Reading the Past to Design Accessible Futures: Blindness and Education from Nineteenth-Century Tactile Books to Twenty-First-Century 3-D Printing

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Touch This Page! Making Sense of the Ways We Read, Norman B. Leventhal Map and Education Center at the Boston Public Library; Lamont Library at Harvard University; Perkins School for the Blind, Watertown, Massachusetts; Snell Library at Northeastern University, Boston; January–April 2019.

“Touch This Page! A Symposium on Ability, Access, and the Archive,” Lamont Library, Harvard University; Renaissance Park, Northeastern University, Boston; April 4–5, 2019.

For many of us, reading has become such an automatic process that we forget how it happens. At Touch This Page! Making Sense of the Ways We Read, a pop-up-style historical exhibit that debuted in four identical versions in libraries and universities in the Boston area, visitors were challenged to question these and other assumptions about reading and to consider what sensations and objects make the process possible. In addition to reflecting on their own reading practices, visitors engaged multiple senses, including touch, to explore the history of a specific reading technology: tactile printing developed in the nineteenth-century United States. In the 1830s, Perkins School for the Blind, the first school for blind students in the United States, began to print tactile books with raised alphabet letters, diagrams, and maps.1 Visitors to Touch This Page could explore these tactile ways of reading by feeling the surfaces of six 3-D-printed plastic versions of pieces of the original books, which are housed and maintained at the Perkins archives in Watertown, Massachusetts.

A multidisciplinary collaboration created the plastic facsimiles of these nineteenth-century tactile prints for public interaction in the exhibit locations. Exhibit co-directors Sari Altschuler (assistant professor of English and associate director of the Northeastern Humanities Center at Northeastern University)
and David Weimer (librarian for Cartographic Collections and Learning at the Harvard Map Collection at Harvard University) coordinated the project. They also conducted the research and narrative analysis for the exhibit text that contextualized the 3-D-printed book pieces. Visitors could read about the exhibit at all the locations in multiple formats, chosen with disability access in mind, by feeling braille panels, by looking at printed text, or by listening to the material in audio form online. To reproduce the tactile qualities of the books for *Touch This Page*, Altschuler and Weimer collaborated with a team of undergraduate designers led by Nicolas Fong at Northeastern University and supervised by Waleed Meleis (associate professor of electrical and computer engineering at Northeastern). The students worked with the input of staff at Perkins, including Kim Charlson, executive director of the library, to design, print, and refine the 3-D prints.

*Touch This Page* used its public history platform to apply material studies methodologies to the study of disability in history. Printing in three dimensions communicated tactile properties of the archival objects to visitors that other processes of copying and dissemination, such as photography, would have failed to transmit. About five years ago, nonindustrial 3-D printing began to attract substantial media and popular attention. That charisma has powered the widespread installation of inexpensive 3-D printers in educational spaces such as schools, libraries, and museums. By posting the 3-D-scanned files for the tactile book facsimiles on the exhibit website for anyone to download and print, *Touch This Page* has made also possible a potentially wide-ranging afterlife for the exhibit and others like it.

*Touch This Page* explicitly linked this exercise in 3-D printing, as well as the history covered in the exhibit, to disability politics. The team chose a tactile form of reproduction in large part because access for blind visitors, the primary group for which the original books were printed in the nineteenth century, was a top priority.² Both the exhibit and companion symposium, “*Touch This Page! A Symposium on Access, Ability, and the Archive*,” invited scholars, designers, librarians, archivists, educators, and students to reflect on and to further experiment with design informed by the project’s central questions. How might engaging with the material qualities of objects in historical context enrich studies of politics, citizenship, identity and more? How might current and emerging technologies, including but certainly not limited to 3-D printing, be applied to the project of addressing the ongoing functional exclusion of disabled people from meaningful access to materials in archives, museums, and libraries around the world?
Disability Public History

*Touch This Page* strategically broke down a complex argument about tactile printing and reading in the nineteenth century by engaging critical disability
history. Over the past several decades, disability history has expanded in the academy as a subfield of the discipline of history and the interdiscipline of disability studies. Despite this growth and despite the near ubiquity of disability as an experience that enters most lives at some point, many individuals inside and outside scholarly circles remain unfamiliar with these analytic frameworks. Aware of the composition and varying backgrounds of its visiting publics, Touch This Page sought to provide conceptual and narrative tools from disability studies (and related arenas of research, such as technology studies) for visitors to grasp the significance of how and why tactile books were produced in particular forms in the nineteenth-century United States. The exhibit laid out a critique that explored the mixed legacy of this technological innovation—embossing raised letters and other symbols onto thick paper in books—for blind readers. Such a critique, detailed later in this essay, depended on disability history methodologies, which, among other techniques, center the experiences of disabled people as a starting point for analysis.

As a strategy to communicate disability history to this public history audience, Touch This Page deliberately deployed an anachronistic phrase—“universal design”—to help visitors understand the logics that informed the way that Samuel Gridley Howe, the first director of Perkins School, created Boston Line Type. Howe printed books that contained text in this typeface, as well as maps and other touchable graphics. In particular, the story of why Howe chose to print these tactile books in Boston Line Type, an embossed typeface of his design that consisted of raised roman alphabet letters, rather than in other kinds of tactile text that existed at the time, such as braille, formed the core of the Touch This Page narrative. In line with recent work by scholars such as Aimi Hamraie, author of Building Access: Universal Design and the Politics of Disability (2017), and Bess Williamson, who wrote Accessible America: A History of Disability and Design (2019), the exhibit directors acknowledged that universal design, as a named concept for an “aspirational ideal that describes a world built for everyone,” was developed in the twentieth century, more than a hundred years after blind readers first began reading with Boston Line Type.

The exhibit argued that Howe, the sighted director of Perkins, “was after something similar” to universal design when he developed Boston Line Type and began printing tactile books with the typeface. Howe sought to design pages that could be read both by blind people with their fingers and by sighted people with their eyes. Howe developed this goal of “universal” access following his interaction with different models of tactile printing during a trip to Europe from 1831 to 1832. He had just been appointed director of a new kind
of institution in the young United States: a school for blind children. While organized education for the blind was novel in the United States, European schools had been teaching blind students since the eighteenth century. John D. Fisher, Howe’s friend from his elite Boston social circle, had been inspired to secure funding for a US school during a trip to France in 1826. In Paris, Fisher encountered the techniques of Valentin Haüy, who taught blind persons to read and write, as well as to study mathematics and language. Back in Boston, Fisher, with the support of his friend and common school booster Horace Mann, petitioned the Massachusetts legislature to secure the initial mandate for the New England school for blind children. Fisher then appointed Howe as the school’s first director, and the school’s board agreed to sponsor Howe’s trip to Europe to prepare for his new post.

At the French school, Howe encountered two kinds of tactile printing for blind readers: alphabetic systems and the braille system. An alphabetic system, which raised the forms of the letters for readers to perceive by touch, would inspire Howe’s design of Boston Line Type back in the United States. Though Howe brought at least one braille book back to Massachusetts, he left the practice of teaching blind students to read with braille in France. Louis Braille, a blind teacher, had designed the system for blind typography that bore his name in 1829 while he was a student at the French school. Braille modified a code introduced by Charles Barbier, a sighted former artillery officer who thought that his system of rapid, encrypted writing for military applications could be of use in the new efforts to foster literacy among the French blind. One of Braille’s innovations on Barbier’s military code was to reduce the number of raised dots that represented each textual unit from twelve to six. With only six dots in each braille cell, trained readers could perceive the content of a cell with a single fingertip, which made for faster reading.

As a public history project that library patrons, staff, tourists, and others could serendipitously encounter in any of the exhibit’s first or future installations, Touch This Page prioritized a tight emphasis on Howe as an individual and the effects that his promotion of Boston Line Type had for blind readers in the United States. While the exhibit space was too small to convey a complex contextualization of nineteenth-century history and critical theory, the project is clearly indebted to deep and rich study in these fields. Thus, while Touch This Page wisely did not include phrases such as “thing theory,” “new materialism,” “agency of the nonhuman,” and “actor-network theory” in its exhibit analysis for a wide audience, the project should be understood within this intellectual context.
The exhibit hinted at some of the deeper and wider logic behind Howe’s decision to print in Boston Line Type rather than braille. Howe, the exhibit informed visitors, feared that teaching blind students to read in braille, which could not be understood by sighted readers who had learned to read ink-print with their eyes, would isolate the blind because “people will not be interested in the subject, and Blind children never will be taught except in Institutions.” Howe’s quotation on the relationship between institutions and disabled/blind education might usefully be located as part of a longer, complex history of institutions in the nineteenth-century United States and elsewhere. His ideas and practices related to tactile printing could also be placed in a larger Atlantic context alongside similar raised print systems that sought to simplify Haüy’s French system and also prioritized raised roman alphabet shapes over other systems. Howe’s enthusiasm for tactile alphabetic forms and graphics can also be situated within the history and philosophy of the senses, as co-director Weimer has done elsewhere in his study of Howe’s tactile maps and printing processes.

Starting with the history of these nineteenth-century tactile books as technological objects anchored to the lives of the disabled readers who interacted with the books at Perkins. What was really under study were the relationships between the books-as-things and the humans who produced and used them. Before the widespread production of books with Boston Line Type and tactile graphics, most blind persons would not have been able to directly access print material—a reality that became disabling in a new way as print cultures expanded in the eighteenth- and nineteenth-century Atlantic world. Benjamin Bowen, one of the first pupils at Perkins, wrote about the value of tactile books for blind readers: “The books which the blind can read themselves, and especially the Bible, furnish benefits that can never be calculated. They enable them to pass usefully many an hour which would else be spent in ennui and listlessness.” Perkins graduate Harriet Gamage, after moving back with her family in New Orleans, recounted to Howe in a letter how she used the raised-print maps from Perkins to teach her sighted nieces, enabling her to teach them geography in addition to other subjects. Perkins and other schools for the blind invested substantial time and money into Boston Line Type, and from a publishing standpoint, the typeface was very successful in the United States. Howe’s goal of inciting interest among the sighted in blind reading and education through Boston Line Type did in part succeed. As one example of the general enthusiasm for Boston Line Type, Charles Dickens paid in 1869 to have 250 copies of his novel The Old Curiosity Shop produced.
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Shop printed in the typeface. Many of the US-based schools for the blind that were founded during the years after Perkins was started were greatly influenced by Howe’s alphabetic printing system, and either relied on the Perkins press for their reading material or adopted alphabetic printing in their own presses. As a result, generations of students learned to read with Boston Line Type in the United States.  

Despite opening a channel to textual literacy to the blind readers who came into the orbit of Perkins and other schools that used Boston Line Type, the success of the typeface inhibited the spread of braille in America and had accessibility costs for the blind readers it purportedly sought to help. A trained reader using braille could typically absorb information much more quickly than someone reading Boston Line, which was also harder to learn. Not only was Boston Line Type more challenging to learn and more time-consuming to decode than braille, blind students could not themselves write in the typeface. They could produce braille, by contrast, with the aid of a stylus.

Touch This Page underscored its criticism of Howe’s investment in Boston Line Type over other systems of tactile printing by comparing this history to the suppression of sign language and the promotion of lipreading and speaking for the d/Deaf in the United States around the same time. From the mid-nineteenth century to the beginning of the twentieth, educators, philologists,
physicians, and others debated the proper modes of communication and instruction for deaf Americans. Howe himself helped establish the Clarke School for the Deaf in 1867 in Massachusetts. Alongside Mann, Howe campaigned against the instruction of sign language. “Oralists”—or those who promoted the teaching of communication techniques like lipreading and speaking in schools for deaf persons—worked to establish institutions and schools that banned or suppressed the teaching of sign language by those who came to be known
as “manualists.” Oralists like Howe and Mann thought that communicating in sign language would isolate deaf persons in a United States dominated by the hearing and speaking. So, just as Howe promoted supposedly universal forms of reading for blind and nonblind readers, such as Boston Line Type, over what he considered particular and isolating forms, such as braille, he supported purportedly universal ways of interpersonal communication, such as vocalized speaking, over the system of sign.

As those familiar with disability history know, to put the campaign for Boston Line Type in the same historical arena as the oralist campaign against sign language, as Touch This Page did, was to sharply critique the effects of the Boston Line Type project on the lives of the blind people who had to rely on Howe and other educator-philanthropists for schooling and other material and cultural resources. Scholars of Deaf history and Deaf activists have made the case that the suppression of sign deprived generations of d/Deaf individuals from an essential linguistic link to their community. In testament to the historical importance of sign as a communication tool and cultural glue, Susan Burch and others have argued that even during the height of sign suppression campaigns, Deaf students found ways to share sign with one another in institutions such as schools. Touch This Page made the case for resonance between sign suppression and the promotion of Boston Line Type over braille: Howe’s faith in Boston Line Type as a generally accessible, rather than blindness-optimized, form of printing technology functionally deprived or diminished the access of multiple generations of blind students in the United States to braille, a more effective reading technology. Because of Howe’s advocacy for his preferred raised text, braille achieved widespread relevance in the United States decades later than in France and other European countries. Perhaps, as one of the final exhibit panels of Touch This Page suggested, on some occasions “creating one design for all is at odds with maximizing accessibility for everyone.”

**Reading as Citizenship Practice**

At the “Touch This Page” symposium, a two-day event held in Boston and Cambridge, Massachusetts, during April 2019, participants gathered to discuss histories, theories, and practices related to disability and the archive, starting with the exhibit but broadening out from it and indicating directions for future research. Presenters and other attendees brought a range of experiences to the event, some with expertise in such areas as embodied and lived disability, and professional arenas related to disability education and support, disability studies
and history, and some from other fields of scholarly study, libraries, archives, the arts, journalism, and the hard sciences. While the project was wide-ranging and interdisciplinary, co-directors Altschuler and Weimer kept disability studies and politics at the center of both the exhibit and the event. This commitment was reflected in the organization of the symposium, the creative and production process of the project, and the incorporation of 3-D printing into the exhibit as both a tactile mode of reproduction and a pedagogical tool.

The reading practices that accompanied the tactile books exhibited for *Touch This Page* are indicative of eighteenth- and nineteenth-century transformations involving citizenship and subjectivity. At the symposium, Benjamin Reiss discussed the significance of the way that the blind pupils who read the tactile materials printed at Perkins were taught to read with these new technologies: silently and alone, just as sighted readers at the time were trained. Even if many of us now access our reading content on screens as well as or instead of paper, this mode of quiet, solitary reading is so familiar that it is easy to forget that it has a history of its own. As Patricia Crain has argued, it was in the early decades of the nineteenth century, the decades leading up to the first tactile books printed by Howe on the Perkins press, that new readers were taught to *internalize* the alphabet as the first step in their literacy training, and later the words, sentences, and texts that this alphabet made up, by themselves.26 Crain defines internalization as one of the components of alphabetization, which she argues “supplant[ed] rhetorical training, not only as a mode of communication but as a primary structuring of subjectivity” in early America.27 Learning to read Boston Line Type according to these practices moved the blind readers at Perkins from the margins of the US citizenry toward the center.28

Paying attention to how some blind readers were integrated into this reading citizenry in the early United States throws the boundaries of this citizenship into greater relief. The blind students at Perkins were eligible to learn this form of reading not only because of the new technologies developed by Howe but also due to their relative privilege as white, nonpoor subjects without multiple disabilities in the new United States.29 Other blind persons of all backgrounds would not have learned to read on any tactile system because they lived in their communities or had been forced to live in almshouses or asylums.30

Research on the politics of nineteenth-century communication could continue to analyze the mode of tactile reading presented in the *Touch This Page* exhibit in a wider context alongside the many other technologies and practices of communication that proliferated in an increasingly diverse United States. Nineteenth-century reading was a profoundly political practice. In many parts
of the United States, free black and enslaved persons were excluded from the reading public by law.\textsuperscript{31} In the years leading up to the onset of tactile printing at Perkins, Native communities within the borders of the new US settler state practiced multiple forms of oral and written communication that defy easy categorization as either marginalizing or integrative.\textsuperscript{32}

Idea about disability, race, and communication were also deeply enmeshed at the time that tactile books in Boston Line were printed at Perkins. In addition to using alphabetic print systems, many Cherokee notably used a system of writing, developed by the intellectual and diplomat Sequoya around 1820, that operated on a logic of syllabization rather than alphabetization: each character represented a spoken syllable rather than a letter.\textsuperscript{33} Non-Native Americans and Europeans also generated theories of communication informed by their ideas about Native peoples, including concepts about the supposedly primitive status of Native and other nonwhite groups. These theories took on new salience as scientific racism was elaborated and further embedded in mainstream discourse during the century. Such ideas, and the practices that they underwrote, were often developed alongside of ideas about disabled people, as prominent scientists and educators believed that sign language represented a more “primitive” way to communicate among the Deaf.\textsuperscript{34} Unpacking the conditions under which syllabization and other forms of nineteenth-century communication were created and used, across multiple areas of study that have often been considered separately (such as Native and disability studies), could work toward a more complete topography of nineteenth-century communication politics and power in the US and Atlantic world.

Drawing on the resources of disability studies, book history, disability theory, and the history of technology, other presenters at the symposium further contextualized the history of blind reading with the Perkins materials by analyzing how the definition of blindness changed in the time period following the Touch This Page history: the late nineteenth and twentieth centuries. Mara Mills analyzed how transformations in medical practice such as the development of new kinds of vision tests and in the state, such as how blind persons were counted in the US Census, altered and solidified the boundary between sightedness and blindness during this later period and further yoked blindness as a disability to the inability to read print.\textsuperscript{35} Mills and fellow presenter Matthew Rubery have explored how, during this same time period, the meanings of both blindness and of books themselves were further destabilized by the introduction of a new reading technology, originally for blind readers and later for others: “talking books” and other audio forms.\textsuperscript{36}
Collaborative Disability Design

A key element of the program at the “Touch This Page” symposium involved reporting out from the exhibit design process. By bringing together practitioners of disability scholarship and design to hear and to respond to the successes, failures, and roads-not-taken of Touch This Page, the project directors engaged the reflexive traditions of disability studies and politics. Just like design itself, critical pedagogy and scholarship are necessarily iterative. But, as the critical design scholar Daniela Rosner and others have shown, the dominant paradigms of design and technology do not always align with feminist and other traditions of liberatory praxis; alternative narratives and practices are necessary to counter and rework these paradigms. By sharing the nuts-and-bolts of project production of the exhibit with symposium participants, the Touch This Page team invited future projects to learn from their design experiences.

From the project’s inception, the Touch This Page exhibit co-directors took care to coordinate the successful completion of a meaningful collaborative project that involved both disability topics and undergraduate participation. Touch This Page intentionally incorporated disability expertise into the production of the exhibit, including the development of the 3-D prints and the presentation of exhibit material. For the exhibit, Touch This Page designed a blindness-accessible installation that used multisensory engagement to encourage its visiting publics to think about ability and disability as situated and constructed, rather than as an inherently embodied phenomena—a key lesson of the past several decades of disability studies research and disability politics.

Thoughtful planning and implementation guided the multi- and interdisciplinary collaborations that produced Touch This Page. The directors, both trained as scholars of literary history, teamed up with the Enabling Engineering undergraduate design group at Northeastern University to produce and refine the 3-D prints. Enabling Engineering has developed as a durable program that provides support, funding, and equipment for students to work closely with disabled individuals and groups who have requested designs from the group. For Touch This Page, Enabling Engineering additionally drew on the disability expertise of the humanists involved in the project throughout the 3-D-printing production process. Disability scholars and professionals working in disability spaces make up the Touch This Page Advisory Board, and at least half of the board identifies as blind and/or disabled. In particular, board member Kim Charlson, who is herself blind, contributed multiple forms of expertise to the process, from the design of the 3-D-printed plastic book pieces to the
way that the exhibit tables were built to display the 3-D prints. Through her connections at Perkins, she gathered input from other blind consultants to evaluate successive iterations of the prints, from which the engineering team learned as they improved the quality of the plastic pieces. For example, when she felt the plastic-printed Boston Line Type on the first round of 3-D-print prototypes, Charlson reported that the rough surfaces and sharp edges of the prints were “tactilely offensive” to her braille-trained fingers. After multiple cycles of design and testing, the team managed to smooth out some of the roughness of the exhibit prints while still maintaining enough relief to feel the tactile letters and graphics.

Some of the most meaningful accessibility features for visitors to the Touch This Page exhibit, especially for braille-trained readers, included fairly low-tech design decisions related to the way that the 3-D prints were presented in their installation spaces. Another example of Charlson’s design intervention in Touch This Page was her suggestion to affix the braille exhibit text panels to horizontal or gently sloping surfaces rather than vertical ones. A nonblind person might have placed braille text on a vertical panel, similar to the way that the visual text for the exhibit was displayed. Charlson drew on her embodied knowledge as an experienced braille reader and her professional experience working on other public installations of braille text to note that reading braille on a vertical surface can be difficult and tiring. Placing braille on a gently sloping horizontal surface better supports the wrists and hands of the reader.41 As performance studies scholars and others have shown, all built environments and objects invite and direct particular kinds of interactions from visitors.42 Design decisions in museums and other public spaces have the potential to send messages to disabled visitors that their interaction and presence are invited, welcomed, and celebrated, extending “access” beyond mere compliance with legal requirements for disability accommodation.

Touch This Page used accessible exhibit design as an opportunity to script visitors to consider the situatedness of disability and ability in both their lives and in the specific nineteenth-century context of the history presented. The tactile text and graphics from the Perkins books were 3-D printed for all visitors to feel, meaning that both blind and sighted visitors could access the facsimiles of the books. However, most of these visitors (blind and sighted) were unable to understand the content-meaning of the text and graphics when they relied solely on direct touch engagement with the 3-D-printed pieces. In some part this difficulty of perceiving the 3-D prints through touch alone was due to the rough texture of the inexpensive plastic used in the printing process. However,
such difficulty is also testament to the way that reading consists not only of sensory experiences but also of cognitive processes. As Rubery reminded “Touch This Page” symposium attendees, reading happens at least as much in the mind as it does in the fingers or the eyes. Visitors to the exhibit learned that diligent practice was required of nineteenth-century readers of tactile prints to master the translation of sensations apprehended by their fingers into meaningful concepts. One blind reader, Henry Stephens, described this difficult process in 1891. Writing for the Perkins alumni magazine, the Mentor, Stephens told of the several months he devoted to learning to read Boston Line Type. He often “[spent] entire days and evenings fingering a single page,” demonstrating “an amount of patience which would have done credit to Job of old,” who, as Stephens wryly pointed out, “never had to learn to read line print.”

Even alphabetic literacy in Boston Line did not necessarily mean that readers, in the nineteenth or twenty-first centuries, would understand the content-meaning of all the tactile prints on exhibit in Touch This Page, especially the tactile graphics. These graphics, including images of four snowflakes, a diagram of a lunar eclipse, and a map of Massachusetts, suggested the complexity of these embodied cognitive processes that make up reading. Interacting with the graphics as a form of technology to aid in the understanding of abstract phenomena encouraged visitors to consider how all reading technologies are assistive—not just those associated with disability. As one example, the raised image of the snowflakes “makes tactile that which even sighted students could not observe directly in nature without the assistance of a microscope.” In a similar vein, the tactile eclipse diagram, which used lines, symbols, and cross-hatching to communicate to readers how the moon comes between the sun and the earth during a lunar eclipse, is an abstraction of a cosmic event rather than an image of a visual phenomenon found in nature that a sighted person could see. The map is similarly an abstract representation of geographic space. Just as nineteenth-century readers would likely have required contextualization to make sense of these tactile graphics when encountering them for the first time, blind and sighted visitors to Touch This Page likely also needed to turn to the exhibit text, which was offered in braille, audio, and visual-print forms.

3-D Printing as Public History

All visitors to the Touch This Page exhibit realized a version of Howe’s dream of a page that both blind and sighted people could interact with when they felt the 3-D-printed plastic book pieces at the tables. From a museum studies
and pedagogical standpoint, the incorporation of 3-D printing is one of the most attention-grabbing elements of Touch This Page. Museums and cultural institutions have been key sites where 3-D printing as a digital fabrication tool has been applied over the past few years. Other educational spaces and DIY-oriented “makerspaces” are additionally engaging the technology on a growing scale. The Touch This Page design team generated facsimiles of the tactile books at Perkins that drew on trends in both these areas. Replicas of cultural artifacts have been produced, of course, for far longer than 3-D printing has been around. However, 3-D printing has afforded new possibilities for replication and dissemination, as well as generated new questions about immanence and ownership of objects. 48 3-D printing projects supported by sufficient funding can scan, edit, and print replicas in a wide range of materials, including ceramic and different kinds of metals. When skilled and experienced designers and technicians use the most sophisticated technology available, it is possible to produce 3-D prints with a high degree of fidelity to certain qualities of the object. In this process, 3-D scanners capture the shape of the objects with newly available accuracy.

The Touch This Page design team chose to make 3-D-printable archival facsimiles that were compatible with most widely available and least-expensive 3-D-printing technologies. Techniques other than 3-D printing could have been used to produce custom one-off replicas of the embossed and bound tactile books.49 However, creating 3-D prints of the books tapped into the possibilities for wider sharing and pedagogical engagement with both the facsimiles themselves and the disability history critique that the prints introduced to visitors. The pieces have been posted online as files for anyone to download and print, meaning that the history and objects from Touch This Page could travel far beyond the original exhibit locations. One could imagine the pieces put to use to teach the history of the book, disability, and material culture, or in a digital humanities practicum. In the spirit of this wide engagement, the Touch This Page design team selected PLA (polylactic acid) plastic for its printing medium. PLA is a popular and inexpensive 3-D-printing material used by many of the desktop printers that have been widely installed in schools, libraries, makerspaces, and homes in recent years.50

The Touch This Page design team produced the files for the 3-D prints of the Perkins tactile books using a 3-D scanner to generate digital renderings of the books, which they then manipulated using modeling software. The tactile books from the Perkins archives are physically large; to print them at scale would exceed the capacity of a standard desktop 3-D printer. Such printers
read the digital files and extrude thin layers of plastic to build the pieces on a printing bed, layer by layer. To create 3-D prints with text and graphics large enough for most people to perceive with their fingers, but small enough to fit the printing beds of these types of printers, the design team created digital models that might be described as pieces or slices of the original book shape.

To try out the public reproducibility of the Touch This Page book pieces, I downloaded the files from the exhibit website and printed some of them at three public libraries. I had neither a technical background nor prior experience with 3-D printing. While desktop 3-D printers have become relatively affordable and widely available in the span of just a few years, the technology is still very new in public and educational spaces such as libraries and schools. Policies on use vary widely from location to location. I was generally allowed to print only in libraries where patrons do
not themselves print the pieces; rather, they can put in orders for a technology specialist or librarian to print a piece for them. The *Touch This Page* print files are richly detailed, high-quality scans, and several of my pieces printed beautifully.

I did find that with current and widely available technology, using 3-D printers to generate facsimiles of the Perkins tactile books posed certain challenges. In part because the files are so detailed, and because some prints measure an inch or more in thickness, the pieces took between ten and fifteen hours to print. For a custom job for a museum or for an industrial job, this would actually be a fairly short print. However, for a printer open to the public or used by many people in a library or a school, ten to fifteen hours is a long time. For example, at the Topeka and Shawnee County Public Library in Kansas, an award-winning public library and a public space of great use in other ways to the community, print times were limited to three hours, a prohibitively short window for the *Touch This Page* files.

Some of my pieces warped during printing or variously generated overly smooth or exceedingly rough versions of the tactile graphics and letters. 3-D
Figure 6.
A plastic 3-D-printed facsimile of a tactile book. The blue plastic piece has been turned to stand on its side on a white background in a vertical orientation that demonstrates the thickness and curvature of the 3-D-printed piece. The text on what has now become the left side of the print contains text, which is not legible in this view, from *Hamlet*. The 3-D-print file was scanned from “To be or not to be,” from *Hamlet* (1885), Perkins School for the Blind Archives, Watertown, Massachusetts. Printed at the Hockessin Public Library in Hockessin, Delaware. Downloaded and printed from touchthispage.com/downloads. Photograph by Donna Molinda.

printers can be temperamental, affected by humidity and other variables. There are seemingly endless ways to tinker with the settings on the printer, the printing environment, and the digital files to maximize the quality of the print. Some of the technology specialists and librarians I worked with were intrigued by
the project and game to apply their printing skills to experiment with me in maximizing the way that the files printed on their specific machines. As one example of this experimentation, we digitally hollowed out some of the files and experimented with slightly reducing the size of the prints in an effort to shorten the print times. We learned that too much of a reduction renders the tactile text and graphics imperceptible to most fingers. This kind of iterative tinkering is an important part of the kind of desktop 3-D printing with which Touch This Page engaged and should be considered in future public history projects involving the technology with its current capabilities.

While most libraries probably cannot staff support for this kind of guided work with patrons, many do offer 3-D-printing classes where attendees can become certified to use the design software and the printers themselves during designated times. Interested amateur printers and “makers” can engage with the process in places other than libraries, too. Many schools and universities have invested in 3-D printers, and prices for personal printers have come down significantly in the past few years. With membership at a private or semipublic “makerspace,” subscribers can pay for membership on a month-to-month basis to use not only 3-D printers but a host of other machines to engage in do-it-yourself projects. This kind of iteration and experimentation, especially plugged into an institutional space like a school, museum, or other educational setting, seems like one of the promising potential futures for the Touch This Page 3-D-print files and files that might be generated for similar projects.

My experience tinkering with the Touch This Page prints in collaboration with library workers and other makers underscored that despite the tactile qualities and potential accessibility applications of 3-D printing, 3-D printing does not itself meaningfully usher in accessibility in these spaces. One theme raised repeatedly at the “Touch This Page” symposium was that of expertise: who has been cast as the expert in these various design processes, and more specifically, are disabled people assuming expert roles in them? With respect to 3-D printing specifically, the modeling software used to generate 3-D-print files generally involves visual manipulation on a screen of two-dimensional digital representations of three-dimensional objects. Blind designers with some useable sight and who use digital magnification software can access these programs, but the programs are not easily paired with screen readers, which convert text on screens to audio forms. There are some open-source possibilities for blind designers who both use screen readers and possess advanced coding skills, but much could be done to improve the accessibility in these programs.

Even so, Touch This Page’s incorporation of 3-D printing, with its charisma for future engagement and reproducibility, makes the project a notable con-
tribution to the landscape of public history projects that use the technology. As the Perkins archivist Jen Hale suggested, the plastic prints in *Touch This Page* function less as replicas of the original tactile books than as objects in their own right that invite novel engagement with this history. Hale admitted that she had been at first skeptical of *Touch This Page*’s entanglement with 3-D printing. She feared that the 3-D prints would fall short of reproducing some of the most interesting and uniquely immanent qualities of the Perkins originals. However, her feelings had changed by the end of the project. The book pieces, with their crisp plastic surfaces and bright colors, had a toy-like quality that invited engagement and play. These observations underscored the value of the *Touch This Page* 3-D prints as educational tools for popularizing the project’s disability history.

Like all forms of copying and reproduction, 3-D printing is better suited to reproduce some features of the original object than others, at least right now. 3-D printing can be a highly accurate way to communicate the shape of the original object. However, some current forms of the process, including the inexpensive desktop printing with plastic for which the *Touch This Page* pieces were designed, are less suited to transmit the texture, temperature, and other qualities the objects they seek to copy. It may be possible in the near future to communicate these features across distance with other emerging technologies that straddle the line between the digital and the material, especially if the high prices of these technologies are lowered. “*Touch This Page*” symposium presenters Emilie Hardman and Brian MacDonald introduced some of these technologies that might be applied to capture various tactile properties of cultural objects, such as haptic gloves developed for virtual-reality gaming and screens that transmit tactile sensations such as texture and temperature to the fingertips via electrical currents. In the case of *Touch This Page*, low-tech craft techniques, such as bookbinding and paper embossing, could have been used to generate replicas of the nineteenth-century books. Of course, while this design route could have potentially generated book copies that hewed more closely to the materiality of the originals, it would have missed the aforementioned pedagogical and interdisciplinary opportunities afforded by 3-D printing with plastic. The design team was in any case less interested in reproducing the books themselves in their totality, with turnable pages and bindings. The more important goal was to copy the raised surface of the book pages with as much fidelity to the original spacing of the letters and formal elements of the diagrams as possible. For this aim, 3-D printing with PLA plastic did produce reasonably successful facsimiles.
3-D printing is one method for creating touch-accessible replicas, but the conversation surrounding disability accessibility in museums extends far beyond just making copies of historical objects; facilitating direct engagement with original objects is another strategy.60 Touch This Page Advisory Board member Georgina Kleege has written about her experience as a blind person on “touch tours” in art museums around the world, during which blind visitors are invited, usually with the guidance of a docent, to explore the art objects via touch. Direct engagement with the originals themselves “engage[s] the full spectrum of touch sensation—texture, temperature, resiliency, as well as form—and draw[s] attention to features that are not apparent to the naked eye.”61 Kleege makes the case for museums to consider touch tours for the blind not as a “pity project” but as an opportunity for the museums to gather information from this unique visiting population to deepen understanding of the artwork itself. Reframings such as Kleege’s posit the disability of blindness as a generative and creative site rather than, in what has become a more familiar narrative to those unfamiliar with disability-positive politics, as a lack. Disability activists and scholars working at the intersection of disability, queer, and literary studies have theorized such “crip” ways of knowing and being as resources for a joyful and subversive disability politics.62 As another example of this dynamic in a different disability context, Gillian Silverman has studied the affinities between the ways that many autistic persons and book scholars interact with books. Silverman points out that both groups attend to the “material properties of texts and the embodied features of reading,” suggesting a underappreciated value in nonnormative ways of reading and knowing and calling for scholars of the book to pay greater heed to these disabled ways of reading.63 Autistic reading suggests that meaning is missed when texts are engaged merely on a semantic level.64 By encouraging its visitors to heed the materiality of reading in history through a specific and textured deep-dive into blind reading in the nineteenth-century United States, Touch This Page operated in this space of disability gain and possibility.

Touch This Page encouraged visitors to consider and critique a specific attempt to design for accessibility in the past. Such a critique pointed to the trade-offs in everyday politics, a dynamic echoed in a later episode in accessible design history. In 1985 the architect and wheelchair user Robert Mace coined the term universal design as a strategy to convince designers to account for the needs of disabled people. He proposed the concept of universal design in the context of a backlash against designing for the disabled. Aware of this backlash against laws passed in the 1960s and 1970s that legislated toward greater
inclusion of the disabled, Mace made the case that designing for “everyone,” rather than what was perceived to be a niche group of people with identifiable disabilities, would benefit all.65 “Universal design” has traveled widely from this original architectural context and has held great appeal in a wide range of design settings. Critics have subsequently called attention to the ways that applications of universal design since 1985 have often erased the contributions of disabled people to original designs, removed disabled people from marketing and use, and designed for imagined rather than actual needs of disabled people.66 Such applications and circulations of Mace’s strategic phrase missed or ignored the political impulse behind its creation.

This history of universal design in the twentieth century may, then, offer a resonant case for understanding both the history covered in the Touch This Page exhibit and the project itself. In the nineteenth century, as Touch This Page has argued, Samuel Gridley Howe prioritized a political pitch to sighted society over the needs of the blind readers for whom tactile books were ostensibly designed. Howe hoped that his universal page would stave off isolation and marginalization of the blind as a minority group in the nineteenth-century United States. His success in boosting Boston Line Type meant that many blind readers in the United States did not learn to read braille, a reading and writing system designed by a blind person that would be adopted in European contexts decades before braille reading became widespread in the United States.

The Touch This Page design process, which reproduced and shared facsimiles of these tactile books in a new, twenty-first century context, also required negotiation and, at times, trade-offs. Choosing the inexpensive and popular reproduction process of desktop 3-D printing to produce facsimiles afforded mass reproducibility. The prints were generated through interdisciplinary collaboration and could be applied to future pedagogical contexts. Crucially, 3-D printing provided a reproduction technique that made the tactile features of the nineteenth-century books as historical objects directly accessible to blind users in the twenty-first century. Museums, libraries, and educational sites should take this technique seriously, especially considering that other widely used techniques of reproduction, such as photography, are highly visual and functionally exclude many blind persons. However, the promise of 3-D printing must be tempered with a realistic assessment of the current state of the technology. A good amount of tinkering time is necessary to build the expertise to produce decent-quality 3-D prints from scanned files. Of course, Touch This Page never claimed that the prints are exact copies of the books, and indeed, even top-quality prints in PLA plastic do not communicate the texture, smell, and other features of the original archival objects. There would be no more
fitting uptake of Touch This Page than for its interlocutors to pick up where the project left off and to apply its lessons in future accessibility work. This broader and ongoing project requires attention to the politics of the material world, and Touch This Page has invited a potentially wide audience to think and act in this register. Finally, all project teams would do well to model the reflexivity and care in the design and presentation of Touch This Page. Perhaps they would also realize that acting in the space created by critique produces the raw materials for fresh critical action.

Notes

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1. When the institution that became Perkins School for the Blind (the name that the school bears today) was first incorporated in 1829, it was called the New England Asylum for the Blind. The name was changed shortly thereafter to the New England Institution for the Education of the Blind, and again in 1839 to Perkins following Thomas Handasyd Perkins’s donation of his home to the school. For convenience, I have referred to the institution as “Perkins” in this essay.

2. Following Touch this Page Advisory Board member Georgina Kleege, I primarily use the designation blind and variations on blindness to “encompass the widest possible range of visual impairments.” This alternative to phrasing qualifies between different forms of blindness, such as low vision or visually impaired. Many people in the English-speaking world today who identify themselves as blind or have been identified by medical professionals or in another way as blind have some eyesight, light perception, and/or usable vision. See Kleege, More Than Meets the Eye: What Blindness Brings to Art (New York: Oxford University Press, 2018), 4.


5. “Samuel Gridley Howe and Universal Design.”


9. Military personnel could send encoded messages by punching dots into paper. Messages could be interpreted by hand without lamplight, which might disclose a strategic position—hence the code’s original name: écriture nocturne (“night writing”).

10. On Barbier’s and Braille’s work on blind reading and writing in France, see Weygand, Blind in French Society, 273–92. NB: I have followed the standard of the Braille Authority of North America, which recommends that when referring to the system of reading and writing with raised dots to write “braille” without a capital letter at the beginning. When referring to Louis Braille, the inventor of this system, appropriate capitalization of “Braille” as a proper noun should be used. See “Capitalization Style for the Word ‘Braille’: A Position Statement of the Braille Authority of North America,” Braille Authority of North America, 2006, www.brailleauthority.org/capitalization/capitalization.pdf.


12. “Samuel Gridley Howe and Universal Design.”

13. Beginning in the 1960s and 1970s, inspired partly by both Foucauldian frameworks and deinstitutionalization politics from the same period, scholars began to generate a large literature related to the eighteenth- and nineteenth-century proliferation of institutions. Key early works were produced by scholars indebted to social theoretical, historical, sociological, and history of medicine approaches: Michel Foucault, Discipline and Punish: The Birth of the Prison (New York: Pantheon Books, 1977); David J. Rothman, The Discovery of the Asylum: Social Order and Disorder in the New Republic, rev. ed. (Boston: Little, Brown, 1990); Gerald N. Grob, From Asylum to Community: Mental Health Policy in Modern America (Princeton, NJ: Princeton University Press, 1991); Grob, The Mad among Us: A
Blindness and Education from Nineteenth-Century Tactile Books to Twenty-First-Century 3-D Printing


15. Weimer, “To Touch a Sighted World.”


21. While braille may be easier to learn than Boston Line Type, learning braille is often still a difficult process, especially for readers who become blind later in life (Matthew Rubery, “Histories of Access panel, “Touch This Page! A Symposium on Ability, Access, and the Archive,” Harvard University, April 5, 2019). In addition to its central story of blind printing and reading in the United States, the exhibit briefly introduced visitors to the contributions of the British educator William Moon, who was himself blind, to the landscape of nineteenth-century tactile reading. Moon’s system combined the ease of use for blind readers of the braille system with the basis in alphabetic forms of systems such as Boston Line Type. Moon’s typeface was informed by both his professional expertise as a director for a school for blind students and his embodied expertise as blind person. Unlike Boston Line Type, which is no longer used widely today, Moon Type is still used in some parts of the world for blind readers whose fingers do not have the haptic sensitivity to perceive the small and fine dots of braille (“Cost of Success”).

22. Here I use the notation d/Deaf, which signifies the heterogeneity in disability and other communities related to the word and recognizes the historical innovation of this capitalization as political practice with twentieth-century roots. In this newer usage, Deaf refers to the community of Deaf persons, a positive and self-consciously political collectivity, rather than the auditory condition of deafness that the lowercase d connotes. As a starting point for this distinction, see Susan Burch, *Signs of Resistance: American Deaf Cultural History, 1900 to World War II* (New York: NYU Press, 2002), 2. On a significant event in twentieth-century Deaf politics, see John B. Christiansen and Sharon N. Barnartt, *Deaf President Now! The 1988 Revolution at Gallaudet University* (Washington, DC: Gallaudet University Press, 2012).
While the late nineteenth and twentieth centuries gave rise to organized blindness movements led by the blind in multiple local, national, and transnational contexts, self-consciously political blind persons and organizations have not widely adopted a widespread capitalization practice for the word "blind.


25. “Cost of Success.”


27. Crain, 5.


30. In her biography of Anne Sullivan Macy, Kim Nielsen has written about Sullivan Macy’s navigation of the shifting and various landscape of nineteenth-century institutions. Sullivan Macy is most well-known for her role as teacher and friend to Helen Keller, who is today one of the most famous deafblind public intellectuals. Less well-known is that Sullivan Macy was herself blind for much of her life; she received her assignment to teach Keller after studying at Perkins. Before Perkins, Sullivan Macy had been sent to the Massachusetts State Almshouse at Tewksbury. Tewksbury, one of several similar institutions founded in the 1850s, was founded as part of a nativist response to increased immigration from Ireland and was intended for indigent immigrants. Sullivan Macy was the child of poor Irish immigrants and was sent to Tewksbury with her younger brother after her mother died and her father could not or did not want to support them. When Sullivan Macy arrived at Tewksbury at the age of ten in 1876, at least nine hundred inmates lived in a building designed for five hundred. Sullivan Macy spoke little of her time in Tewksbury, though in unpublished and lightly fictionalized writings she produced later in life, she wrote about the trauma endured at “Dookesbury Asylum” by “Johannah Dunnivan.” Sullivan Macy herself had left Tewksbury for Perkins in 1880. She may have heard about Perkins from another blind inmate at Tewksbury and convinced a state inspector to sponsor her transfer to the school. See Kim E. Nielsen, Beyond the Miracle Worker: The Remarkable Life of Anne Sullivan Macy and Her Extraordinary Friendship with Helen Keller (Boston: Beacon, 2009), 13–35.


32. Reading and writing in European languages that used alphabetic systems was a fraught practice for Native Americans. The valences and stakes of literacy varied greatly among Native groups and changed over time. This form of literacy was one of the tools used by white settlers to convert Native Americans to Christianity. Teaching reading and writing was also a practice of the abusive boarding schools to which white settlers forcibly sent Indian children over the course of the nineteenth century. However, for some Native groups and individuals, alphabetic literacy was empowering and became a tool for making sovereignty and other claims to the US state. See Philip J. Deloria, “Historiography,” in A Companion to American Indian History, ed. Philip J. Deloria and Neal Salisbury (Malden, MA: Blackwell, 2002), 6; Clara Sue Kidwell, “Native American Systems of Knowledge,” in Deloria and Salisbury, Companion to American Indian History, 87–102; Sean P. Harvey, Native Tongues: Colonialism and Race from Encounter to the Reservation (Cambridge, MA: Harvard University Press, 2015); Harvey,


34. Baynton, *Forbidden Signs*.


39. “About Us—Enabling Engineering,” accessed July 18, 2019, enablingengineering.org/about. Jocelyn Maffin has written about how many of the slick wheelchair models proposed by design students have little use to actual wheelchair users or could be useful but have little chance of ever moving from conceptual proposal to actual design. Maffin and others, such as the design educator Emeline Brulé, seek not to shut down innovative disability-centered design and experimentation but to propose best practices that translate the lessons of disability activism and justice into these pedagogical projects. See Maffin, “Dear Industrial Designers and Engineering Students: Just . . . STOP,” *Spinal Cord Injury BC* (blog), January 25, 2018, sci-bc.ca/wheeled-mobility/; Emeline Brulé, “On Teaching Disability Design, Design Projects, and ‘Disability Dongles,’” *Design and Society*, April 24, 2019, sociodesign.hypotheses.org/2019/04/24/on-teaching-design-and-disability-and-disability-dongles/.

40. All the principal individual players on the *Touch This Page* team, including members of the Advisory Board, were employed and/or supported by educational institutions. The not-for-profit project was funded by some of these institutions, including Perkins School for the Blind, Northeastern University (the provost’s office, Enabling Engineering, and the Northeastern Library), and the Harvard Library. Many disabled people are not affiliated with institutions and do not have access to the resources and power brought by this kind of affiliation. While this consideration was thus not directly relevant for *Touch This Page*, future projects that incorporate the labor and expertise of disabled persons should be aware of and address these and other forms of precarity in knowledge-work. On disabled designers and culture-makers, see Alice Wong, “Ep 47: Design with Liz Jackson,” *Disability Visibility Project* (podcast), accessed July 18, 2019, disabilityvisibilityproject.com/2019/03/24/ep-47-design-with-liz-jackson/. On disability in higher education, see Margaret Price, “The Precarity of Disability/Studies in Academe,” in *Precarious Rhetorics*, ed. Wendy S. Hesford, Adela C. Licona, and Christa Teston (Columbus: Ohio State University Press, 2018), 191–211; Jay T. Dolmage, *Academic Ableism: Disability and Higher Education* (Ann Arbor: University of Michigan Press, 2017).

41. Kim Charlson, interview with the author, April 18, 2019; Sari Altschuler, phone interview with the author, April 19, 2019.


45. As Katherine Ott has pointed out, all technology is by definition assistive, but “assistive technology” has become historically defined as something related to disability, an association which, in Ott’s words, “denigrated” “entire classes of artifacts” (“Material Culture, Technology, and the Body in Disability History,” 129).


49. Such techniques include bookbinding and/or embossing with stiff paper, wood carving with laser cutting or methods, and other processes. Thanks to David Corr for discussing 3-D printing with me and demonstrating some of the possibilities of the 3-D printers and other “makerspace” machines at the Arts & Craftsmen Workshop in Topeka, Kansas (Corr, interview with the author, June 12–13, 2019). Thermal expansion printers can also produce raised images and text. Images and text are printed with ink on specifically designed paper and fed through a thermal expansion printer. The machine recognizes the black ink and applies heat to the inked regions to produce a raised print. See Robert S. Jaquiss, “Tactile Images and You: A Comparison of Thermal Expansion Machines,” Braille Monitor, May 2003, nb.org/images/nfb/publications/bm/bm03/bm0305/bm030507.htm.

50. Future scholarship might productively consider the phenomenon of desktop 3-D printing with PLA plastic from environmental history perspectives, deepening a tradition of seeking to understand disability in the Anthropocene begun by writers, scholars, and artists such as Eli Clare and Sunaura Taylor. See Eli Clare, Exile and Pride: Disability, Queerness, and Liberation; and Sunaura Taylor, Beasts of Burden: Animal and Disability Liberation (New York: New Press, 2016). Scholars of photography and other mass-produced representational media have begun to explore the relationships between the materials and labor processes that produce images and other representations; such methodologies could also be applied to 3-D printing. For a suggestive interpretation of the material economy of photography as well as of more recent digital technologies, see Robin Kelsey’s contribution in the forum “Notes from the Field: Materiality,” Art Bulletin 95.1 (2013): 21–23.


52. Anecdotally, some of these policies may have been developed in response to concerns about patrons putting 3-D printing to dangerous or otherwise undesirable ends, such as the 3-D printing of weapons. Some libraries might also restrict print times to prevent large-scale or for-profit projects. For my small-scale printing requests, I was not charged by these libraries to print, though one location did limit me to one print per week. In my nonscientific sample of a small group of libraries, I did encounter one library that charged for prints.

53. Researchers who surveyed Thingiverse, a repository of downloadable 3-D printing files that is popular within the maker community, found that despite the potential of 3-D printing for designing accessible
technology within this community, assistive technologies were vastly underrepresented on the website. And, of the assistive designs that were posted, complex and flashy prosthetics or similar designs were more likely to receive attention, including “likes” and “makes,” than simpler but potentially beneficial designs, such as a “bottle opener designed for users with limited dexterity.” See Erin Buchler, Stacy Branham, Abdullah Ali, Jeremy J. Chang, Megan Hofmann, Amy Hurst, Shaun K. Kane, “Sharing Is Caring: Assistive Technology Designs on Thingiverse,” in Proceedings of the Thirty-Third Annual ACM Conference on Human Factors in Computing Systems, CHI ’15 (New York: ACM, 2015), 525–34, www.firah.org/upload/notices3/2015/sharing-is-caring-assistive-technology-designs-on-thingiverse-notice-a-metitre-en-ligne.pdf. As “Touch This Page” symposium participant Meryl Alper has written, there is much potential to generate what she has called a “mixed-ability maker culture,” which she defines as “a collaborative culture within which people with and without disabilities can co-exist and co-create as they work to maximize and develop their skills.” Such a culture would include both “making useful things for people with disabilities” and, significantly, “getting people with disabilities involved in making.” See Alper, “Making Space in the Makerspace: Building a Mixed-Ability Maker Culture,” 2013, 1, teethingontech.files.wordpress.com/2013/03/ide13-workshop_meryl-alper.pdf. There are some models and guidelines for these kinds of inclusive and disability-accessible makerspaces, but accessible and inclusive design for disabled makers remains far from a mainstream practice. The DO-IT (Disabilities, Opportunities, Internetworking, and Technology) Center at the University of Washington has put together a guide for creating accessible makerspaces: “Making a Makerspace: Guidelines for Accessibility and Universal Design,” DO-IT Center, accessed June 16, 2019, www.washington.edu/doi/making-makerspace-guidelines-accessibility-and-universal-design. One example of a blindness-specific craft space is the Colorado Center for the Blind (CCB) woodshop and home maintenance workshop. All the blind and low-vision students who come to the center for orientation training learn how to use the “saw, chop saw, drill press, lathe, planer and more” with “confidence” (“Woodshop & Home Maintenance,” Colorado Center for the Blind, accessed June 13, 2019, cocenter.org/our-programs/independence-training/woodshop-home-maintenance/).

I thank Jacob Ayers, digital fabrication and design specialist at the Indiana School for the Blind and Visually Impaired, and Chancey Fleet, assistive technology coordinator at the Andrew Heiskell Braille and Talking Book Library at New York Public Library, for our conversations on 3-D printing and accessibility for designers with visual disabilities, as well as on the nuts-and-bolts of tactile printing processes (Ayers, phone conversation with the author, June 20, 2019; Fleet, phone conversation with the author, August 13, 2019).

At the MediaLab of the Metropolitan Museum of Art, two interns used 3-D-printed versions of 3-D-scanned art objects from the museum to create food molds. Users could then pour chocolate into the molds to create edible versions of the art objects. This project represents a kind of public history engagement with 3-D printing where the goal is to generate conversation and interest in the history in a new way. See Jimmy Tang and Yuanjin Zhao, “Edible Met: Eating Art to Understand,” Metropolitan Museum of Art, June 9, 2015, www.metmuseum.org/blogs/digital-underground/2015/edible-met. Jennifer Hale, “Community Collaborations” panel, “Touch This Page! A Symposium on Ability, Access, and the Archive,” Harvard University, April 5, 2019.

Scholars in American studies and related fields have much to offer in the theorization and critique of 3-D printing as a newly popular and more readily available mass-producible and mass-reproducible representational process. The popularity of relatively inexpensive desktop 3-D printing, a decentralized mass-market digital-material technology, during an era of neoliberalism and techno-obsession, invites further sustained inquiry. Scholars such as “Touch This Page” symposium participant Robert McRuer have begun to situate the ways that representations of disability, including but not limited to representations in advertisements, videos, and internet memes, have been used to support neoliberal projects such as austerity measures, which harm many disabled people by cutting back on programs upon which they rely. Considering the circulation of 3-D-printed objects related to disability may continue to deepen a critical understanding of the logics and imperatives of neoliberalism. See Robert McRuer, Crip Times: Disability, Globalization, and Resistance (New York: New York University Press, 2018).

Since the exhibit was designed for repeated interactions with visitors over the course of several months, durability of the tactile materials would have also been a factor to consider in design.

While museums and archives have long exhibited their material for pedagogical purposes in situ or with traveling exhibitions, creating multiple replicas for ‘Touch This Page’ allowed for simultaneous exhibition of the tactile books’ touchable qualities. Several exhibitions over the past five years have shared original tactile books produced in various national contexts with visiting publics: “Touching the Book: Embossed Literature for Blind People in the Nineteenth Century” (2013), curated by Heather Tilley, and “How We Read: A Sensory History of Books for Blind People” (2014), curated by Tilley and Matthew Rubery, exhibited primarily British tactile books at the Peltz Gallery in London. These exhibitions incorporated interactive tours and a variety of accessibility features for visitors with visual disabilities to explore the exhibit themselves, such as magnifying glasses, enlarged images of the exhibition objects, relief drawings of objects, and image descriptions. See “How We Read: A Sensory History of Books for Blind People,” accessed July 16, 2019, www.howweread.co.uk/; and “Touching the Book: Embossed Literature for Blind People in the Nineteenth Century,” accessed July 16, 2019, blogs.bbk.ac.uk/touchingthebook/. In 2015 and 2016 the scholar and curator Vanessa Warne traveled with tactile books from the University of Manitoba Archives & Special Collections for “Books without Ink: Reading, Writing and Blindness, 1830–1930.” Warne led workshops in the various exhibition stops that guided visitors through interactive and contextualized experience with the books as objects. See University of Manitoba Archives & Special Collections, Books without Ink Exhibit Video, 2015, www.youtube.com/watch?v=GNQ6xUZlO58.

Kleege, More Than Meets the Eye, 11, 60–73; For meditations on and analyses of blindness and art in diverse contexts, see “Blindness Arts,” special issue, ed. Hannah Thompson and Vanessa Warne, Disability Studies Quarterly 38.3 (2018), dsq-sds.org/issue/view/160.

Crip in disability justice and activist movements performs similar work to queer in these circles, reclaiming a word which has origins as a slur against disabled people and transforming it into a positive and political identification. In the words of Sunaura Taylor: “Many disabled people identify as crips, and to crip something does not mean to break it but to radically and creatively invest it with disability history, politics, and pride while simultaneously questioning paradigms of independence, normally, and medicalization,” (Taylor, Beasts of Burden, 12).

Gillian Silverman, “Neurodiversity and the Revision of Book History,” PMLA 131.2 (2016): 307. “‘Touch This Page’ symposium presenter Rachel Adams prompted conference participants to consider disability categories other than blindness, such as intellectual disability, in discussions of art and museum practice. Adams’s presentation featured the work and story of the fiber sculptor Judith Scott, who lived with Down Syndrome and deafness and had been separated from her twin sister and family in 1950, and confined to an institution for more than thirty years on the advice of medical professionals. Rachel Adams, “Theories and Technologies of Access” panel, “‘Touch This Page! A Symposium on Ability, Access, and the Archive,” Harvard University, April 5, 2019.

Silverman; Reiss, “Histories of Access” panel; Adams, “Theories and Technologies of Access” panel.

Williamson, Accessible America, 148.

Williamson, 147–216; Liz Jackson, “We Are the Original Lifehackers,” New York Times, May 30, 2018, www.nytimes.com/2018/05/30/opinion/disability-design-lifehacks.html. Mara Mills has theorized the “assistive pretext” in another context. Conceptually, the “assistive pretext” is a related critique to the critique of universal design. Mills offers the “assistive pretext” to describe cases in which engineers use the impetus of disability for original design, in some cases a “precursor, in others a pretense,” but fail to account for the needs of disabled users and designers later in the design or circulation processes. See Mills, “Deaf Jam: From Inscription to Reproduction to Information,” Social Text, no. 102 (2010): 35–58.