Home Inspection: Mina Rees and National Computing Infrastructure

Abstract: This essay seeks to undermine the primacy of Vannevar Bush as an architect of digital culture by reimagining the story of national computing infrastructure through the framework of feminized care work. It argues that early forms of networked computational media were situated in collaborative spaces in which labor oriented around utilization, maintenance, and other forms of reproductive labor associated with domesticity were understood to be essential duties. This essay also tries not to focus exclusively on programmers, engineers, or designers as potential "mothers of invention." Using theoretical frameworks from global feminists working on contemporary information and communication technologies, this essay argues that those who engage with the messiness of networks of relationships that constitute infrastructure should be acknowledged as critical in the history of computing, particularly to question myths of disintermediation that are so dominant in technological discourses. In considering recovered histories of women in computing, this essay examines the career of Mina Rees, who headed the mathematics department of the U.S. Office of Naval Research, as a way to rethink the origin stories of computer history.

Introduction

Histories of digital media often begin with Vannevar Bush and his famed account of personal computing and disintermediation, which was to be enabled by an imagined device that he called the "memex." In collections of seminal texts – from Noah Wardrip-Fruin and Nick Montfort's *New Media Reader* (2003) to Thomas Keenan and Wendy Chun's *New Media, Old Media* (2006) – the curation of essays authored by Bush seems to burnish his reputation as a pioneer and prophet. As one of what Peter Lunenfeld has called "the patriarchs" in the history of computing culture (2011), Bush was also the head of the U.S. Office of Scientific Research and Development (OSRD) and an architect and administrator of the military-industrial complex and policies to advance science, technology, engineering, and mathematics.

Although Bush imagined the memex as an item of furniture, specifically a kind of desk equipped with scanning and replication technologies, the domestic context of computing is largely excised from his account of a future "machine which types when talked to."[1] According to Bush, access to a device capable of automated selection will supposedly liberate its operator from repetitive drudgery and information overload. Bush describes the prospective memex owner as a hyper-masculine enthusiast for information about antique armaments and tells the tale of his Turkish bow research project that is shared with a male colleague. But no one seems to worry about the memex being maintained in Bush's story. Unlike other kinds of household technologies that might generate "more work for mother" (Cowan, 2008) as expectations for performance are continually recalibrated and scutwork is consigned to women, Bush's memex is presented unconditionally as a labor-saving device for which strategies of care and repair require no consideration.

But what if we tell the story of innovation differently to rebut the canonical account of the solo white male inventor myth? Important work has already been done on the history of women collaborating in computing as programmers by Janet Abbate (2012) and many others, but relatively little has been written about their challenging roles as infrastructural planners who were responsible for organizing and rationalizing material, financial, legal, and human resources to establish specific geographical hubs for technological innovation, many of which were far from Silicon Valley, Xerox PARC, or other sites of celebrated discovery. Locations were often chosen based on domestic rather than entrepreneurial criteria with inspection of the computer's potential home environment at a university or research center a necessary precondition for consideration.

Despite often being perceived as low status “assistants” who were responsible for site visits and summarizing documents, those who were attentive to technological carework were often essential decision makers for establishing the conditions of what AnnaLee Saxenian (2000) has called “regional advantage.“

Mothers of Invention

Today the name “Mina Rees” is rarely invoked as significant in the history of computational media. Yet as the head of the mathematics division of the Office of Naval Research after World War II, she was a key decision-maker. For example, Rees’s role negotiating infrastructural conflicts appeared to be central in my viewing of the archives of UCLA Provost Clarence Dykstra. The archive documents Dykstra’s struggles to establish the Institute for Numerical Analysis at UCLA with the National Bureau of Standards and Rees’s Office of Naval Research. Dykstra was ultimately successful in 1947. However, prior to that date he frequently appealed to Rees to adjudicate competing claims of superiority in caregiving fitness from Stanford and UC Berkeley as possible homes for institutional computing. He knew Rees might be likely to support UCLA as a site for nurturing the computational needs of the burgeoning local aerospace and defense industries based on her frequent road trips to the area. (In a special anniversary issue of an Association for Computing Machinery journal, Rees’s account of the early days of digital machines is illustrated with photos of herself posing next to cars and highways.)

To understand how the histories of infrastructure can be reimagined I would like to transpose the trope of “home evaluation” from the feminized field of social work to the post-war context of big data and computational culture. In recounting this history, I would also challenge the idea that innovation is always synonymous with disintermediation by drawing on recent studies by feminist researchers examining the need for intermediaries in technocultural environments.

Once I started to encounter Mina Rees’s name in the archive, the need for a more comprehensive analysis of her important rhetorical position as a negotiator, careworker, and matchmaker seemed obvious, although published accounts of her contributions already existed. For example, even though Amy Shell-Gellasch’s book on Rees (2011) primarily focuses on Rees’s contributions to mathematics rather than to computer science, she demonstrates that Rees’s “travels and interactions with researchers around the country” placed her in a unique position to argue for “multiple inputs and visual displays for output.” In these efforts Rees often encountered “strong resistance” to her calls for more user-friendly devices.

In an earlier article on Rees’s role in funding mathematical science, Shell-Gellasch catalogues a number of ways that Rees challenged the status quo of computational culture by focusing on updating components in digital machines:

> Not only did Rees have a broad knowledge of computing, she also had a keen sense for potential future innovations in computing. She was an avid proponent of magnetic-core memory and later of electrostatic memory. She foresaw the switch from vacuum tubes to transistors, when many people in the field did not. She promoted visual display equipment and multiple inputs. And she pushed for faster and faster machines with larger memories, anticipating the commercial and academic uses of computers. It should be noted that Rees advocated the development of simple and cheap computers for widespread use at universities, counter to majority opinion at the time.[2]

While Shell-Gellasch compares Rees with Vannevar Bush as a fellow infrastructural planner concerned with federal support for research, in another history of Rees Kathleen Broome Williams (2001) pairs Rees with Grace Hopper. It is true that both Hopper and Rees were employed by the Navy – one as a career officer and the other as a civilian academic loaned by her institution. However, I would argue that in a gendered history of computer technology we should disambiguate invention and delivery, innovation and maintenance, and skill in programming and skill in managing networks in order to give more attention to the roles associated with connection, mediation, and caregiving. Informed by the perspective of science and technology studies and feminist theories of infrastructure, affective labor, and intersectional identities in work culture, it is possible to see Rees in ways that resist the conventional patriarchal innovation paradigm that excessively values inception over reproduction and care.

Perhaps it is more useful to think about Rees's alliance with Warren Weaver – another widely recognized pioneer of information science who focused on problems of communication in technological fields and mathematical theories of probability and statistics – to understand how Rees might have appreciated knowledge as situated in particular contexts and information as the management of uncertainty in her work as an infrastructural planner and home inspection specialist. Weaver was also an infrastructural manager of support networks who used his position in the Rockefeller Foundation to encourage developing scientists and nurture their environments.

Disquieting and Discreet Girls

At the end of my first book *Virtualpolitik* (2009) I performed close readings of the texts of Bush and Weaver to analyze how the rhetoric of information science in the history of computing deployed the figure of the "girl" and her technological labor (as well as possible disjunctions with the lived experiences of actual girls working as human computers in ethnically diverse Southern California). Like many feminists I had become interested in recovered histories after reading Anne Balsamo's "my mother was a computer" story in *Technologies of the Gendered Body* (1997), a personal narrative that describes her own family history with the comptometer in the Sears Roebuck workforce. This origin story was powerful as a narrative about feminism and technology, and I have since seen many ways that Balsamo's trope of computer-mothers has circulated and has been subsequently remixed and appropriated by others.

Reading the primary literature produced by the major historical proponents of computer science, however, I quickly encountered far more "girls" than "mothers." In "As We May Think" (1945), Bush bemoans what he sees as a crisis of knowledge unfolding in contemporary society, because so much scientific inquiry is going on at a rapid pace simultaneously at many locations in laboratories and research universities, and yet "methods of transmitting and reviewing the results of research are generations old." According to Bush, massive computerization could solve the information overload problem, and imagined devices for personal use like the memex could supplement human memory and communication. Although this essay is often read as a blueprint for the digital future, in many ways Bush's document is deeply reactionary, as Wendy Chun (2011) points out, in being informed largely by analog technologies. In *Virtualpolitik* I argued that Bush's essay also appears to be reactionary in asserting traditional notions of gender – by rejecting keyboard interfaces associated with women's expertise – and casting female presence as disruptive, arguments he made with more explicit misogyny in his published work on business management.[3]

For example, at one point in “As We May Think” Bush indicates the inappropriateness of the professional spectacle of “girls” in the company of engineers, men of science, and others occupied in the business of the public sphere:

> The other element is found in the stenotype, that somewhat disconcerting device encountered usually at public meetings. A girl strokes its keys languidly and looks about the room and sometimes at the speaker with a disquieting gaze.

The device is “disconcerting,” but so is the “disquieting” operator of it, who sensuously “strokes” the keys “languidly” and discomfits the speaker by making a male the object of an attentive if not predatory gaze. By creating “a machine which types when talked to,” Bush would be able to remove this “girl” from the scene, and – with a little creative engineering – preserve the decorum of the public meeting, which could then take place in a suitably all-male environment.[4]

The figure of the “girl” reappears in Warren Weaver’s introduction to Claude Shannon’s ground-breaking technical work *The Mathematical Theory of Communication* (1999). It is interesting, however, that rather than reject the “girl’s” labor, as Bush does, Weaver makes her into the very epitome of his profession. At one point, Weaver compares the new discipline that Shannon is launching to a “girl” in the telecommunications industry and thus makes the young working woman into one of his central rhetorical tropes.

> An engineering communication theory is like a very proper and discreet girl accepting your telegram. She pays no attention to the meaning, whether it be sad, or joyous, or embarrassing. But she must be prepared to deal with all that come to her desk.[5]

In other words, in Bush’s account the female intermediary is a potentially problematic obstacle to progress who can be replaced by the machine that types when spoken to, but in Weaver’s account the female intermediary is paradigmatic for the emerging field as a facilitator and functionary.

Infrastructural Inversions

Feminist scholarship in infrastructure studies encourages understanding computer networks as an aggregation of relationships. As a rule, however, such infrastructure tends to be hidden from view. As Genevieve Bell and Paul Dourish observe, “the infrastructures of daily life – the electricity system, the water system, telephony, digital networking, or the rest” require someone to “[l]ift the cover, peer behind the panels, or look underneath the floor” to make visible the “mess” that is “never far away.”[6] It is useful to undertake what Geof Bowker and Leigh Star have called an “infrastructural inversion,” because such infrastructure often goes unnoticed unless it has broken down. By “recognizing the depths of interdependence of technical networks and standards” and “the real work of politics and knowledge production,”[7] infrastructure can become an object of study, and it becomes possible to see the ecologies of unseen support systems. Rees’s inspections were designed to make visible all of these invisible elements: funding, personnel, equipment, supply chains, policies, and social dynamics.

But how precisely should infrastructure be defined? Star and Karen Ruhleder famously define it as follows: “It is both engine and barrier for change; both customizable and rigid; both inside and outside organizational practices. It is product and process.”[8] Following Star’s reasoning, infrastructure can be both abstract (such

as common standards, classification systems, and schedules) and concrete (such as cables, antennae, and maintenance tunnels). It can be composed of inanimate material objects (such as cooling systems) and human actors (such as staff monitoring equipment). In addition to being a "what," infrastructure can be a "how" and a "who" – and even a "when." As Star explains, something "becomes infrastructure in relation to organized practices," so that in a given cultural context timing dictates the definition of infrastructure. In this way, "the cook considers the water system a piece of working infrastructure integral to making dinner; for the city planner, it becomes a variable in a complex equation."[9]

As an infrastructural manager and custodian, Rees must demonstrate all of the aspects of an "ethic of care": attentiveness, responsibility, competence, and responsiveness (Tronto, 2015). However, this feminized positioning could also be humiliating in necessitating deference to the needs of others as a primary directive. Shell-Gellasch describes how Rees was frequently frustrated by being mistaken for Weaver's secretary rather than a member of the Applied Mathematics Panel in her own right and how she pleaded with allies to introduce her as "Dr. Rees" to newcomers to avoid slights and debasement.

Because she was cast as Weaver's subordinate, Rees's expertise was often read as both typical and contradictory for her gender identity. At the same time male university administrators were forced to concern themselves with domestic arrangements for these new technocultural spaces within computing hubs.

Home Inspection

Certainly Rees was often perceived as a low status "assistant" to Weaver, a minor player who was assumed to be only responsible for perfunctory site visits and summarizing documents for her busy superior. Official accounts of the establishment of computing infrastructure in California sometimes even made the geographical positioning of what is now called "Silicon Beach" seem arbitrary. For example, the location of hubs on the West Coast was attributed to happy memories of vacations or nostalgia for sunny campuses with an emphasis on the experiences of male planners and to a lesser extent their wives. Yet oral histories, correspondence, and Rees's own published work on the history of computing suggest that she was an extremely important advocate for the region, who traveled across the country as a go-between. She was particularly effective at placing major hubs for computation within reach of aviation and other companies experimenting with new varieties of strategic planning, assembly line labor, and supply chains. Building on my prior work about the RAND corporation (2016), it appears that gender also plays a significant role in the regional story of computer engineering in Southern California in considering how embodied practices and tacit understanding operating in work culture are enacted in spaces for collaboration and distributed cognition.

Although by November of 1947 J. H. Curtiss, Chief of the National Applied Mathematics Laboratories, had come around to supporting UCLA as the future home of the Institute of Numerical Analysis, he had opined in an earlier January letter that Stanford may prove a better site for the ONR facility because UCLA's existing analog computing initiatives were already gaining publicity and might create competition for resources if UCLA also became the caretaker of the government's proposed investment in a $300,000 IBM digital machine. The non-digital 1947 differential analyzer, which appeared in the university's promotional films and even a few Hollywood B pictures, was an analog computer built by General Electric and had been considered to be a signature project of UCLA's Dean Boelter. After seeing Curtiss's letter, Provost Dykstra appeared agitated by the possibility that the government would choose Stanford, which had the Ames Research Center nearby and prestigious experts and seemingly better buildings.

Dykstra's papers indicate that he carefully reviewed all the particulars of outfitting a computing structure at UCLA to strengthen the campus's bid. From these documents, the UCLA provost often seems drawn into the minutiae of everything from the choice of Venetian blinds to the location of the lunchroom hotplate, attention to domestic details that might feminize his role. Meanwhile Dykstra's supposed allies in the aviation industry seemed to prove themselves to be inept negotiators by lobbying Washington in unseemly ways, making the UCLA academic culture appear provincial and weak. Finally, in 1948 when Dykstra probably thought everything was settled and that his campus at last had secured the prestigious institute - they were preparing the space for the impending arrival of the IBM machine - he experienced an abrupt eleventh-hour reversal involving James Corley, the university's representative to state government in Sacramento. Corley had announced that Berkeley would be put back into consideration as a possible site of the INA.

On April 27, Dykstra sent a plaintive telegram to Corley that reads: "CAN WE NOT GO AHEAD AS AGREED IN THE TAYLOR LETTER IT SEEMS STRANGE THAT WE SHOULD HAVE A REVERSAL AT THIS LATE DATE." It is significant that Corley sent Dykstra correspondence that accused him of "setting up in one division equipment or facilities which are not standard and in accordance with university policy" and preached to him about surrendering "in order that all of our family can be happy." Obviously Corley's vision of family harmony will remind feminist scholars of oppressive patriarchal norms in which UC Berkeley should be the commanding father and UCLA the compliant mother, albeit a mother judged by Corley to be an unfit parent for the IBM machine.

Throughout these tumultuous times of domestic squabbles between institutions and instability for establishing a suitable environment for digital computing at UCLA, invoking Rees' name would have been ideal, as the person who had already definitively vetted the institution for Weaver and the federal government and had judged it to be an appropriate home. Unfortunately in Rees's archive at CUNY we don't appear to have her side of the UCLA story of regional preference and designing intimate work spaces. As Rees did not keep diaries and minimized correspondence, it is difficult to gain more insight into her philosophy of home inspection as she applied it at UCLA.

At the very least, in the CUNY archive it becomes clear that Rees was an extremely valued employee by Weaver and someone he completely trusted as a surrogate and advisor. He wrote her many laudatory letters chronicling his everyday appreciation, he advocated for a raise in her salary, he secured for her the same civilian honors that diplomatic allies had bestowed upon him, and he repeatedly sent memos encouraging her to continue to speak up in meetings. Although she often cast herself in a supporting role, her awareness of administrative nuances was clearly essential to care and repair of infrastructure.

However, despite her human-centric role in familial dramas and care work, her ideas that human beings would inevitably be in service to machines in order to have a smoothly functioning infrastructure were clearly seen as heretical in some quarters. For example, in a 1947 letter written on January 2 to Rees Richard Courant expressed consternation about her planned statement for an official address about the training of "young persons" for "the machines which will be ready in a few years." After reviewing her draft he stated emphatically: "The main thing is that the machines should serve as tools for human beings, and not the other way around." She revised the offending passage, although her marginal comments indicated some confusion about the faux pas she had supposedly committed. She continued to refer to computers as agents dictating human behavior long after Courant's rebuke. For example, she described Project Whirlwind as "a computer in search of a mission" (Rees, 1982).

Rees also spoke about human attachments to computers in parental terms, as she did of John Von Neumann: “he talked to me about the ENIAC with such enthusiasm that I would have expected that he was there at the birth, if you know what I mean” (Computer Oral History, 1972). In an oral history she also spoke about her own care work to support the field of mathematics by nurturing fledgling mathematicians and nourishing senior mathematicians with research time. In managing familial relations, domestic arrangements, and reproductive labor, Rees was an essential infrastructural designer.

Mediation and Disintermediation

Recent work by transnational feminist research teams asserts that to understand technology as the wielding of tools is inevitably to misunderstand it. In challenging ICT models for development, such feminists question disintermediation myths and how those in the Global North may evangelize for optimized technologies and personal devices without understanding why people might prefer the presence of “infomediaries” (Ramirez *et al*., 2009). As Janaki Srinivasan and Elisa Oreglia point out, “intermediaries perform a double intermediation: not only between users and technology, but also between the multiple systems of values represented by ICT to different actors in their community. They are thus connecting agents that belong to different networks, and identify with each as required. Because they belong to different sets of social rules, their identities are constantly shifting, and their allegiance to the different networks changes according to the changing circumstances” (Srinivasan and Oreglia, 2016), Srinivasan has described herself as "interested in intermediaries, the importance of how the intermediary was introduced, and why he is always a villain” (Losh, 2017).

While Bush presents a vision of disintermediation in which a machine types when spoken to, thereby displacing the disquieting girl in the scene, Rees offers a more sympathetic view of the role of intermediaries in the scene of computation and wishes to acknowledge the importance of their labor and its reproductive redundancies. When Rees imagined digital machines being used in many kinds of human-computer interactions – including at banks and insurance companies, for airline-reservation systems and air-traffic control, and in inventory control – she speaks of networks of relationships between intermediaries rather than, like Bush’s memex owner, the mastery of a man equipped with a tool.

Conclusion

Rees’s rejection of instrumentality and her understanding of interdependence in the history of computer engineering indicates a sophisticated sensibility for recognizing invisible labor and managing competing needs. When a good history of Rees finally is written that provides a meaningful counternarrative to the trite just-so infrastructural stories about Vannevar Bush, I expect that we will learn a lot, not only about the history of computing and the rise of contemporary engineering culture, but also about the affective and domestic aspects of the military-industrial complex, the modern North American research university, and information science more generally. When we think about the ethic of care at the heart of the feminized duties of home inspection that Rees performed, we can imagine a different paradigm for social histories of computing. To tell better origin stories about technology in the context of the U.S. nation-state, we can also benefit from the theoretical frameworks of global feminists who challenge myths of disintermediation and acknowledge the material, embodied, affective, labor-intensive, and situated character of technology.

Contents

Notes

[1] Bush, 1945.

[2] Shell-Gellasch, 2002, pp. 886.

[3] I am grateful to Ruth Schwartz Cowan for challenging my blanket characterizations of Bush in *Virtualpolitik* in our conversation at the 2016 annual convention of the Society for the History of Technology (SHoT). Cowan described Bush's apparent personal liberality granting unrestricted parental leave to a female employee and his interest in seeking professional mentoring for his own daughter in scientific fields.

[4] It is interesting to note that when Bush revisited this essay two decades later, he relabeled the "girl" as a "stenographer" and removed the gendered references, although he keeps references to the operator who "strokes its keys languidly" and discomforts the speaker with a "disquieting gaze." See Vannevar Bush, "Memex Revisited," *Science Is Not Enough* (New York: William Morrow & Company, Inc., 1967), pp. 93.

[5] Shannon and Weaver, 1999, pp. 27.

[6] Dourish and Bell, 2011, pp. 4.

[7] Bowker and Star, 1999, pp. 34.

[8] Star and Ruhleder, 1996, pp. 111-134.

[9] Star, 1999, pp. 377–391.

References

Janet Abbate, 2012. *Recoding Gender*. Cambridge, Mass.: MIT Press.

Ann Marie Balsamo, 1997. *Technologies of the Gendered Body: Reading Cyborg Women*. Durham: Duke Univ. Press.

Geoffrey C. Bowker and Susan Leigh Star, 2008. *Sorting Things out: Classification and Its Consequences*. Cambridge, Mass.: MIT Press.

Vannevar Bush, 1945. “As We May Think,” *The Atlantic* (July) at https://www.theatlantic.com/magazine/archive/1945/07/as-we-may-think/303881/, accessed 11 December 2017.

Wendy Hui Kyong Chun, 2011. *Programmed Visions: Software and Memory*. Cambridge, Mass: MIT Press.

Computer Oral History Collection, 1972. Mina Rees Interview, October 20, 1972, Archives Center, National Museum of American History.

Ruth Schwartz Cowan, 2008. *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave*. New York, NY: Basic Books.

Paul Dourish and Genevieve Bell, 2014. *Divining a Digital Future: Mess and Mythology in Ubiquitous Computing*. Cambridge, Mass: MIT Press.

Thomas Keenan and Wendy Hui Kyong Chun, 2006. *New Media Old Media: A History and Theory Reader*. New York, N.Y. ; London: Routledge.

Elizabeth Losh, 2016. “Playing Defense: Gender, Just War, and Game Design,” in *Zones of Control*, ed. Pat Harrigan and Matthew Kirschenbaum. Cambridge, Mass.: MIT Press: 355-370.

Elizabeth Losh, 2015. “Revisiting the Fishers of Kerala with Janaki Srinivasan.” Institute for Money, Technology, and Financial Inclusion (IMTFI) (21 May), at http://blog.imtfi.uci.edu/2015/10/fisherman-in-kerala-with-janaki.html, accessed 28 May 2017.

Elizabeth M. Losh, 2009. *Virtualpolitik an Electronic History of Government Media-Making in a Time of War, Scandal, Disaster, Miscommunication, and Mistakes*. Cambridge, Mass.: MIT Press.

Peter Lunenfeld, 2011. *The Secret War between Downloading and Uploading: Tales of the Computer as Culture Machine*. Cambridge, Mass.: MIT Press.

Ricardo Ramirez, Balaji Parthasarathy, and Amy Gordon, 2009. “Infomediaries: Brokers of Public Access | Technology & Social Change Group.” Technology and Social Change Group at University of Washington Information School (23 September), at http://www.globalimpactstudy.org/2009/09/infomediaries/, accessed 12 December 2017.

Mina Rees, 1982. “The Computing Program of the Office of Naval Research, 1946-1953.” *Annals of the History of Computing*, volume 4, number 2, pp. 102–20.

AnnaLee Saxenian, 2000. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge, Mass.: Harvard University Press.

Claude Elwood Shannon and Warren Weaver, 1999. *The Mathematical Theory of Communication*. Urbana: University of Illinois Press.

Amy Shell-Gellasch, 2002. “Mina Rees and the Funding of the Mathematical Sciences.” *The American Mathematical Monthly,* volume 109, number 10, pp. 873–89.

Amy Shell-Gellasch, 2011. *In Service to Mathematics: The Life and Work of Mina Rees*. Boston, Mass.: Docent Press.

Janaki Srinivasan and Elisa Oreglia, 2016. “Digital Myths and the Making of a Moral Economy.” Society for the Advancement of Socio-Economics (25 June), at https://sase.confex.com/sase/2016am/webprogram/Paper4995.html, accessed 11 December 2017.

Susan Leigh Star, 1999. “The Ethnography of Infrastructure.” *American Behavioral Scientist*, volume 43, number 3, pp. 377–91.

Susan Leigh Sstar and Karen Ruhleder, 1996. “Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces.” *Information Systems Research*, volume 7, number 1, pp. 111–34.

Joan Tronto, 2015. *Moral boundaries: a political argument for an ethic of care*. New York: Routledge.

Noah Wardrip-Fruin and Nick Montfort, 2003. *The New Media Reader.* Cambridge, Mass.: MIT Press.

Kathleen Broome Williams, 2001. *Improbable Warriors: Women Scientists and the U.S. Navy in World War II*. Annapolis: Naval Institute Press.