaine Maxwell of trafficking her as a minor to Epstein's private island to have coerced sex. She names Marvin Minsky as one of the people she was forced to have sex with. When the accusations came to light in 2019, a Media Lab member and founder of the Free Software Foundation, Richard Stallman, downplayed the accusations against Minsky. In an email to the CSAIL mailing list, Stallman wrote that he took exception to the use of the word "assault" to describe the accusation against Minsky: "The word 'assaulting' presumes that he applied force or violence, in some unspecified way, but the article itself says no such thing. Only that they had sex." Stallman's email was exposed in a *Medium* post by an MIT graduate named Selam Jie Gano. Stallman was forced to step down for his comments, which were taken as not only insufficiently compassionate and factually wrong, but emblematic of a toxic and abusive culture within the CSAIL and Media Lab communities. Gano's *Medium* post publishing the email begins, aptly, "I'm writing this because I'm too angry to work." Selam Jie Gano, "Remove Richard Stallman," *Medium*, <https://medium.com/@selamjie/remove-richard-stallman-fec6ec210794>; Victoria Bekiempis, "MIT Scientist Resigns over Emails Discussing Academic Linked to Epstein," *The Guardian*, September 17, 2019, <https://www.theguardian.com/education/2019/sep/17/mit-scientist-emails-epstein>.
61. Frenkel notes that this passage, one of many about MIT in the issue, is from Jennifer Tidwell's unpublished paper on MIT's "Terminal Garden" written in the spring of 1990. Frenkel, "Women and Computing," 36–37.
62. Carrie Rentschler, "Witnessing: US Citizenship and the Vicarious Experience of Suffering" *Media, Culture & Society* 26, no. 2 (2004): 296–304.
63. Amia Srinivasan, "The Aptness of Anger," *Journal of Political Philosophy* 26, no. 2 (2018): 127.
64. Srinivasan, "Aptness," 136.
65. Kenneth Burke, *Permanence and Change: An Anatomy of Purpose* (Los Altos, CA: Hermes Publications, 1954), 18.
66. Thorstein Veblen, *The Instinct of Workmanship and the State of the Industrial Arts* (New York: Macmillan, 1914).
67. Burke, *Permanence and Change*, 18.

68. Luce Irigaray, *Speculum of the Other Woman* (Ithaca, NY: Cornell University Press, 1985), 13 (emphasis in original).
69. Michael T. Eismann, "Farewell, Lena," *Optical Engineering* 57, no. 12 (2018): 120101.
70. "A Note on the Lena Image," *Nature Nanotechnology* 13, no. 12 (2018): 1087.
71. A sonnet written to the Lena image, by Thomas Colthurst, was published online in the early 2000s and since then has been reposted widely. The original is available at <http://thomaswc.com/poems.html>.
72. A 2016 exhibit at the Vancouver Art Gallery called "Mashup: The Birth of Modern Culture" features the Lena image in an artwork by Amber Frid-Jimenez. In this piece, *This Is Not a Test* (2016), the full centerfold is wrapped around a 3D triangular sculpture and is overlaid with quotes from feminist authors. Another artwork, by Trevor Paglen, uses the full centerfold—though he has removed the *Playboy* watermark—for a piece titled *Lenna: Empress of Invisible Images, Queen of the Internet* (2017).
73. This video is viewable on the artist's website: <http://www.jamieallen.com/killinglena/>.
74. Sara Ahmed, *Queer Phenomenology: Orientations, Objects, Others* (Durham, NC: Duke University Press, 2006).
75. John Berger, *Ways of Seeing* (London: Penguin Books, 1972).

CHAPTER 5

1. Kevin Ferguson, "How Do You Teach Medical Students Bedside Manner? Hire an Actor," *Off-Ramp*, August 20, 2015, radio program, <https://www.scp.org/programs/offramp/2015/08/20/44184/how-do-you-teach-medical-students-bedside-manner-h/> (emphasis added).
2. Janelle S. Taylor, "The Moral Aesthetics of Simulated Suffering in Standardized Patient Performances," *Culture, Medicine, and Psychiatry* 35, no. 2 (2011): 138 (emphasis added).
3. Here, I am referring to the work of Arlie Russell Hochschild, who coined the term "emotional labor" during her study of airline attendants and bill collectors, though the term is now widely used in a range of disciplines and denotes a much wider set of practices than Hochschild's originally restrained scope. She intentionally excluded doctors from her original study of those susceptible to the regimes of emotional labor because their emotions were not supervised. However, since the time she first published her book, *The Managed Heart*, this kind of supervision has become a necessary component of medical education and licensing, as seen in the standardized patient program. Arlie Russell Hochschild, *The Managed Heart: Commercialization of Human Feeling*, 2nd ed. (Berkeley: University of California Press, 2012).
4. This has been the case in Canada since 1993 and the United States since 2004. The first physicians who were required to pass the SP test were foreign-trained physicians trying to practice in either country. Before it seemed necessary or acceptable to require domestically trained physicians to pass a test using SPs or to impose it as a licensing requirement, it was field-tested on "outsiders" of the Canadian and American medical systems. Brian David

- Hodges and Nancy McNaughton, "Who Should Be an OSCE Examiner?" *Academic Psychiatry* 33, no. 4 (2009): 282–284; L. Stephen Jacyna and Stephen T. Casper, *The Neurological Patient in History* (Rochester, NY: University of Rochester Press, 2012); Roy Porter, "The Patient's View: Doing Medical History from Below," *Theory and Society* 14, no. 2 (1985): 175–198.
5. Sara Ahmed, *The Promise of Happiness* (Durham, NC: Duke University Press, 2010); Patricia T. Clough, "The Affective Turn: Political Economy, Biomedicine and Bodies," *Theory, Culture & Society*, 25, no. 1 (2008): 1–22; Ruth Leys, *The Ascent of Affect* (Chicago: University of Chicago Press, 2017).
 6. Hodges and McNaughton, "Who Should Be an OSCE Examiner?" 282.
 7. Adam I. Levine and Mark H. Swartz, "Standardized Patients: The 'Other' Simulation," *Journal of Critical Care* 23, no. 2 (2008): 179–184.
 8. Physicians proceed through twelve examinations, with an interview and physical examination of a patient that lasts fifteen minutes and a ten-minute station where the examinee writes a record of the SP's history and physical findings.
 9. Donald E. Melnick, Gerard F. Dillon, and David B. Swanson, "Medical Licensing Examinations in the United States," *Journal of Dental Education* 66, no. 5 (2002): 595–599.
 10. Howard S. Barrows, Paul R. Patek, and Stephen Abrahamson, "Introduction of the Living Human Body in Freshman Gross Anatomy," *British Journal of Medical Education* 2, no. 1 (1968): 33–35.
 11. Howard Barrows and Stephen Abrahamson, "The Programmed Patient: A Technique for Appraising Student Performance in Clinical Neurology," *Journal of Medical Education* 39 (1964): 802–805.
 12. SPs and related persons have been given many other names as well: "patient instructor," "patient educator," "professional patient," "surrogate patient," and "teaching associate." Howard S. Barrows, "Simulated Patients in Medical Training," *Canadian Medical Association Journal* 98 (1968): 674–676; Howard S. Barrows, *Simulated Patients (Programmed Patients): The Development and Use of a New Technique in Medical Education* (Springfield, IL: Charles C. Thomas, 1971).
 13. Peggy Wallace, "Following the Threads of an Innovation: The History of Standardized Patients in Medical Education," *Caduceus* 13, no. 2 (1997): 6.
 14. C. Donald Combs, "Humans as Models," in *Modeling and Simulation in the Medical and Health Sciences*, eds. John A. Sokolowski and Catherine M. Banks (Hoboken, NJ: John Wiley & Sons, Inc., 2011), 92.
 15. Michel Foucault, *The Birth of the Clinic*, trans. A. M. Sheridan (London: Routledge, 2003[1973]), 122.
 16. Hsuan L. Hsu and Martha Lincoln, "Biopower, Bodies . . . the Exhibition, and the Spectacle of Public Health," *Discourse*, 29, no. 1 (2007): 23.

17. John Forrester, "If *p* Then What? Thinking in Cases," *History of the Human Sciences* 9, no. 3 (1996): 1–25.
18. University of Texas Medical Branch, "Template for Standardized Patient Script," <http://www.utmb.edu/ocs/FacDevTools/script-template.asp>.
19. Baylor College of Medicine, "Standardized Patient Script Example: Back Pain Script," <https://www.bcm.edu/education/schools/medical-school/programs/standardized-patient-program/become-a-standardized-patient/script-example>.
20. Rachel Hall, *The Transparent Traveler* (Durham, NC: Duke University Press, 2015), 4.
21. The MIRS document is adapted from the Arizona Interview Rating Scale (ACIR), developed by Paula Stillman, and it is written to reflect the 2001 Kalamazoo Consensus on "Essential Elements of Communication in Medical Encounters." Gregory Makoul, "Essential Elements of Communication in Medical Encounters: The Kalamazoo Consensus Statement," *Academic Medicine* 76, no. 4 (2001): 390–393.
22. Elaine Scarry, *The Body in Pain: The Making and Unmaking of the World* (New York: Oxford University Press, 1985), 12.
23. Scarry writes that "if property (as well as the ways in which property can be jeopardized) were easier to describe than bodily disability (as well as the ways in which a disabled person can be jeopardized), then one would not be astonished to discover that a society had developed sophisticated procedures for protecting 'property rights' long before it had succeeded in formulating the concept of 'the rights of the handicapped.'" *The Body in Pain*, 12.
24. Scarry, *The Body in Pain*, 13.
25. Ronald Melzack, "The McGill Pain Questionnaire: Major Properties and Scoring Methods," *Pain* 1, no. 3 (1975): 277.
26. Lochlann Jain, *Injury: The Politics of Product Design and Safety Law in the United States* (Princeton, NJ: Princeton University Press, 2006); Michelle Murphy, *Sick Building Syndrome and the Problem of Uncertainty: Environmental Politics, Technoscience, and Women Workers* (Durham, NC: Duke University Press, 2006).
27. Kelly M. Hoffman, Sophie Trawalter, Jordan R. Axt, and M. Norman Oliver, "Racial Bias in Pain Assessment and Treatment Recommendations, and False Beliefs about Biological Differences between Blacks and Whites," *Proceedings of the National Academy of Sciences* 113, no. 16 (2016): 4298.
28. Hoffman et al., "Racial Bias," 4297–4298.
29. Hoffman et al., "Racial Bias," 4300.
30. Soraya Chemaly, *Rage Becomes Her* (New York: Atria, 2018); Francis B. Nyamnjoh, "Black Pain Matters: Down with Rhodes," *Pax Academica* 1, no. 2 (2015): 47–70.
31. Elena Ruíz, "Cultural Gaslighting," *Hypatia* 35, no. 4 (2020): 687–713; Harriet A. Washington, *Medical Apartheid: The Dark History of Medical Experimentation on Black Americans from Colonial Times to the Present* (New York: Doubleday Books, 2006).

32. Ruíz, “Cultural Gaslighting.”
33. Angelique M. Davis and Rose Ernst, “Racial Gaslighting,” *Politics, Groups, and Identities* 7, no. 4 (2019): 761; Ruíz, “Cultural Gaslighting.”
34. Barrows and Abrahamson, “The Programmed Patient,” 803 (emphasis added).
35. Barrows and Abrahamson, “The Programmed Patient,” 803 (emphasis added).
36. Erving Goffman, *Stigma: Notes on the Management of Spoiled Identity* (Englewood Cliffs, NJ: Prentice Hall, 1962), 5.
37. Rosemary Garland Thomson, *Extraordinary Bodies: Figuring Physical Disability in American Culture and Literature* (New York: Columbia University Press, 1997), 8; see also Aimi Hamraie, *Building Access: Universal Design and the Politics of Disability* (Minneapolis: University of Minnesota Press, 2017).
38. Robert McRuer, “Compulsory Able-Bodiedness and Queer/Disabled Existence,” in *The Disability Studies Reader*, 3rd ed., ed. Lennard Davis (London: Routledge, 2010): 383–392.
39. Lennard Davis, *Enforcing Normalcy: Disability, Deafness, and the Body* (London: Verso, 1995), 2.
40. Meryl Alper, *Giving Voice* (Cambridge, MA: MIT Press, 2017); Hamraie, *Building Access*; Alison Kafer, *Feminist, Queer, Crip* (Bloomington; Indiana University Press, 2013).
41. Colin Barnes, “Understanding the Social Model of Disability,” in *Routledge Handbook of Disability Studies*, eds. Nick Watson, Alan Roulstone, and Carol Thomas (London: Routledge, 2012), 12–29.
42. Barnes, “Understanding,” 18.
43. Kafer, *Feminist, Queer, Crip*; Tom Shakespeare and Nicholas Watson, “The Social Model of Disability: An Outdated Ideology?” *Research in Social Science and Disability* 2 (2002): 9–28; Jonathan Sterne, “Ballad of the Dork-o-phone: Towards a Crip Vocal Technoscience,” *Journal of Interdisciplinary Voice Studies* 4, no. 2 (2019): 179–189; Shelley Tremain, “On the Subject of Impairment,” in *Disability/Postmodernity: Embodying Disability Theory*, eds. Mairian Corker and Tom Shakespeare (New York: Bloomsbury, 2002); Susan Wendell, *The Rejected Body: Feminist Philosophical Reflections on Disability* (New York: Routledge, 1996).
44. Kafer, *Feminist, Queer, Crip*, 9.
45. Kafer, *Feminist, Queer, Crip*.
46. Granola bars and mints are also the things I carried with me while interviewing for jobs. It is possible that they are a standard part of the equipment that many people use to maintain their bodies and minimize the discomfort that those bodies might compel in other people. Leslie Jamison, *The Empathy Exams* (Minneapolis: Graywolf Press, 2014), 3.
47. Louise Aronson, “Examining Empathy,” *The Lancet* 384, no. 9937 (2014): 16.
48. Aronson, “Examining Empathy,” 16.

49. Constantin Stanislavski, *An Actor Prepares* (London: Routledge, 1989), 12.
50. David Mendel, *Proper Doctoring: A Book for Patients and Their Doctors* (New York: New York Review Books Classics, 2013[1984]), 5.
51. Mendel, *Proper Doctoring*, 9.
52. Mendel, *Proper Doctoring*, 19.
53. Mendel, *Proper Doctoring*, 20.
54. Rebecca Schneider, *Performing Remains: Art and War in Times of Theatrical Reenactment* (London: Routledge, 2011), 41.
55. Schneider, *Performing Remains*, 41 (emphasis in original).
56. Dylan Mulvin, "Media Prophylaxis: Night Modes and the Politics of Preventing Harm," *Information & Culture* 53, no. 2 (2018): 175–202.
57. Richard Schechner, *Between Theatre and Anthropology* (Philadelphia: University of Pennsylvania Press 1985), 97.
58. Taylor, "The Moral Aesthetics."
59. Christopher Pearce and Steve Trumble, "Computers Can't Listen: Algorithmic Logic Meets Patient Centredness," *Australian Family Physician* 35, no. 6 (2006).
60. Barrows, "Simulated Patients in Medical Training,;" Howard S. Barrows, Paul R. Patek, and Stephen Abrahamson, "Introduction of the Living Human Body in Freshman Gross Anatomy," *Medical Education* 2, no. 1 (1968): 33–35.
61. Howard S. Barrows, "An Overview of the Uses of Standardized Patients for Teaching and Evaluating Clinical Skills," *Academic Medicine* 68 no. 6 (1993): 444.
62. Taylor, "The Moral Aesthetics," 155.
63. Tobin Siebers, "Disability as Masquerade," *Literature and Medicine* 23, no. 1 (2004): 18.
64. Sasha Constanza-Chock, *Design Justice* (Cambridge, MA: MIT Press, 2020); Kafer, *Feminist, Queer, Crip*.
65. Anne Herrmann-Werner, Teresa Loda, Lisa M. Wiesner, Rebecca Sarah Erschens, Florian Junne, and Stephan Zipfel, "Is an Obesity Simulation Suit in an Undergraduate Medical Communication Class a Valuable Teaching Tool? A Cross-sectional Proof of Concept Study," *BJM Open* 9 (2019): e029738.
66. Herrmann-Werner et al. "Obesity Simulation Suit."
67. Linda Long-Bellil et al., "Teaching Medical Students about Disability: The Use of Standardized Patients," *Academic Medicine* 86, no 9 (2011): 1166.
68. Long-Bellil et al., "Teaching Medical Students about Disability," 1166.
69. Barrows, "Overview," 446.
70. Wallace, "Following the Threads."

71. "Models Who Imitate Patients: Paradise for Medical Students," *San Francisco Chronicle*, September 28, 1965.
72. Barrows, *Simulated Patients*, 15.
73. Barrows, *Simulated Patients*, 14.
74. Barrows, *Simulated Patients*, 15.
75. Barrows, "Overview," 444 (emphasis added).
76. This was precisely the context in which Kramer and his friend Mickey became SPs in an episode of the television program *Seinfeld*. Kramer was a quintessential gig worker and (sometimes) actor. One of the jokes in the *Seinfeld* episode, "The Burning," in which Kramer must perform as a patient with gonorrhea, involves Kramer and Mickey escalating their SP performances to the point of absurdity and competing for the "best" diseases to perform. Barrows, *Simulated Patients*; Emily Cegielski, "For Actors, Pretending to Be Sick Can Pay Off," *Backstage.com*, <http://www.backstage.com/news/for-actors-pretending-to-be-sick-can-pay-off/>.
77. "Models Who Imitate Patients."
78. Lisa D. Howley, Gayle Gliva-McConvey, Judy Thornton, and Association of Standardized Patient Educators, "Standardized Patient Practices: Initial Report on the Survey of US and Canadian Medical Schools," *Medical Education Online* 14 (2009): doi: 10.3885/meo.2009.F0000208.
79. Lena H. Sun, "Demand Is High for Pretend Patients," *Washington Post*, October 14, 2011, A1.
80. See <https://health.usf.edu>.
81. Temple University School of Medicine, "Standardized Patient Program: Questions and Answers about Working as a Standardized Patient for Temple University School of Medicine" (2013): <https://medicine.temple.edu/sites/medicine/files/files/FAQs.pdf>.
82. Richard Terry, Erik Hiester, and Gary D. James, "The Use of Standardized Patients to Evaluate Family Medicine Resident Decision Making," *Family Medicine* 39, no. 4 (2007): 263.
83. Taylor, "The Moral Aesthetics."
84. Taylor, "The Moral Aesthetics," 156.
85. Greg Downey, "Making Media Work: Time, Space, Identity, and Labor in the Analysis of Information and Communication Infrastructures," in *Media Technologies: Essays on Communication, Materiality, and Society*, eds. Tarleton Gillespie, Pablo Boczkowski and Kirsten Foot (Cambridge, MA: MIT Press, 2014), 164.
86. Howard S. Barrows, *Simulated Patient Training: Acute Paralysis of Both Legs in a Young Woman* (Chapel Hill, NC: Health Sciences Consortium, 1988).
87. Barrows's original simulation, for a patient whom he gave the name "Patty Dugger," was also paraplegic, and in an early newspaper article about the program, it mentions that

Barrows's first patients were trained to simulate (presumably among other things) paralysis, loss of sensation, blindness, and abnormal reflexes. Wallace, "Following the Threads"; "Models Who Imitate Patients."

CHAPTER 6

1. Steven Jackson, "Rethinking Repair," in *Media Technologies: Essays on Communication, Materiality, and Society* (Cambridge, MA: MIT Press, 2014), 221–239.
2. Sarah Ganz Blythe and Edward D. Powers, *Looking at Dada* (New York: Museum of Modern Art, 2006), 52.
3. Marcel Duchamp, *The Writings of Marcel Duchamp* (New York: Da Capo Press, 1989), 22.
4. Herbert Molderings, *Duchamp and the Aesthetics of Chance: Art as Experiment* (New York: Columbia University Press, 2010), 2.
5. Ken Alder, *The Measure of All Things: The Seven-Year Odyssey and Hidden Error That Transformed the World* (New York: Free Press, 2002).
6. Matthew Fuller approaches "media ecologies" through standard objects—such as the shipping container and packet switching protocols—and he understands a standard to be a continuum with itself at one pole and total disorder at the other. *Media Ecologies: Materialist Energies in Art and Technoculture* (Cambridge, MA: MIT Press, 2005).
7. David Turnbull, "The Ad Hoc Collective Work of Building Gothic Cathedrals with Templates, String, and Geometry," *Science, Technology, & Human Values* 18, no. 3 (1993): 315–340.
8. Lawrence Busch, *Standards: Recipes for Reality* (Cambridge, MA: MIT Press, 2011).
9. Michael Baxandall, *Painting and Experience in Fifteenth-Century Italy: A Primer in the Social History of Pictorial Style* (Oxford: Oxford University Press, 1988), 86–89.
10. Jacob Gaboury, "Image Objects: An Archaeology of 3D Computer Graphics, 1965–1979," PhD dissertation (New York University, 2015); Ann-Sophie Lehmann, "Taking the Lid off the Utah Teapot towards a Material Analysis of Computer Graphics," *Zeitschrift für Medien-und Kulturforschung* 2012, no. 1 (2012): 169–184.
11. As Lehmann states about the Utah Teapot in "Taking the Lid off the Utah Teapot," 176, In the white, male, and mostly bearded scientific community that produced the first computer graphics in the 1970s, it was an object not from the lab but from the home, a different, yet familiar thing, blending the efficiency of mathematics with the cosiness of a warm cup of tea. The teapot thus crossed boundaries between genders and cultures, but also between art and science, as it served to develop and express visual creativity in a scientific environment, or joined the left and right side of the brain, as James Blinn once put it.
12. Hito Steyerl, *How Not to Be Seen: A Fucking Didactic Educational .MOV File*, 2013, video, Museum of Modern Art, New York, <https://www.moma.org/collection/works/181784>.

13. Christopher Williams, *Kodak Three Point Reflection Guide* © 1968 Eastman Kodak Company, 1968 (*Meiko laughing*), Vancouver, B.C., April 6, 2005, Whitney Museum of American Art, New York, <https://whitney.org/collection/works/27531>.
14. Ken Gewerts, "A Bevy of Unknown Beauties," *Harvard Gazette*, July 21, 2005, <http://news.harvard.edu/gazette/2005/07.21/00-girls.html>.
15. I attended this lecture myself, and both Raven and her audience focused on the formal simplicity of test materials as their most compelling aspect.
16. Adam Broomberg and Oliver Chanarin, *To Photograph the Details of a Dark Horse in Low Light*. Gallery TPW R&D and Scotiabank Contact Photography Festival, 2013, <http://gallerytpw.ca/rd/broomberg-chanarin/billboard-locations/>.
17. Robin Lynch, "Man Scans: The Matter of Expertise in Art and Technology Histories," *RACAR* (Spring 2021, forthcoming).
18. Genevieve Yue has compiled a long list of appropriations of test images in contemporary art. See Genevieve Yue, "The China Girl on the Margins of Film," *October*, no. 153 (2015), 96–116; Jonathan Sterne, *MP3: The Meaning of a Format* (Durham, NC: Duke University Press, 2012).
19. See Ryan Maguire, "The Ghost in the MP3," 2014, <http://ryanmaguiremusic.com/theghostinthemp3.html>.
20. Howard S. Barrows, "Simulation in Medical Education," *Caduceus* 13, no. 2 (1997): 4.
21. On other recent artistic appropriations of computer vision, see Jill Walker Rettberg, "Machine Vision as Viewed through Art: Hostile Other or Part of Ourselves?" Paper presented at Post-Screen Festival: PSF2016, Lisbon, November 17–18, 2016.
22. Paul Du Gay, Stuart Hall, Linda Janes, Anders Koed Madsen, Hugh Mackay, and Keith Negus, *Doing Cultural Studies: The Story of the Sony Walkman* (London: SAGE, 2013).
23. Friedrich Kittler, *Gramophone, Film, Typewriter* (Palo Alto, CA: Stanford University Press, 1999); Friedrich Kittler, *Optical Media* (Cambridge, UK: Polity, 2010).
24. Geoffrey C. Bowker, *Science on the Run Information Management and Industrial Geophysics at Schlumberger, 1920–1940* (Cambridge, MA: MIT Press, 1994), 10–14.
25. Susan Leigh Star and Karen Ruhleder, "Steps toward an Ecology of Infrastructure: Design and Access for Large Information Spaces," *Information Systems Research Information Systems Research* 7, no. 1 (1996): 111–134.
26. Geoffrey C. Bowker, Karen Baker, Florence Millerand, and David Ribes, "Toward Information Infrastructure Studies: Ways of Knowing in a Networked Environment," in *International Handbook of Internet Research*, ed. Jeremy Hunsinger, Lisbeth Klasttrup, and Matthew M. Allen (Dordrecht, Netherlands: Springer, 2010); Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out* (Cambridge, MA: MIT Press, 1999); Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010); Sterne, *MP3*.

27. Star and Ruhleder, "Steps toward an Ecology of Infrastructure," 113 (emphasis added). Note, as well, that these items are drawn from a longer list of the characteristics of infrastructure.
28. Bowker et al., "Toward Information Infrastructure Studies."
29. Lisa Gitelman, *Always Already New* (Cambridge, MA: MIT Press, 2006), 7.
30. Nick Montfort and Ian Bogost, *Racing the Beam: the Atari Video Computer System* (Cambridge, MA: MIT Press, 2009), 2–3.
31. Tarleton Gillespie, *Wired Shut: Copyright and the Shape of Digital Culture* (Cambridge, MA: MIT Press, 2007), 93–94.
32. Mikkel Flyverbom, *The Digital Prism* (Cambridge: Cambridge University Press, 2019); Mike Ananny and Kate Crawford, "Seeing without Knowing: Limitations of the Transparency Ideal and Its Application to Algorithmic Accountability," *New Media & Society* 20, no. 3 (2018): 973–989.
33. Flyverbom, *Digital Prism*, 97.
34. Martha Lampland and Susan Leigh Star, *Standards and Their Stories* (Ithaca, NY: Cornell University Press, 2009), 17 (emphasis added).
35. Mentions of an infrastructure crisis in the United States started to gather in the 1980s. In subsequent decades they expanded and multiplied exponentially. In an early comment on this emergent pattern, Heywood T. Sanders expressed rare skepticism on the topic: "What Infrastructure Crisis?" *Public Interest*, no. 110 (1993): 3–18.
36. Star and Ruhleder, "Steps toward an Ecology of Infrastructure"; William J. Rankin, "Infrastructure and the International Governance of Economic Development, 1950–1965," in *Internationalization of Infrastructures*, eds. Jean-François Auger, Jan Jaap Bouma, and Rolf Künneke (Delft, Netherlands: Delft University of Technology, 2009): 61–75.
37. Jennifer Holt and Patrick Vonderau, "Where the Internet Lives," in *Signal Traffic* (Urbana: University of Illinois Press, 2015), 71–93; Mél Hogan, "Facebook Data Storage Centers as the Archive's Underbelly," *Television & New Media* 16, no. 1 (2015): 3–18; Louise Amoore, *Cloud Ethics: Algorithms and the Attributes of Ourselves and Others* (Durham, NC: Duke University Press, 2020).
38. Kregg Hetherington, "Surveying the Future Perfect: Anthropology, Development and the Promise of Infrastructure," in *Infrastructures and Social Complexity: A Companion*, eds. Penelope Harvey, Casper Bruun Jensen, and Atsuro Morita (London: Routledge, 2016): 42.
39. Shaylih Muehlmann, "Clandestine Infrastructures: Illicit Connectivities in the US-Mexico Borderlands," in *Infrastructure, Environment, and Life in the Anthropocene*, ed. Kregg Hetherington (Durham, NC: Duke University Press, 2019): 45–65; Brian Larkin, "The Politics and Poetics of Infrastructure," *Annual Review of Anthropology* 42, no. 1 (2013): 327–343; Lauren Berlant, "The Commons: Infrastructures for Troubling Times," *Environment and Planning D: Society and Space* 34, no. 3 (2016): 393–419; Megan Finn, *Documenting*

- Aftermath: Information Infrastructures in the Wake of Disasters* (Cambridge, MA: MIT Press, 2018); Marisa Elena Duarte, *Network Sovereignty: Building the Internet across Indian Country* (Seattle: University of Washington Press, 2017).
40. Gabrielle Hecht, "Interscalar Vehicles for an African Anthropocene: On Waste, Temporality, and Violence," *Cultural Anthropology* 33, no. 1 (2018): 109–141.
 41. Paul N. Edwards, "Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems," in *The History of Sociotechnical Systems: Modernity and Technology*, eds. Thomas Misa, Philip Brey and Andrew Feenberg (Cambridge, MA: MIT Press): 185–226.
 42. Thomas Pachirat examines the "politics of sight" involved in the managed invisibility of the US meat industry and its slaughterhouses. For a different approach, see the issue of *Postcolonial Studies* on toilets and the politics of modernity and transparency. Thomas Pachirat, *Every Twelve Seconds* (New Haven, CT: Yale University Press, 2011); Michael Dutton, Sanjay Seth, and Leela Gandhi, "Plumbing the Depths: Toilets, Transparency, and Modernity," *Postcolonial Studies* 5, no. 2 (2002): 137–142.
 43. Jas Rault, "Tricks of Transparency in Colonial Modernity," Digital Research Ethics Col-laboratory (DREC), <http://www.drecollab.org/tricks-of-transparency/>.
 44. Armond R. Towns, "Toward a Black Media Philosophy," *Cultural Studies* 34 (2020): 853.
 45. Rachel Hall, *The Transparent Traveler* (Durham, NC: Duke University Press, 2015).
 46. Shannon Mattern, "Maintenance and Care," *Places Journal*, November 2018, <https://placesjournal.org/article/maintenance-and-care/>.
 47. Ingrid Burrington, *Networks of New York: An Illustrated Field Guide to Urban Internet Infrastructure* (Brooklyn: Melville House Printing, 2016).
 48. Burrington, *Networks of New York*.
 49. Craig Robertson, *The Passport in America: The History of a Document* (Oxford and New York: Oxford University Press, 2010).
 50. Carolyn Steedman, "Something She Called a Fever: Michelet, Derrida, and Dust," *American Historical Review* 106, no. 4 (2001): 1163.
 51. Sara Ahmed, *Queer Phenomenology: Orientations, Objects, Others* (Durham, NC: Duke University Press, 2006).
 52. Judith Butler, *Bodies That Matter: On the Discursive Limits of "Sex"* (New York: Routledge, 1993), ix.

