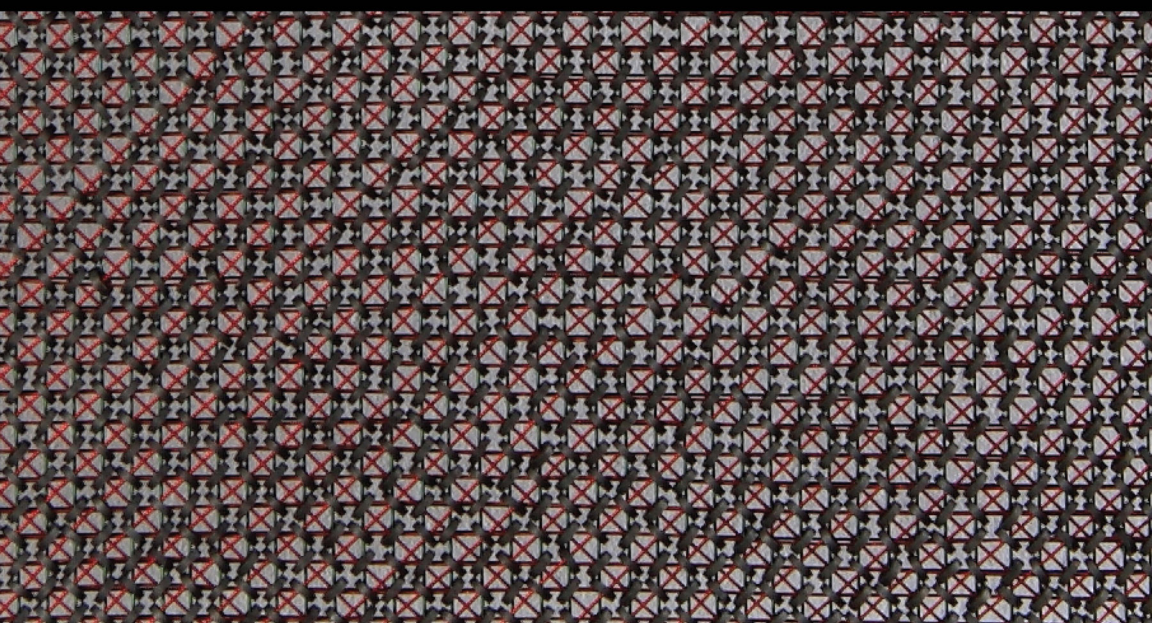


THE FABRIC OF INTERFACE

Mobile Media, Design, and Gender

Stephen Monteiro



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For Manisha and Dhruv

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Introduction

Contemporary digital media appear to have little in common with those of only a generation ago. In addition to transformations in their content, infrastructure, and application, our interactions and physical engagement with the digital media object have changed fundamentally. Encounters with digital networks and media frequently occur through handheld, electronic devices that accompany us through the day, carried in our back pocket or handbag. We turn and tilt these small plastic or metal frames with our hands and arms. We stroke and tap their glass screens with our fingertips. Through these physical interactions with the object and its surface, we make things: images, links, sites, networks. Our ability to effectively and efficiently identify patterns and build connections in this bodily performance, to bind the material of networked digital culture in new ways—whether it be in a game or on a social media platform—may earn us money, points, credit, followers, or some other desired quantitative reward.

Digital media's most unassuming components and operations are not self-evident or neutral entities, but cultural artifacts forged from long-standing social and ideological forces. As manual dexterity, patternmaking, and linking have risen to the forefront of everyday digital practice, our media interactions have taken on traits common to textile and needlecraft culture. Our smartphones and tablets share much with the handloom, the needlepoint hoop, and the lap-sized quilting frame. Each of these represents a portable platform, upon which one can create patterns, images, and other potentially meaningful visual configurations. Historically, looms, hoops, and quilting frames have been tools of the home, but they also have served as a means for greater social interaction, as with the communal functions of pattern sharing, fabric exchange, and quilting bees. Likewise, with the advent of the networked platforms for personal data and information

sharing known collectively as social media, our portable electronics have become tools for a variety of interactions with others through the digital material that we access and its relation to our everyday circulation through the social sphere.

How may a handheld screen function like a loom, visual data function like swatches of fabric, and tactile interfaces function like needlework? What can such affinities tell us about communicative technology's adaptation of popular cultural codes? How does this create new ways of thinking about digital media's relationship to labor, identity, space, and the senses? Such questions frame the perspective and scope of *The Fabric of Interface*. Through its sustained exploration of weaving, fabric manipulation, and needlecraft as fundamental to historical and contemporary digital frameworks and interfaces, this book identifies important connections between contemporary networked media and practices often construed as alien to media technologies. It contends that social distinctions and gender divisions are reflected not only in what is made and circulated on digital devices and networks—as has been argued elsewhere¹—but also through the immaterial and material forms, structures, and requirements of these devices and networks as they play out in electronic and physical actions and exchanges.

In their study of digital interaction design, Jay Bolter and Diane Gromala assert: "If we only look *through* the interface, we cannot appreciate the ways it shapes our experience. ... If we cannot also step back and see the interface as a technical creation, then we are missing half of the experience that new digital media can offer."² Stepping back to examine the correlation of digital and textile performativity in haptic and visual interface is significant for two reasons, both of which have consequences far beyond digital interactivity. First, it brings to the surface elements of computing's historical dependency on textile design, its production methods, and its labor models. This story is buried in computing's material past and scattered across its global sites of hard- and software manufacture and assembly, where women regularly have been responsible for the manual labor of weaving memory, threading hardwired programs, and integrating circuits. Second, the reification of this relationship in contemporary interface design and user practices raises vital questions about the relationship between gender and bodily interface in mobile media at a moment when such technologies would seem to transcend the issue. When considering ways an iPhone might be gendered, for example, one may be prone to begin and end with

obvious marketing maneuvers such as the introduction of a pink (or “rose gold,” according to Apple) back cover. “Are you man enough for a pink iPhone 6s?” *Esquire* asked its readers when the cover was introduced, referring to the result as a “powder-puff smartphone.”³ Yet such overt gestures toward the most conventional methods of coding gender in the everyday imply that these devices and their functionality are otherwise gender-neutral platforms upon which such codes may be added. In fact, the availability of colored covers or the production and use of deliberately gender-specific apps or language represent diversions that effectively obscure far more pervasive, but less easily identifiable, gendered characteristics of mobile media.

The look, feel, and function of contemporary media devices and their supporting software derive from deep-seated patterns of cultural practice, social structuring, and technological hierarchizing. This reflects Lisa Gitelman’s contention that media are “muddy” entities requiring consideration of how they are formed through social protocol as much as how they function technologically. “Media include a vast clutter of normative rules and default conditions, which gather and adhere like a nebulous array around a technological nucleus,” she states.⁴ The approach of this book differs from Gitelman’s, however, in its emphasis of the technological nucleus itself as constructed from normative rules and default conditions. In other words, socially constructed rules and conditions not only form around a technology, but also contribute significantly to that technology’s formation in the first place. Any medium, any technology, is already muddy when it comes out of the box.

This book explores the muddy roots of networked digital media’s forms and practices in emphasizing their historical, cultural, and aesthetic dependency on gendered embodiment and labor forms. Making the link between sewing, weaving, and quilting and contemporary technologies gives access to new ways of conceptualizing hardware and software design, sensorial experience, and personal networked media practice. It contributes to an alternative historical narrative of digital interactivity—one centered on the relationship between gender and interface aesthetics. Recent changes in the screen as an interactive object and tool represent a critical turning point in this story, producing new physical and ideological relationships between user, device, and digital production. Any consideration of the material design and functioning of media—in this case, the hardware of portable touchscreens and wearables and the software that guides and

brings meaning to our actions upon them—must be informed by these long-established gendered discourses of social differentiation and power imbalance that they reify and sustain.⁵

Producing such an alternative narrative sharpens our understanding of the ways contemporary digital media may represent new modes of social production and interaction, and in what ways they merely adapt and redeploy modes already embedded in the history of computing and digital communication. Specifically, this narrative challenges the perceived breaks between industrial (or commercial) computing and personal computing in the closing decades of the twentieth century, and personal computing and social media in the opening decades of this century. Bridging these shifts is digital culture's continued reliance on textile and needlecraft practices, techniques, and methods drawn from spheres alternately labeled as feminine, private, and domestic. In this way, qualities of intimacy and engagement seen as novel to today's touchscreen media devices are in fact attributes already present in earlier conditions of digital production, where manual gestures common to home handicrafts played a fundamental role in the manufacture of mainframes.

In attempting to uncover the little-explored material, ideological, and social links between networked, mobile media practices and textile and needlecraft culture, however, it is important to recognize clues that have long hovered near the surface. In particular, metaphors of textile and craft permeate the history of computing and communication networks. We do not have to reflect long before they spring to mind. Software developers and engineers “weave” code that includes “threads,” such as bulk calls, to subroutines and threads of execution. Internet administrators and users “weave” the “web” with “threaded” discussions and by “linking” (a term for joining knitted fabrics). Data structures—from lists to trees—can be “zippered,” and when files are compressed and uncompressed they are “zipped” and “unzipped.” Problems in existing programs and their underlying software code are repaired with “patches” made from additional code. Digital images are “stitched” together or “quilted” by image-editing programs to produce larger images, such as landscape panoramas and game environments. All of this material is guided through the distributed network of the Internet via nodes of gridded circuits known as switch “fabrics.”⁶ The prevalence of textile metaphors conceptually marks digital practices in ways that distance them from other crafts. Although links might be drawn

to scrapbooking, modeling, or other methods of object making, the imaginary of computing (from its earliest history, as we shall see) is fashioned from processes surrounding the making and assembling of cloth.⁷ Despite the presence of so many examples of the language of textile crafts in discussions of computing and digital media, however, they rarely have been treated as emblematic of deeper connections between digital communications and what has been called “homecraft” or “women’s work.”

Apart from these linguistic clues, contemporary digital media’s intersections with textiles and crafts may be most evident in the success of online crafting communities and marketplaces. Jack Bratich and Heidi Brush, two scholars who consider this trend, identify a convergence of craft and digital culture that they call “fabriculture.” These observations are noteworthy and valuable, pointing to the way very old and very new media have harmonized and contributed to each other.⁸ Another pair of scholars, Stella Minahan and Julie Wolfram Cox, adopt the term “Stitch’nBitch” to identify this trend, a name that emphasizes the relationship between collective needlecraft and interpersonal communication through and around digital networks. “*Stitch’nBitch* may be an example of a new way of connecting that is based on material production using traditional craft skills and yarns as well as the optical fibre and twisted pair cable used for telecommunications,” they explain, representing “a local and global phenomenon in which production and consumption of gender, technology and society collide.”⁹ In addition to traditional forms of meeting to assemble textiles, virtual bees have sprung up, in which a quilter will send other members of the bee her fabric choices and suggestions for styling the block. Members will then sew the pieces into blocks and return them to her for final assembly.¹⁰ Bratich mentions “peer-to-peer textiling” as a way to describe an evolving craft culture that combines online and off-line group communication, meetings, and exchanges of information.¹¹ While online marketplaces specializing in such handmade objects, including Etsy and Cargoh, also have thrived, digital networks have been the place to organize and promote craftivism, which seeks to expose and confront social injustice and inequality through craft.¹² Kirsty Robertson has argued, however, that craftivism’s dependence on these global networks for organization and promotion may undermine the power of its anti-neoliberal message.¹³

Conversely, the design and operation of digital devices, interfaces, and networks have informed the aesthetics of crafts and hand production—from



Figure 0.1

Needlepoint grid produced by KnitPro 2.0 from a photo of a New England textile mill. Original photo by the author.

sculpture to rug hooking—in important ways. James Bridle has called this the “New Aesthetic,” explaining that it “reproduces the structure and disposition of the network itself, as a form of critique.”¹⁴ A fitting instance of this intersection of network and craft aesthetics is KnitPro, a web application that allows users to convert GIF, JPEG, and PNG image files into gridded patterns for needlepoint and knitting.¹⁵ Such apps convert the photographic image into a grid of tiles that already suggests a woven or embroidered surface (figure 0.1). Sites such as Sprite Stitch, a blog for “video game crafts,” celebrate the visual correspondences between computer-generated imagery and textiles, with everything from cross-stitched Pokémon Kanto maps to crocheted Mario dolls.¹⁶ These examples amount to an open dialogue between craft culture and digital media. Moving away from an explicit emphasis on textiles, Minecraft nevertheless would be an example of a popular game that joins the block construction of craft culture with the raster-and-pixel aesthetic of early screen-based computing.

Another area of overlap between textile culture and computing, one that departs from craft as described in the foregoing examples, is the development of wearable media. This includes eyewear and wristwear, although objects such as eyeglasses and wristwatches have, in fact, always been wearable media. Smart fabrics and e-textiles created by companies such as Intelligent Textiles are woven of a conductive warp and weft to produce clothing capable of cybernetic circuits.¹⁷ Other textiles incorporate optical fibers. These have been used in warfare and medicine, but also sports and fashion.¹⁸

While some of the preceding examples enter into the present narrative at significant moments—particularly in discussions of gendered labor and the senses—for the most part they remain peripheral to its objective and argument. These initial layers of explicit intersection between digital media and textile culture—whether tied to technological innovation, the creation of motifs, or the migration of craft communities to electronic forums—can overshadow the more profound ways the culture of textiles has shaped digital media structures and practices. Beneath the surface is a deeper material, performative, and ideological intertwining of textile-based crafts and digital technologies, processes, and habits. This hidden layer of relations and correspondences exposes the larger social forces at work in the most basic elements and actions of everyday media use and their dependency on pre-digital notions of gendered labor and production. It is this layer that may help explain, for example, why mobile media users willingly contribute their labor and creative production to social media platforms at no cost, while the companies behind these platforms gain billions of dollars of profits from this situation.

Objects and Processes

Writing about interfaces, Johanna Drucker asserts, “In a very real, practical sense we carry on most of our personal and professional business through interfaces. Knowing how interface structures our relation to knowledge and behavior is essential.”¹⁹ Invoked in diverse discussions and contexts, *interface* has become a twenty-first-century trope. According to Branden Hookway, it “describes a cultural moment as much as it does a specific relationship between human user and technological artifact.”²⁰ The word gains traction through its connotations of advanced technology and

contemporary communication forms, suggesting both immediacy and engagement. As a trope it represents and conveys important ideological meanings. Wendy Chun has stated that the digital object's interface is "a functional analog to ideology" in that such devices can formally produce false consciousness and represent an individual's imaginary relationship to the real. "The 'choices' operating systems offer limit the visible and the invisible, the imaginable and unimaginable," Chun claims, adding that "interfaces also produce users through benign interactions."²¹ Similarly, Drucker points out that an interface "combines two ideological illusions in a single paradoxical identity: the predictability of a mechanized automaton and the myth of autonomous agency."²² As such, the interface as an idea as well as a series of actions between human and machine in time and space remains an important site in contemporary culture—perhaps the most important site—for the function of power on, and through, the individual. In their collection, *Interface Criticism: Aesthetics Beyond Buttons*, Christian Ulrik Andersen and Søren Bro Pold explain that "interfaces can embed choices, conduct, languages, and ultimately values, worldviews and aesthetics into technical infrastructures. ... Today we perceive our environment through interfaces."²³

Interface as it is explored in this study refers first and foremost to its most common meaning for media today—the site of contact between people and portable networked devices, and the events that take place there. This is most frequently experienced through the bodily manipulation of a screen-object and consequent changes in the digitally produced effects manifested by the object at or around the point of contact. Of course, software operations and network flows that underlie and facilitate this superficial, material activity are integral to the process. The understanding of interface deployed here draws on theories articulated by Hookway and Alexander Galloway, both of whom study interface in ways that reach far beyond popular, contemporary understandings of the term, to consider how an interface may surpass these parameters while nevertheless containing them at its center.²⁴ Galloway's idea of the interface as a "threshold" (Hookway uses the term as well) related to the exercise of neoliberal ideologies is particularly germane to the claims made here.²⁵ The interface allows, encourages, and guides certain patterns of activity and production practiced in multiple contexts that further the breakdown between distinctions of work and leisure, for example, while quantifying and monetizing our most basic and necessary

social interactions. In his exploration of the effects of interface, Galloway explains: “Interfaces are not simply objects or boundary points. ... Interfaces are themselves the effects of other things, and thus tell the story of the larger forces that engender them.”²⁶ Studying the effect of interface—and interface as effect—in regard to contemporary mobile communication lies at the heart of this book as well.

Hookway similarly considers the interface as “a relation with technology rather than as a technology in itself.” For him, “the interface describes a boundary condition that is at the same time encountered and worked through toward some specific end.”²⁷ This meeting of two otherwise distinct entities produces what he calls “augmentation,” which is aimed at control and power. Augmentation could be called the event of interface, and the chapters that follow argue that control and power through this encounter extend well beyond the interface because augmentation draws upon existing social conditions and actions.²⁸ This points to an additional aspect of interface considered here, especially in chapter 4: interface as physical space organized to regulate exchanges between people, space that increasingly accommodates interactions between the body and digital technologies. Such a space could be a living room, bedroom, or kitchen, but it is also a lobby, a park, a classroom, and even the sidewalk. As Hookway observes, the interface is a contested zone, where social and material meet, one that “governs the production of sites and events.”²⁹

In considering the relationship between portable media devices, social hierarchies, and communication, the mobility of devices (and our access to their networks) produces significant changes in our understanding of the meaning and function of our physical spaces and their ties to the ideology of a (problematic) public sphere of face-to-face interaction and expression. According to Andersen and Pold, “The interface is a dominant cultural form providing a way to mediate between humans and machines and between culture and data, affecting the way we perceive cultural activities and perform them in public and private.”³⁰ From home to office to street, ideas of private and public space, of workspace and leisure space, are challenged by the paradoxically constant, but intermittent, use of networked portable devices throughout the day. This embodied performance of the digital interface across vastly different social spaces has the potential to challenge engrained assumptions concerning the role of those spaces and—refracted through gender, race, and other social lenses—what sorts of expressions and

actions they will permit.³¹ This is at the heart of what Malcolm McCullough has called the “ambient commons,” an intermingling of spaces, bodies, and networks that not only changes the perceptual parameters of everyday living, but also requires new approaches to understanding and assessing attention, distraction, and participation.³²

While interface is a thoroughly modern and relatively uncontested concept, one developed in nineteenth-century masculine spheres of fluid dynamics and mechanical engineering (according to Hookway), gender is a much older idea that has received considerable scrutiny and challenge in contemporary thought. Gender can be considered in at least two ways significant to the claims of this book. First, it exists as a qualitative distinction that can be applied to a greater or lesser extent to any form of human activity, communication, or invention. This is much the way grammatical gender functions in many languages, marking nouns as masculine or feminine. Second, it can be considered to be the process of making distinctions and the ensuing consequences of these distinctions as they impact and form identity, agency, and the place of the body within the social sphere. Gender, as it is considered in *The Fabric of Interface*, develops from both of these possibilities, not only signifying cultural distinctions of masculinity and femininity and their sociopolitical applications for regulating public and private spheres, but also serving as the linchpin in this book’s exploration of the relationship between material production and social action. The body is at the center of this operation much as it is in critical explorations of gender and sexuality such as Judith Butler’s *Bodies That Matter*, insofar as the material expression of sexual difference and the materiality of the body are considered here as they intersect with contemporary media forms and structures. Butler speaks of a “process of materialization” in regard to sex and gender as social entities, one that “stabilizes over time to produce the effect of boundary, fixity, and surface we call matter.”³³ Elsewhere, she has argued that “if a true gender is a fantasy instituted and inscribed on the surface of bodies, then it seems that genders can be neither true nor false, but are produced as the truth effects of a discourse of primary and stable identity.”³⁴ The relationships between bodies and these truth effects have been the object of study of Elizabeth Grosz, who has endeavored to tease out the connections across gender, body, and space. Building on feminist scholarship on the political role of the gendered body from Simone de Beauvoir to Iris Marion Young, Grosz asserts that “patriarchal oppression ... justifies

itself, at least in part, by connecting women much more closely than men to the body." In this way, "women's corporeal specificity is used to explain and justify the different (read: unequal) social positions and cognitive abilities of the two sexes."³⁵

The argument elaborated here builds on existing theorizations of the relationship between the performativity of the body and the circulation of gender by describing the interface's relationship to gender at the levels of material design, physical interaction, and software coding. The way gender is regulated through these, how it is represented and performed, are among the most prominent and significant of the discursive effects raised by Butler and explored by Grosz. Indeed, contemporary hardware and software's frequent need for regular bodily intervention to function effectively would suggest that the human body itself may act as their interface within this context. This book therefore extends the important theoretical discussions of technology, gender, race, and identity already undertaken by scholars including Wendy Hui Kyong Chun, Lisa Nakamura, Donna Haraway, N. Katherine Hayles, and others, which—invoked in the pages that follow—have important implications for gender studies.

It is also imperative to point out that there is a significant racial component to the gendering of both craft culture and media's materiality and processes. For example, quilting took on particular importance among African American women in the nineteenth century as a means to make inexpensive blankets by sewing together scraps from worn garments as well as a means of building and preserving family and historical narratives in the face of politically enforced low literacy rates. Similarly, industrial assembly in the electronics industry has relied on the work of women of color, from the first digital computer with memory, which was hand-strung by an African-American woman technician in MIT's Lincoln Laboratory, to the latest smartphones put together by women in assembly houses scattered from China to Malaysia. While not the focus of this book, the role of race is considered at key points, building on the important work already done by Chun and Nakamura, among others.

Existing Threads

Mobility and tactility are central components of the processes to be described and analyzed here. The proliferation of small, networked, touchscreen

devices has produced dramatic changes not only in how we use devices and networks, but also where, when, and why. As recently as 1998, for example, computer scientist David Gelernter described a very different environment in musing on digital media design:

Portable computers are easy to carry around, but it's likely to be quite a while before you can stuff one in your briefcase or coat pocket as nonchalantly as you can a sheaf of papers. ... You can work with papers when you are sprawled on a sofa, sitting on a beach, riding a subway, having coffee at a lunch counter, lying in bed unable to sleep at three in the morning, meeting with a dozen colleagues at a conference table and ostensibly examining the budget report. ... Yes, you *could* use a portable computer in all these circumstances, but it's a pain and few people do. Computerized files inevitably give something up to paper ones in portability, and that is likely to remain true for some time.³⁶

Two decades into the twenty-first century, Gelernter's view appears comically myopic. Of course, this eventually becomes the case with most writing about technology, but it is worth noting that the Internet, cell phones, and handheld computing devices such as Apple's Newton and Palm's PalmPilot already were commercially available and in use when Gelernter made his remarks. His description demonstrates not only the difficulty of imagining large-scale portable networked computing in the late 1990s, but also the difficulty of conceiving of such computing except in terms of work and business (e.g., meetings and budget reports). By contrast, today's portable digital devices and their social media applications represent a brave new world.

While contemporary mobile media and their interfaces have become basic to everyday life in many parts of the world, critical inquiries into the social and historical origins of their formal logic and material attributes have lagged. Studies often privilege instead the transformative effects of their use. Though there have been some important exceptions—including work by Adrian Mackenzie, Tung-Hui Hu, Jonathan Sterne, and Matthew Fuller and Andrew Goffey, in addition to that of Chun, Galloway, Gitelman, and Hookway—many studies emphasize what digital objects and interfaces facilitate or produce (e.g., networks, data, social systems) rather than scrutinize their appearance, construction, and formatting.³⁷ Unlike the outlook of this book, existing research into the form and function of mobile media, software, and interface often also emphasizes movement and locativity—whether physical or imagined—as guiding properties tied

to navigational, spatial, topological, and cartographic conceptualizations of interface and data exchange.³⁸ This bias toward structures of space and motion can reinforce the primacy of visual processes and effects traditionally coded as masculine—travel, exploration, route-finding, mapmaking, systems-building—in the development of these technologies and their use. Mobile media design researchers Frank Bentley and Edward Barrett, for example, claim that two of the three principal features of a mobile device are “always-available connection to others” and “sensing and capturing environments” within which the device circulates.³⁹ Despite the success of GPS and location-based social media such as Tinder, Grindr, and Four-square, mobile media are never always mobile and much of what is done on them is not dependent on locativity. As portable media that often involve long periods of stationary user engagement, they are as much—or indeed more—about sedentary and intricate or repetitive tasks, as analogous to the handloom and quilting frame as they are to the compass, lens, or transmitter for visualizing, interacting with, or traversing space. For every minute a device is used to understand or interact with one’s environment, there are likely to be many more where it is employed in watching videos, playing games, updating social media accounts, shopping, and reading the news.⁴⁰

This book similarly challenges competing narratives of networked media use that situate the manipulation and recombination of digital data within a pedigree of modernist avant-garde remix practices such as collage, assemblage, and montage.⁴¹ For example, in his contribution to *The New Media Reader* (an early and important collection on digital culture), Lev Manovich identifies in that book’s contents a “notion of parallel developments in modern art and in computing.”⁴² He prescribes a list of propositions for new media that includes “new media as the encoding of modernist avant-garde” and “new media as parallel articulation of similar ideas in post-WWII art and modern computing.” Accordingly, Manovich claims, “new media indeed represents the new avant-garde, and its innovations are at least as radical as the formal innovations of the 1920s,” yet this new avant-garde is also post-media since it “is no longer concerned with seeing or representing the world in new ways but rather with accessing and using in new ways previously accumulated media.”⁴³

More recently, Eduardo Navas has taken a similar stance in his theory of digital culture as remix. For Navas, remixing describes common operations

of creative expression emerging at the turn of this century, such as music sampling, mash-ups, and photo memes. He ties these to the avant-garde “as a cultural example in which remixing is at play explicitly on two layers that [he] define[s] as the framework of culture”—namely, the introduction of material and the process of producing value: “Social media relies on the framework of culture to develop a new type of economy. ... Historically, creative production appears to resist established patterns of production, but eventually is sublated by cultural economies and becomes vital to capital as a whole.”⁴⁴ While Navas’s views on the absorption of culture resonate with the claims and examples in this book, his comparison of avant-garde tactics and everyday personal communication—as with Manovich’s—raises more questions than it answers.

The problem with these formulations is twofold. First, they would suggest that the everyday user activity of putting together materials is guided by a similar, conscious effort to subvert existing power structures, even if this work is entirely inscribed within, and only possible through, the continued functioning of the technological manifestations of those structures. Although such subversion can be the object in specific cases, the comparison distorts the nature and aim of most networked assemblage activity on mobile devices (for example, using filters on social media photos), where assembly emerges as a conventional and conformist practice. Second, these formulations find novelty in processes of reuse, modification, and compositing that in many ways reflect and follow longstanding domestic practices of craft culture and handicraft’s reliance on reusable and recyclable materials more closely than they do the countercultural aesthetic tactics of avant-garde movements. While sharing a belief in contemporary media’s reliance on sampling and mixing, this book highlights this digital flexibility’s compelling similarities to the “lower” (yet far more widely practiced, particularly among women) popular arts that constitute textile and needlecraft culture. Although they come closer to this book’s interest in the digital’s relationship to sedentary, absorptive material practices, references to the avant-garde—sometimes inflected with industrial overtones—perpetuate masculinizing narratives of technology and practice through their emphasis on a modernist history of art, photography, and film that was partially constructed on a distinction between elite culture and the history and aesthetics of craft.⁴⁵ While avant-garde movements may have contributed to some aspects of network culture, particularly among its earliest

practitioners, far more familiar, popular cultural practices lie behind much of today's networked, digital interactivity.

In addition to the examples provided here of Bratich and Brush and Minahan and Cox, other researchers have pointed out links between digital culture and craft practices on occasion. This was particularly so in the 1990s, as the rise of the Internet produced any number of software practices diverging from previous norms. Asking "What kind of patroness would suit this virtual world of the net and the web?" Eric McLuhan nominated the weavers of Greek mythology, Arachne and Penelope, to represent the decentralized scope and endless production of digitally networked living.⁴⁶ Malcolm McCullough found a close relationship between interactive computing and craft in his *Abstracting Craft: The Practiced Digital Hand*. "In digital production, craft refers to the condition where people apply standard technological means to unanticipated or indescribable ends," he explains. "Works of computer animation, geometric modeling, and spatial databases get 'crafted' when experts use limited software capacities resourcefully, imaginatively, and in compensation for the inadequacies of prepackaged, hard-coded operations."⁴⁷ While McCullough makes important claims about the role of the hand—typically grasping a mouse, at the time he wrote—his idea of craft is based on the tradition of craftsmanship and the craftsman. It is of the workshop and the guild, not of the woman occupied with the domestic labor of the home. His contribution serves as a reminder that "craft" is a notoriously ambivalent word, applicable to diverse and sometimes opposite situations.⁴⁸ In this book, craft is not the historically superior cultural form of the craftsman, but emphatically the "inferior" form of production that has been called craft because it has been deemed unskilled, intellectually vacant, or of little economic value.

Working during the same period, Brenda Danet drew a correspondence between the techniques of making and sharing images in Internet Relay Chat (IRC) and crafts, explaining that the synchronous, collaborative aspect of chat rooms aligns with ideas of folk art. Danet likened IRC images built from typed characters to the stitch-based crafts of embroidery and needlepoint, not only because of their appearance, but also because of the hours it would take constructing an image from individual keystrokes. The collective sharing and display of these images in chat rooms borrows from techniques of quilting and the social process of the quilting bee.⁴⁹ "The analogy with quilting is especially apt because quilting is more often a

social activity, at least in part ... and because [IRC] images often resembled those of quilts," Danet states.⁵⁰

Sadie Plant's *Zeroes + Ones: Digital Women and the New Technoculture* and Jack Bratich's "The Digital Touch: Craft-Work as Immaterial Labour and Ontological Accumulation," in addition to Bratich and Brush's "Fabricating Activism: Craft-Work, Popular Culture, Gender" and Minahan and Cox's "Stitch'nBitch: Cyberfeminism, a Third Place and the New Materiality," are perhaps the most compelling texts in regard to textile crafts and digital culture, however. Each of these engages the relationship between digital culture and textiles and handicrafts as it pertains to matters of gender, power, and agency.⁵¹ All four are treated in greater detail in the pages that follow, but it is worth pointing out now how each diverges from the present study in significant ways. Plant's work lays down a feminist interpretation of computing as a weaving process, emphasizing the role of Augusta Ada King, Countess of Lovelace, in the early development of digital and information theory. It is significant as a theoretical exploration that undoes much of the historical record and "common sense" that had surrounded digital culture and masculinity. Yet it also extends that exploration in ways that lead away from materialist readings of technology. Also, because it was published in 1997, many of its assertions are less applicable to the tactile, networked mobile media and digital image environment at the center of this book. Plant's claims therefore are more useful in consideration of the history of computing, but less vital when measured against the major cultural changes in digital media use in this century. The work of Bratich and Brush and Minahan and Cox, on the other hand, emerges from these changes. They are on the mark in their comparisons of textile and digital practices, particularly in linking immaterial digital labor to an underlying communicative, immaterial component of textile-based craftwork. However, they do not bring this to bear on the mechanics of media use in any sustained way, nor do they address the larger question of mobile media's relationship to gender as embodied practice, as is the case here. In their focus on the historical and theoretical components of the relationships among digital culture, gender, and textile crafts, other areas—such as material practices and design issues—remain underexplored.

Pattern of the Book

Four points orient the structure and progression of *The Fabric of Interface*. They roughly correspond to its four chapters. The first point is that the history of computing has always relied on the sort of gendered labor that this book associates with, and identifies within, contemporary interfaces. The second is that understandings of the digital image as being of a different nature than images of the past have contributed to particularly gendered aspects of contemporary interfaces. This is significant in our increasing reliance on the image as a communicative and social tool. The third point is that the physical gestures and networked repercussions of contemporary, image-based interfaces mimic those of gendered textile work, suggesting deeper social and economic correspondences between often exploitative needle-based assembly and networked, immaterial labor. The last point is that ingrained beliefs in gender differences surrounding the senses produce value judgments about technology use and what constitutes a successful interface. In particular, these beliefs contribute to negative connotations of haptic interactivity. Let us consider how these points unfold in their respective chapters.

Chapter 1 establishes historical links across textiles, gender, and computing by tracing the role of needlecraft and textile techniques in the production of hardware and software from their conception in the nineteenth century through twentieth-first-century globalized electronics industries. It explains how Joseph Marie Jacquard's industrial loom apparatus of the early nineteenth century relied on complex weaving sequences—often to produce fabrics bearing elaborate images—that were stored on punched cards read by the loom's rods. Serving as a primitive form of computing memory, the stack of attached cards need only have been loaded into the mechanism to produce the textile. The introduction of such programs allowed quick, accurate, and repeated production of intricate weaves, obviating the need for highly paid, skilled weavers and opening the door to the increased presence of women as loom tenders, a trend noted by computing pioneer Charles Babbage. In 1843, Ada Lovelace—often considered the first computer programmer—wrote that Babbage's own Analytical Engine “weaves algebraic patterns just as the Jacquard-loom weaves flowers and leaves.”⁵² Babbage saw the punched-card programs of the loom as the key to

programming computing machines, and articulated his invention through the language of textile manufacture.

While punched cards had facilitated automated weaving and the origins of computing, more sophisticated twentieth-century computers relied on hand weaving to create the hardware behind their versatility. At MIT's Lincoln Laboratory and later at IBM plants in North America and Asia, women produced computer memory by interlacing metal filaments through small magnetic rings called "cores." These fabrics of memory followed the principles of on-loom bead weaving by locking each core into the grid of filaments through multiple threading, in this case of driving, sensing, and inhibiting wires. A similar process was behind the production of the Apollo space program's memory, when NASA hired retired women textile workers to weave rope memory for space capsule navigation systems. Even in the shift to total plant production of semiconductor-based memory in the 1960s—first in the western United States, then Asia—women remained responsible for hardware assembly, soldering integrated circuit boards and microchips. Assembly houses in Southeast Asia have relied primarily on low-paid female hand labor often drawn from textile manufacturing or trained in domestic handicraft, raising important questions about gender and manual labor (as well as race) in "pre-tactile" digital culture.

Chapter 2 examines the influence of textile culture on the defining role that images play in contemporary digital media. It considers textual and visual discourses around the digital image that position it as a malleable fabric across its production, access, and use. Beginning with the construction of the image itself, this chapter draws analogies between the screen device and the handloom or quilting frame as the physical structure upon which images are manipulated individually and in patterned series. Each digital image's material instantiation and visual presence exists as a raster grid of picture elements (pixels) displayed on the screen's patterned weave of diodes. Stored in long strands of binary code, the image is only visible when these strands pass through a microprocessor. Accordingly, every digital image may be understood as a performance of weaving that ends only when the file is closed or the screen is darkened. In multi-image displays, software algorithms regularly arrange images in vertical and horizontal patterns according to their shape and content, much as a quilter arranges blocks on a frame.

These characteristics of digital imagery set it in opposition to understandings of analog photographic images developed in nineteenth-century positivist—and twentieth-century modernist—discourses. Yet the early history of photography closely links the medium's processes of image making to computational thinking through the material and metaphor of the textile. Exploring that history reveals that negative-positive photography inventor William Henry Fox Talbot's interest in fabrics as a primary photographic subject able to demonstrate his invention's properties brought photography into the gridlike structure and cultural logic of digital image production and display at the medium's earliest moments.

Consideration of the basics of digital image-processing systems reveals the continuing, explicit use of concepts of textile assemblage in the manipulation of files to create an integrated visual fabric. "Image stitching" and "image quilting" employ algorithms to produce "seamless" images, whether by joining fragments into a whole (as in a series of photos of partial views of a landscape) or by taking a single image pattern, multiplying it, then assembling these pieces of visual material into a larger image. Such processes—essential to building virtual visual environments—recognize the photograph as a patterned swatch that, when combined with other patterned swatches in particular ways, can produce further patterns prompting differing visual and perceptual experiences. These developments mark a gendered discursive shift in the conversion from film-based to digital imagery as the language of mechanical assembly common to film production—splicing and compositing—is replaced by the feminized language of sewing and quilting.

Recent interfaces for accessing stored digital images, such as infinite scroll, extend the logic of swatch integration into networked processes of mobile media by arranging multiple images into a patchwork quilt. Infinite scroll—commonly found in operations such as search engine results—recalls the associative logic of nineteenth-century "album quilts" as it visualizes results aggregated from distributed networks in an ever-lengthening whole as users scroll down a display. "Stitched" together as it is extended by the user, this length of interlocking images can be restitched in turn into new layouts simply by modifying search parameters.

Chapter 3 considers the relationship between the digital labor of networked, mobile media assemblage practices (such as liking, linking, and tagging) and earlier forms of collective, "mobile" production such as quilting

bees and textile industry piecework. It explores similarities between the interactive, integrative practices of contemporary digital devices and their networked users, on the one hand, and the aims and mechanics of sewing and needlework, on the other. Correspondences between these are embodied in the multiple, basic operations of contemporary interfaces, social media platforms, and casual game apps, where matching and arranging material is a common activity. Such processes of contemporary digital culture parallel the quilting bee or other social groups created out of networked patterns of labor, and are marketed to users through a rhetoric of “groups” or “communities” rather than “organizations” or “networks.” Immaterial, affective digital labor blurs the line between work and leisure in ways common to textile and handicraft culture, which often takes place amid other domestic responsibilities and tasks, such as cooking and childcare. In contrast to the algorithmically generated patterns studied in chapter 2, these activities bear a closer resemblance to the gendered labor structures presented in chapter 1 and represent a new phase of the “home economy” of gendered digital production. Their affinities to women’s work permit intermittent and frequent interactions with the device and network that—despite their brevity—are monetized by network platforms with little or no remuneration for users. Yet they also lead to critiques of social media and casual game use as little more than frivolous, unproductive distractions.

Chapter 4 incorporates the findings of the preceding chapters into an assessment of the role of gender and sensory distinctions in contemporary mobile media. It considers the consequences of the parallels established across textile, needlecraft, and digital culture in relation to wider gender structures around work, embodiment, and visibility. Beginning with two historical binaries of mind and body, and sight and touch, as these have been deployed in the ideological exercise of gender as a sociopolitical tool, it demonstrates how both have influenced understandings of mobile touchscreen media and their use in diverse social contexts. Handheld devices with tactile interfaces connote intimacy, moving from the desktop to the lap or pocket, from the office to the living room or bedroom. Patchwork, haptic interface techniques of *bricolage* accompany these shifts. This convergence of intimacy and handiwork at the screen interface, coupled with the textile aesthetics mentioned earlier, genders networked culture and activity in unexpected ways. By obliging touchscreen users to direct their eyes downward to the screen, for example, the proliferation of these

activities in public spaces and collective societal contexts—from the coffee shop to the street—can challenge the forward, upright, masculinized gaze that has historically constructed and dominated these environments. Construed as distraction and disruption, these activities seem to undermine the idealized “open,” face-to-face contact of the public sphere. Amid this potential threat, virtual reality (VR) systems, and the totalizing view they promise, have reemerged as an area of consumer technology development after lying relatively dormant for nearly two decades. This chapter considers hands-free, vision-based augmented reality (AR) and VR systems such as Google Glass, Google Cardboard, and Oculus Rift—and the rhetoric surrounding them of a return of agency—as a presumed next step in networked media. While these technologies may estrange users from their immediate physical and social environments, they nevertheless offer the illusion of a retrieved, unimpeded gaze, where the interface seems to disappear. What such developments illustrate is the extent to which gender may enter—explicitly or not—into the design and use of devices and software, regardless of the content these technologies may contain or convey. This realization not only underlines the importance of investigating computing’s extensive ties to activities of textile and needlecraft culture historically gendered as feminine, but also demonstrates the larger need to reconsider the social consequences of hardware and software design itself.

Notes

Introduction

1. See, for example, numerous essays collected in Gail Dines and Jean M. Humez, eds., *Gender, Race, and Class in Media: A Critical Reader*, 3rd ed. (Thousand Oaks, CA: SAGE, 2011); Mary Celeste Kearney, ed., *The Gender and Media Reader* (New York: Routledge, 2011); and Niall Richardson and Sadie Wearing, *Gender in the Media* (Basingstoke: Palgrave Macmillan, 2014). Since most TV series, films, games, and even greeting cards are distributed through digital networks accessible to mobile media, nearly any treatment of gender in contemporary media content implicitly concerns mobile media content.

2. Jay Bolter and Diane Gromala, *Windows and Mirrors: Interaction Design, Digital Art, and the Myth of Transparency* (Cambridge, MA: MIT Press, 2003), 27.

3. Esquire Editors, "Are You Man Enough for a Pink iPhone 6s?," *Esquire*, September 26, 2015, <http://www.esquire.com/lifestyle/cars/news/a38262/new-iphone-6s-colors/> (accessed January 7, 2017).

4. Lisa Gitelman, *Always Already New: Media, History, and the Data of Culture* (Cambridge, MA: MIT Press, 2006), 7.

5. Another, related path of exploration might be networked mobile media's ties to telephony and the gendered labor and communicative practices that have marked that medium's history.

6. See Andrew Butterfield, Gerard Ekembe Ngondi, and Anne Kerr, eds., *A Dictionary of Computer Science*, 7th ed. (Oxford: Oxford University Press, 2016). Additional examples can be found in Jack Bratich, "The Digital Touch: Craft-Work as Immaterial Labour and Ontological Accumulation," *Ephemera* 10, no. 3–4 (2010): 303.

7. For example, while this book draws an analogy between the mobile screen and the handloom, Francesco Casetti suggests the metaphor of the scrapbook is apt, since networked users "construct images of themselves in the first person, by

assembling photos, texts and comments often lifted from elsewhere.” The frequent use of the term “cutting and pasting” to describe such activities would support his choice. See Francesco Casetti, “What Is a Screen Nowadays?,” in *Public Space, Media Space*, ed. Chris Berry, Janet Harbord, and Rachel O. Moore (Basingstoke: Palgrave Macmillan, 2013), 26.

8. Lisa Gitelman’s work is an important example here, as she has sought to dissolve the false, and sometimes arbitrary, divides that rise between old and new media. See Lisa Gitelman and Geoffrey B. Pingree, eds., *New Media, 1740–1915* (Cambridge, MA: MIT Press, 2003); and Lisa Gitelman, *Always Already New: Media, History, and the Data of Culture* (Cambridge, MA: MIT Press, 2006).

9. Stella Minahan and Julie Wolfram Cox, “Stitch’nBitch: Cyberfeminism, a Third Place and the New Materiality,” *Journal of Material Culture* 12, no. 1 (2007): 6. Emphasis in original.

10. Alissa Haight Carlton and Kristen Lejnieks, *Block Party: The Modern Quilting Bee* (Lafayette, CA: C&T Publishing, 2011), 9.

11. Bratich, “The Digital Touch,” 307.

12. The Craftivist Collective (<https://craftivist-collective.com/>) is an example.

13. Kirsty Robertson explores the paradox of craftivists using online media in “Rebellious Doilies and Subversive Stitches: Writing a Craftivist History,” in *Extra/Ordinary: Craft and Contemporary Art*, ed. Maria Elena Buszek (Durham, NC: Duke University Press, 2011), 184–203.

14. James Bridle, “The New Aesthetic and Its Politics,” June 12, 2013, <http://booktwo.org/notebook/new-aesthetic-politics/> (accessed January 7, 2017).

15. <http://www.microrevolt.org/knitPro/>.

16. <http://www.spritestitch.com>.

17. Richard Trenholm, “Wearables at War: How Smart Textiles Are Lightening the Load for Soldiers,” CNet, March 11, 2015, <https://www.cnet.com/news/wearables-at-war-how-smart-textiles-are-lightening-the-load-for-soldiers/> (accessed January 7, 2017).

18. For the technical side of these fabrics, see Gilsoo Cho, ed, *Smart Clothing: Technology and Applications* (Boca Raton: CRC Press, 2010); the social uses and implications of smart clothing are considered in Susan Elizabeth Ryan, *Garments of Paradise: Wearable Discourse in the Digital Age* (Cambridge, MA: MIT Press, 2014).

19. Johanna Drucker, *Graphesis: Visual Forms of Knowledge Production* (Cambridge, MA: Harvard University Press, 2014), 8.

20. Branden Hookway, *Interface* (Cambridge, MA: MIT Press, 2014), 16.

21. Wendy Hui Kyong Chun, *Programmed Visions: Software and Memory* (Cambridge, MA: MIT Press, 2011), 66–67. Here Chun is drawing on descriptions of ideology by Friedrich Engels and Louis Althusser.
22. Drucker, *Graphesis*, 146.
23. Christian Ulrik Andersen and Søren Bro Pold, “Interface Criticism: Aesthetics Beyond Buttons,” in *Interface Criticism: Aesthetics Beyond Buttons*, ed. Christian Ulrik Andersen and Søren Bro Pold (Aarhus: Aarhus University Press, 2011), 9.
24. Alexander R. Galloway, *The Interface Effect* (Malden, MA: Polity, 2012); and Hookway, *Interface*.
25. Galloway, *The Interface Effect*, vii–viii; Hookway, *Interface*, 6–7.
26. Galloway, *The Interface Effect*, vii.
27. Hookway, *Interface*, ix.
28. *Ibid.*, 39–40.
29. *Ibid.*, ix.
30. Andersen and Pold, “Interface Criticism,” 7. See also Dragana Antic and Matthew Fuller, “The Computation of Space,” in *Interface Criticism*, ed. Andersen and Pold: 130–142.
31. This points to not only the biopolitics of Michel Foucault, but also Henri Lefebvre’s theory of space as social production in and of itself. Both of these theories have contributed to the perspective and approach of this book. See Michel Foucault, *Discipline and Punish: The Birth of the Prison*, trans. Alan Sheridan (New York: Vintage, 1995); and Henri Lefebvre, *The Production of Space*, trans. Donald Nicholson-Smith (Oxford: Blackwell, 1991).
32. Malcolm McCullough, *Ambient Commons: Attention in the Age of Embodied Information* (Cambridge, MA: MIT Press, 2015).
33. Judith Butler, *Bodies That Matter: On the Discursive Limits of Sex* (New York: Routledge, 1993), 9.
34. Judith Butler, *Gender Trouble: Feminism and the Subversion of Identity* (New York: Routledge, 1990), 136.
35. Elizabeth Grosz, *Volatile Bodies: Toward a Corporeal Feminism* (Bloomington: Indiana University Press, 1994), 14. See also Simone de Beauvoir, *The Second Sex*, trans. Constance Borde and Sheila Malovany-Chevallier (London: Jonathan Cape, [1949] 2009); and Iris Marion Young, “A Phenomenology of Feminine Body Compartment Motility and Spatiality,” *Human Studies* 3, no. 2 (1980): 137–156.
36. David Gelernter, *Machine Beauty: Elegance and the Heart of Technology* (New York: Basic Books, 1998), 89. Emphasis in original.

37. Wendy Hui Kyong Chun, *Control and Freedom: Power and Paranoia in the Age of Fiber Optics* (Cambridge, MA: MIT Press, 2006); Wendy Hui Kyong Chun, *Updating to Remain the Same: Habitual New Media* (Cambridge, MA: MIT Press, 2016); Matthew Fuller and Andrew Goffey, *Evil Media* (Cambridge, MA: MIT Press, 2012); Alexander R. Galloway, *Protocol: How Control Exists after Decentralization* (Cambridge, MA: MIT Press, 2004); Lisa Gitelman, *Paper Knowledge: Toward a Media History of Document* (Durham, NC: Duke University Press, 2014); Hookway, *Interface*; Tung-Hui Hu, *A Prehistory of the Cloud* (Cambridge, MA: MIT Press, 2015); Adrian Mackenzie, *Cutting Code: Software and Sociality* (New York: Peter Lang, 2006); and Jonathan Sterne, *MP3: The Meaning of a Format* (Durham, NC: Duke University Press, 2012).

38. Examples include Eric Gordon and Adriana de Souza e Silva, eds., *Net Locality: Why Location Matters in a Networked World* (Malden, MA: Wiley-Blackwell, 2011); Rob Kitchin and Martin Dodge, eds., *Code/Space: Software and Everyday Life* (Cambridge, MA: MIT Press, 2011); Jason Farman, *Mobile Interface Theory: Embodied Space and Locative Media* (New York: Routledge, 2012); Nanna Verhoeff, *Mobile Screens: The Visual Regime of Navigation* (Amsterdam: Amsterdam University Press, 2012); and Marianne Van Den Boomen, *How Metaphors Matter in New Media: Transcoding the Digital* (Amsterdam: Amsterdam University Press, 2015).

39. Frank Bentley and Edward Barrett, *Building Mobile Experiences* (Cambridge, MA: MIT Press, 2012), 7.

40. See Joe Marshall and Paul Tennent, "Mobile Interaction Does Not Exist," in *CHI2013 Changing Perspectives: Extended Abstracts: The 31st Annual CHI Conference on Human Factors in Computing Systems*, ed. Patrick Baudisch, Michel Beaudouin-Lafon, and Wendy E. Mackay (New York: Association for Computing Machinery, 2013), 2069–2078.

41. Among these are Lev Manovich, *The Language of New Media* (Cambridge, MA: MIT Press, 2001); Lev Manovich, *Software Takes Command* (London: Bloomsbury, 2013); Noah Wardrip-Fruin and Nick Montfort, eds., *The New Media Reader* (Cambridge, MA: MIT Press, 2003); and Eduardo Navas, *Remix Theory: The Aesthetics of Sampling* (New York: Springer, 2012).

42. Lev Manovich, "New Media from Borges to HTML," in *The New Media Reader*, ed. Noah Wardrip-Fruin and Nick Montfort (Cambridge, MA: MIT Press, 2001), 16.

43. *Ibid.*, 22–23.

44. Eduardo Navas, "Culture and Remix: A Theory on Cultural Sublation," in *The Routledge Companion to Remix Studies*, ed. Eduardo Navas, Owen Gallagher, and xtine burrough (New York: Routledge, 2014), 116.

45. Bruce Metcalf, "Replacing the Myth of Modernism," in *Neo-Craft: Modernity and the Crafts*, ed. Sandra Alfody (Halifax: Press of the Nova Scotia College of Art and Design, 2007), 4–32.

46. Eric McLuhan, "Arachne or Penelope: Queen of the Net, Mistress of the Web?," chap. 1 in *Electric Language: Understanding the Present* (Toronto: Stoddart, 1998), 7.
47. Malcolm McCullough, *Abstracting Craft: The Practiced Digital Hand* (Cambridge, MA: MIT Press, 1996), 21–22.
48. Another example of such an understanding of craft would be the call to "flexible specialization" through "craft forms of production" in Michael J. Piore and Charles F. Sabel, *The Second Industrial Divide: Possibilities for Prosperity* (New York: Basic Books, 1984), 17.
49. Brenda Danet, *Cyberpl@y: Communicating Online* (Oxford: Berg, 2001), 243–244 and 257–258.
50. *Ibid.*, 244.
51. Sadie Plant, *Zeroes + Ones: Digital Women and the New Technoculture* (New York: Doubleday, 1997); Bratich, "The Digital Touch"; Jack Bratich and Heidi Brush, "Fabricating Activism: Craft-Work, Popular Culture, Gender," *Utopian Studies* 22, no. 2 (2011): 233–260; and Minahan and Cox, "Stitch'nBitch."
52. L. F. Menabrea, "Sketch of the Analytical Engine Invented by Charles Babbage, Esq.," trans. Ada Lovelace, in *Scientific Memoirs, Selected from the Transactions of Foreign Academies of Science and Learned Societies, and from Foreign Journals*, vol. 3, ed. Richard Taylor (London: Richard and John E. Taylor, 1843), 696. Emphasis in original removed.

1 Woven Memory

1. There are scores of examples. To provide a few: M. V. Wilkes, *Automatic Digital Computers* (London: Methuen, 1956), 6–9; Albert Paul Malvino and Donald P. Leach, *Digital Principles and Applications*, 2nd ed. (New York: McGraw-Hill, 1975), 1–3; René Moreau, *The Computer Comes of Age: The People, the Hardware, the Software*, trans. J. Howlett (Cambridge, MA: MIT Press, [1981] 1984), 13–14; Martin Campbell-Kelly and William Aspray, *Computer: A History of the Information Machine* (New York: Basic Books, 1996), 55–57; James Essinger, *Jacquard's Web: How a Hand-Loom Led to the Birth of the Information Age* (Oxford: Oxford University Press, 2004); Neil Barrett, *The Binary Revolution: The Development of the Computer* (London: Weidenfeld & Nicolson, 2006), 20–22; Ian Watson, *The Universal Machine: From the Dawn of Computing to Digital Consciousness* (New York: Copernicus Books, 2012), 27–28; and Joel Shurkin, *Engines of the Mind: A History of the Computer* (New York: W. W. Norton, 1984), 58–59.
2. Jacquard's invention was an improvement on less complex versions of punched-card weaving systems devised in France by Basile Bouchon in 1725 and Jacques de Vaucanson in 1745. See Eric Broudy, *The Book of Looms: A History of the Handloom*

from *Ancient Times to the Present* (Hanover, NH: University Press of New England, 1979), 134.

3. In France's brocade industry in the eighteenth century, young women sometimes performed this physically demanding job. Discussions of allowing drawgirls into weavers' guilds, however, brought resistance from master weavers of the time. See Daryl M. Hafter, "The 'Programmed' Brocade Loom and the Decline of the Draw-Girl," in *Dynamos and Virgins Revisited: Women and Technological Change in History*, ed. Martha Moore Trescott (Metuchen, NJ: Scarecrow Press, 1979), 49–66; and Daryl M. Hafter, *Women at Work in Preindustrial France* (State College: Pennsylvania State University Press, 2010), 197–198.

4. Julie Holyoke, *Digital Jacquard Design* (London: Bloomsbury, 2013).

5. George Caffentzis is one of the few scholars to make the connection. He explains: "[An] important reason for the neglect of Babbage's Engines was that neither Babbage, nor Marx, nor anyone else at the time saw the essential connection between computation and *all* forms of the labor process, even though the key was staring Babbage and Marx in the face all along. That key was the Jacquard loom." George Caffentzis, *In Letters of Blood and Fire: Work, Machines, and the Crisis of Capitalism* (Chicago: PM Press, 2013), 195.

6. This summary of the Analytical Engine's construction is based on the detailed description of its physical attributes and functioning provided in Allan G. Bromley, "Charles Babbage's Analytical Engine, 1838," *Annals of the History of Computing* 4, no. 3 (July 1982): 196–217.

7. Charles Babbage, *Passages from the Life of a Philosopher* (London: Longman, Green, Longman, Roberts, & Green, 1864), 116–117.

8. John von Neumann, "First Draft of a Report on the EDVAC," in *Great Papers in Computer Science*, ed. Phillip Laplante (St. Paul, MN: West Publishing, 1996), 211. Emphasis in original.

9. Wendy Hui Kyong Chun, "The Enduring Ephemeral, Or the Future Is a Memory," *Critical Inquiry* 35 (Autumn 2008): 154, reprinted in "The Enduring Ephemeral, Or the Future Is a Memory," in *Media Archaeology*, ed. Erkki Huhtamo and Jussi Parikka, 188. See also Gerd Gigerenzer and Daniel G. Goldstein, "Mind as Computer: Birth of a Metaphor," *Creativity Research Journal* 9, no. 2–3 (1996): 131–144.

10. Hannah B. Higgins, *The Grid Book* (Cambridge, MA: MIT Press, 2009), 240.

11. Ada Lovelace has been a leading figure in histories and theories of computing developing out of 1990s cyberfeminism. Sadie Plant made Lovelace's life and work the organizing trope in *Zeroes + Ones: Digital Women and the New Technoculture* (New York: Doubleday, 1997), her theorization of the relationship between gender and technology. Alex Galloway has called this the "recuperationist school" of cyberfeminism, which highlights the achievements of Lovelace and subsequent women in

computing, such as the twentieth-century American computer developer Grace Hopper. See Alex Galloway, "A Report on Cyberfeminism: Sadie Plant Relative to VNS Matrix," *Switch* 4, no. 1, <http://switch.sjsu.edu/web/v4n1/alex.html> (accessed January 7, 2017). In this chapter Lovelace is most significant for her cultural interpretation of the Analytical Engine, all the more important given her work on its programming. Because this study concerns gendered popular culture and labor practices as they have impacted the design and function of contemporary digital devices and interfaces, however, the individual roles played by many women in computing history have largely been set aside. For those pivotal contributions, see Janet Abbate, *Recoding Gender: Women's Changing Participation in Computing* (Cambridge, MA: MIT Press, 2012); and Autumn Stanley, *Mothers and Daughters of Invention: Notes for a Revised History of Technology* (Metuchen, NJ: Scarecrow Press, 1993), 642–745.

12. L. F. Menabrea, "Sketch of the Analytical Engine Invented by Charles Babbage, Esq.," trans. Ada Lovelace, in *Scientific Memoirs, Selected from the Transactions of Foreign Academies of Science and Learned Societies, and from Foreign Journals*, vol. 3, ed. Richard Taylor (London: Richard and John E. Taylor, 1843), 696. Emphasis in original.

13. *Ibid.*, 698.

14. Kax Wilson, *A History of Textiles* (Boulder, CO: Westview Press, 1979), 263.

15. See Anne Isabella Byron's journal entry of July 17, 1834—in which she illustrates the punched-card system of a Coventry mill and describes the child labor conditions there—as reproduced in Essinger, *Jacquard's Web*, 138–139.

16. Menabrea, "Sketch of the Analytical Engine Invented by Charles Babbage, Esq.," 706. Emphasis in original.

17. Natalie Rothstein, "The Introduction of the Jacquard Loom to Britain," in *Studies on Textile History: In Memory of Harold B. Burnham*, ed. Veronika Gervers (Toronto: Royal Ontario Museum, 1977), 282.

18. Joy Spanabel Emery, *A History of the Paper Pattern Industry: The Home Dressmaking Fashion Revolution* (London: Bloomsbury Academic, 2014), 19–28.

19. Tim Putnam, "The Sewing Machine Comes Home," in *The Culture of Sewing: Gender, Consumption, and Home Dressmaking*, ed. Barbara Burman (Oxford: Berg, 1999), 269. See also Ruth Brandon, *A Capitalist Romance: Singer and the Sewing Machine* (Philadelphia: Lippincott, 1977).

20. For this history, see Kevin L. Seligman, *Cutting for All!: The Sartorial Arts, Related Crafts, and the Commercial Paper Pattern* (Carbondale: Southern Illinois University Press, 1996); and Emery, *A History of the Paper Pattern Industry*.

21. Essinger's book-length examination of Jacquard, his apparatus, and their impact on computing, for example, makes no mention of the invention's more immediate social or economic ramifications. Essinger, *Jacquard's Web*.

22. Wilson, *A History of Textiles*, 63.
23. Jennifer Harris, "A Survey of Textile Techniques," in *5,000 Years of Textiles*, ed. Jennifer Harris (London: British Museum, 1993), 19; and William Felkin, *History of the Machine-Wrought Hosiery and Lace Manufacturers* (Newton Abbot: David & Charles, [1867] 1967), 324–343. Natalie Rothstein notes that the Jacquard mechanism did not enter into common use in the Lyon textile industry until the 1810s. She attributes the delay to the popular preference for simple patterns and prints in early nineteenth-century Europe. Rothstein, "The Introduction of the Jacquard Loom to Britain," 284.
24. Other circumstances contributing to this social movement included the introduction of shearing frames with gig mills to automatically finish cloth and the "cut-up" technique of manufacturing knitwear. Woolen mills employing this technique would knit swathes of fabric that would then be cut and stitched in the same way as woven cloth, rather than knitting the articles directly. Cut-up assembly produced cheap, poorly finished articles that deteriorated quickly. A. L. Morton and George Tate, *The British Labour Movement* (London: Lawrence & Wishart, 1956), 36–38; and J. L. Hammond and Barbara Hammond, *The Skilled Labourer, 1760–1832* (New York: Harper & Row, [1919] 1970), 226–227 and 257–258.
25. *Annual Register* (London: Otridge and Son, 1812), 385, as quoted in Hammond and Hammond, *The Skilled Labourer*, 257. Hammond and Hammond discredit workplace gender shifts as a factor in Luddism, although homeworking women were involved in the movement. Nevertheless, Parliament's acknowledgment of gender and manufacturing suggests how remarkable such changes were at that time. For his part, Lord Byron argued in sympathy of workers involved in the protests. See Malcolm Kelsall, *Byron's Politics* (Sussex: Harvester Press, 1987), 38–51.
26. Charles Babbage, *On the Economy of Machinery and Manufactures* (London: John Murray, [1832] 1846), 336–337.
27. *Ibid.*, 341.
28. *Ibid.*, 339.
29. For an analysis of the ways automation historically has benefited the male workforce and social sphere while increasing work—particularly underpaid or unpaid work—and diminishing social opportunities for women, see Susan Strasser, *Never Done: A History of American Housework* (New York: Pantheon, 1982).
30. Judy Lown, *Women and Industrialization: Gender at Work in Nineteenth-Century England* (Minneapolis: University of Minnesota Press, 1990), 43–45.
31. For an analysis of the ideological relationship between skill and gender in labor practices, see Shirley Dex, *The Sexual Division of Labour* (Brighton: Wheatsheaf Books, 1985), 99–104 and 187–193.

32. Mary Frank Fox and Sharlene Hesse-Biber, *Women at Work* (Palo Alto, CA: Mayfield Publishing, 1984), 86. For information on collective actions, see Thomas Dublin, *Women at Work: The Transformation of Work and Community in Lowell, Massachusetts, 1826–1860* (New York: Columbia University Press, 1979), chapters 6 and 7.

33. Joel Shurkin, *Engines of the Mind: The Evolution of the Computer from Mainframes to Microprocessors* (New York: W. W. Norton, [1984] 1996), 126.

34. A particularly late example of human computers is the West Area Computing Unit of the National Advisory Committee for Aeronautics and the National Aeronautics and Space Administration. It employed many African-American women mathematicians from the 1940s into the 1960s. See Margot Lee Shetterly, *Hidden Figures: The Untold True Story of Four African-American Women Who Helped Launch Our Nation into Space* (New York: Harper, 2016).

35. David Rutland, *Why Computers Are Computers: The SWAC and the PC* (Philomath, OR: Wren, 1995), 29–30.

36. Jennifer Light, “When Computers Were Women,” *Technology and Culture* 40, no. 3 (July 1999): 455–483.

37. *Ibid.*, 471. See also W. Barkley Fritz, “The Women of ENIAC,” *IEEE Annals of the History of Computing*, 18, no. 3 (1996): 13–28.

38. The multiple strands of this development emerge in Paul E. Ceruzzi, *A History of Modern Computing*, 2nd ed. (Cambridge, MA: MIT Press, [1998] 2003); Raúl Rojas and Ulf Hashagen, eds., *The First Computer: History and Architectures* (Cambridge, MA: MIT Press, 2002); and Michael Sean Mahoney, *Histories of Computing*, ed. Thomas Haigh (Cambridge, MA: Harvard University Press, 2011).

39. Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, MA: MIT Press, 1996), 75.

40. An extensive description of the development and functioning of core memory can be found in Emerson W. Pugh, *Memories That Shaped an Industry: Decisions Leading to IBM System/360* (Cambridge, MA: MIT Press, 1984), 62–128.

41. For a detailed explanation of the configuration and operation of core memory that nevertheless remains accessible to nonspecialists, see Wilkes, *Automatic Digital Computers*, 194–209. Forrester’s description can be found in Jay W. Forrester, “Digital Information Storage in Three Dimensions Using Magnetic Cores,” *Journal of Applied Physics* 22, no. 1 (January 1951): 44–48.

42. C. Robert Weiser, “The Cape Cod System,” *Annals of the History of Computing* 5, no. 4 (October 1983): 362–369. Those working on core memory included independent inventor Frederick Viehe, Jan Rajchman at RCA Laboratories, Munro K. Haynes at IBM, and An Wang at the Harvard Computation Laboratory. Wang’s account is

available in An Wang and Eugene Linden, *Lessons: An Autobiography* (Reading, MA: Addison-Wesley, 1986), 45–61. See also Michael R. Williams, *A History of Computing Technology*, 2nd ed. (Los Alamitos, CA: IEEE Computer Society Press, 1997), 319–320; and Emerson W. Pugh, *Building IBM: Shaping an Industry and Its Technology* (Cambridge, MA: MIT Press, 1995), 209.

43. Martin Campbell-Kelly, William Aspray, Nathan Ensmenger, and Jeffrey R. Yost, *Computer: A History of the Information Machine*, 3rd ed. (Boulder, CO: Westview Press, 2014), 150.

44. William N. Papian, “A Coincident-Current Magnetic Memory Unit” (MA thesis, Massachusetts Institute of Technology, 1950).

45. Bernard Widrowitz, “The 16 by 16 Metallic Memory Array, Model 1,” Report R-216, Digital Computer Laboratory, Massachusetts Institute of Technology (September 25, 1952). The use of a single example of a 16×16 array is confirmed by Maurice Wilkes, who visited the lab in August 1952. Maurice V. Wilkes, *Memoirs of a Computer Pioneer* (Cambridge, MA: MIT Press, 1985), 181.

46. Pugh, *Memories That Shaped an Industry*, 98–99. Papian envisioned the 64×64 array in his master’s thesis, and examples were assembled by August 1953. In 1954, the lab produced 128×128 arrays and planned to attempt a 256×256 array, which would require hand-threading and orienting 65,536 cores. See Papian, “A Coincident-Current Magnetic Memory Unit”; and Pugh, *Memories That Shaped an Industry*, 127.

47. The laboratory’s Memory Section hired another woman technician, Betty Kollet, a few months later to help with testing cores. “Bi-Weekly Report,” Memorandum M-1779, Digital Computer Laboratory, Massachusetts Institute of Technology (January 2, 1953), 14 and 32; “Bi-Weekly Report,” Memorandum M-1825, Digital Computer Laboratory, Massachusetts Institute of Technology (February 9, 1953), 9; and “Bi-Weekly Report,” Memorandum M-2356, Digital Computer Laboratory, Massachusetts Institute of Technology (August 15, 1953), 14.

48. N. H. Taylor, “The Construction of Memory Planes for the MTC Memory,” Memorandum M-2225, Digital Computer Laboratory, Massachusetts Institute of Technology (June 10, 1953), 1.

49. Wilkes offers his firsthand impressions of the development of core memory from his visits to MIT between 1950 and 1953 in Wilkes, *Memoirs of a Computer Pioneer*, 181–182.

50. As quoted in the video *Quick Facts: The World’s First RAM Chip, with Inventor Bernard Widrow*, dir. Michael Whelan (Schenectady, NY: Edison Tech Center, 2009). Little more than Widrow’s reminiscence and Carpenter’s 2013 online obituary remain in the public record to document her contribution. See “Hilda Carpenter,” *Florida Times-Union*, August 23, 2013, <http://www.legacy.com/obituaries/timesunion/obituary.aspx?pid=166570014> (accessed January 7, 2017).

51. Unfortunately, there is no mention of Carpenter in Clarence G. Williams, ed., *Technology and the Dream: Reflections on the Black Experience at MIT, 1941–1999* (Cambridge, MA: MIT Press, 2001), though her obituary states that she was a long-time member of the NAACP. See “Hilda Gwendolyn Carpenter,” A. B. Coleman Mortuary, http://www.abcoleman.net/sitemaker/memsol.cgi?user_id=1067889 (accessed August 14, 2016). Carpenter continued at Lincoln Laboratory after Whirlwind. A photograph in the collection of the Computer History Museum (catalog number 102622651) documents her subsequent participation on the development team of the LINC minicomputer. See <http://www.computerhistory.org/collections/catalog/102622651> (accessed January 7, 2017).

52. Pugh recounts that when IBM began producing core memory planes “Occasionally the women assembling the core frames broke down and cried when a final inspection revealed a fault in the wiring that required the wires be removed and restrung. The emotion of seeing so much labor lost was too much for the conscientious people needed for this exacting work.” One might also consider that, in view of the tight delivery schedules, repeated faults in wiring would likely cost an assembler her job. Pugh, *Memories That Shaped an Industry*, 111–112.

53. Fellowcrafters Guild, *Easiweaving: A Pattern Book* (Boston: Fellowcrafters, 1936), i.

54. H. Atwood Reynolds, *Complete Book of Modern Crafts* (New York: Blue Ribbon Books, 1940), 223.

55. Despite core memory’s close aesthetic and material relationship to these processes, the final product would be stacked and shut away in cases in the computer room, while handloom creations were meant to be displayed, shared, and exchanged.

56. E. A. Guditz and L. B. Smith, “Vacuum and Vibration Speed Assembly of Core Memory,” *Electronics* 29, no. 2 (February 1956): 214.

57. Pugh, *Building IBM*, 177 and 207–219.

58. Michael Williams, *A History of Computing Technology* (Los Alamitos: IEEE Computer Society Press, 1997), 320.

59. Stan Augarten, *Bit by Bit: An Illustrated History of Computers* (New York: Ticknor & Fields, 1984), 257.

60. Jury E. Seleznev, Jury A. Burkin, Sergei V. Kuzmin, “Ferrite Core Memory,” U.S. 4161037 A, filed January 17, 1977, and issued July 10, 1979.

61. David R. Boles, John S. Davis, and Paul E. Wells, “Apparatus for Woven Screen Memory Devices,” U.S. 3377581 A, filed November 12, 1963, and issued April 9, 1968; J. S. Davis and P. E. Wells, “Investigation of a Woven Screen Mass Memory System,” *AFIPS* (1963): 311–326; and H. Maeda, M. Takashima, and A. J. Kolk Jr., “A

High-Speed, Woven Read-Only Memory," *AFIPS* (1965): 789–799. To avoid hand assembly, Western Electric developed "ferrite sheet" memory. A layered, meshlike product that avoided cores and bias stitching, ferrite sheet was fully adaptable to mechanized batch production. It apparently did not match the desirable combination of versatility, capacity, and speed found in core memory planes, however, and found application primarily in automated telephone switching stations, where temporary memory needs were simple, but critical. See Robert J. Chapius and Amos E. Joel, *100 Years of Telephone Switching: Electronics, Computers, and Telephone Switching, 1960–1985* (Amsterdam: IOS Press, 2003), 98.

62. Lucien V. Auletta, Herbert J. Hallstead, and Denis J. Sullivan, "Ferrite Core Planes and Arrays: IBM's Manufacturing Evolution," *IEEE Transactions on Magnetics* 5, no. 4 (December 1969): 764–774.

63. Pugh, *Memories That Shaped an Industry*, 137.

64. This was called the "Mecca wiring pattern," after the name of the task force that created it. Another, less effective array pattern reduced the array to two wires running through each core. Emerson W. Pugh, Lyle R. Johnson, and John H. Palmer, *IBM's 360s and Early 370 Systems* (Cambridge, MA: MIT Press, 1991), 186–187 and 198; and Pugh, *Memories That Shaped an Industry*, 231–233.

65. Richard Thomas DeLamarter, *Big Blue: IBM's Use and Abuse of Power* (New York: Dodd, Mead, and Company, 1986), 207.

66. Pugh, Johnson, and Palmer, *IBM's 360s and Early 370 Systems*, 208.

67. David A. Grier, *Too Soon To Tell: Essays for the End of the Computer Revolution* (Hoboken, NJ: Wiley, 2009), 91.

68. Pugh, Johnson, and Palmer, *IBM's 360s and Early 370 Systems*, 209.

69. Systems were tested for vibration, shock, acceleration, temperature, vacuum, humidity, salt fog, and electronic noise. The durability results for MIT's original configurations were disastrous, requiring a thorough redesign through which rope memory emerged as an expensive but viable option. See James E. Tomayko, "Computers in Spaceflight: The NASA Experience," in *Encyclopedia of Computer Science and Technology* 18, suppl. 3, ed. Allen Kent and James G. Williams (New York: Marcel Dekker, 1987), 40. Malvino and Leach explain, "Because of its inherent ruggedness, the core is a particularly useful logical element in applications where environmental extremes are experienced, for example, the temperature extremes and radiation exposure experienced by space vehicles." Malvino and Leach, *Digital Principles and Applications*, 331.

70. Eldon C. Hall, *MIT's Role in Project Apollo*, vol. 3 (Cambridge, MA: Charles Stark Draper Laboratory, 1972), 90–93.

71. As quoted in the video *Computer for Apollo*, dir. Russell Morash (Cambridge, MA: MIT/WGBH, 1965).

72. Tomayko, "Computers in Spaceflight," 38.
73. See David A. Mindell, *Digital Apollo: Human and Machine in Spaceflight* (Cambridge, MA: MIT Press, 2008). On the design and functioning of the guidance system, see also Paul E. Ceruzzi, *Beyond the Limits: Flight Enters the Computer Age* (Cambridge, MA: MIT Press, 1989), 210–212.
74. The rope core weaving process is described and demonstrated in detail in *Computer for Apollo*, throughout which the middle-aged memory weavers are referred to as "girls" by the Raytheon representative. This 1965 video also demonstrates the automatic wire wrap machine, which connected modules of rope memory via a punched-card system in a process remarkably similar to loom weaving with the Jacquard device.
75. As quoted in the video *Moon Machines: The Navigation Computer*, dir. Nick Davidson and Christopher Riley (London: DOX Productions/Discovery Science Channel, 2008).
76. Mindell, *Digital Apollo*, 155.
77. Jan Mazurek, *Making Microchips: Policy, Globalization, and Economic Restructuring in the Semiconductor Industry* (Cambridge, MA: MIT Press, 1999), 50–53; and David Kaplan, *The Silicon Boys and Their Valley of Dreams* (New York: William Morrow, 1999), 56–57. See also Christophe Lécuyer and David C. Brock, *Makers of the Microchip: A Documentary History of Fairchild Semiconductor* (Cambridge, MA: MIT Press, 2010).
78. Glenna Matthews, *Silicon Valley, Women, and the California Dream* (Palo Alto, CA: Stanford University Press, 2003), 230.
79. Shiprock dedication commemorative brochure, Fairchild Semiconductor publication XX-OO-0650-89, September 6, 1969, <http://archive.computerhistory.org/resources/access/text/2014/07/102725169-05-01-acc.pdf> (accessed January 7, 2017).
80. Shiprock plant manager Paul Driscoll, as quoted in Lisa Nakamura, "Indigenous Circuits: Navajo Women and the Racialization of Early Electronic Manufacture," *American Quarterly* 66, no. 4 (December 2014): 926.
81. Shiprock dedication commemorative brochure.
82. Dexter Ellis, "Age of Electronics Aids Economy of the Navajos," *Deseret News*, November 24, 1965, 6.
83. UPI, "Forty Armed Indians Seize a Building on Navajo Land," *New York Times*, February 25, 1975, 42; and Mike Cassidy, "What Went Wrong at Shiprock," *San Jose Mercury News*, May 7, 2000, 18.
84. See the genealogical chart by Don Hoefler, Harry Smallwood, and James E. Vincler, <http://corphist.computerhistory.org/corphist/documents/doc-45ff3e214d9ea.pdf?PHPSESSID=89ad1d889a28ce5a1a26d8a9b6cf2d4b> (accessed January 7, 2017);

and Christophe Lécuyer, *Making Silicon Valley: Innovation and the Growth of High Tech, 1930–1970* (Cambridge, MA: MIT Press, 2006).

85. Rogers and Larsen, *Silicon Valley Fever* (New York: Basic Books, 1984), 145; Matthews, *Silicon Valley, Women, and the California Dream*, 142. For more on labor conditions and related social issues in Silicon Valley, see Dennis Hayes, *Behind the Silicon Curtain: The Seductions of Work in a Lonely Era* (Boston: South End Press, 1989); and David Naguib Pellow and Lisa Sun-Hee Park, *The Silicon Valley of Dreams: Environmental Injustice, Immigrant Workers, and the High-Tech Global Economy* (New York: New York University Press, 2002).

86. Barbara Ehrenreich and Annette Fuentes, "Life on the Global Assembly Line," *Ms.* 9, no. 7 (January 1981): 71. See also Rachael Grossman, "Women's Place in the Integrated Circuit," *Radical America* 14, no. 1 (1980): 29–50.

87. Thomas R. Howell, *The Microelectronics Race: The Impact of Government Policy on International Competition* (Boulder, CO: Westview Press, 1988), 85. A similarly alarmist tune can be found in Fred Warshofsky, *The Chip War: The Battle for the World of Tomorrow* (New York: Charles Scribner's Sons, 1989), 8–16. For the figures on this shift, see Dan M. Khanna, *The Rise, Decline, and Renewal of Silicon Valley's High Technology Industry* (New York: Garland Publishing, 1997), 15–26.

88. See Allen J. Scott and David P. Angel, "The Global Assembly-Operations of US Semiconductor Firms: A Geographical Analysis," *Environment and Planning A* 20, no. 8 (1988): 1047–1067; Rosalinda Pineda-Ofreneo, "Women, Work and Micro-Electronics: Focus on the Philippines," in *Women, Work, and Computerization: Forming New Alliances*, ed. Kea Tijdens, Mary Jennings, Ina Wagner, and Margaret Weggelaar (Amsterdam: North-Holland, 1989), 317.

89. For an examination of the assembly work and its relationship to gender and globalization, see Teri L. Caraway, *Assembling Women: The Feminization of Global Manufacturing* (Ithaca, NY: ILR Press, 2007).

90. Simon Partner, *Assembled in Japan: Electrical Goods and the Making of the Japanese Consumer* (Berkeley: University of California Press, 1999), 231.

91. *Ibid.*, 209.

92. It is significant that even when Asian electronics companies have opened plants in Europe, as Matsushita and NEC did in Britain the 1980s and 1990s, most of the shop floor jobs have gone to women. "The fact that these new employment opportunities are mostly confined to women has aroused some controversy in South Wales, where skilled men are losing their jobs in the coal and heavy industries." Mary Saso, *Women in the Japanese Workplace* (London: Hilary Shipman, 1990), 177.

93. Ray A. Killian, *The Working Woman: A Male Manager's View* (New York: American Management Association, 1971), 24.

94. Susan S. Green, "Silicon Valley's Women Workers: A Theoretical Analysis of Sex Segregation in the Electronics Industry Labor Market," in *Women, Men, and the International Division of Labor*, ed. June C. Nash and María Patricia Fernández-Kelly (Albany: State University of New York Press, 1983), 292.

95. Les Levidow, "Women Who Make the Chips," in *Women, Work, and Gender Relations in Developing Countries: A Global Perspective*, ed. Parvin Ghorayshi and Claire Bélanger (Westport, CT: Greenwood Press, 1996), 45–46. See also Caraway, *Assembling Women*.

96. M. Patricia Marchak, *The Integrated Circus: The New Right and the Restructuring of Global Markets* (Montreal: McGill-Queen's University Press, 1991), 143.

97. Pun Ngai, *Made in China: Women Factory Workers in a Global Workplace* (Durham, NC: Duke University Press, 2005), 149.

98. Diane Elson and Ruth Pearson, "'Nimble Fingers Make Cheap Workers': An Analysis of Women's Employment in Third World Export Manufacturing," *Feminist Review* 7 (1981): 93. For an extended consideration of skill and gender in the contemporary globalized context, see Caraway, *Assembling Women*, 48–55.

99. Michael Sharpston, "International Subcontracting," *World Development* 4, no. 4 (1976): 334.

100. Adam Hocherman, "Going It Alone, Part III: Inside the Factory Walls," *TechCrunch*, May 1, 2010, <https://techcrunch.com/2010/05/01/going-it-alone-part-iii-inside-the-factory-walls/> (accessed January 7, 2017).

101. For a consideration of exploitative labor practices and iPhone assembly in particular, see Jon Agar, *Constant Touch: A Global History of the Mobile Phone*, 2nd ed. (London: Icon, [2004] 2013), 213–219.

102. Helen Grace, "iPhone Girl: Assembly, Assemblages, and Affect in the Life of an Image," in *Public Space, Media Space*, ed. Chris Berry, Janet Harbord, and Rachel O. Moore (New York: Palgrave Macmillan, 2013), 135–161. See also Aditya Chakraborty, "The Woman Who Nearly Dies Making Your iPad," *The Guardian*, August 5, 2013, <https://www.theguardian.com/commentisfree/2013/aug/05/woman-nearly-died-making-ipad> (accessed January 7, 2017).

103. Seth Perlow, "On Production for Digital Culture: iPhone Girl, Electronics Assembly, and the Material Forms of Aspiration," *Convergence* 17, no. 3 (August 2011): 246.

104. *Ibid.*, 248.

105. Jennifer Terry and Melodie Calvert, "Machines/Lives," in *Processed Lives: Gender and Technology in Everyday Life*, ed. Jennifer Terry and Melodie Calvert (New York: Routledge, 1997), 7. Indeed, as Susan Strasser notes, the invention of the sewing

machine in the nineteenth century not only changed the nature of home labor, but also brought industrial production into the domestic sphere as women sewed garments for clothing manufacturers out of their homes. Such piecework has played a part in the Asian electronics industry as well. Partner identifies the practice in over two thousand Japanese electronics companies in the late 1960s, where home-based workers would assemble transistors and transformers, wind coils, and solder components. Strasser, *Never Done*, 139; Partner, *Assembled in Japan*, 216.

106. Chun, *Programmed Visions*, 2–4.

107. Alan Sondheim, “Further Notes on Codework,” *American Book Review* 22, no. 6 (2001): 1–2, as quoted in Geoff Cox and Alex McLean, *Speaking Code: Coding as Aesthetic and Political Expression* (Cambridge, MA: MIT Press, 2013), 39.

108. Agar, *Constant Touch*, 200–201.

2 Image Fabric

1. Sadie Plant, *Zeroes + Ones: Digital Women and the New Technoculture* (New York: Doubleday, 1997), 189.

2. Lev Manovich, *The Language of New Media* (Cambridge, MA: MIT Press, 2001), 100; Lev Manovich, *Software Takes Command* (New York: Bloomsbury, 2013), 33.

3. Martin Lister and others argue that the digital image is not a distinct entity, but rather a network practice. See *The Photographic Image in Digital Culture*, ed. Martin Lister, 2nd ed. (New York: Routledge, 2013).

4. Vannevar Bush, “As We May Think,” *Atlantic Monthly* 176 (July 1945): 101–108.

5. Larry J. Schaaf, *Out of the Shadows: Herschel, Talbot, and the Invention of Photography* (New Haven: Yale University, 1992), 33.

6. Talbot accomplished many of his photographic discoveries and techniques in 1834 and 1835, only returning to work on his processes when the invention of photography was made public in 1839. Allan Bromley claims that Babbage’s work on the Analytical Engine began when construction of the Difference Engine halted in late 1833, and much of the conception and design was in place by 1838. Allan G. Bromley, “Charles Babbage’s Analytical Engine, 1838,” *Annals of the History of Computing* 4, no. 3 (July 1982): 196–217.

7. See Charles Babbage to William Henry Fox Talbot, January 19, 1838, Fox Talbot Collection, British Library, LA38-3, <http://foxtalbot.dmu.ac.uk/letters/transcriptFreetext.php?keystring=babbage&keystring2=&keystring3=&year1=1800&year2=1877&pageNumber=23&pageTotal=51&referringPage=1> (accessed January 7, 2017); and an undated letter from Talbot to Babbage, Department of Manuscripts, British Library, Add MS 37201 f551, <http://foxtalbot.dmu.ac.uk/letters/>

transcriptFreetext.php?keystring=babbage&keystring2=engine&keystring3=&year1=1800&year2=1877&pageNumber=0&pageTotal=5&referringPage=0 (accessed January 7, 2017).

8. William Henry Fox Talbot to Charles Babbage, May 10, 1839, Department of Manuscripts, British Library, Add MS 37191 f159, <http://foxtalbot.dmu.ac.uk/letters/transcriptName.php?bcode=Babb-C&pageNumber=12&pageTotal=20&referringPage=0> (accessed January 7, 2017); William Henry Fox Talbot to Constance Talbot, February 2, 1840, Fox Talbot Collection, British Library, LA(H)40-1, <http://foxtalbot.dmu.ac.uk/letters/ftbh.php?docnum=04015> (accessed January 7, 2017).

9. Charles Babbage to William Henry Fox Talbot, February 26, 1844, Fox Talbot Collection, British Library, LA44-9, <http://foxtalbot.dmu.ac.uk/letters/transcriptName.php?bcode=Babb-C&pageNumber=19&pageTotal=20&referringPage=0> (accessed January 7, 2017).

10. Steve Edwards argues that photography brought the “sketching and fancywork” that had been feminized in the nineteenth-century commercialization of the picturesque, back into a masculine register of “machines and culture.” See Steve Edwards, *The Making of English Photography: Allegories* (University Park: Pennsylvania State University Press, 2006), 27–28.

11. See William Henry Fox Talbot to John Herschel, February 19, 1839, Royal Society, HS 17:284, <http://foxtalbot.dmu.ac.uk/letters/transcriptDate.php?month=2&year=1839&pageNumber=25&pageTotal=40&referringPage=1> (accessed January 7, 2017).

12. Geoffrey Batchen, “Electricity Made Visible,” in *New Media, Old Media: A History and Theory Reader*, ed. Wendy Hui Kyong Chun and Thomas Keenan (New York: Routledge, 2006), 30.

13. “Many thanks for your kind attention in sending me your Photogenic specimens. ... They are very interesting especially the Lace one.” David Brewster to William Henry Fox Talbot, February 12, 1839, National Media Museum, 1937-4832, <http://foxtalbot.dmu.ac.uk/letters/transcriptDate.php?month=2&year=1839&pageNumber=19&pageTotal=40&referringPage=0> (accessed January 7, 2017). Talbot’s mother, who advocated strongly for his invention, said: “I wish you would do some worked muslin & lace I sent you—the veracity of those is level with the meanest capacity & is consequently popular—people claim ‘how natural is that bit of lace!’” Elisabeth Theresa Feilding to William Henry Fox Talbot, June 29, 1839, Fox Talbot Collection, British Library, LA40-002, <http://foxtalbot.dmu.ac.uk/letters/transcriptDate.php?month=6&year=1839&pageNumber=11&pageTotal=13&referringPage=0> (accessed January 7, 2017). Talbot exhibited ninety-three images, most being contact prints of lithographs, plants, and textiles. There were also twenty-one scenes made with a camera, all taken on and around his estate. William Henry Fox Talbot,

“Photogenic Drawings Exhibited in 1839,” in *Henry Fox Talbot: Selected Texts and Bibliography*, ed. Mike Weaver (Oxford: Clío, 1992), 57–58.

14. Theresa Ann Maria Digby to William Henry Fox Talbot, April 13, 1839, Fox Talbot Collection, British Library, LA39-032, <http://foxtalbot.dmu.ac.uk/letters/transcriptDate.php?month=4&year=1839&pageNumber=11&pageTotal=21&referringPage=0> (accessed January 7, 2017). For an illustrated example of Talbot’s ribbon prints, see Schaaf, *Out of the Shadows*, 105. A contact print by Talbot of lace ribbon is reproduced in Gail Buckland, *Fox Talbot and the Invention of Photography* (Boston: David R. Godine, 1980), 122.

15. George Butler to William Henry Fox Talbot, May 31, 1839, Fox Talbot Collection, British Library, LA39-043, <http://foxtalbot.dmu.ac.uk/letters/transcriptDate.php?month=5&year=1839&pageNumber=10&pageTotal=13&referringPage=0> (accessed January 7, 2017).

16. William Thomas Horner Strangways to William Henry Fox Talbot, March 7, 1840, Fox Talbot Collection, British Library, LA40-32, <http://foxtalbot.dmu.ac.uk/letters/transcriptDate.php?month=3&year=1840&pageNumber=5&pageTotal=12&referringPage=0> (accessed January 7, 2017).

17. W. Hamish Fraser, “The Working Class,” in *Glasgow, Volume II: 1830–1912*, ed. W. Hamish Fraser and Irene Mayer (Manchester: Manchester University Press, 1996), 109 and 304.

18. Douglas R. Nickel, “Nature’s Supernaturalism: William Henry Fox Talbot and Botanical Illustration,” in *Intersections: Lithography, Photography, and the Traditions of Printmaking*, ed. Kathleen Stewart Howe (Albuquerque: University of New Mexico Press, 1998), 19.

19. Geoffrey Batchen, *Each Wild Idea: Writing, Photography, History* (Cambridge, MA: MIT Press, 2002), 167.

20. *Ibid.*, 169.

21. Talbot’s insistence on the photograph as a “picture which makes itself,” Steve Edwards has shown, mirrors descriptions of labor and textile production at the time that aimed for the absence of the hand in production. Edwards points out that it was the same ideology that guided Babbage’s Analytical and Difference engines as calculating devices that would obviate the need for mathematical labor. See Edwards, *The Making of English Photography*, 31.

22. Larry J. Schaaf, “‘The Caxton of Photography’: Talbot’s Etching of Light,” in *William Henry Fox Talbot: Beyond Photography*, ed. Mirjam Brusius, Katrina Dean, and Chitra Ramalingam (New Haven: Yale University Press, 2013), 169–173. Sean Cubitt argues that this halftone grid is instrumental in establishing the raster image display format that has prevailed in later image technologies including cathode-ray tube television and LED digital screens. “Now the raster grid is normalized as the form

not just of the display, but in many instances of the signal being prepared for them," he claims. However, as with many other theorists of digital culture, Cubitt associates this with Cartesian grids originating in mathematical graphs as "one of the great signatures of modernity, from urban planning to modern art, and from the cartographers' longitude and latitude to the rows and columns of Microsoft Excel." Cubitt's genealogy effectively ties the raster grid to an exclusively phallogocentric history, excluding the grid's much older and more ubiquitous application in textiles. See Sean Cubitt, "LED Technology and the Shaping of Culture," in *Urban Screens Reader*, ed. Scott McQuire, Meredith Martin, and Sabine Niederer (Amsterdam: Institute of Network Cultures, 2009), 103.

23. Photo emulsion masks—essentially photographic negatives—have also been employed in printing chip surfaces, though it is an uncommon method. Keith Leaver, *Microelectronic Devices* (New York: John Wiley & Sons, 1989), 131.

24. Contact printing and the similar proximity printing process were common from the inception of the microchip through the 1970s. Since then, most chips have been produced through projection printing. Gene E. Fuller, "Optical Lithography," in *Handbook of Semiconductor Manufacturing Technology*, 2nd ed., ed. Robert Doering and Yoshio Nishi (Boca Raton: CRC Press, 2008), 18-1.

25. LG Electronics' 55EM960V OLED TV, for example, has a 140-centimeter (55-inch) screen display, but a depth of only four millimeters.

26. Anne Friedberg, *The Virtual Window: From Alberti to Microsoft* (Cambridge, MA: MIT Press, 2006), 1.

27. Jacques Derrida, *The Truth in Painting*, trans. Geoff Bennington and Ian McLeod (Chicago: University of Chicago Press, 1987), 60–61. Emphasis in original.

28. For a similar argument specific to cinema architecture and the screen, see Siegfried Kracauer, "Cult of Distraction: on Berlin's Picture Palaces," in Siegfried Kracauer, *The Mass Ornament: Weimar Essays*, ed. and trans. Thomas Y. Levin (Cambridge, MA: Harvard University Press, 1995), 323–328.

29. Derrida, *The Truth in Painting*, 57.

30. Stanley Cavell, *The World Viewed: Reflections on the Ontology of Film* (Cambridge, MA: Harvard University Press, 1979), 24–25.

31. This is similar to the production process of ikat fabrics, where thread is selectively dyed, sometimes with multiple colors, to produce pre-determined images and patterns that emerge only during the weaving process. See Jackie Battenfield, *Ikat Technique* (New York: Van Nostrand Reinhold, 1978); and Manisha Iyer, "Les Textiles Patola de Patan (Inde), XVIIe et XXIe Siècles: Techniques, Patrimoine, Mémoire" (PhD diss., Université Paris 1—Panthéon-Sorbonne, 2015).

32. For more on Fairchild's early adoption of photolithographic methods developed at the Diamond Ordnance Fuze Laboratory and Bell Laboratories, see Christophe

Lecuyer and David C. Brock, *Makers of the Microchip: A Documentary History of Fairchild Semiconductor* (Cambridge, MA: MIT Press, 2010), 19–20.

33. Edmond Couchot, “The Ordered Mosaic, or the Screen Overtaken by Computation,” trans. Stephen Monteiro, in *The Screen Media Reader*, ed. Stephen Monteiro (New York: Bloomsbury Academic, 2017), 134.

34. Geoffrey Batchen, *Burning with Desire: The Conception of Photography* (Cambridge, MA: MIT Press, 1997), 216. For more on these debates, see Martin Hand, *Ubiquitous Photography* (Cambridge: Polity, 2012), 59–95.

35. William J. Mitchell, *The Reconfigured Eye: Visual Truth in the Post-Photographic Era* (Cambridge, MA: MIT Press, 1992), 4–5.

36. Couchot, “The Ordered Mosaic,” 137.

37. Batchen, *Each Wild Idea*, 179.

38. Mitchell nominates “digital image,” while Martin Lister suggests “photographic image” as “more generic and less causal than ‘photograph.’” See Mitchell, *The Reconfigured Eye*, 49, and Martin Lister, “Introduction,” in *The Photographic Image in Digital Culture*, ed. Martin Lister (London: Routledge, 1995), 3.

39. Lister, “Introduction,” 2; and Kevin Robins, “Will the Image Move Us Still?,” in *The Photographic Image in Digital Culture*, ed. Martin Lister (London: Routledge, 1995), 30–31.

40. Mitchell, *The Reconfigured Eye*, 24 and 28.

41. John Tagg, *The Burden of Representation: Essays on Photographies and Histories* (Amherst: University of Massachusetts Press, 1988), 2–4. Emphasis in original. John Roberts asserts: “In essence, what the new imaging techniques produce is not the death of the ‘truth’ of the photograph, but the cultural displacement of the indexicality of the photograph as an *automatic truth-effect*.” John Roberts, *The Art of Interruption: Realism, Photography, and the Everyday* (Manchester: Manchester University Press, 1998), 221. Emphasis in original.

42. Fred Ritchin, *After Photography* (New York: W. W. Norton, 2009), 31. For an interpretation of this passage, see Sarah Kember, *Virtual Anxiety: Photography, New Technologies, and Subjectivity* (Manchester: Manchester University Press, 1998), 28–29.

43. “Because the computer works with small bits of the image, alterations can be totally *seamless* and wholly realistic.” See Gloria S. McDarrah, Fred W. McDarrah, and Timothy S. McDarrah, *The Photography Encyclopedia* (New York: Schirmer Books, 1999), 92; Fred Ritchin, “Photojournalism in the Age of Computers,” in *The Critical Image: Essays on Contemporary Photography*, ed. Carol Squiers (Seattle: Bay Press, 1990), 29.

44. Mitchell, *The Reconfigured Eye*, 7.
45. The JPEG format is known for image-quality loss when compressed, producing artifacts and a patchwork effect, while PNG is slower but maintains its quality when compressed.
46. Ritchin, *After Photography*, 141.
47. Dennis R. Cohen and Erica Sadun, *Mac Digital Photography* (Alameda, CA: SYBEX, 2003), 115.
48. Chun-Wei Hsieh, Tse Cheng, Cheng-Chin Chiang, and Shu-Cheng Huang, "Intelligent Stitcher for Panoramic Image-Based Virtual Worlds," U.S. patent 6011558 A, filed September 23, 1997, and issued January 4, 2000.
49. This process is also known as feathering. See Ken Milburn, *Digital Photography: Expert Techniques* (Sebastopol, CA: O'Reilly, 2004), 133.
50. The Butterick Publishing Company, *The New Dressmaker* (New York: The Butterick Publishing Company, 1921), 146–147.
51. Joseph A. Ippolito, *Understanding Digital Photography* (New York: Thomson/Delmar Learning, 2003), 180.
52. "Combine images to create a panoramic photograph. ... Click Browse [sic] to add images that you want to combine." See dialog boxes illustrated in Adobe, *Adobe Photoshop Elements 5.0 Classroom in a Book* (Berkeley, CA: Adobe Press, 2007), 222–226.
53. Molly Joss, *How to Do Everything with Photoshop Elements* (Berkeley, CA: Osborne/McGraw-Hill, 2001), 129. See also Deke McClelland and Galen Fott, *Photoshop Elements for Dummies* (New York: Hungry Minds, 2001), 320.
54. Mike Woolridge, *Teach Yourself Visually Photoshop Elements 2* (New York: Wiley, 2003), 262.
55. McClelland and Fott, *Photoshop Elements for Dummies*, 320.
56. Milburn, *Digital Photography*, 95.
57. Alexei A. Efros and William T. Freeman, "Image Quilting for Texture Synthesis and Transfer," *SIGGRAPH '01* (2001): 341.
58. See "Google Maps API: Street View Service," Google, <https://developers.google.com/maps/documentation/javascript/streetview> (accessed January 7, 2017).
59. For background into the development of packet switching in data networks, see Lawrence G. Roberts, "The Evolution of Packet Switching," *Proceedings of the IEEE* 66, no. 11 (November 1978): 1307–1313.

60. Daniel Rubinstein and Katrina Sluis, "The Digital Image in Photographic Culture: Algorithmic Photography and the Crisis of Representation," in *The Photographic Image in Digital Culture*, ed. Martin Lister, 2nd ed. (New York: Routledge, 2013), 30.
61. Julia H. Farago, Hugh E. Williams, James E. Walsh, Nicholas A. Whyte, et al., "Object Search UI and Dragging Object Results," U.S. patent 7664739 B2, filed February 14, 2006, and issued February 16, 2010. See also Hugh Williams, "Ideas and Invention (and the Story of Bing's Image Search)," Hugh E. Williams, <https://hughewilliams.com/2012/03/06/ideas-and-invention-and-the-story-of-bings-image-search/> (accessed January 7, 2017).
62. Yogev Ahuvia, "Infinite Scrolling: Let's Get to the Bottom of This," *Smashing Magazine*, May 3, 2013, <https://www.smashingmagazine.com/2013/05/03/infinite-scrolling-lets-get-to-the-bottom-of-this/> (accessed January 7, 2017).
63. Ibid.; see also Mike Takahashi "Should You Use Infinite Scroll Instead of Pagination to Load More Content?," Taka Designs, November 29, 2010, <http://www.takadesigns.com/blog/2010/11/29/should-you-use-infinite-scroll-instead-of-pagination-to-load-more-content/> (accessed January 7, 2017).
64. Dmitry Fadeyev, "When Infinite Scroll Doesn't Work," *Usability Post*, January 7, 2013, <http://usabilitypost.com/2013/01/07/when-infinite-scroll-doesnt-work/> (accessed January 7, 2017). Emphasis in original.
65. Since digital culture's relationship to quilting as a networked social practice is taken up in chapter 3, consideration here is restricted to quilting's formal visual qualities.
66. Hettie Risinger, *Innovative Machine Quilting* (New York: Sterling Publishing, 1980), 22.
67. André Guntherth, "The Conversational Image: New Uses of Digital Photography," trans. Fatima Aziz, *Études photographiques*, no. 31 (Spring 2014), <https://etudesphotographiques.revues.org/3546> (accessed January 7, 2017).
68. Rubinstein and Sluis, "The Digital Image in Photographic Culture," 31.
69. Carleton L. Safford and Robert Bishop, *America's Quilts and Coverlets* (New York: Bonanza Books, 1980), 145.
70. It would appear that is not strictly the case. A search of a well-known monument at sunset, for example, will produce results of the same monument in similar colors.
71. Rubinstein and Sluis, "The Digital Image in Photographic Culture," 33.
72. Matthew Panzarino, "Instagram's Latest App Update Fixed My Biggest Pet Peeve, and People Hate It," *The Next Web*, December 18, 2012, <http://thenextweb.com/apps/2012/12/18/instagrams-latest-app-update-fixed-my-biggest-pet-peeve-and-people-hate-it/> (accessed January 7, 2017).

73. Liz Stinson, "Instagram Ends the Tyranny of the Square," *Wired*, August 27, 2015, <https://www.wired.com/2015/08/instagram-says-goodbye-square-photos/> (accessed January 7, 2017).

74. Josh Constine, "Snapchat Memories Is a Searchable Replacement for Your Camera Roll," *Techcrunch*, July 6, 2016, <https://techcrunch.com/2016/07/06/snapchat-memories/> (accessed January 7, 2017).

75. Safford and Bishop, *America's Quilts and Coverlets*, 145.

76. Seth Fiegerman, "Snapchat Introduces SnapKidz for Users under 13," *Mashable*, June 24, 2013, <http://mashable.com/2013/06/24/snapchat-kidz/#JISzLrnyDgqO> (accessed January 7, 2017).

77. Martin Lister, "Introduction," in *The Photographic Image in Digital Culture*, ed. Martin Lister, 2nd ed. (New York: Routledge, 2013), 8.

3 Piecework

1. Ben Shneiderman, *Leonardo's Laptop: Human Needs and the New Computing Technologies* (Cambridge, MA: MIT Press, 2002), 2.

2. Wendy Hui Kyong Chun, *Updating to Remain the Same: Habitual New Media* (Cambridge, MA: MIT Press, 2016).

3. Claire Zillman, "Facebook Is Now More Valuable than Exxon," *Fortune*, February 1, 2016, <http://fortune.com/2016/02/01/facebook-value-exxon/> (accessed January 7, 2017).

4. Even when such assembly is minimal, as with browsing and scrolling, the user's path and choices through this material leave new wrinkles in the algorithms that manage it, shaping when and how it will appear in the future.

5. More recently, when the AIDS crisis struck America in the 1980s, activists turned to the production of a large-scale quilt, the AIDS Memorial Quilt, eventually comprising over 48,000 panels. Although representing all affected by the disease, it has also served as a visual and material representation of the particularly large toll the virus has taken among African Americans and gay populations. See Charles E. Morris III, *Remembering the AIDS Quilt* (East Lansing: Michigan State University, 2011).

6. Even sites that explicitly trade in paid online labor, such as Amazon's Mechanical Turk, will frame the process in ways that suggest it may function as leisure-time entertainment on par with casual gaming and social media interactivity. See Geoff Cox and Alex McLean, *Speaking Code: Coding as Aesthetic and Political Expression* (Cambridge, MA: MIT Press, 2013), 48–49.

7. David Weinberger, *Small Pieces Loosely Joined: A Unified Theory of the Web* (Cambridge, MA: Perseus Publishing 2002), x.

8. Chris Messina is credited for launching hashtags on Twitter with an August 23, 2007, tweet “how do you feel about using # (pound) for groups. As in #barcamp [msg]?”
9. Theodor H. Nelson, *Literary Machines*, vers. 87/1 (Swarthmore, PA: Theodor H. Nelson, 1987), 0/2.
10. George P. Landow, *Hypertext: The Convergence of Contemporary Critical Theory and Technology* (Baltimore: Johns Hopkins University Press, 1992), 4.
11. Jenny Sundén, “What If Frankenstein(’s Monster) Was a Girl?: Reproduction and Subjectivity in the Digital Age,” in *Bits of Life*, ed. Anneke M. Smelik and Nina Lykke (Seattle: University of Washington Press, 2008), 158.
12. Sheri Pocilujko, “10 Reasons Women Like Casual Games: Why Casual Games and Female Gamers Go Together,” *Casual Connect Magazine*, Fall 2006, <http://www.casualconnect.org/content/gamedesign/pocilujko-ten.html> (accessed January 7, 2017).
13. Alison Harvey, *Gender, Age, and Digital Games in the Domestic Context* (New York: Routledge, 2015), 33, 131.
14. Aubrey Anable, “Casual Games, Time Management, and the Work of Affect,” *Ada 2* (2013), <http://adanewmedia.org/2013/06/issue2-anable/> (accessed January 7, 2017).
15. Sven Grundberg and Jens Hansegard “Women Now Make Up Almost Half of Gamers,” *Wall Street Journal*, August 20, 2014, <http://www.wsj.com/articles/gaming-no-longer-a-mans-world-1408464249> (accessed January 7, 2017); Keith Stuart, “UK Gamers: More Women Play Games than Men, Report Finds,” *The Guardian*, September 17, 2014, <https://www.theguardian.com/technology/2014/sep/17/women-video-games-iab> (accessed January 7, 2017).
16. Harvey, *Gender, Age, and Digital Games in the Domestic Context*, 32–33. For the historically male—and misogynist—orientation of gamer culture, see also Adrienne Shaw, *Gaming at the Edge: Sexuality and Gender at the Margins of Gamer Culture* (Minneapolis: University of Minnesota, 2014); and Mia Consalvo, “Confronting Toxic Gamer Culture: A Challenge for Feminist Game Studies Scholars,” *Ada 1* (2012), <http://adanewmedia.org/2012/11/issue1-consalvo/> (accessed January 7, 2017).
17. Kyle Stock, “Highlights from the Candy Crush IPO Filing: 500 Million Downloads and Counting,” Bloomberg, February 18, 2014, <https://www.bloomberg.com/news/articles/2014-02-18/king-digitals-ipo-filing-shows-500-million-candy-crush-downloads> (accessed January 7, 2017).
18. Aubrey Anable, “Casual Games, Time Management, and the Work of Affect.”
19. Andrew Webster, “Half a Billion People Have Installed ‘Candy Crush Saga,’” *The Verge*, November 15, 2013, <http://www.theverge.com/2013/11/15/5107794/candy-crush-saga-500-million-downloads> (accessed January 7, 2017).

20. The tracing line also exists for other genres, such as word-puzzle apps including WordWhizzle by Apprope.
21. Gordon Calleja, *In-Game: From Immersion to Incorporation* (Cambridge, MA: MIT Press, 2011), 27.
22. Brian Janosch, "Patrick Moberg, Dots God: How High Art and Bill Cosby Inspired the Hottest Mobile Game," Neat, May 13, 2013, <http://www.cultivatedwit.com/patrick-moberg-dots-god-how-high-art-bill-cosby-inspired-the-hottest-mobile-game/> (accessed January 7, 2017).
23. Matthew Lynley, "Behind the Hit Game 'Dots,'" *Wall Street Journal*, May 7, 2013, <http://blogs.wsj.com/digits/2013/05/07/behind-the-hit-game-dots/> (accessed January 7, 2017).
24. Seth Fiegerman, "Nearly 20 Million Downloads Later, Dots Looks to Build a Gaming Franchise," Mashable, April 30, 2014, <http://mashable.com/2014/04/30/dots-profile/#b15Ke.oDbGq6> (accessed January 7, 2017). Emma Westecott has argued for another approach to game design that involves craft culture at an ideological level. Studying independent game production outside commercial, mass-market models, she identifies opposing possibilities for empowerment and exploitation in its design practices, particularly concerning the historically marginalized role of women in gaming. See Emma Westecott, "Independent Game Development as Craft," *Loading ... The Journal of the Canadian Game Studies Association* 7, no. 11 (2013): 78–91.
25. The Jeff Rubin Show, "'Dots' Creator Patrick Moberg," April 28, 2014, <https://soundcloud.com/jeffrubinjeffrubin/118-dots-creator-patrick> (accessed January 7, 2017).
26. Matthew Fuller and Andrew Goffey, *Evil Media* (Cambridge, MA: MIT Press, 2012), 52.
27. Not surprisingly, then, sites explicitly oriented toward professional goals, such as LinkedIn, emphasize network over community.
28. Robert Shaw, *American Quilts: The Democratic Art, 1780–2007* (New York: Sterling, 2009), 7.
29. Whole cloth quilts use a single piece of fabric, upon which stitched patterns produce the design and texture. Appliqué quilts involve hemming smaller pieces of fabric onto a larger, underlying fabric.
30. For numerous examples, from Central Asia to the Middle East and South America, see Caroline Crabtree and Christine Shaw, *Quilting, Patchwork and Appliqué: A World Guide* (London: Thames & Hudson, 2007).
31. Barbara Brackman, "American Adaptation: Block-Style Quilts," in *American Quilts in the Modern Age, 1870–1940: The International Quilt Study Center Collections*,

ed. Marin F. Hanson and Patricia Cox Crews (Lincoln: University of Nebraska Press, 2009), 22–23.

32. O. W. Scott, “Aunt Bina’s Quilt,” reprinted in *A Patchwork of Pieces: An Anthology of Early Quilt Stories, 1845–1949*, ed. Cuesta Ray Benberry and Carol Pinney Crabb (Paducah, KY: American Quilter’s Society, 1993), 170.

33. *Ibid.*, 171.

34. *Ibid.*, 176.

35. Cuesta Ray Benberry and Carol Pinney Crabb, eds., *A Patchwork of Pieces: An Anthology of Early Quilt Stories, 1845–1949* (Paducah, KY: American Quilter’s Society, 1993), 12.

36. For other examples of narrative and communication through textile crafts across cultures, and their potential relation to digital practices, see Jack Bratich, “The Digital Touch: Craft-Work as Immaterial Labour and Ontological Accumulation,” *Ephemera* 10, no. 3–4 (2010): 306.

37. Ruth Finley, *Old Patchwork Quilts* (Philadelphia: J. B. Lippincott, 1929), 33.

38. Bratich, “The Digital Touch,” 307.

39. Marguerite Ickis, *The Standard Book of Quilt Making and Collecting* (New York: Dover, 1959), vii.

40. Lucy R. Lippard, “Up, Down, and Across: A New Frame for New Quilts,” in *The Artist and The Quilt*, ed. Charlotte Robinson (New York: Alfred A. Knopf, 1983), 32.

41. Tony Blackshaw, *Leisure* (New York: Routledge, 2010), x–xi.

42. In a 2015 Pew study, 59 percent of smartphone owners said they used their apps “several times a day” and 27 percent said they used them “continuously” (this jumped to 43 percent among those eighteen to twenty-nine years old. Lee Rainie and Kathryn Zickuhr, “Americans’ Views on Mobile Etiquette,” Pew Research Center, August 26, 2015, <http://www.pewinternet.org/2015/08/26/americans-views-on-mobile-etiquette/> (accessed January 7, 2017).

43. David Rowe, “Leisure, Mass Communications and Media,” in *A Handbook of Leisure Studies*, ed. Chris Rojek, Susan M. Shaw, and A. J. Veal (New York: Palgrave Macmillan, 2006), 330.

44. *Ibid.*, 329.

45. In “The Concept of Leisure,” philosopher Cyril Barrett describes the complexity of separating leisure from work time by explaining that compulsory chores in leisure time must be described as work while “knitting or playing cards, if that is what one wants to do, is leisure, even if done during office hours or in work time.” Of course, the two have little in common, since knitting is a hand skill that produces clothes

while card games are strategy tasks—depending on the game—often tied to gambling. And while someone may desire to knit while at another paid task, who's to say the garments produced aren't being made out of necessity? Cyril Barrett, "The Concept of Leisure: Idea and Ideal," in *The Philosophy of Leisure*, ed. Tom Winnifrith and Cyril Barrett (Basingstoke: Macmillan, 1989), 11.

46. Susan Strasser, *Never Done: A History of American Housework* (New York: Pantheon, 1982), 185.

47. Ruth Schwartz Cowan, *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave* (New York: Basic Books, 1983), 63–65. Strasser notes that the sewing machine also introduced increased industrial production in the home through piecework for manufacturers. See Strasser, *Never Done*, 139.

48. Melissa Gregg, *Work's Intimacy* (Cambridge: Polity, 2011), 3.

49. David Staples, "Women's Work and the Ambivalent Gift of Entropy," in *The Affective Turn: Theorizing the Social*, ed. Patricia Ticineto Clough and Jean O'Malley Halley (Durham, NC: Duke University Press, 2007), 125–126.

50. Maurizio Lazzarato, "Immaterial Labor," in *Marxism Beyond Marxism*, ed. Saree Makdisi, Cesare Casarino, and Rebecca E. Karl (London: Routledge, 1996), 133.

51. Jan L. Harris and Paul A. Taylor, *Digital Matters: Theory and Culture of the Matrix* (New York: Routledge, 2005), 186.

52. Cox and McLean, *Speaking Code*, 49.

53. David Staples, "Women's Work and the Ambivalent Gift of Entropy," in *The Affective Turn*, ed. Patricia Ticineto Clough and Jean O'Malley Halley (Durham, NC: Duke University Press, 2007), 125.

54. Tiziana Terranova, *Network Culture: Politics for the Information Age* (London: Pluto Press, 2004), 74.

55. See *Homeworkers in Global Perspective: Invisible No More*, ed. Eileen Boris and Elisabeth Prügl (New York: Routledge, 1996); Ping-Chun Hsiung, *Living Rooms as Factories: Class, Gender, and the Satellite Factory System in Taiwan*; Charles B. Hennon and Suzanne Loker, "Gender and Home-Based Employment in a Global Economy," in *Gender and Home-Based Employment*, ed. Charles B. Hennon, Suzanne Loker, and Rosemary Walker (Westport, CT: Auburn House, 2000), 17–43.

56. Eileen Boris, *Home to Work: Motherhood and the Politics of Industrial Homework in the United States* (Cambridge: Cambridge University Press, 1994), 10.

57. Susan M. Strasser, "An Enlarged Human Existence? Technology and Household Work in Nineteenth-Century America," in *Women and Household Labor*, ed. Sarah Fenstermaker Berk (Beverly Hills, CA: SAGE, 1980), 45.

58. Ibid., 46; see also Sheila Allen and Carol Wolkowitz, "Homeworking and the Control of Women's Work," in *Waged Work: A Reader*, ed. Feminist Review (London: Virago Press, 1986), 238–264.
59. Cynthia R. Daniels, "Between Home and Factory," in *Homework: Historical and Contemporary Perspectives on Paid Labor at Home*, ed. Eileen Boris and Cynthia R. Daniels (Urbana: University of Illinois Press, 1989), 14–15.
60. Jamie Faricellia Dangler, "Electronics Subassemblers in Central New York," in *Homework: Historical and Contemporary Perspectives on Paid Labor at Home*, ed. Eileen Boris and Cynthia R. Daniels (Urbana: University of Illinois Press, 1989), 147–164.
61. Ibid., 153.
62. Ibid., 152. In that same period, 20 percent of New York City's 250,000 garment workers were working illegally in sweatshops and as homeworkers. See Boris, *Home to Work*, 342.
63. Laura C. Johnson, *The Seam Allowance: Industrial Home Sewing in Canada* (Toronto: Women's Educational Press, 1982), 9.
64. Haraway's essay first appeared as "Manifesto for Cyborgs," but has been published and reprinted subsequently as "A Cyborg Manifesto." See Donna Haraway, "Manifesto for Cyborgs: Science, Technology, and Socialist Feminism in the 1980s," *Socialist Review*, no. 80 (1985): 65–108; and Donna J. Haraway, "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century," chap. 8 in *Simians, Cyborgs and Women: The Reinvention of Nature* (New York: Routledge, 1991), 149–181.
65. Haraway, "A Cyborg Manifesto," 166.
66. Ibid., 170.
67. Martha Rosler, "Image Simulations, Computer Manipulations: Some Considerations," in *Photography after Photography: Memory and Representation in the Digital Age*, ed. Hubertus von Amelnunxen, Stefan Iglhaut, Florian Rötzer, and Alexis Cassel (Amsterdam: G+B Arts, 1996), 50.
68. Nicole B. Ellison, *Telework and Social Change: How Technology Is Reshaping the Boundaries between Home and Work* (Westport, CT: Praeger, 2004), 116.
69. Ibid., 120. Emphasis in original.
70. Ned Rossiter, *Organized Networks: Media Theory, Creative Labour, New Institutions* (Amsterdam: Institute of Network Cultures, 2006), 14–15.
71. Jan van Dijk, *The Network Society*, 3rd ed. (London: SAGE, 2012), 181.
72. Terranova, *Network Culture*, 74.
73. Ibid., 77.

74. *Ibid.*, 91–92.

75. Bratich, “The Digital Touch,” 304.

4 Domestic Disturbances

1. Device accessories like Logitech’s AnyAngle stands perpetuate this idea of unlimited body-device orientations. See Logitech, “The New Logitech AnyAngle Brings Flexibility and Protection to the iPad Air 2 and iPad mini,” <http://news.logitech.com/press-release/consumer-products/new-logitech-anyangle-brings-flexibility-and-protection-ipad-air-2-a> (accessed January 7, 2017).

2. Mindy McAdams, “Gender without Bodies,” *CMC Magazine* 3, no. 3 (March 1996), <http://www.december.com/cmc/mag/1996/mar/mcadams.html> (accessed January 7, 2017).

3. Ken Pimentel and Kevin Teixeira, *Virtual Reality: Through the New Looking Glass* (New York: Intel/Windcrest/McGraw Hill, 1993), 7–8.

4. Kees Overbeeke, Tom Djajadiningrat, Caroline Hummels, Stephan Wensveen, and Joep Frens, “Let’s Make Things Engaging,” in *Funology: From Usability to Enjoyment*, ed. Mark A. Blythe, Kees Overbeeke, Andrew F. Monk, and Peter C. Wright (Dordrecht: Kluwer Academic Publishers, 2003), 7 and 16.

5. Donald A. Norman, “Why Interfaces Don’t Work,” in *The Art of Human–Computer Interface Design*, ed. Brenda Laurel (Reading, MA: Addison-Wesley, 1990), 209.

6. See Kimberly A. Neuendorf and Evan A. Lieberman, “Film: The Original Immersive Medium,” in *Immersed in Media: Telepresence in Everyday Life*, ed. Cheryl Campanella Bracken and Paul D. Skalski (New York: Routledge, 2010), 9–38.

7. See Wanda Strauven, “The Observer’s Dilemma: To Touch or Not to Touch,” in *Media Archaeology: Approaches, Applications, and Implications*, ed. Erkki Huhtamo and Jussi Parikka: 148–163. Strauven even claims an “archaeology of the ‘touch screen’” grounded in early cinema systems such as the Mutoscope, which required the viewer to crank a handle to set and keep images in motion. See *ibid.*, 155–158.

8. Erkki Huhtamo, “Screenology; or, Media Archaeology of the Screen,” in *The Screen Media Reader: Culture, Theory, Practice*, ed. Stephen Monteiro (New York: Bloomsbury Academic, 2017), 108.

9. Designers speak of “hand- and finger-based occlusion.” It is compensated for through interface features such as keyboard offset controls for selecting letters.

10. Teresa de Lauretis, *Technologies of Gender: Essays on Theory, Film, and Fiction* (Bloomington: Indiana University Press, 1987), 13.

11. Jacques Rancière, *The Politics of Aesthetics: The Distribution of the Sensible*, trans. Gabriel Rockhill (London: Continuum, 2004), 13.
12. Constance Classen, "Feminine Tactics: Crafting an Alternative Aesthetics in the Eighteenth and Nineteenth Centuries," in *The Book of Touch*, ed. Constance Classen (Oxford: Berg, 2005), 228.
13. See Nicholas Mirzoeff, *The Right to Look: A Counterhistory of Visuality* (Durham, NC: Duke University Press, 2011).
14. Elizabeth Grosz, *Volatile Bodies: Toward a Corporeal Feminism* (Bloomington: Indiana University Press, 1994), 3–4.
15. Maurice Merleau-Ponty, *The Phenomenology of Perception*, trans. Colin Smith (London: Routledge, [1962] 2002), 369. Interestingly, when explaining tactile perception, Merleau-Ponty relies on the example of handling textiles. See *ibid.*, 368–369.
16. Elizabeth Grosz ties Merleau-Ponty's ideas on tactility to gender distinctions in *Volatile Bodies*, 98–107. See also Heidi J. Nast and Audrey Kobayashi, "Re-corporealizing Vision," in *Bodyspace: Destabilizing Geographies of Gender and Sexuality*, ed. Nancy Duncan (London: Routledge, 1996), 75–93.
17. Christian Metz, "The Imaginary Signifier," *Screen* 16, no. 2 (Summer 1975): 60.
18. Mirzoeff, *The Right to Look*, 3.
19. See, for example, *The Feminism and Visual Culture Reader*, ed. Amelia Jones (New York: Routledge, 2003).
20. See Laura Mulvey, "Visual Pleasure and Narrative Cinema," *Screen* 16, no. 3 (Autumn 1975): 6–18; Mary Ann Doane, "Film and Masquerade: Theorising the Female Spectator," *Screen* 23, no. 3–4 (1982): 74–88; Stephen Heath and Teresa de Lauretis, eds., *The Cinematic Apparatus* (New York: St. Martin's Press, 1980).
21. AMC CEO Adam Aron explained: "When you tell a 22-year-old to turn off the phone, don't ruin the movie, they hear please cut off your left arm above the elbow. You can't tell a 22-year-old to turn off their cellphone. That's not how they live their life." Brent Lang, "AMC Entertainment CEO Open to Allowing Texting in Some Theaters," *Variety*, April 13, 2016. See also AMC Theaters, "No Texting at AMC," Twitter, April 15, 2016, <https://twitter.com/amctheatres/status/720972338699702272> (accessed January 7, 2017).
22. Constance Classen, *The Color of Angels: Cosmology, Gender and the Aesthetic Imagination* (New York: Routledge, 1998), 1.
23. Donna J. Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective," chap. 9 in *Simians, Cyborgs and Women: The Reinvention of Nature* (New York: Routledge, 1991), 189.

24. Allucquère Rosanne Stone, *The War of Desire and Technology at the Close of the Mechanical Age* (Cambridge, MA: MIT Press, 1995); and Allucquère Rosanne Stone, "Will the Real Body Please Stand Up? Boundary Stories about Virtual Cultures," in *Cyberspace: First Steps*, ed. Michael Benedickt (Cambridge, MA: MIT Press, 1994), 81–118.

25. Priska Gisler, "Does Gender Still Matter? Bodily Functions in Cyberspace: A Feminist Approach," in *Women, Work and Computerization: Spinning a Web from Past to Future, Proceedings of the 6th International IFIP Conference, Bonn, Germany, May 24–27, 1997*, ed. A. Frances Grundy, Doris Köhler, Veronika Oechtering, and Ulrike Petersen, (New York: Springer, 1997), 219 and 220.

26. Anita Greenhill, "...Virtually There: The Social Construction of Computer Mediated Identity," Spaceless.com, <http://www.spaceless.com/papers/13.htm> (accessed January 7, 2017).

27. Charles W. Griffith, "Marksmanship Practicing Means," U.S. patent 2007082 A. filed April 12, 1934, and issued July 2, 1935. Chester Braselton filed a patent application for a television photo-cell pickup system in 1936. Chester Braselton, "Photo-Cell Pickup System," U.S. patent 2193789, filed January 20, 1936, and issued March 19, 1940.

28. "Seeburg Ray-o-Lite Presented after 20-Month Test," *Atomic Age* (January 1937): 243.

29. Lincoln Laboratory technicians initially had tested joysticks as selection devices, a choice that would have located the hand controls outside the frame of the screen, but light guns allowed military personnel to select and deselect screen objects more quickly. For discussion of the joystick and light gun, see "Bi-weekly, Project 6673," Memorandum M-2074, Electronic Computer Division, Servomechanisms Laboratory, Massachusetts Institute of Technology (October 27, 1950), 4. For details on the light gun's construction, see "Bi-weekly, Project 6673," Memorandum M-2075, Electronic Computer Division, Servomechanisms Laboratory, Massachusetts Institute of Technology (November 11, 1950), 9.

30. The same system would become commercially available as the Magnavox Odyssey Shooting Gallery in 1972, part of the first commercial home video game console.

31. SAGE was a continental surveillance system (the largest of its kind at the time), representing a scale of technological visualization that would only be superseded by the supra-stratospheric perspective of artificial satellites in the late 1950s. See Kent C. Redmond and Thomas M. Smith, *From Whirlwind to MITRE: The R&D Story of the SAGE Air Defense Computer* (Cambridge, MA: MIT Press, 2000).

32. Surprisingly, even Wendy Chun does not note this discrepancy in her analysis of the SAGE interface in *Programmed Visions*. She refers to the gun as a "light pen," although the book includes an illustration of the pistol grip device in use by

servicemen. See Wendy Hui Kyong Chun, *Programmed Visions: Software and Memory* (Cambridge, MA: MIT Press, 2011), 60–61.

33. C. R. Wieser, “Cape Cod System and Demonstration,” Memorandum VI, L-86, Lincoln Laboratory, Massachusetts Institute of Technology (March 13, 1953). It further explains: “The light gun is a photocell device which is placed over the desired blip on the display scope and then sends a pulse into the computer to indicate to the computer that action (for example, ‘start tracking’) is to be taken on that particular aircraft. ... The human beings make decisions and improvise while the computer handles routine tasks under their supervision.”

34. Benj Edwards, “The Never-Before-Told Story of the World’s First Computer Art (It’s a Sexy Dame),” *The Atlantic*, January 24, 2013, <http://www.theatlantic.com/technology/archive/2013/01/the-never-before-told-story-of-the-worlds-first-computer-art-its-a-sexy-dame/267439/> (accessed January 7, 2017).

35. “SAGE A/N FSQ-7,” http://www.smecc.org/sage_a_n_fsq-7.htm (accessed January 7, 2017).

36. For a consideration of SAGE’s contributions to digital gaming culture, see Patrick Crogan, *Gameplay Mode: War, Simulation, and Technoculture* (Minneapolis: University of Minnesota Press, 2011), 6–12. Sadly, Crogan makes no mention of the Girley programs.

37. As Patrick Crogan explains in his study of the tightly interlinked history of military technology and the video game industry: “The military technoscientific legacy forged in the face of total war and the nuclear age inaugurated by the cold war ... inhabit[s] the technological lineages of digital computing, visual displays and interactivity, virtual space simulation, and software development.” Crogan, *Gameplay Mode*, xii.

38. Branden Hookway, *Interface* (Cambridge, MA: MIT Press, 2014), 150.

39. Ivan Edward Sutherland, “Sketchpad: A Man-Machine Graphical Communication System” (PhD diss., MIT, 1963), 57–60. Unfortunately, many subsequent descriptions of Sketchpad mistakenly claim that the pen has to touch the screen to function, an error presumably derived from the title Sutherland chose for his program.

40. In the early development of mobile touchscreen devices, designers considered the possibility of using a crosshair as a screen cursor that would allow the finger to accurately select data on the screen. See Wilbert O. Galitz, *The Essential Guide to User Interface Design* (New York: John Wiley & Sons, 1997), 309.

41. Sutherland, “Sketchpad,” 130–135.

42. *Ibid.*, 132.

43. Manovich, *Software Takes Command*, 86.

44. Nanna Verhoeff, *Mobile Screens: The Visual Regime of Navigation* (Amsterdam: Amsterdam University Press, 2012), 66.
45. German Lopez, "Pokémon Go, Explained," *Vox*, August 5, 2016, <http://www.vox.com/2016/7/11/12129162/pokemon-go-android-ios-game> (accessed January 7, 2017).
46. The author observed this activity on a Montreal municipal bus in fall 2016.
47. Malcolm McCullough, *Ambient Commons: Attention in the Age of Embodied Information* (Cambridge, MA: MIT Press, 2013), 13–15.
48. Wendy Hui Kyong Chun, *Updating to Remain the Same: Habitual New Media* (Cambridge, MA: MIT Press, 2016), 171 and 53.
49. Apple, "Designing for iOS," <https://developer.apple.com/library/iad/documentation/UserExperience/Conceptual/MobileHIG/index.html> (accessed August 14, 2016). Contrast this with the similar effect of Microsoft's AERO operating system aesthetic, which Microsoft likens to glass, rather than paper.
50. Heidi Rae Cooley, "It's All about the Fit: The Hand, the Mobile Screenic Device and Tactile Vision," *Journal of Visual Culture* 3, no. 2 (August 2004): 137.
51. Jon Agar, *Constant Touch: A Global History of the Mobile Phone*, 2nd ed. (London: Icon, [2004] 2013), 180–181.
52. Apple, "iOS Human Interface Guidelines," <https://developer.apple.com/library/iad/documentation/UserExperience/Conceptual/MobileHIG/InteractivityInput.html> (accessed August 14, 2016). This sense of intimacy generated sexist parodies upon the release of Apple's iPad in 2010. Apple's promotion of the iPad as small, slim, and easily toted in a bag provoked jokes comparing the device and its marketing to maxi pads and other women's hygiene products. See Dawn Chmielewski and Alex Pham, "Women Mock the iPad Calling It the iTampon," *Los Angeles Times*, January 27, 2010, <http://latimesblogs.latimes.com/technology/2010/01/women-mock-the-ipad-calling-it-itampon.html> (accessed January 7, 2017); "Slogan Showdown: Tampons vs. iPad," *The Week*, January 28, 2010, <http://theweek.com/articles/497214/slogan-showdown-tampons-vs-ipad> (accessed January 7, 2017).
53. Ingrid Richardson, "Pocket Technospaces: The Bodily Incorporation of Mobile Media," *Continuum* 21, no. 2 (June 2007): 214.
54. Ingrid Richardson, "Faces, Interfaces, Screens: Relational Ontologies of Framing, Attention and Distraction," *Transformations*, no. 18 (2010), http://www.transformationsjournal.org/wp-content/uploads/2017/01/Richardson_Trans18.pdf (accessed January 7, 2017).
55. Regarding this understanding of interface, consider Branden Hookway's claim that "a human-machine interface, for example, would be fully bounded by the 'faces' of human and machine." Hookway, *Interface*, 9.

56. Lee Rainie and Kathryn Zickuhr, "Americans' Views on Mobile Etiquette," Pew Research Center, August 26, 2015, <http://www.pewinternet.org/2015/08/26/americans-views-on-mobile-etiquette/> (accessed January 7, 2017).
57. Henrik Kaare Nielsen, "The Net Interface and the Public Sphere," in *Interface Criticism: Aesthetics Beyond Buttons*, ed. Christian Ulrik Andersen and Søren Bro Pold (Aarhus: Aarhus University Press, 2011), 218.
58. Jon Agar considers the many restrictions on phone use in public spaces, claiming they produce "oases of quiet." See Agar, *Constant Touch*, 241–252.
59. Jack Bratich and Heidi Brush, "Fabricating Activism: Craft-Work, Popular Culture, Gender," *Utopian Studies* 22, no. 2 (2011): 237. Emphasis in original.
60. Stella Minahan and Julie Wolfram Cox, "Stitch'nBitch: Cyberfeminism, a Third Place and the New Materiality," *Journal of Material Culture* 12, no. 1 (2007): 10–11. Emphasis in original.
61. Bratich and Brush, "Fabricating Activism," 236.
62. Kate Kershner, "Is It Rude to Knit in Public?" Howstuffworks, <http://people.howstuffworks.com/is-it-rude-to-knit-in-public.htm> (accessed January 7, 2017).
63. Judith Martin, "Miss Manners: Not Every Rite of Passage Is Supposed to Be Fun," *The Spokesman-Review*, August 1, 2011, <http://www.spokesman.com/stories/2011/aug/01/not-every-rite-of-passage-is-supposed-to-be-fun/> (accessed January 7, 2017).
64. Jack Bratich, "The Digital Touch: Craft-Work as Immaterial Labour and Ontological Accumulation," *Ephemera* 10, no. 3–4 (2010): 308.
65. Bratich, "The Digital Touch," 308.
66. Rob Walker, "The D.I.Y. Revolutionaries of the Pussyhat Project," *The New Yorker*, January 25, 2017, <http://www.newyorker.com/culture/culture-desk/the-d-i-y-revolutionaries-of-the-pussyhat-project> (accessed April 15, 2017); see also <https://www.pussyhatproject.com>.
67. Constance Classen, "Feminine Tactics: Crafting an Alternative Aesthetics in the Eighteenth and Nineteenth Centuries," in *The Book of Touch*, ed. Constance Classen (Oxford: Berg, 2005), 229.
68. Matt Honan, "I, Glasshole: My Year with Google Glass," *Wired*, December 30, 2013, <https://www.wired.com/2013/12/glasshole/> (accessed January 7, 2017).
69. Howard Rheingold, *Virtual Reality* (New York: Summit Books, 1991), 46.
70. Haraway, "Situated Knowledges," 189.
71. Anne Balsamo, *Technologies of the Gendered Body: Reading Cyborg Women* (Durham, NC: Duke University Press, 1995), 127.

72. Ken Hillis, *Digital Sensations: Space, Identity, and Embodiment in Virtual Reality* (Minneapolis: University of Minnesota Press, 1999), xv–xvi.

73. *Ibid.*, xx.

74. J. David Bolter and Richard Grusin, *Remediation: Understanding New Media* (Cambridge, MA: MIT Press, 1999), 53 and 161.

75. *Ibid.*, 54–55.

76. Bolter and Grusin further explain: “Virtual reality is a powerful expression of the desire for transparent immediacy and an enactment of the traditional male gaze that has been associated by Mulvey and others with the apparatus of the cinema.” *Ibid.*, 240 and 248.

77. Diane Gromala, “Pain and Subjectivity in Virtual Reality,” in *Clicking In: Hot Links to Digital Culture*, ed. Lynn Hershman Leeson (Seattle: Bay Press, 1996), 222.

78. *Ibid.*, 226.

79. *Ibid.*, 224.

80. Cheris Kramarae, “Backstage Critique of Virtual Reality,” in *CyberSociety: Computer-Mediated Communication and Community*, ed. Steve Jones (Thousand Oaks, CA: SAGE, 1995), 40.

81. *Ibid.*, 37 and 45.

82. While Glass is no longer available to consumers, Google—now housed in the holding company Alphabet—has continued research into interactive eyewear and other wearables with remnants of the Glass development team working under the title “Project Aura.” Alistair Barr, “Google Glass Gets a New Name and Hires from Amazon,” *Wall Street Journal*, September 16, 2015, <http://blogs.wsj.com/digits/2015/09/16/google-glass-gets-a-new-name-and-hires-from-amazon/> (accessed January 7, 2017).

83. Google, “Today We Announced +Project Glass,” Google+, April 4, 2012, <https://plus.google.com/+google/posts/YZYCe65gj8T> (accessed January 7, 2017). My emphasis.

84. See especially Aruna D’Souza and Tom McDonough, eds., *The Invisible Flâneuse?: Gender, Public Space, and Visual Culture in Nineteenth-Century Paris* (Manchester: Manchester University Press, 2006).

85. Griselda Pollock, *Vision and Difference: Femininity, Feminism, and the Histories of Art* (New York: Routledge, 1988), 71. For more on the unraveling of male dominance through the flâneur and the crisis of gaze in modernity, see Elizabeth Wilson, “The Invisible Flâneur,” *New Left Review* 191 (January–February 1992): 90–110; and David B. Clarke, *The Consumer Society and the Postmodern City* (New York: Routledge, 2003), 84–85.

86. Pollock, *Vision and Difference*, 67.
87. Google, "Glass: Explorers," <https://sites.google.com/site/glasscomms/glass-explorers> (accessed January 7, 2017).
88. Sergey Brin, "Sergey Brin Talks about Google Glass at TED 2013," TED, Long Beach, CA, 2013, <https://www.youtube.com/watch?v=rie-hPVJ7Sw> (accessed January 7, 2017).
89. Ibid.
90. Isabel Pedersen, *Ready to Wear: A Rhetoric of Wearable Computers and Reality-Shifting Media* (Anderson, SC: Parlor Press, 2013), 4–5. Emphasis in original.
91. Of course, eyeglasses have long been seen as masculine, as reflected in the saying "Boys don't make passes at girls who wear glasses."
92. Google, "Glass: Explorers."
93. "Google Cardboard," <https://vr.google.com/cardboard/> (accessed August 14, 2016).
94. Sumit Passary, "Samsung, LG, Xiaomi and Others to Make Android Daydream VR-Ready Smartphones," *Tech Times*, May 20, 2016, <http://www.techtimes.com/articles/159512/20160520/samsung-lg-xiaomi-and-others-to-make-android-daydream-vr-ready-smartphones.htm> (accessed January 7, 2017).
95. David Pierce, "The Future of Virtual Reality Is inside Your Smartphone," *Wired*, March 6, 2015, <https://www.wired.com/2015/03/future-virtual-reality-inside-smartphone/> (accessed January 7, 2017).
96. Sherry Turkle, *The Second Self: Computers and the Human Spirit* (Cambridge, MA: MIT Press, [1984] 2005), 101–102.
97. Judy Wajcman, *Feminism Confronts Technology* (Cambridge: Polity, 1991), 156.
98. See Norman Bryson, "The Gaze in the Expanded Field," in *Vision and Visuality*, ed. Hal Foster (New York: The New Press, 1988), 88–94.