Abstracts

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The digital humanities is today overwhelmingly visual. Even as DH has increased access to the humanities at an astonishing rate, it has inadvertently exacerbated a tendency to privilege sight as the sense through which knowledge is accessible. We must now add new dimensions to a field structured predominately by flat screens. Emphasizing touch, we call for a textured digital humanities, challenging the logic governing many notions of access—that is, the unproblematic translatability of information across the senses. As an epistemological intervention, texturing DH promises new ways to approach sensorial history and to engage diverse sensorial abilities and experiences—past, present, and future. As an ethical intervention, it emphasizes our responsibility to evaluate carefully the structures of digital accessibility and to increase access for all. Now is the time to confront the epistemological issues posed by sensory exclusivity in digitization methods, to address the questions of access raised by material history, and to imagine the new horizons of humanistic inquiry opened up by tactile technologies. (SA and DW)

Texturing the Digital Humanities: A Manifesto

SARI ALTSCHULER AND DAVID WEIMER

THE DIGITAL HUMANITIES IS TODAY OVERWHELMINGLY VISUAL. Screens, Johanna Drucker has argued, "structure our relation to knowledge *visually*," and so it is imperative that we understand how the visual shapes what we know and how we know it (6).[1] The visuality of DH extends from its principal medium—the screen—to data visualization, graphical user interfaces, and the conceptual underpinnings of many DH accomplishments. Projects like the Walt Whitman Archive, Early English Books Online, and the Internet Archive have made books, manuscripts, letters, and archival material more visible than ever before. They have changed the ways many of us interact with pages while also making these pages accessible to people around the world. Similarly, big data approaches have made it possible to visualize in graphs and charts invisible trends across thousands of stories, novels, and newspapers. Nevertheless, in spectacularly increasing public access to the humanities, such initiatives have inadvertently exacerbated a tendency to privilege sight as the sense through which knowledge is accessible. Having succeeded wonderfully in making the invisible visible, the digital humanities must now add new dimensions to a field structured predominantly by the flat screen. It is time to texture the digital humanities.

Practically speaking, this shift toward texture is inevitable. Tactile interfaces like touchscreens are rapidly proliferating, and DH will need to find new ways to include tactile experiences as "merely" seeing becomes increasingly quaint. Yet our call pushes further. The turn to texture is simultaneously an epistemological and ethical imperative. As an epistemological intervention, texture engages with the history of the senses and the realities of diverse embodied experiences, which a purely visual (or even a visual and auditory) digital humanities is poorly equipped to address. The textured DH

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we call for here acknowledges that we cannot study knowledge only abstractly, apart from the senses, and that we cannot study literature, art, and history without including the history of embodied experiences. As an ethical intervention, texturing DH signals our responsibility to think more carefully about the structures of digital accessibility. This responsibility applies particularly to archival materials, as scholars, lay researchers, and students increasingly turn to digital surrogates rather than and in addition to physical archives. Texturing the digital humanities can thus increase access for all users while addressing both sensorial history and the diversity of sensorial abilities and experiences—past, present, and future.[2]

In rethinking how people access archives, the digital humanities has a chance to correct a centuries-long imbalance in sensorial access. The visual emphasis that has predominated in so much of DH is based on the useful fiction that visual information is essentially enough on its own. Vision has been at the top of many hierarchies of the senses that can be traced as far back as Aristotle in the Western tradition. However, this fiction developed in earnest only in the early nineteenth century through cultural shifts, which included the emerging paradigm of scientific objectivity and the rise of the modern museum.[3] Eighteenth-century museums admitted only wealthy visitors, who expected to handle everything from scientific specimens to the crown jewels.[4] In contrast, by the middle of the nineteenth century, museums had opened their doors to middle- and working-class people, but, largely because of class anxiety, had forbidden touching the collections.[5] People from a wider spectrum of the population could experience their collections, but only visually.

Yet, the idea that a purely visual form of widespread access to art is sufficient for museum goers has always been a fiction. While museums have been banning touch for centuries, visitors routinely break that rule. This

is not the collective fault of generations of visitors. Trying to stop people from touching museum objects is, as one anonymous museum attendant has said, "like trying to turn back the sea" (qtd. in Giaimo). Visitors who get handsy with artifacts are not simply uncouth or unrepentant rule breakers; rather, it is curators who have not taken touch seriously enough as a means through which visitors learn (Candlin, "Dubious Inheritance").[6] Similarly, book historians, notably Roger Chartier, Robert Darnton, and D. F. McKenzie, have emphasized the long, multisensorial history of reading—citing textual practices such as Cyrano de Bergerac's listening to lunar audiobooks in the seventeenth century (Chartier 63–82) and readers' literally eating books in order to digest them in the eighteenth (Darnton 172). Experiencing art and text has long been understood as a set of multisensory practices, even if our methods of providing access have not always reflected this.

DH has the opportunity to address the long-standing inequalities in tactile access not simply by embracing tactility but also by adding texture to knowledge derived from sensorial experiences. To make the most of this, DH must prioritize digital strategies that reproduce texture instead of only translating textured knowledge through visual experiences. Consider the digital image of the front cover of an 1852 edition of Harriet Beecher Stowe's *Uncle Tom's Cabin* published by J. P. Jewett, available on the Internet Archive's Web site.[7] Visual surrogates like this one, although never perfect facsimiles, as many book historians and digital humanists have noted, can foster new forms of access. For instance, because the surrogate reproduces the cover visually, users can compare the patterned border and golden cabin scene of the copy at Wellesley College with the cover of another copy in a different library, or they can zoom in to see details not immediately apparent to the human eye.[8] But this visual reproduction also asks users to judge tactile information by

translating it into visual information through a screen. A textured DH should aim to reproduce, rather than simply translate, the contours and the shapes of nineteenth-century books—deeply important features for the readers for whom these books were made—for twenty-first-century readers, who work either at a distance or in archives whose preservation imperatives seriously circumscribe tactile encounters with archival objects. Simultaneously, a textured DH could return forms of tactile engagement and the history that these objects tell to geographically dispersed blind and low-vision readers, who have been poorly served by digital surrogates.

In reaching beyond the visual emphasis of these surrogates, we build on the work of digital humanists who have begun investigating historical prototyping. By engaging in the process of making and remaking historical artifacts, these scholars have argued that technologies like 3-D printing can "create situations in which aspects of the past can be revisited, explored, interrogated, and remixed" (Elliott et al. 127).[9] Such scholars have focused on the experimental features of these new forms. While we celebrate how scholars use new media to open up new ways of knowing, we also press digital humanists to respond to the more immediate need: to make the centuries of tactile textual history not just available but fully accessible. Only by harnessing digital approaches to the history of touch will we be able to refine new and existing technologies so that we can disseminate, curate, and investigate sensorial history through digital means.

We are issuing a call here to texture the digital humanities that challenges the logic governing many notions of access—that of the "universal translatability of information between any sense organ" (Paterson, "On Haptic Media" 1550). The call has twin aims: to expand the sensory accessibility of archives for all users and to do so through the digital reproduction—rather than the translation—of tactile knowledge. The need for expanded ac-

cess is, of course, particularly acute for communities that have been generally excluded from the digital humanities because of its visual grounding and orientation, but attending to the experiences of those communities also teaches us how much we all have to gain from a tactile turn. In fact, in envisioning a textured DH, we can do no better than to partner with communities, like those of people who are blind and low-vision, whose expertise in tactility will be central to, and will certainly prove invaluable for, reimagining our digital futures. Now is the time for scholars to confront the epistemological issues posed by the neglect of the nonvisual senses in current digitization methods, to address the fundamental questions of access raised by material history, and boldly to imagine the new horizons of humanistic inquiry opened up by existing and emerging tactile technologies.

Helen Keller's Books: An Object Lesson

Imagine a young Helen Keller seated in the library of the Perkins School for the Blind, where she spent much time as a child in the late 1880s and early 1890s, reading Emerson's *Essays* (fig. 1). Keller, a voracious reader, was enthralled by Ralph Waldo Emerson's works. Michael Anagnos, then the director of Perkins, recalled how Keller would "worship" at the "temples" of nature with Emerson and Henry David Thoreau, "joining them in their gratulatory hymns of praise" (89) and was "always ready to discourse" on philosophers like Emerson, whose old house she visited just three years after arriving at Perkins (19).[10]

What excitement Keller—like any nineteenth-century reader—might well have felt as she read Emerson's invigorating message in "Self-Reliance": "Insist on yourself; never imitate. . . . That which each can do best, none but his Maker can teach him. No man yet knows what it is, nor can, till that person has exhibited it" (68).[11] And how alienating Emerson's words might also have been—"A

man must consider what a blindman's buff is this game of conformity. . . . Most men have bound their eyes with one or another handkerchief"—as she finger read the copy printed in raised lettering by the Perkins School's press (45). In "Self-Reliance," blindness is self-reliance's figurative antithesis. For Emerson, it was the state of dependency par excellence. It is no secret that Emerson was terrified of losing his vision: "nothing can befall me in life," he famously opined in *Nature*, "no disgrace, no calamity, (leaving me my eyes,) which nature cannot repair" (12–13).[12] Yet, like many nineteenth-century writers, Emerson was well aware of Perkins and its internationally famous work; after all, Emerson lived nearby and had recommended Thoreau for a job at the school.[13] While Keller did not document her reaction to reading "Self-Reliance," she elsewhere recorded her strong response to canonical treatments of blindness.[14] As contemporary critics, we are left to wonder how she felt when first reading such troubling lines about her own visual experience.

The pages of the Perkins edition of Emerson's *Essays* are useful for texturing what we know about student experiences at Perkins, about "Self-Reliance" as a text, and about book history. Keller's ability to read these Emersonian pages self-reliantly brings us new, multivalent—and at times contradictory—senses of texture. The books like Emerson's *Essays* that the young Keller read in the Perkins School library were not printed in braille but rather in Boston line type, a system of raised roman letters developed at Perkins in the 1830s and designed to be read both by sight and by touch (fig. 1). Perkins's founder and first director, Samuel Gridley Howe (1801–76), insisted on roman letters because he worried that so-called arbitrary systems like braille would cut off individuals with visual impairments from their sighted peers and alienate sighted people who might wish to help educate those students. Howe wanted to enable students at Perkins to graduate as

independent citizens but he also developed a printed form that paternalistically yoked sight and touch together.[15] Howe wanted students with blindness or low-vision to be able to read, but he insisted on a form that sighted users could also easily access. When sighted researchers experience an image of these pages such as figure 1, they can see the primacy of visual culture in Howe's work, but they cannot feel the texture of independence and freedom that these forms offered a reader like Keller. Yet visual readers are themselves also impaired by the sensory restrictions imposed by digital reproduction; the digital photograph in figure 1 is, after all, very difficult to read, even if its deep formal familiarity among today's visual researchers obscures the limitations of this digital technology.[16]

The textured medium is not merely incidental to the message. The material form of the Perkins edition disrupts Emerson's opposition between blindness and self-reliance. Readers with visual impairments like Keller accessed Emerson's ideas by touch. Keller herself "devoured everything in the shape of a printed page that has come within the reach of my hungry finger tips," reading her first books until she had flattened the pages to be "so worn and pressed that I could scarcely make them out" (105). Keller experienced the most profound version of self-reliance of her early life while reading in the Perkins library. She called the library "my Utopia." "Here," she wrote, "I am not disfranchised. No barrier to the senses shuts me out from the sweet, gracious discourse of my book-friends" (117).[17]

Standard digital humanities methods for accessing archives, successful for so many materials, leave Keller's books behind. Although Perkins and the books it printed for blind and low-vision readers were the subject of international interest and drew the attention and financial support of figures including William Wordsworth, Oliver Wendell Holmes, and Charles Dickens, today the books Keller read are consulted mostly on-

line, without the very texture that made them noteworthy.[18] The collections of these books are concentrated in a few places. Perkins holds "one of the largest collections anywhere on the non-medical aspects of blindness" with "more than a thousand early embossed books" and "roughly 500 years of the history of blindness and deafblindness," and the American Printing House for the Blind houses a collection of over twenty thousand items, including early presses used for embossed printing (Stothert-Maurer et al. 18).[19] Even for researchers who know and can afford to travel to Watertown, Massachusetts, and Louisville, Kentucky, to access these texts in person, the norms and preservation priorities of most reading rooms limit researchers' experiences of texture. Standard methods of preservation and digital access have devalued textured knowledge. The logic of preservation generally holds that if we want to preserve historical texts and artifacts in the archive, we must limit our ways of physically interacting with them. The digital methods of visual reproduction that have helped address this concern for many rare and fragile documents only highlight the continuing inaccessibility of textured history. Without tactile access to archival objects, we cannot research the texture of historical experience.

The Challenges of Digitizing Texture

A textured DH has the potential to make not just the books Keller read but also the entire contextual archive associated with those books more accessible than they have ever been. To meet this opportunity, the digital humanities needs to address a set of realities that scholars, librarians, activists, and engineers have approached only in pieces thus far. That is, DH needs a new approach because the standard tools and approaches for digitizing and disseminating archives are inadequate for textured histories.

We begin with digitization because the scanning and optical processing of text has created a foundation for DH by making so much literature and history available as data. One enormous problem for the preservation and dissemination of the history of blindness has been how to digitize braille. Engineering teams and for-profit companies have developed software and even special scanners for optical braille recognition (OBR), but OBR currently has more potential than practical value and has been used only sporadically at a large scale on archival documents.[20] The most prominent institution using OBR, the National Library Service at the Library of Congress, currently scans and runs OBR on its braille musical scores and then manually checks for errors in the scans. For a one-hundred-page score, the process can take between six and thirty hours depending on the quality of the original (Smith; Hanson; Koh). To ensure accuracy in this process, archivists need to find either tactile readers of braille who can offer their time to travel to the archives and manually check transcriptions in person or volunteers from a very small population who can read braille visually and will work remotely (Selsdon, Interview). By contrast, in 2011 the Internet Archive scanned a ninety-eight-page braille magazine for visual reading—that is, without OBR—in under five minutes (Scott). The process of making braille documents digitally accessible with OBR is, by DH standards, incredibly slow. Yet without OBR, digitized braille materials are not functional digital surrogates but only technological curiosities.

Although braille texts present unique challenges, they make up only part of the archive of blindness. Nonbraille texts have their own set of digital demands. For example, merely scanning Keller's handwritten correspondence in braille and alphabetic text does little for visitors with visual impairments. Seeking to craft "a Gold Standard" of access for "Sighted, Hearing, Blind, and Deaf Au-

diences," the American Foundation for the Blind uses OCR with crowdsourced manual corrections for printed archival materials and also enlists volunteers to transcribe Keller's correspondence for their Helen Keller Archive (Selsdon et al., "Sharing Our Progress"). That OCR has continued to develop but still struggles with complex characters, handwritten documents, and, of course, braille offers, as Mara Mills notes, "a particular historical irony" because "OCR was originally developed to provide blind readers access to print" by enabling assistive devices to read aloud visual text ("Beyond Recognition").[21] As heartening as it is to read accounts of volunteers engaging with Keller's archives (Selsdon, "Transcribing"), the tools that DH has developed do not meet the needs of the archives of the history of visual impairment and the people who use them.

The hurdles to digitization are as much structural as they are technological. The archivist Lisa J. Sisco argues that "codified information about braille preservation" is limited precisely because not enough people consider braille texts valuable and therefore have not standardized and disseminated rigorous best practices for conserving braille documents (18). Too many archivists assume that braille merely duplicates ink-printed texts and that it has been superseded by text-to-speech software (23).[22] The need to change their assumptions is urgent. In a striking example of the archival losses we have already incurred, no copies of the book containing a tactile code that was created fifty years ago for the Cherokee Nation can be located today (Charlson).[23] The damage done here involves not only the loss of a single object but the loss of the history and forms of communication associated with two structurally marginalized communities. While the efforts to preserve texts like the Cherokee tactile code are at the very heart of digital humanities initiatives, DH's ability to do so in cases like these has thus far been limited by approaches or-

ganized technologically and conceptually around the visual.[24]

Digitization faces obstacles, but dissemination has equally difficult technical and conceptual challenges. While projects like the Helen Keller Archive are working to rediscover, correct, and transcribe archival materials, the surrogates they produce enter a digital world that is only slowly adopting standards for accessibility. This is a critical practical and ethical problem to which scholars, community organizations, and activists have begun suggesting promising solutions. George H. Williams has recently argued persuasively for a universal design approach to the digital humanities based on open-source accessibility tools and has implemented his vision through a *WordPress* plug-in for braille conversion ("Disability"; "Final Performance Report"). Organizations like the American Printing House for the Blind have been developing new technology, such as more affordable refreshable braille displays—devices that have one line of pins that can provide braille text line by line. These organizations advocate using refreshable braille displays in combination with free software that translate digital pages into braille (Chong).

Universal design—an aspirational ideal of the disability rights movement that understands disability as a problem of the built world—has spurred a number of productive projects to make digital environments more accessible.[25] Most of these projects focus on tools to modify or translate existing content and designs. While very worthwhile, these tools represent an incomplete solution. As Richard Godden and Jonathan Hsy incisively argue, "even the most well-intentioned universalist discourses risk effacing crucial particularities of embodied experience." With Godden and Hsy, we hope to expand access by balancing an "embrace of [universal design] with further attention to the particulars of embodied experience" through our sus-

tained attention to sensory differences in accessibility and knowledge production.[26]

Technical strategies for the dissemination of the digital humanities that rely on universal design alone still do not address the central conceptual problem: translation cannot provide access to texture in the ways that reproduction can. As we intimated with the example of the digital version of *Uncle Tom's Cabin* from the Internet Archive, digital archives constructed for visual access routinely emphasize close reproductions over transcriptions of archival texts. In contrast, existing strategies for users with blindness and low vision—describing images, text-to-speech technology, audio resources, etc.—are more translational than reproductive. A braille or auditory description captures very little about Perkins's edition of Emerson's *Essays* that would distinguish it from other editions of Emerson's works. Even for sighted users, purely visual reproductions of tactile archives not only devalue tactile knowledge but also often fail to make tactile material accessible. A carefully constructed visual illusion showing the diversity of nineteenth-century systems for tactile printing (fig. 2) looks more tactile than most images of pages with actual raised lettering (fig. 3). These systems for tactile reading were designed themselves as translations of visual systems. To translate those translations into another medium is to engage in an elaborate game of telephone with sensorial knowledge. This emphatically visual, digital form alienates us from the very aspects of the text that are central to our understanding of it.

Translation and transcription, as digital repositories amply demonstrate, are not the same as a reproduction—especially when considering texture. We need to move beyond the visual when thinking about how we might digitally recover and reproduce the three-dimensional elements and tactile epistemologies of texts. Doing so promises to increase access to and broaden users' experiences with

textual features and objects without making potentially problematic assumptions about which kinds of translation make knowledge universally available.

While the promises of touch in the digital humanities are myriad, in the project we describe below we have focused on digitizing and disseminating historical materials from institutions for the education of students with visual impairments because they represent an area of acute need: to make a little-known textual and technological history not only available to the broader public but, more importantly, to the communities whose history it is. This project also gives us the opportunity to collaborate with experts who are visually impaired on a related, tactile version of this manifesto for texture. In the essay's final section, we extend the scope of our call even further to imagine a range of possible futures for a textured digital humanities.

A Manifesto You Can Touch

A manifesto for texture cannot be issued on paper and screens alone. Therefore, in collaboration with Enabling Engineering at Northeastern University and the Perkins School for the Blind, we have produced an exhibition that tactilely manifests the need to texture the digital humanities. *Touch This Page! Making Sense of the Ways We Read* is a collaborative project that animates the ethical and epistemological imperatives we articulate here. This manifesto—more tactile and less rhetorical—takes the form of a set of public, pop-up-style exhibitions that invite visitors of various abilities to consider the multisensory nature of most reading. Our goal has not been to solve the problem of texture—we harbor no illusions that a quick fix or simple solution is possible—but to issue a public clarion call to raise awareness of its importance.

Touch This Page! uses 3-D printed facsimiles of raised-letter text to inspire reflection on the assumptions most people make

about which senses are involved in reading (fig. 4).[27] The exhibition draws in visitors with a simple question printed across the bottom of its three double-sided panels: How do you read? The exhibition's six stations engage visitors both narratively and experientially. A narrative printed on the vertical panels invites them to read about Boston line type in the context of universal design and their own nonvisual experiences of reading. In a box below each panel, visitors can tactilely experience objects that were 3-D printed with Boston line type. If they are sighted, they can open the box's hinged top to view each object. Through labels inside the box, braille cards affixed to the box lids, and visual and audio text at touchthispage.com, visitors are encouraged to read about the objects—five from books printed in Boston line type books and a sixth from a book printed in another raised-character system (fig. 5)[28]—and about the people who used them. The exhibition combines these textured experiences with the contextualizing narrative so that visitors can connect the history of tactile print to their own embodied acts of reading. Through the exhibition, visitors can better understand reading as a widely shared meaning-making activity that often involves multiple senses.

In addition to its epistemological dimensions, *Touch This Page!* emphasizes the possibility for broad accessibility in the experience of texture as an ethical imperative. The exhibition is designed to be maximally accessible on-site through sight, touch, and sound while also providing the expansive access of a distributed, online platform. Upon its first public launch, *Touch This Page!* appeared physically at four Boston-area locations in spring 2019 and, for an even wider audience, online. Its Web site not only makes the exhibition's textual content available in multiple senses for anyone with a connected device but also, more important, hosts the six printable files of the exhibition's objects and provides printing instructions. Touchthispage.com allows any

individual or institution with a computer and 3-D printer to create the objects or the entire exhibition for their own needs. The exhibition's digital portion models a new strategy for disseminating a textured DH by making contextualized 3-D objects from the history of blindness widely accessible visually and tactilely. The decentralized nature of this dissemination builds on the model that many visual DH projects use to circulate rare and archival material but extends this work into the realm of texture. In both formats, *Touch This Page!* draws public attention to the richness of tactile archives while also calling for visitors to consider the digital possibilities for making that material history maximally accessible.

Touch This Page! showcases our initial strides toward a textured digital humanities, even as the limitations of the project's tactile innovations speak directly to the underdeveloped state of current technology and approaches to texture. With little precedent for producing 3-D printed facsimiles of inkless, embossed pages, we pursued two digitizing tactics. Our team of engineers first experimented with a scalable, labor-efficient algorithmic approach that extrapolates the shape of letters from 2-D images of pages in Boston line type.[29] Although the algorithmic approach produced a promising prototype, the objects it generated were not tactilely precise enough (figs. 6a, 6b, and 6c). We then turned to a more costly, labor-intensive method for making printable models: high-resolution, 3-D scanning (fig. 7).[30] Even with more precise models, the objects required significant preparation before and after printing because tessellation—a central part of the 3-D modeling process, which uses hundreds of thousands of triangles to approximate the shape of the original page—reduces tactile legibility.[31] Whereas the eye often corrects for common defects, such as pixelated roughness or sharp tessellation points, the hand seeks out those same features, making it difficult to differentiate the actual shape from errors introduced by

either the scanner or the modelling software's algorithms. Here, again, the visual technologies of light-based scanners and screen-based modelling software have difficulty anticipating the realities of tactile experience.

As a manifesto, *Touch This Page!* asks visitors to think about what a textured DH makes possible, and we have launched the exhibition to inspire colleagues and the public to join us in the considerable work ahead. The exhibition itself enlivens the possibilities of that work by bringing together the ethical and epistemological importance of texture in an embodied history of reading. In turn, the production of *Touch This Page!* reveals the experiential gulf between the digital tools available for reproducing visual experiences and those that do the same for tactile experiences. Texture, as the exhibit exhorts visitors to understand, is an issue our digital worlds need to address urgently.

Imagining Tactile Futures

While we look forward to the future innovations, the imperative ethical and epistemological issues created by DH's visual orientation mean we cannot afford to wait for the "imminent but perpetually deferred future" that David Harlan Parisi has identified as a standard feature of narratives about haptic technologies (3). We need to texture the digital humanities now. Texturing the digital humanities will involve using existing tools in new ways, creating new tools and practices for fostering tactile experience, and expanding our fundamental understanding of touch.

To suggest more concretely what a textured DH might achieve, let us briefly envision three tactile futures grounded in what our present technologies can do.

First, picture a young researcher seated at a computer in the British Library in the year 2025. Navigating the library catalog, she clicks on a digital item. As it loads, she swivels over to what looks like an empty table. Don-

ning a headset and pair of gloves, she sees a fourteenth-century manuscript of the Roman de Brut in front of her. She leans forward to read the text and glides her fingers from the page's smooth, hard corners to its scruffy center[32]—so different, she notices, from the scratchy paper of the eighteenth-century map she touched a few hours earlier.[33]

Second, imagine a librarian at the Library Company of Philadelphia in 2030 removing a copy of Milton's *Poetical Works* in Boston line type from its blue archival box. He lifts his tactile scanner—a thin cylinder with a side padded like his own hand, designed to mimic a finger's tactile receptors. He uses this scanner to digitize the tactile features of this edition of the blind poet's works, carefully recording the suppleness of the letters, the fibrous resistance of the pages, and even the moisture of the paper. The librarian checks the data on his computer and uploads the tactile model to his library's Web site, where users like the researcher above can download a visual copy with descriptive data, engage with the text in virtual reality, and create their own textured facsimile. This technology once more makes possible the tactile reading experiences for which this volume was designed and promises library patrons a richer engagement with touch than most archives can currently provide—even in person.[34]

Third, a student with a visual impairment in 2035 locates on her home computer a catalog record of Henry Wadsworth Longfellow's wildly popular *Evangeline: A Tale of Acadie* (1847)—a book with important connections to the history of blind reading and education.[35] In the metadata, she finds alphanumeric codes for the texture of pages and bindings from various nineteenth-century editions. Calibrating the printer beside her, which uses those codes to match the texture of both page and binding, she prints facsimiles of a page's corner or the book's cover in materials that reproduce each edition's texture. She has choices: print from the American

Antiquarian Society's 1856 London edition, the Huntington Library's 1864 Paris edition, Perkins's 1881 Boston-line-type edition, or the Pennsylvania Institution for the Instruction of the Blind's 1894 braille edition; print textured covers from the 1848 Ticknor and Company, 1866 Houghton and Mifflin, or 1910 Barse and Hopkins edition; or print pages whose texture reproduces that of the first edition as it appeared hot-off-the-press or as she might find it on a library shelf today. Using an array of facsimiles, she studies the feel of pages and bindings, drawing novel conclusions about Longfellow's work from *Evangeline*'s material history across time and space.[36]

All three futures animate the ethical and epistemological imperatives of a textured digital humanities. They insist we attend to the physical senses that mediate our access to knowledge—sight, touch, and hearing. Simultaneously, they remind us that the processes we use to produce digital information are based on sensory mediation—light, friction, and pressure waves. In fact, although it is beyond the scope of this essay, we believe it is necessary and inevitable that sound, smell, and potentially taste be taken up by the digital humanities. Visual ways of knowing have, for too long, fundamentally structured the production of and access to much digital humanities methods and content; we cannot and must not keep thinking of knowledge outside the embodied experiences we use to know things.[37] Nevertheless, no one solution can meet all our epistemological and ethical needs. For example, we must avoid tilting after the fiction of some ideal digital surrogate—like a virtual reality system that would flawlessly mimic original objects—lest we become digital Pierre Menards, expending extensive energy to improve our reproductions to discover, at last, that only the original impeccably represents itself. We must also avoid reinscribing the fictions of universal ways of knowing. Instead, we envision in our tactile futures multiple strategies that could not only open up

access to varied experiences—past and present—but also diversify the ways embodied experiences structure our digital worlds.

While the futures we have imagined here are rooted in methods for increasing archival access, the area where we have focused our own energies, the possibilities of a textured DH are expansive. Systematic coding of texture data would allow big data projects on, for instance, the changing texture of paper or bindings over time—distant touching, if you will. But a textured DH has the potential to offer, even more broadly, an epistemological alternative to the logic at the very heart of big data and the visualizations that make big data legible. A textured future for DH can offer better purchase on concepts like mediation and individuation, which visual forms of DH often allow scholars to overlook in favor of abstraction and universality.[38] In pursuing questions of texture creatively, expansively, and multidimensionally, a textured digital humanities will increase access for those too often underserved by the digital revolution and broaden our collective sense of the epistemological history, value, and potential of touch in hitherto unimaginable ways.

If such a project seems overly ambitious, we need only look for inspiration in the sophisticated systems of and technologies for visual understanding that, in the last few centuries, have created our visually oriented world. Today it is not uncommon to expect a sighted child to select exactly the right crayon or a lipstick shopper to discern precisely between similar shades of red. Likewise, most sighted Americans give little thought to their easy recognition of Coca-Cola's or Tiffany's signature hues. Highly refined understandings of color are now commonplace for many sighted populations, making it easy to forget that such visual sophistication is actually the result of centuries of theorization, experimentation, and technological advancement.[39] Research on sight was more spurred than hindered by the difficulties and ambigui-

ties of color, and it revolutionized how most sighted people understand what they see. Texture has yet to experience such a revolution. Research in textured DH has the potential to foster tactile epistemology in the humanities and to inspire interdisciplinary approaches to systematizing our understanding of texture, as researchers once systematized our understanding of sight. This research, in turn, will further expand our understanding of the value and promise of tactile knowledge. Now is the time to develop methods that emphasize tactility, to insist on the epistemological significance of touch, and to increase access for diverse users with a wide range of abilities. Now is the moment for texture.

Notes

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1. For examples, see D'Ignazio and Klein; Kasunic and Sweetapple; Whitley.

2. In doing this, DH might draw more from the history of computing. The early-nineteenth-century Jacquard loom, a device that used punch cards to create weaving patterns, offers a well-known origin story for computer coding. The recent collaboration between Google and Levi's for so-called smart clothing is named for the loom and draws on the possibilities inherent in the early history of digital technology ("Jacquard").

3. See Candlin, *Art* 9–27; Daston and Galison. The organization of art history as a discipline in the early twentieth century further established this trend (Battles and Maizels). Scholars such as Sedgwick have also approached the "sense of touch"—with attention to texture explicitly—as a mode of experience that "makes nonsense out of any dualistic understanding of agency and passivity" (14). On the "intermodal communication"—the particular interplay of touch and sight—in empirical philosophy of the seventeenth and eighteenth centuries, see Girten 501.

4. See especially the work of scholars such as Candlin (*Art*, "Dubious Inheritance"); Classen; and Maerker. "Crown jewels" is not an exaggeration. Classen describes eighteenth-century visitors to the Tower of London who were invited to reach through the iron trellises to feel the jewels' heft (900).

5. Candlin argues that the "changing class constituency" of British museums resulted in the "loss of touch as a valid means of engaging with collections" (*Art* 85).

6. For another perspective, see Kleege's account of what blindness contributes to visual art (*More*).

7. The digitized copy is owned by Wellesley College.

8. The scholarly literature on digital facsimiles is too vast for summary, but for relatively recent scholarship by book historians on digital processing and digital facsimile data, see Cordell; Werner.

9. See Elliott et al.; Sayers, "Prototyping the Past" and "Why Fabricate?" While interested in the history of the senses, Elliott and his coauthors prototype magic and illusions, an approach still principally based in ocular perception. Likewise, our work builds on and departs from Sayers's work; he calls for "remak[ing] technologies that no longer function, no longer exist, or may only have existed as fictions, illustrations, or one-offs," while we focus on the value of replicating nonvisual aspects of archival materials, a method he suggests but does not develop ("Why Fabricate?" 158). Like these scholars, we insist that replicas will always differ from original objects, but we are interested in new ways researchers will understand historical replicas through touch.

10. For Keller's letter on her trip, in 1891, see Anagnos 56. Emerson had died nine years earlier.

11. Emerson's *Essays* would have been the only book of Emerson's work available to Keller in raised print.

12. For a reading of this passage and Emerson's relation to visuality, see Thomas.

13. See Thoreau. Perkins interested many Romantic thinkers and educators, from William Wordsworth and Thomas Carlyle to Horace Mann and Henry Wadsworth Longfellow.

14. Reading about Gloucester's blinding in *King Lear*, she wrote, "Anger seized me, my fingers refused to move, I sat rigid for one long moment, the blood throbbing in my temples, and all the hatred that a child can feel concentrated in my heart" (114).

15. On Howe and the development of Perkins's printed books, see Gitter 39; Harris 13; Trent 101; Weimer. On Howe's paternalism, see Klages.

16. In identifying the disabling features of digital reproduction, we build on the long-standing recognition that disability is socially constructed—a product of social, cultural, political, and technological practices and design. While the social model of disability has been complicated recently, a core tenet of disability studies remains that society and culture play central roles in

producing disability. For recent theoretical work on the construction of disability, see McRuer; Mitchell; Puar; and Snyder and Mitchell.

17. Using a compatible approach, Silverman has examined the ways disability can reframe our understanding of book history and material text studies.

18. One of the main reasons that Perkins became a site of international interest was Howe's work with Laura Bridgman, the first person with deafblindness to learn to communicate, read, and write. For more on Bridgman, see Freeberg; Gitter; Klages; Trent.

19. Major research libraries hold only a small sampling. The American Antiquarian Society (AAS) and the Library Company of Philadelphia (LCP) hold some of the larger collections outside of institutions for blind education. The AAS has fifty-one raised-print items; the LCP just over a hundred. Schools for visually impaired students in the United States also have libraries that stretch back to the nineteenth century.

20. See Antonacopoulos and Bridson. Mills rightly summarizes the issues with OBR as similar to the Eurocentrism with OCR, because OCR performs less well with Asian languages and "routinely fails with pages that contain multiple languages and obsolete or non-standard spelling or characters" ("Beyond Recognition").

21. For more on this history, see Mills, "Optophones"; and Chan et al.

22. The former Perkins archivist Jan Seymour-Ford echoes Sisco's concern, lamenting that braille "is not considered valuable as an artifact in itself," unlike the "first printing of a book from 1860" (qtd. in Sisco 21). There are some exciting initiatives to preserve braille digitally. In 2014 Hanson blogged about the Library of Congress's efforts to digitize its braille music collection using OBR. For all the limitations of OBR, one unforeseen advantage of its errors, Hanson notes, is that they can call attention to flattening in original documents, which is information the library can use to reemboss text.

23. Acquiring more information about the lost code has proved difficult, further underscoring the vulnerable nature of tactile text in the digital age. Still, there are tantalizing hints. We located the records of two copies of a book that might contain the code, *Beginning Cherokee*, in braille from 1976 in WorldCat, although, despite what the records indicated, we could not locate the copies at either the Minnesota State Services for the Blind Communication Center or the American Printing House for the Blind. We also consulted experts in the Cherokee Nation and at the Commonwealth Braille and Talking Book Cooperative who collaborated on a new tactile Cherokee syllabary in 2014. Neither the staff at the Educational Services for the Cherokee Nation nor Tamara Kearney, the developer of the 2014 tactile syllabary and the manager of braille research and development at the Commonwealth Braille and Talking Book Library, had more information about the lost code. For more on the 2014

tactile syllabary, see Kearney; and "Cherokee Language." Unfortunately, even the twenty-first-century code, which is available online, remains more theoretical than practical; it is accessible by screen but is not yet available in three dimensions for tactile readers.

24. For Perkin's recent work on preservation and 2-D digitization, see Stothert-Maurer et al. 21–25. To digitize raised print, Perkins's archivists use a raking light to photograph each page and upload it to *Flickr*. The collections are available at www.digitalcommonwealth.org/institutions/commonwealth:6d570760d.

25. See Eyman et al.; *Fluid*; "Making the Web Accessible"; and Yergeau et al.

26. For a sustained critique of universal design, see Hamraie.

27. Some museums have been experimenting with using 3-D printing to enhance access to their collections and exhibitions (Maffei). These efforts are in addition to the established practice of tactile tours for people with blindness or low vision (Kleege, "Blindness").

28. The five pages in Boston line type are a section of the New Testament, a diagram of a lunar eclipse, a diagram of a magnified snowflake, a map of Massachusetts, and Hamlet's "to be or not to be" soliloquy; the sixth page is the Lord's Prayer in Moon type.

29. This process requires optimizing lighting configurations to bring out useful contours and then converting the photo into gray scale. Our engineers devised an algorithm in MATLAB to input this photo and convert it into an STL file. The algorithm assigns a height to each pixel based on their shading in the grayscale image. Once the two-dimensional grayscale image is associated with height values, we generate the STL file in which each pixel is tessellated—that is, modeled in three dimensions using triangular planes—at a predetermined height.

30. An object like the one pictured in figures 6a, 6b, and 6c can take a skilled operator over an hour to produce. Furthermore, high-resolution scanners are prohibitively costly for many.

31. After printing, to smooth sharp points and edges and diminish printing layer lines, we applied a heat gun across the surface for approximately ten seconds on medium-high heat.

32. We have in mind British Library Egerton 3028. Thanks to Hannah Weaver for information on this manuscript.

33. Gloves are being developed that can simulate force, weight, and stiffness (Parkin; El Saddik et al. 67–103). A glove of this kind is being developed commercially by CyberGlove Systems.

34. Researchers have been working on prototypes of tactile sensors based on human fingers for the past decade (Zhang et al.; Zhang and Miki).

35. Longfellow was Howe's close friend; Perkins published in two editions of *Evangeline* in Boston line type in the nineteenth century; and, in 1852, Bridgman wrote

to Longfellow, "I should love to meet [Evangeline] with my soul in heaven" (qtd. in McFarland 2). For the print history of *Evangeline*, see McFarland.

36. Engineers are increasingly interested in taxonomies of tactile perception as they develop new haptic interfaces and technologies (El Saddik et al. 45–66; Hashim et al.). Their work is linked to the growth of materials libraries that provide collections where visitors can compare tactile qualities (Miodownik). Examples of these libraries include the Institute of Making (www.instituteofmaking.org.uk/materials-library/about) and Material Biblioteket (www.materialbiblioteket.se/).

37. Some researchers work on extending the concept of visualization to tactile media and haptic experiences (Dragicevic and Jansen; Wernimont and Grumbach).

38. Paterson has discussed tactile mediation in relation to the idea of "abstracted visual representation" as "a model for universal reason" ("Forgetting" 116).

39. Color has continuously challenged fields as diverse as physics, physiology, commercial printing, design, and rare-book cataloging. Over the centuries, experiments with color have included work with prisms, color wheels, and color matching systems (Blaszczyk 44–71; Rossi 276–353; Kuehni and Schwarz 178–226). For example, Albert Munsell's color matching system used three axes to model how human beings experience color. With this theorization came practical and commercial applications in standardizing colors, especially in the textile and ink-printing industries (Blaszczyk 163–89, 296–97). The Textile Color Card Association and Pantone offer good examples of such applications.

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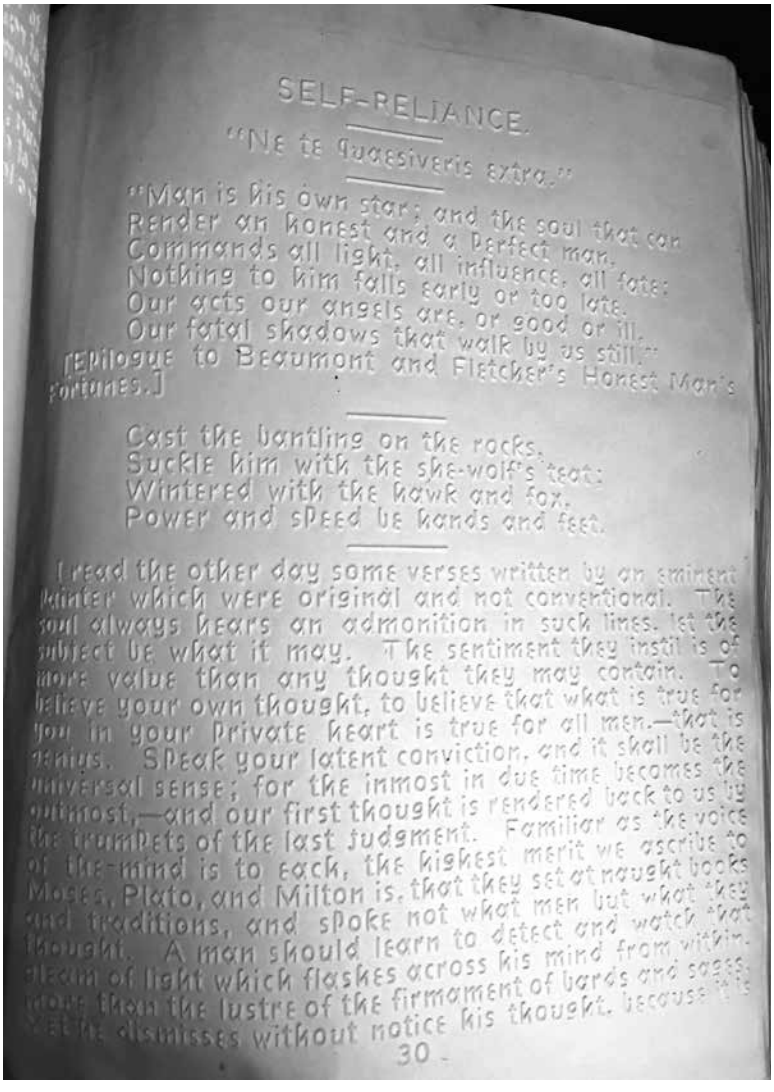

SELF-RELIANCE.

"Ne te quaesiveris extra."

"Man is his own star; and the soul that can
Render an honest and a perfect man,
Commands all light, all influence, all fate;
Nothing to him falls early or too late.
Our acts our angels are, or good or ill,
Our fatal shadows that walk by us still."
[Epilogue to Beaumont and Fletcher's Honest Man's Fortunes.]

Cast the bantling on the rocks,
Suckle him with the she-wolf's teat;
Wintered with the hawk and fox,
Power and speed be hands and feet.

I read the other day some verses written by an eminent painter which were original and not conventional. The soul always hears an admonition in such lines, let the subject be what it may. The sentiment they instil is of more value than any thought they may contain. To believe your own thought, to believe that what is true for you in your private heart is true for all men,—that is genius. Speak your latent conviction, and it shall be the universal sense; for the inmost in due time becomes the outmost,—and our first thought is rendered back to us by the trumpets of the last judgment. Familiar as the voice of the mind is to each, the highest merit we ascribe to Moses, Plato, and Milton is, that they set at naught books and traditions, and spoke not what men but what they thought. A man should learn to detect and watch that gleam of light which flashes across his mind from within, more than the lustre of the firmament of bards and sages. Yet he dismisses without notice his thought, because

30

Fig. 1

The first page of "Self-Reliance," from Emerson's *Essays* (Howe Memorial Press, 1885). The image depicts page thirty of the thick edition of Emerson's work set in Boston line type. The text begins at the top with the title in capital letters and ends with "notice his thought, because it is." Courtesy of Perkins School for the Blind Archives.

Six Principal Systems of Embossed Type

Fig. 2

"Six Principal Systems of Embossed Type" (Stadelman 310). This image displays the six most popular tactile alphabets at the turn of the twentieth century visually by darkly shading the page and leaving raised elements of the text white. The image represents the systems of Valentin Haüy, James Gall, Howe, William Moon, Louis Braille, and William Bell Wait. Haüy's, Gall's, and Howe's systems use roman letters, and Moon's is drawn from roman letters but simplifies their shapes. Braille's and Wait's use dot-based alphabets.

Fig. 3

Howe's "Map of Massachusetts," from *Atlas of the United States* (1837). This map depicts the Atlantic Ocean on the right with parallel lines. In the interior, solid lines show the course of rivers, dotted lines show the political boundaries, and triangles show the mountains. Courtesy of Perkins School for the Blind Archives.

Fig. 4

The exhibition *Touch This Page!* at Northeastern University's Snell Library. *Touch This Page!* was installed simultaneously at Snell, Harvard University's Lamont Library, the Boston Public Library's Copley branch, and the Perkins School for the Blind from January to April 2019. In this oblique view of the exhibition, three stations are visible. Each station is double-sided, composed of a rectangular box that rests on thirty-inch legs and bisected by a double-sided panel with text. Each station is approximately thirty inches wide and six feet tall. "How Do You Read?" is printed in large font across the bottom of the three visible panels. The full exhibition text and additional materials are available in accessible formats at touchthispage.com.

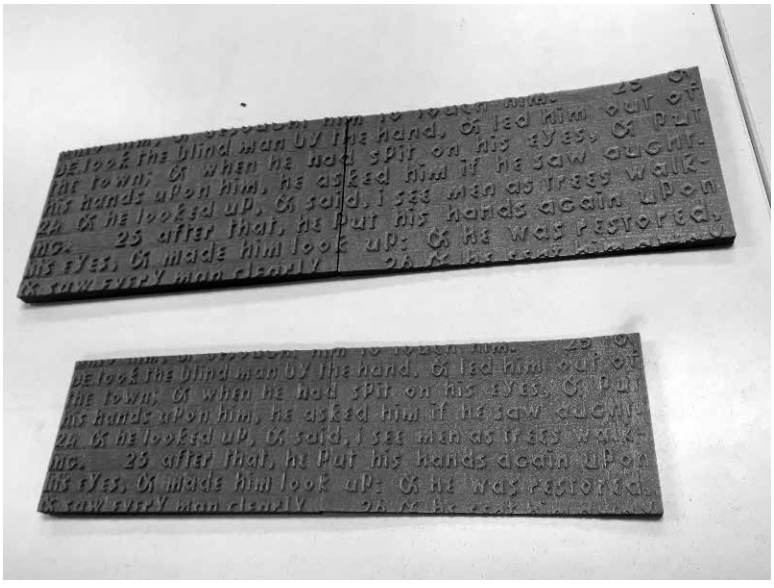

Fig. 5

3-D print of lines from an edition of the New Testament (1833). Objects appear at 200% and 150% scale with letter heights elevated by 0.5 millimeters to improve tactile legibility. These objects feature verses 23–25 from chapter 8 of the Gospel according to Mark, which describe Jesus curing blindness.

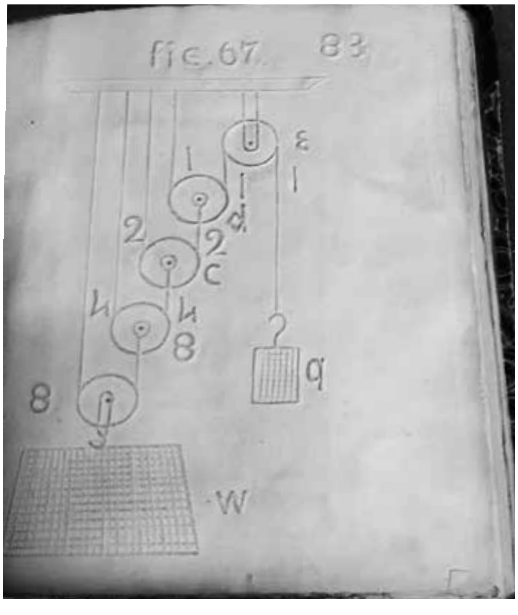

Fig. 6a

The initial object a page from a nineteenth-century natural philosophy book featuring a five-pulley system counterbalanced with a weight. Courtesy of Perkins School for the Blind Archives.

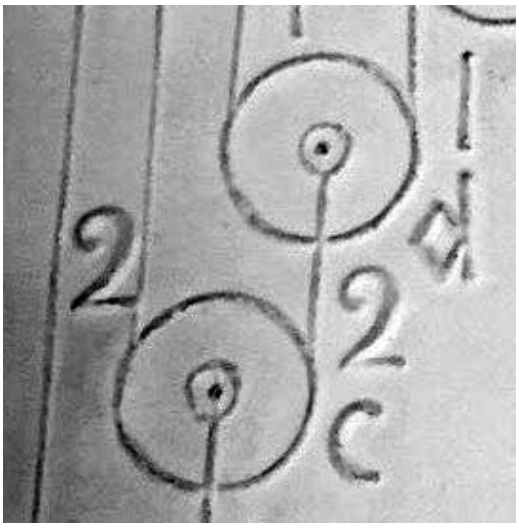

Fig. 6B

The cropped initial object processed in gray scale.

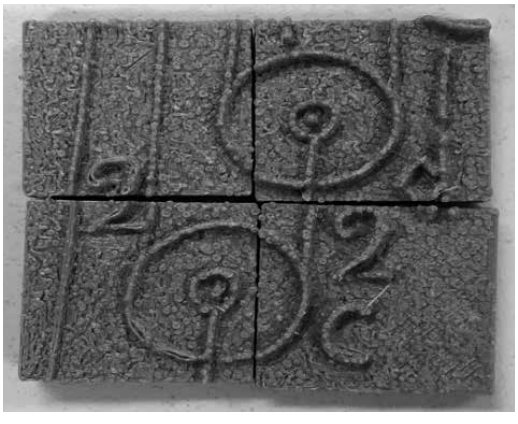

Fig. 6C

The 3-D printed proof-of-concept reproduction of the initial object, measuring two square inches.

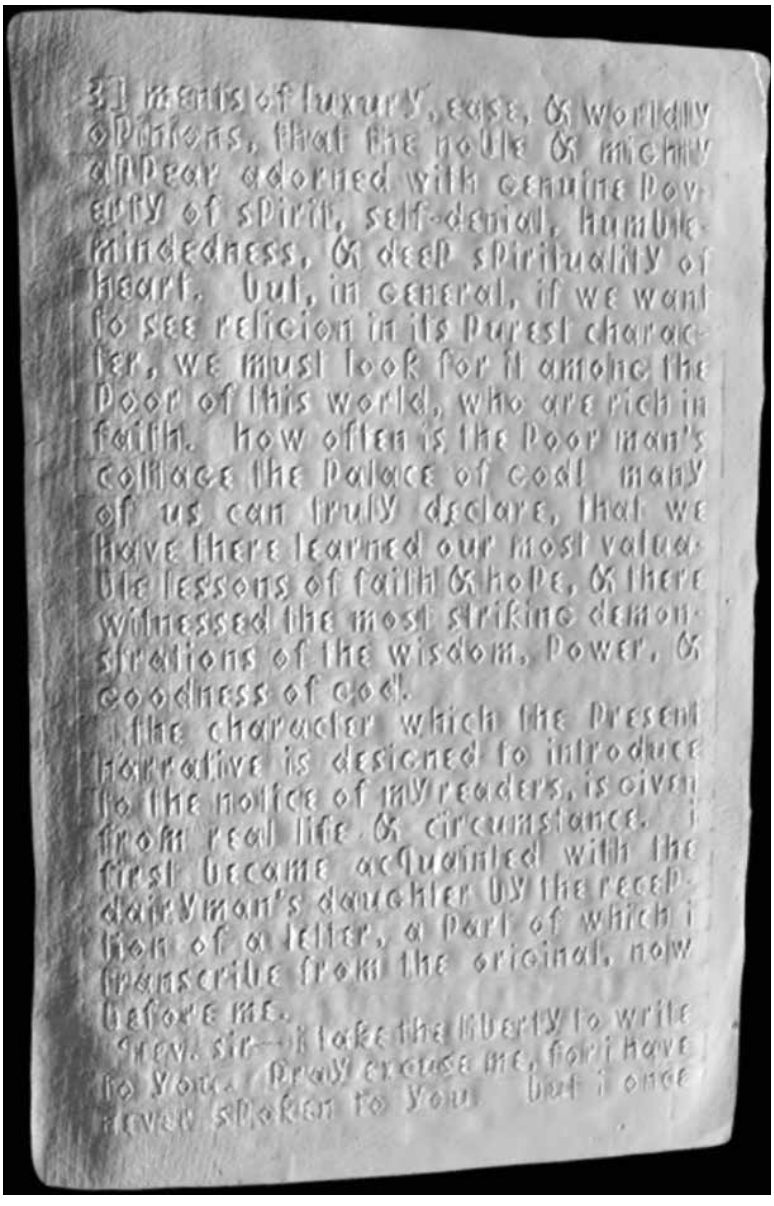

FIG. 7

3-D scan from "The Dairyman's Daughter" (1835) in Boston line type. We produced high-resolution scans using the Artec Space Spider and rendered them in Sketchfab. This image depicts a complete page of text beginning with "-ment of luxury" and ending with "I once," which curves left where the book spine bent the page. The Sketchfab version can be expanded, collapsed, and rotated visually: sketchfab.com/models/5764a245dcb64fdcbb4db8c0c51969e7.