Cartographic Perspectives

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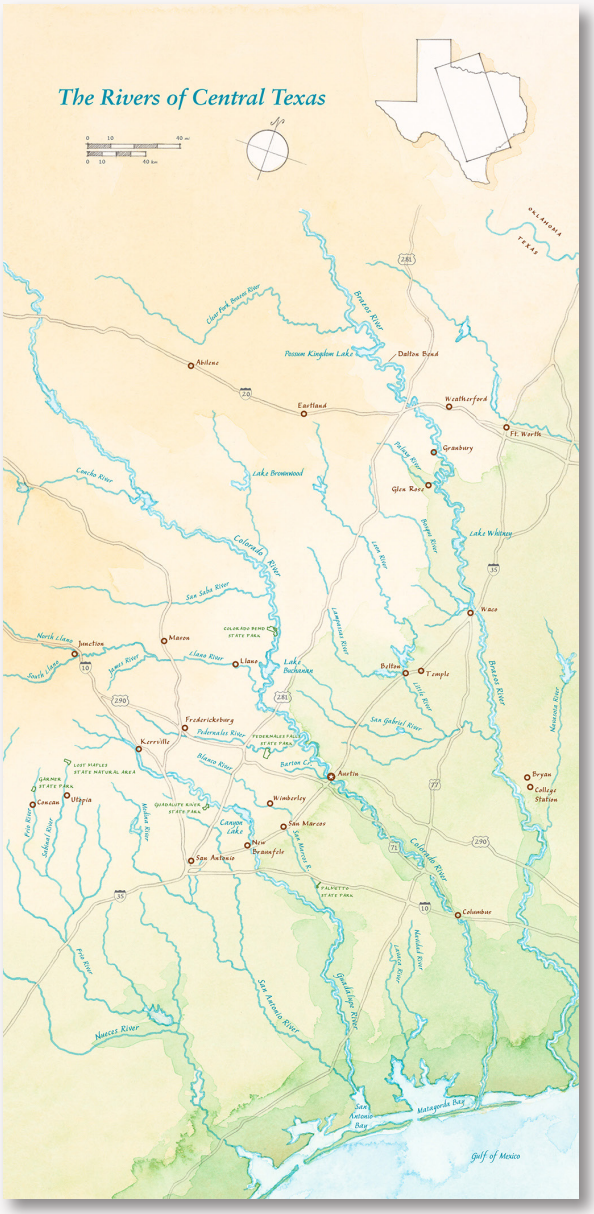
ABOUT THE COVER

The cover of this issue of *CP* is a detail from a map by Molly O'Halloran, created in pen, ink, watercolor, and type for *Viva Texas Rivers! Adventures, Misadventures, and Glimpses of Nirvana along Our Storied Waterways*, edited by Steven L. Davis and Sam L. Pfiester (Texas A&M University Press, 2022). You can see more of Molly's work at **mollyohalloran.com**.



Cartographic Perspectives

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LETTER FROM THE EDITOR

The one hundred and first issue of *Cartographic Perspectives* marks a time of change for the journal. In her final letter as editor, Amy Griffin took the opportunity of publishing the 100th issue of CP to look backwards at our earliest days and to reflect upon the changes that have occurred over our thirty-four years of existence. I'd like both to thank Amy for her phenomenal work as editor, and to echo her encouragement that readers take a moment to look through our online archives (**cartographicperspectives.org**) to explore the history of our journal and, through that, the histories of both our organization and the field of cartography itself. That's not to suggest that NACIS or *Cartographic Perspectives* are commensurate with cartography or one another; rather, it's to remind us all that there's value in tracing the lines of thought that have led us to the present, that influence and structure the lines we place on our maps.

Reading through the archive over the past month or two has led me to contemplate my own role as the tenth editor of the journal and what that might mean for its future. What drew me to *Cartographic Perspectives* was what, I hope, draws many of us into roles within the NACIS organization—a desire to give back to a community from which we've drawn so much. I still remember my first presentation at a NACIS conference. It was my first conference presentation as a graduate student and it did not go well. But, rather than the typical scorn or side-eyed looks one receives in many environments, I was met with encouragement—critical feedback, but offered in a productive and welcoming manner. From there, the NACIS meeting rapidly became something I've looked forward to every year *and* something to which I've dragged countless friends and colleagues. I've been around long enough to now watch as my former students bring *their* students, a chain of introduction that spans generations and builds community across spatial and temporal divides. As I take over *Cartographic Perspectives*, it's with an eye towards that experience. I take seriously the question of how CP can reflect the NACIS community at large and, as that community confronts issues of diversity, equity, and inclusion, how might CP continue to do so as well.

Through the support of the NACIS organization, CP is able to publish peer-reviewed research in a fully open source format; with high resolution, color imagery; and without the need to charge page fees. As such, it's a truly special journal, one that I hope to continue to grow in the coming years with the support of an editorial board and section editors both old and new. On that front, and before introducing the contributions found in this issue, I'd like to call attention to some changes that have occurred on the board and amongst our section editors. First, I'd like to thank Alicia Cowart (PRACTICAL CARTOGRAPHER'S CORNER) and Nicholas Bauch (VISUAL FIELDS) for stepping into their editorial roles. Additionally, Rich Donohue will be taking over VIEWS ON CARTOGRAPHIC EDUCATION after this issue, as

Fritz Kessler transitions off. I'd also like to welcome Luke Bergmann, Meghan Kelly, Bill Limpisathian, Jennifer Mapes, and Joanna Merson to our editorial board; each will bring years of experience and a unique perspective to shaping our journal. But we also bid farewell to Cynthia Brewer who, after many years on the editorial board, not to mention countless contributions to the NACIS community at large, is taking a well earned break and stepping down from her position. All told, these changes hopefully signal the continued health of our journal and will guide its growth in the coming years.

There is more to say and more to come with respect to the journal and some exciting initiatives we have planned; however, while those take shape, issue 101 contains articles and research that will appeal to a wide spectrum of readers. The issue features two PEER-REVIEWED ARTICLES, entries in both the PRACTICAL CARTOGRAPHER'S CORNER and VIEWS ON CARTOGRAPHIC EDUCATION sections, and six book REVIEWS. The first article, by Thomas Mantzaris, asks us to reconsider the relations between maps and literature in light of "multimodal literature: texts that are conceptualized and created as a synthesis of meaning-making elements on the page surface" (10). Taking a collection of sixteen works as a case study, Mantzaris proposes a taxonomy for understanding the relationship between maps and literary texts that better understands multimodal texts and the opportunities they offer for novel forms of cross-disciplinary artistic collaborations. The second, by Harrison Cole, rigorously examines a realm of mapping that's too often been passed over: tactile maps intended for use by blind and low vision readers. By combining a multivalent consideration of accessibility that looks beyond the immediate technology in question with a focus on cartography specifically as opposed to media at large, Cole has produced an important intervention in this area. While the results suggest additional research is needed, his clearly structured methodology and analysis open new pathways for cartographers interested in accessibility.

Outside of the peer reviewed sections of the journal, Gene Trantham offers an applied approach to improving hillshades in common GIS tools in the PRACTICAL CARTOGRAPHER'S CORNER. In VIEWS ON CARTOGRAPHIC EDUCATION, Heather Rosenfeld offers reflections on *ungrading* two semesters of "cartography-oriented" courses at Smith College. As higher education continues to change in response to new generations of students, new technologies, and new conditions of instruction, these sorts of insights and reflections are of paramount importance in seeking effective alternatives for the future of cartographic education. Guided by Mark Denil, the section editor, our REVIEWS run the gamut from an atlas of a contemporary state park to the latest by Mark Monmonier, a historical examination of the rural addressing system developed by John Byron Plato. Also featured are a history of William Smith and the origins of geology as a formal, recognized scientific practice, a book focused on helping designers produce better maps, and an exploration of the pioneering graphic design and mapping work of Emma Willard. All told, these reviews offer multiple entry points into cartography, highlighting the history, present, and potential futures of the field.

With that, I will once more thank my predecessors for helping to build *Cartographic Perspectives* into the journal it is today. I look forward to serving our community in the months and years to come.

Best,
Jim Thatcher
Oregon State University

LETTER FROM THE PAST-PRESIDENT

I can hardly believe I am nearing completion of my fourth and final year of the NACIS presidential track, from October 2019 through October 2023. While the pandemic created a whirlwind of change in the world around us all, I feel fortunate to have been part of NACIS, a volunteer-based organization focused on bringing our members together as a community. Our annual conferences were a port in the pandemic storm and served as an important way to gather and share, both in person and virtually.

During planning of the 2020 conference, I stood in awe of Mamata Akella as she led the effort to pivot from an in-person to a fully online conference. This was only possible with assistance, creative input, patience, and technological mastery from so many people, from the presenters (who had to shift to either pre-recording their presentation or delivering it live online), to our partners at e3 Webcasting, to our members who proved enthusiastic about using new tools to exchange ideas and socialize. For the 2020 conference, I organized Practical Cartography Day, and thank co-moderators Ross Thorn and Katie Perry for their tireless work to make it a success.

In planning the 2021 conference, we had hoped to get back to a fully in-person format, but COVID—namely the Delta variant—had other plans. A fully online conference would have meant a huge monetary loss to our organization, so our amazing Business Manager Susan Peschel was able to re-negotiate our contract with the venue in Oklahoma City, allowing us to have a hybrid conference. Although we had experience with organizing both an in-person and an online conference, I must admit that at times it felt like a hybrid conference was such a huge lift that it couldn't have been possible without extra help from everyone who worked so tirelessly to make successful. Of special note, thank you to Director of Continuity Ginny Mason, Director of Operations Nick Martinelli, Associate Business Manager Martha Bostwick, Secretary Hans van der Maarel, and Treasurer Mary Beth Cunha, for their constant guidance and support. One of my personal highlights of the meeting was the keynote speakers recommended by our Diversity, Equity, and Inclusion (DEI) Committee: Tristan Ahtone and Bobby Lee, who talked about "Land Grab Universities." Another was the panel session entitled "A More Inclusive Career Panel," in which Vanessa Knoppke-Wetzel, Tanya Buckingham Andersen, Rosemary Wardley, Hannah Dormido, and Bill Limpisathian spoke frankly and insightfully of career challenges that may not be apparent to our broader membership.

The NACIS Annual Meeting and all other activities in the Society run on volunteers. While there is not space enough to mention everyone who has contributed to NACIS during my tenure, I would like to thank a few dedicated volunteers who have served in critical roles: Alex Fries, who has done so much as our Social Media Coordinator; Bill Limpisathian, who oversees our Slack channels; Amy Rock, who makes our Map Gallery such a success; and Kate Leroux, who informs us all with NACIS News.

Publications are also important to our efforts to engage with, build, and grow our cartographic community. The *Atlas of Design* continues to be way to showcase the best of our mapping and design efforts in print, and the 6th Edition is jaw-dropping. Thank you to Editors Nat Case, Josh Ryan, Tracy Tien, and Aaron Koelker for their efforts. *Cartographic Perspectives*, our society's journal, continues to provide the highest quality content for academics, professionals, and map lovers alike. I would like to thank Amy Griffin for leading these efforts as Editor over the last six years, and I am so excited that Jim Thatcher has assumed the role of Editor with new, creative ideas.

I have also thoroughly enjoyed working with all the at-large members of the Board these last years. Their energy and commitment to a better NACIS is palpable, and together we continue to do so much to maintain and improve our organization. Board members channel their many of their efforts via committees, and I applaud the significant accomplishments of the Awards, Communications and Outreach, NACIS Store, Membership Analytics, and DEI Committees. One new initiative of note is the Mentor Program, which we hope broadens opportunities in an inclusive manner.

One of the most important emerging priorities at NACIS during my term was a focus on issues of diversity, equity, and inclusion. These efforts began a few years ago as a subcommittee of the Communications and Outreach Committee when Rosemary Wardley was Chair, and have grown to the point that DEI now has its own committee, one that is present and active in all we do. The number of non-Board volunteers on the DEI Committee illustrates to me how important these goals are to so many members. Thank you to our DEI Committee and its leaders, including past-Chair Vanessa Knoppke-Wetzel and current Chairs Travis White and Hannah Dormido, for moving our work forward.

I often reflect on how fortunate I am to have been in a leadership position while DEI has became an increasingly critical initiative at NACIS. We all bring our personal experiences and unique perspectives to programs and projects, and can grow by examining things through different lens. As we continue this journey together—and as excitement builds for NACIS 2023 in Pittsburgh in October—I will share with you a personal statement of my life and observations beginning at age three, by first zooming in on my childhood home in Pittsburgh and then slowing zooming out.

Zoom 1, covering a parcel 35 feet wide, encompasses my childhood home. Its occupants are diverse in age and gender, and include my grandpa, dad, mom, identical aunt, and the next generation: two girls plus two boys born in the span of just over four years. The men spoke in soft brogues when planning to convert the upstairs bathroom into a fourth bedroom and the hall closet into the bathroom so that we could all fit in this small brick house.

Zoom 2 is a 300-foot radius, and includes St. Bede's Church. Each Sunday at church we could see the diversity that our parish had to offer, a collection of Catholic immigrants and

their offspring that have come from Poland, Italy, Ireland, Czechoslovakia, Hungary, and elsewhere to work at primarily blue-collar jobs. In a few years, after my dad's death in 1972, my mom would become secretary at the elementary school attached to the church, and her work proved a constant source of purpose, pride, and joy in her life until she retired at age 70.

My childhood home, as painted by my daughter Jamie Kennelly.

Zoom 3, at 1,500 ft, reveals most of Point Breeze, which was also Mac Miller, Annie Dillard, and Mr. Rogers's neighborhood. When I was not much older than three, my mom would send me to Frick Park Market, later made famous by Mac Miller's song, to pick up a missing dinner item. I'd pass by the previous home of Annie Dillard, Pulitzer Prize-winning author of *Tinker at Pilgrim Creek*, who wrote of her early explorations of this same neighborhood in *An American Childhood*. I would sometimes go to a slightly larger grocer over the hill in the other direction, passing by the residence of Fred Rogers of PBS fame, who used his national platform in simple and subtle manners to promote inclusivity.

Zoom 4, at 3,500 ft, shows the boundaries of Point Breeze and increasing diversity. To the north is Penn Avenue which served as the de-facto and sharp boundary with the predominantly African-American neighborhood of Homewood. To the west was the much more porous boundary with the traditionally Jewish neighborhood of Squirrel Hill. The first landmark encountered while walking to Squirrel Hill was the Tree of Life Synagogue, the site of the 2018 shooting that left eleven people dead, including survivors of the Holocaust.

Zoom 5, at 3 miles, shows a traditional Pittsburgh workplace. The neighborhood of Homestead included the closest steel mill to our house, the USS Homestead Steel Works, first acquired by Andrew Carnegie in 1883 and the site of the deadly 1892 Homestead Strike. Some steel mills in Pittsburgh were still glowing bright at night when we drove by them in my youth, but the decline of steel production was a constant topic of conversation. It was not uncommon to hear the lament that inexpensive steel imported from southeast Asia was a threat to the city's livelihood.

Zoom 6, at 5 miles, includes the neighborhood of Oakland, where changes were in the air. As a child, the most exciting spot in this neighborhood was Forbes Field, where Roberto Clemente played baseball for the Pirates, the first team to field an all Hispanic, Latino, and Black lineup in 1971. Roberto was from Puerto Rico, a heritage he shared with 0.5% of Pittsburgh residents. A victim of systemic racism throughout the league, Roberto chose to

focus on charitable work, which led to his fatal plane crash on New Year's Eve in 1972 while delivering aid to earthquake victims in Nicaragua.

I later attended high school in Oakland when everyone was abuzz about early organ transplants occurring a few blocks down the road at the University of Pittsburgh Medical Center. Few at that time would likely have predicted that UPMC and Pitt would eventually supplant traditional industrial giants as Pittsburgh's largest employer, pumping new lifeblood into the city's economy. A few blocks up the street in the other direction from my high school was Carnegie Mellon University, a burgeoning hub for science and engineering. CMU was instrumental in adding high-tech to the diversity of industry in Pittsburgh and its neighborhoods. The old Nabisco Bakery on Penn Avenue, which was close enough to waft mouth-watering scents into Point Breeze during my childhood, became the Pittsburgh headquarters of Google at Bakery Square, after they outgrew a smaller office space on the CMU campus. CMU alumnus Andy Warhol exemplifies how a new art scene contributed to Pittsburgh's resurgence, when an old industrial warehouse in Pittsburgh's North Shore neighborhood was converted into the Andy Warhol Museum in 1994. Such revitalization in turn has led to a greater diversity of people calling Pittsburgh and its neighborhoods home.

While my youthful glimpses into many aspects important to DEI were peripheral, I like to think that what my daughter Jamie (who was fortunate enough to get to know my childhood home and Point Breeze) calls "being a Pittsburgher at heart" instills some of the city's best values into me. It's my hope to use these values to continue to support DEI efforts at NACIS, as we progress on our journey and contribute positive change to our community and the world.

I am excited to return to my hometown with all of you this year for 2023 NACIS at Station Square—our conference at the confluence. Station Square is a renovated railroad station that offers final glimpses of the Monongahela before it merges with the Allegheny to form the Ohio River at Point State Park. Pittsburgh has so much to offer our group, with its rich history and geography, good food, and wonderful culture. I look forward to seeing you there!

Pat Kennelly
NACIS Past-President

February 2023

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PEER-REVIEWED ARTICLE

Understanding Maps after Multimodal Literature: A New Taxonomy

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The article examines literature's multifaceted engagement with maps and proposes a five-category taxonomy that refines existing classifications. I suggest that the understanding of maps in literature should be increasingly informed by practices encountered in multimodal literary texts, a genre with a rapidly expanding critical framework. The innovative collection of map-based stories Where You Are *(2013) by Visual Editions, is provided as a case study. The analysis of three selected pieces from the collection highlights the intersections between literature and cartography as well as establishes the significance of design in building literary narratives.*

KEYWORDS: multimodal literature; maps; innovative storytelling; literary cartography; contemporary writing

INTRODUCTION

In 2013, the innovative London-based publisher Visual Editions released *Where You Are*, a collection of stories created by 16 writers/artists/thinkers, with each contribution "exploring the idea of what a map can be" (back cover; see Table 1). Although the front cover describes it as a "book," the collection does not adhere to traditional book formats or binding conventions, but instead appears in the form of a thick paper box that contains sixteen contributions that are individually bound (Figure 1).[1]

The intriguing material artifact was designed by Bibliothèque studio with the assistance of Google's Creative Lab, a long-time collaborating partner of Visual Editions. Opening the box, the reader encounters map-based stories that are marked by the inventiveness of their design as well as by the engaging cartographic and literary experiences they enable. I approach *Where You Are* as an example of multimodal literature: texts that are conceptualized and created as a synthesis of meaning-making elements on the page surface—such as verbal writing, images, and maps, along with varying typography and graphic design—all of which collectively form the narrative world and result in innovative combinations and

Authors	Titles
Chloe Aridjis	"Map of a Lost Soul"
Lila Azam Zanganeh	"A Map of Six Impossible Things"
Alain de Botton	"On the Pleasure of Maps"
James Bridle	"You Are Here"
Joe Dunthorne	"Ghost Pots"
Geoff Dyer	"The Boy Out of Cheltenham"
Olafur Eliasson	"Subtle Nows"
Sheila Heti + Ted Mineo	"How to Be Good When You're Lost"
Tao Lin	"The Lunar Hamsters of 8G-932"
Valeria Luiselli	"Swings of Harlem"
Leanne Shapton	"Tablescapes"
John Simpson	"Nature's Valley"
Adam Thirlwell	"Places I've Nearly Been to But Have Not"
Peter Turchi	"Roads Not Taken"
Will Wiles	"My Atlases"
Denis Wood	"The Paper Route Empire"

1. The distinct format of a box is evocative of B. S. Johnson's *The Unfortunates* (2009) and Marc Saporta's *Composition No. 1* (2011).

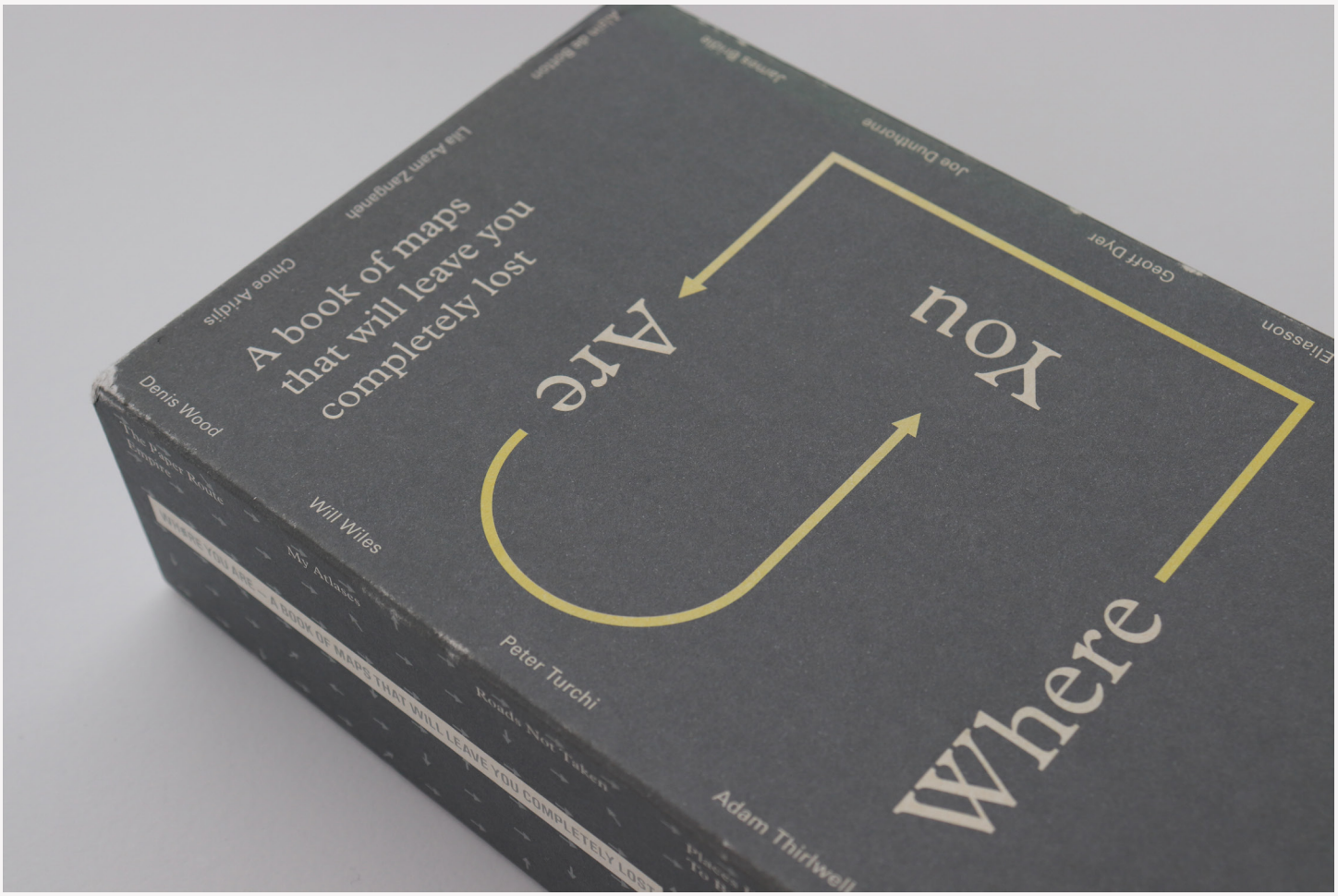

Figure 1. *Where You Are: A Book of Maps that Will Leave You Completely Lost* (2013), by Visual Editions.

readerly experiences. Although certain affinities between multimodal literature and other genres may be recognized, such as children's literature, comics, artists' books, or concrete poetry, the texts belonging to these categories follow different traditions and principles from those pertaining to multimodal literature. In particular, multimodal literary texts are mass-produced (in contrast to artists' books) and have emerged, predominantly in the form of a novel, partly in response to the elegies of the 1990s as regards the future of the print book medium, and partly as a recognition of uncharted possibilities for composing literary narratives in the digital age. This body of (mainly) twenty-first century literary texts is primarily print-based, and the creative combination of verbal and non-verbal modes of representation that multimodal texts comprise has fueled an interdisciplinary critical context, within which this article is situated.

Triggered by the growing body of multimodal literature and *Where You Are* in particular, my aim in this article is to propose a refined taxonomy of literature's engagement with maps, and to re-locate the understanding of the presence of maps in literary texts towards scholarly avenues that are informed by the practices appearing in multimodal literature. I identify four main categories of literary engagement with maps, and suggest that *Where You Are* expands this framework, proposing a fifth category.

This article begins with a literature review section that describes previous attempts to theorize the presence of maps in literary texts, followed by existing classifications and the five-category taxonomy that I propose. The next section examines the role of maps in literary texts, focusing on the publishing industry, the context of multimodal literature, and the case study of *Where You Are*. Finally, the concluding remarks emphasize the interdisciplinary nature of multimodal literary texts, and the potential for further research and creative production that is built on the intersections between literature and cartography.

Scholarly interest in the maps found in literary texts was fairly limited until just after the turn of the twenty-first century. Notable early contributions include Philip Muehrcke and Juliana Muehrcke's "Maps in Literature" (1974), Martha Hopkins and Michael Buscher's *Language of the Land: The Library of Congress Book of Literary Maps* (1999), Jeremiah Benjamin Post's *An Atlas of Fantasy* (1979), and Katharine Harmon's *You Are Here* (2003). In their attempt to chronicle the presence of maps in literary texts (Hopkins and Buscher 1999), to catalogue maps in a specific genre (Post 1979), to investigate a wide range of invented maps and consider their implications as human practice (Harmon 2003), and to theorize literary cartography (Muehrcke and Muehrcke 1974), these works offered a foundation for significant scholarly work emerging in the twenty-first century.[2]

In *Reading and Mapping Fiction*: S*patialising the Literary Text* (2020), Sally Bushell sketches an integrative approach that involves "a model of interdisciplinary interpretation based in literary studies that reaches towards and draws upon other disciplines" (Bushell 2020, 2). The interdisciplinary approach to the interpretation of maps resonates with fundamental principles as regards the operation of maps in multimodal novels, but Bushell's definition of a literary map as "a representation of spatial relations between places, people or objects (real or imagined) that corresponds *visually* to the world that the text purports to represent *verbally*" (2020, 6; emphasis in original) partly separates visual from verbal stimuli. In multimodal literary texts, the visuality of verbal writing is often foregrounded through design strategies such as typographic variation or handwriting (simulated or authentic). Moreover, maps in themselves typically comprise verbal and non-verbal elements in their representation. Hence, both verbal writing and maps bear visual and verbal components, which synergically form the multimodal literary text and generate its meaning-making processes. In this regard, Bushell's definition can be considered more suitable for describing maps in less experimental literary texts.

Lastly, the study examines an array of works drawn from several genres such as adventure and detective fiction, fantasy, children's fiction, realist fiction and so on, but the growing genre of multimodal fiction is not mentioned.[3] This is also the case with most scholarly works: *Literature and Cartography: Theories, Histories, Genres* (2017) edited by Anders Engberg-Pedersen; *Literary Mapping the Digital Age* (2016) edited by David Cooper, Christopher Donaldson and Patricia Murrieta-Flores; *Deep Maps and Spatial Narratives* (2015) edited by David J. Bodenhamer, John Corrigan and Trevor Harris; and *Novels, Maps, Modernity: The Spatial Imagination, 1850–2000* (2009) by Eric Bulson constitute book-length studies that comprehensively explore the intersections between literature and cartography in various contexts, yet do not address multimodal literary texts. By bringing multimodal novels to the fore of the discussion as rich terrains for critical scholarship, this article bridges the gap, expands the existing critical framework, and therefore makes interdisciplinary investigations of maps and literature more inclusive.

There have been limited instances where multimodal novels have been present in relevant scholarly work, as in Renate Brosch's "Mapping Movement: Reimagining Cartography in *The Selected Works of T.S. Spivet*." Nonetheless, the view that the "*main* text of the book is *supplemented* by meticulous representations of geographical surfaces" (Brosch 2013, 56; emphasis added) supports an understanding of the text's elements that is in accordance with earlier practices of book illustration, when illustrations merely reflected the content of the verbal text, were often not part of the author's creative process, and typically appeared only in select editions, as they were not considered essential parts of the text. Such practices are often encountered in special editions of literary classics but are not applicable to multimodal texts which are created with the principle that all composite elements are integral to the narrative due to their crucial role in the text's meaning-making processes.[4] Therefore, greater attention needs to be drawn to the genre of multimodal novels, one that is combined with a

2. More recently, Huw Lewis-Jones's *The Writer's Map: An Atlas of Imaginary Lands* (2018) features a significant variety of maps that appear in (or have inspired) literary texts across genres. Valuable input on designing as well as integrating these maps into the creative process is also provided by the writers themselves.

3. Similarly, Giada Peterle's study *Comics as a Research Practice: Drawing Narrative Geographies Beyond the Frame* (2021) examines narrative geographies in comics with an interdisciplinary approach, revealing the genre's research potential but evoking different contexts and traditions from those pertaining to novels.

4. An example of a practice that was not part of the text's original conception is found in **The Vintage Classics Dickens Series**, which involves six classic novels by Charles Dickens published with fresh covers and black fore-edges. Designer and illustrator Ellie Curtis was commissioned to create covers for *A Tale of Two Cities*, *David Copperfield*, *Oliver Twist*, *Great Expectations*, *A Christmas Carol*, and *Hard Times* in collaboration with the Penguin designer Suzanne Dean. As Dean (2017) reveals, "[w]e intended from the start to add black smoky edges to the pages, framing the covers to evoke the grimy industrial age described by Dickens," which clearly indicates how a long tradition of the purported transparency of design, as concept and as practice, becomes increasingly challenged in contemporary literary

refreshed understanding of the book surface as a complete space upon which a literary text is built.

EXISTING CLASSIFICATIONS

A number of existing taxonomic classifications have been devised to organize maps in fiction, though none have completely accounted for the context of their appearance in multimodal novels. For example, Robert Stockhammer's classification involves four categories: "1. Map precedes the text; 2. Author draws maps during writing; 3. Publisher puts a map in second or third edition; 4. Map is drawn by readers and critics" (qtd. in Ryan, Foote, and Azaryahu 2016, 59). With a pronounced emphasis on "the relative temporality of map production and authorship" (Bushell 2020, 7), Stockhammer's classification provides a useful tool for the examination of maps in literary texts. The first two categories seem applicable to the body of multimodal literature, as authors often integrate pre-existing maps or design maps during the creative process. However, the third category does not take into consideration the context of multimodal novels and their operative principles, where a publisher intervention in a subsequent edition would alter the literary text significantly. Finally, readers have attempted to map the fictional environment of novels using current technological affordances, as in the case of **the interactive map** of Abrams and Dorst's *S.*, which portrays locations using the interface of Google Maps.[5] Matthew Graves (2006) has provided an alternate classification of literature maps, identifying four categories: paratextual maps (frontispieces), intra-textual maps (embedded in narrative), intertextual maps (referring to an external geography, real or imagined), and logo-textual maps (comprised of verbal text). In the case of multimodal novels, paratextual maps are not applicable, as all verbal and non-verbal elements are integral to the narrative, therefore falling under Graves's category of intra-textual maps, which are embedded in the narrative. Moreover, logo-textual maps are described as "word maps or narrated maps that are pure text, bereft of graphic form." However, strictly speaking, any form of writing bears a graphic form and, given the experimentation with typography and the different meaning-making processes that typography can convey or trigger, the "purity" of verbal text is challenged.

Finally, Marie-Laure Ryan's work has focused on cognitive maps that "internalize an experience of space which is usually based on visual cues" (Ryan 2003a, 231); this aspect of Ryan's work falls beyond the scope of this article, as it corresponds to readerly constructions of "a mental model of spatial relations" (Ryan 2003a, 215). However, Ryan also organizes maps into two categories: internal maps, "designed by an author or illustrator as part of the interface between the text and the reader" (Ryan 2003b, 336), and external maps that are drawn by readers or critics. Ryan's external maps appear similar to Stockhammer's fourth category, and Ryan's internal maps to Graves's intra-textual maps.

While these three categorizations offer valuable ways to conceptualize maps in fiction, they do not account sufficiently for the context of multimodal literature, and there is a need for a more inclusive taxonomy. To this end, I have identified five main categories of literary engagement with maps, including one based upon the example of *Where You Are*, which opens up further possibilities for literature and cartography.

PROPOSED TAXONOMY

My proposed taxonomy involves five categories of relationships regarding maps and literary texts:

The first category includes *maps as inception*, in which the creation of a map object precedes the literary creative process. In this case, authors draw inspiration from pre-existing maps, and develop their literary narrative after being stimulated by the object.

The second category includes *maps that are embedded in the creative process*, in which the object is developed along with the narrative. Regardless of the map's presence in the final form of the literary text, it is an intrinsic part of the writing process.

production. This illustrates the relevance of multimodal literature as a terrain of experimentation and its significant potential to inform broader practices of literary and cultural production in the digital age. The initiative by Vintage Classics is considerably different from recent marketing-oriented publication practices that involve colored fore-edges, as evidenced in Janice Hallett's *The Twyford Code* (2022; blue), Danya Kukafka's *Notes on an Execution* (2022; yellow), Charmaine Wilkerson's *Black Cake* (2022; coral red), Lee Child and Andrew Child's *Better Off Dead* (2021; orange), Nina de Gramont's *The Christie Affair* (2022; red), and Monica Ali's *Love Marriage* (2022; pink, yellow, green, blue, and red). Colored fore-edges also appear in specific hardcover editions of works of fantasy: the deluxe editions of Frank Herbert's *Dune* (2019; blue) and Patrick Rothfuss's *The Name of the Wind* (2018; red), and the illustrated editions of J. R. R. Tolkien's *The Silmarillion* (2022; lime green) and *The Lord of the Rings* (2021; red), which also features engraved writing on its fore-edge.

5. Reader-generated interactive maps have also been developed for other novels such as J. R. R. Tolkien's *The Lord of the Rings*, revealing a vibrant readerly community and the rise of participatory culture. The Lord of the Rings Project, featuring an interactive map of Middle Earth, can be accessed at **lotrproject.com**.

The third category includes *maps that appear in the published works*. They are often found as frontispieces or endpapers, and this common positioning offers a clue to their usual function.[6] Located "outside" or at the border of the verbal text, they serve as a tool of orientation to the reader. The fourth category includes *maps that are present in multimodal literary texts*, whose defining operative principles suggest that all parts of a narrative are integral to compositional and readerly processes. In this category, maps constitute intrinsic parts of the text, and their positioning as well as their particular characteristics depend on their distinct narrative function rather than on publishing conventions.

The fifth category includes literary texts that consider *maps as both the foundation and the endpoint of a creative process*. In *Where You Are*, authors have turned to old maps as sources of inspiration, which alludes to the first category, but their ultimate objective has also been to create a map. Therefore, a creative process that commences from a map and leads to one can be considered a distinct category, and the outcome may be described as map-based fiction. In this context, the term "map-based" refers to a map as both a foundation for the creative process and as an intended objective for the broader project.

The aforementioned categories are not mutually exclusive, and they are not intended to be restrictive either: for instance, a map can be embedded in the creative process *and* appear in the published work. The purpose of this categorization is to refine our understanding of literary engagements with maps, prompted by the growing contemporary contexts of multimodal novels and that of critical interdisciplinary developments in literature and cartography. Therefore, this categorization aims to spark critical discussion on the changing landscape of the intersections between literature and cartography, one that is triggered by the emergence of multimodal literary texts in the early twenty-first century.

MAPS IN LITERARY TEXTS

In June 2019, Penguin Random House released ten classic novels with new covers through its imprint, Vintage Classics. The **Vintage Voyages** series, as it is called, features texts such as Joseph Conrad's *Heart of Darkness* and Virginia Woolf's *To the Lighthouse*, alongside less popular ones such as Bruce Chatwin's *In Patagonia*, and Tim Butcher's *Blood River*. Varying forms of maps and highlighted routes are depicted on the covers of the books, creating a sense of uniformity in their design.[7] The launching of the series was accompanied by the description, "[a] world of journeys, from the tallest mountains to the depths of the mind," emphasizing each novel's thematic engagement with maps and traveling. This initiative is an example of the deep fascination that literature has with maps, one that has been registered throughout its history in multiple forms.

Writers have often linked the inception of a literary text to a map (Lewis-Jones 2018), or have created a map from scratch, firming up the text's spatial context and transforming envisioned territories into more concrete geographies. On certain occasions, these maps are present in the finalized form of the literary text, typically as a frontispiece that precedes the beginning of the verbal text. In multimodal novels, maps are integral to the narrative, and hence their positioning on specific pages serves the literary text's narrative function. Thus, maps have served as sources of inspiration, triggering the writers' imaginative process, and often guiding the unfolding of a literary narrative. In multimodal literary texts, their functions have been enhanced significantly, as maps operate in conjunction with other modes of representation in the meaning-making process. However, there have been few instances where maps have served both as the starting point and as the endpoint of a creative literary process. *Where You Are* serves as a distinct example of map-based narratives whose literariness both derives from a map (found or created) and leads to one.

MAPS IN MULTIMODAL LITERATURE

In multimodal novels, maps can appear in a range of forms: hand-drawn or computer-generated, black-and-white or full color, inhabiting a segment of a page surface

6. This practice is more typical in the genre of fantasy, where authors craft a map of the imagined world. Examples include J. R. R. Tolkien's *The Lord of the Rings*: *The Fellowship of the Ring* (2012) and *The Hobbit* (1995), and George R. R. Martin's *A Game of Thrones* (2011). But they do appear in more classic literature such as William Faulkner's *Absalom, Absalom!* (1964), which ends with a map of Yoknapatawpha County.

7. All covers have been designed and illustrated by members of the Vintage Design team.

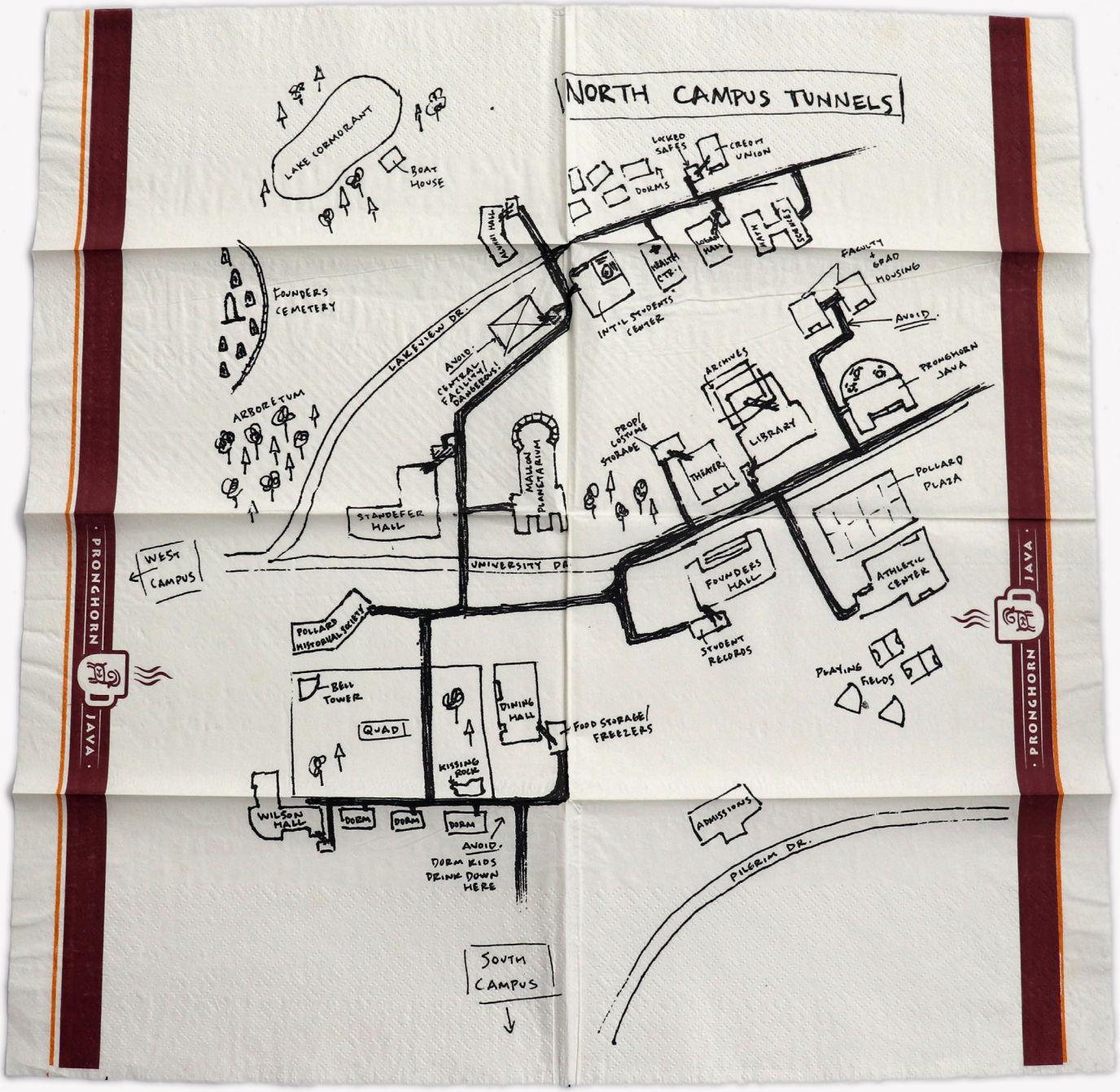

Figure 2. Napkin map in J. J. Abrams and Doug Dorst's *S.* (2013).

or an entire page spread; they can also be found positioned in various places in the text. Unlike other forms of literary text, maps in multimodal texts do not operate simply as frontispieces or decorative elements, and so this variation in their design properties and positioning is intimately connected to their narrative function. All modes of representation in multimodal texts bear meaning and collectively shape the narrative.

Two specific examples illustrate the functions and varieties of maps that may be found in multimodal texts. In J. J. Abrams and Doug Dorst's *S.* (2013), the reader confronts a campus map that is conspicuously tactile, as it is designed upon a paper napkin inserted between the pages of the novel: a material artifact that is tightly woven into the narrative while being a physically independent object (Figure 2). The napkin, including a logo, appears as if it belonged to the Pronghorn Java cafe on the north campus of the fictional Pollard State University. It is the surface upon which a main character of the novel has drawn a map to share his knowledge of the campus tunnels with another character. The map is revealed once the reader unfolds the napkin

completely, emphasizing performativity in readerly engagements with the map, as well as temporarily eclipsing the experiencing of other elements in the book. In terms of my proposed taxonomy, *S.* belongs to several categories, as the map has been embedded in the creative process (second category), appears in the published outcome (third category), and is part of the novel's multimodal composition (fourth category). The performative aspect of the reader's engagement with the map in *S.*, echoes J. R. R. Tolkien's intention as regards Thror's map in *The Hobbit* (1937) which involved "'secret' moon-letters written on the other side of the sheet [which were] meant to be read by holding the sheet up to a light, thus simulating the effect of the runes as they are revealed to Elrond," as Wayne Hammond and Christina Scull reveal (2011, 49).

Contemporary advances in technology and the proliferation of open-access software have enhanced the possibilities for publishing innovations, which in turn allow creative writers to consider material actualizations that were previously deemed unfeasible. Particularly in the case of *S.*, the material texture of the napkin map contributes considerably to the readerly experience, as the artifact is designed to appear as part of a specific narrative level.

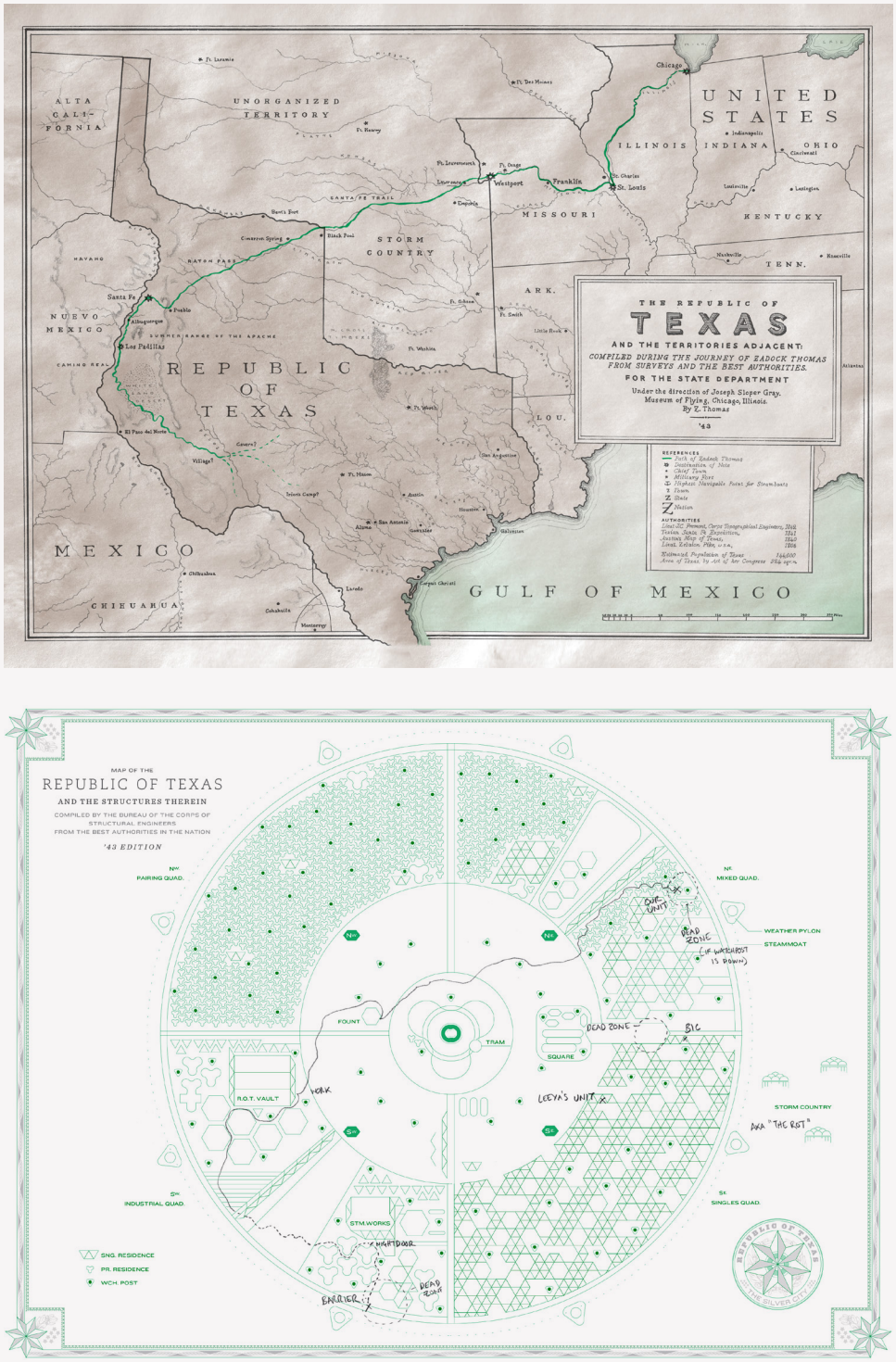

Figure 3. Maps of Texas pertaining to the timescapes of 1843 and 2143 in Zachary Thomas Dodson's *Bats of the Republic: An Illuminated Novel* (2015, 16–17; 32–33)

In another multimodal novel, Zachary Thomas Dodson's *Bats of the Republic: An Illuminated Novel* (2015), the reader encounters two full-color maps of Texas, each pertaining to a different timescape (1843 and 2143) and reflecting, in its design, the sensibilities of that particular timescape (Figure 3). While the 1843 map resembles a topographic map, and chronicles the journey of a young naturalist across the wilderness of Texas (Dodson 2015, 16–17), the 2143 map is more rigid and structure-based in order to reflect the post-apocalyptic environment of

the surveillance-driven City-State that characters in that timescape experience (Dodson 2015, 32–33).[8]

The maps are consistent with the color-coding that Dodson employs in each storyline throughout the novel: brown dominates the pages pertaining to the 1843 storyline, while vivid green echoes the artificiality of the 2143 storyline. The scale of the two maps is also strikingly different: while the first one depicts a vast area, including territories *adjacent to* The Republic of Texas, the second one is concentrated on the City-State and displays structures *inside* it.

Both maps were designed by Dodson (Mantzaris 2020, 193), which places *Bats of the Republic* in the second, third, and fourth category of my proposed taxonomy, as the maps are embedded in the creative process, appear in the published outcome, and are part of a multimodal assemblage. Each map inhabits a page spread in the novel, which renders all other textual elements temporarily inaccessible, and intensifies the presence of maps. In addition, their positioning early in the text allows the reader to invest the maps they have encountered with subsequent narrative content, highlighting what Muehrcke and Muehrcke describe as a map's "paradoxical ability to be both more and less than itself" (Muehrcke and Muehrcke 1974, 329). As the reader is exposed to a range of visual and verbal stimuli on the surface of the novel's pages—including handwritten and typed letters, a book within a book, sketches of animal species and urban structures, among others—the presence of the two maps in the opening sections of *Bats of the Republic* shows the relevance of Rob Kitchin and Martin Dodge's argument that "maps are constantly in a state of becoming" (2007, 335).

These two examples demonstrate the potential of cartographic representation in literary fiction, one that multimodal novels not only bring to the fore, but also experiment with, resulting in innovative and engaging readerly experiences. Particularly in this context of experimentation with multimodality in literary fiction,[9] inventive maps are not isolated representational units, but interact with other design elements such as typographic variation, photographic images, and page layout, therefore enhancing their narrative potential. Operating against the invisibility of book design as articulated by Beatrice Warde's famous crystal goblet essay (1955), multimodal novels highlight design's crucial role not merely in supporting, but in *forming* narrative content. *Where You Are* is not a novel but a collection of multimodal literary texts that, when viewed within this interdisciplinary framework, can shed light on the significant narrative capacity of maps that remains untapped.

CASE STUDY: WHERE YOU ARE: A BOOK OF MAPS THAT WILL LEAVE YOU COMPLETELY LOST

Despite its relatively recent publication in 2013, *Where You Are* has been out of print for several years, with used copies being sold on platforms such as Abebooks or Ebay for high prices. *The Workers* studio was commissioned by Google Creative Lab and Visual Editions to develop a **digital interpretation** of *Where You Are*, offering an online experience of the book. They provide a snapshot of the visual landscape of each map-based narrative, with partial access to the map and text of each piece, but complete access to the stories appears to have been disabled. This restricted access has likely limited critical examination of *Where You Are*. Thus, in this article I want to draw attention to this elaborate collection and remedy the lack of attention that *Where You Are* has received.

The varying engagements of authors with maps in *Where You Are* challenge traditional taxonomic classifications, while their innovative designs and inventive storytelling configurations suggest new avenues for literary narratives. The contributors not only resort to different visual stimuli such as old maps, satellite imagery, handmade drawings, and photography, but utilize them imaginatively in conjunction with verbal text, creating map-based compositions that mobilize cross-disciplinary insights and propel multimodal syntheses.[10] As a collection, *Where You Are* falls under the fifth category of my proposed taxonomy,

8. This is considerable different from the three maps that appear as frontispieces in Hanya Yanagihara's recent novel *To Paradise* (2022). Although each map in Yanagihara's text corresponds to a particular timescape, too (1893/1993/2093), typographic elements are uniformly employed in the design of the maps.

9. The novel form appears to constitute the most common terrain of experimentation with multimodality in the early twenty-first century. Multimodal experiments in poetry activate different frameworks and conventions that render their examination considerably different.

10. Though most of the contributors employ multiple modes of representation or resort to different resources as composite elements of their pieces, Lila Azam Zanganeh's "A Map of Six Impossible Things" features mainly verbal text, pointing to cognitive mapping processes and thematically alluding to Italo Calvino's *Invisible Cities* (1974), while Peter Turchi's "Roads Not Taken" mainly comprises verbal text in addition to a few symbols. The mental or cognitive maps that constitute the outcome of solely verbal text form a different category of engagement with maps, one that falls beyond the scope of this article.

Figure 4. Satellite imagery in Chloe Aridji's "Map of a Lost Soul."

since maps involve both the foundation and the endpoint of the creative process. However, the individual pieces comprising the collection can be thought to belong to one or more categories of the taxonomy.[11] In this section, I will focus on three contributions that feature innovative renderings of maps: Chloe Aridjis's "Map of a Lost Soul," Valeria Luiselli's "Swings of Harlem," and Adam Thirlwell's "Places I've Nearly Been to But Have Not."

The first story is about the life of Margaret Aberlin, a 65-year-old woman who was abandoned by her family while on vacation and lived on a bench in the streets of Mexico City for four years before being repatriated. Chloe Aridjis employs a combination of satellite imagery of Mexico City, photographic images, and verbal text in "Map of a Lost Soul," while simultaneously revealing their incapacity to fully capture the experiences of this character. This booklet-bound piece begins with two large satellite images occupying two consecutive page spreads (Figure 4). Each is overlaid with rectangular shapes that evoke portrait or landscape photographs. The information removed from the images is partially restored by the combination of verbal text and photography throughout the piece. This inventive combination demonstrates the inherent incompleteness of what satellite imagery displays.[12]

Philip Leonard observes that "the stories and other texts in *Where You Are* continually trouble the notion that the satellite's celestial gaze recentres us, creates a better connection with the world itself or produces a perceptual system that reliably captures the world's immanent character" (2019, 101). In addition, by employing photographic images taken on the ground level, Aridjis provides an alternate camera angle to the one provided by Google Maps, blending machinic capturings of locations via different media and agencies.

Aridjis utilizes an online platform of mapping that is pervasive in our everyday reality, that of Google Maps, and shows how personal narratives remain obscure and elusive to the satellite lens. The multimodal landscape of "Map of a Lost Soul" can be associated with different categories of my proposed taxonomy, as it involves pre-existing maps (first category) that appear in the published outcome (third category), albeit partly modified, and is multimodal (fourth category) due to the presence of satellite imagery, photographic images, and verbal text.

The next piece I want to examine from *Where You Are* is Valeria Luiselli's "Swings of Harlem," with a focus on the interaction between the multiple modes of representation

11. For example, maps that precede the creative process (first category) and appear in the published outcome (third category) are present in Alain de Botton's "On the Pleasure of Maps," in Will Wiles's "My Atlases," and in Denis Wood's "The Paper Route Empire." Also, maps that are embedded in the creative process (second category) appear in Wood's piece as well as in Joe Dunthorne's "Ghost Pots."

12. Similarly, in "The Boy out of Cheltenham," Geoff Dyer invests Google Maps imagery of Cheltenham with personal experiences, resulting in an autobiographical rendering of a satellite map. Resisting the singularity and stability of the satellite imagery, Dyer contests the complexity and transience of an ostensibly fixed map.

that her visual map comprises, and the framing of this interplay via an elaborately designed dust jacket that displays a satellite image of Harlem in New York City. In her piece, Luiselli embraces the potential of satellite imagery and Polaroid photography alongside verbal writing. Within the booklet, each page spread operates with a degree of independence, with full-color or sepia-tone Polaroids positioned opposite the inscribed verbal text (Figure 5). Spatial information on the upper part of the page attaches the story to a particular location, energizing it with Luiselli's narrative.

In an interview with Lily Meyer (2019), Luiselli reveals the process of creating "Swings of Harlem":

> Visual Editions asked me to write a visual map, and I decided to make it a map of swings in Harlem. My daughter was little, and I was a student, and I only had so many hours of day care. I just decided that I couldn't work against the time I had, so I needed to work with it, to integrate her into the project. We went around for months, taking pictures of every swing in Harlem. She had fun fooling around with the Polaroid, and then while she was swinging, I took notes. I think that's a place you can write from: not insulating yourself from noise and mess and distraction, but integrating them.

Bearing in mind the properties of Polaroid photographs as singular material objects transfixed in time, Luiselli integrates the conditions of creating the particular visual map into her narrative, which resonates with what several scholars (Caquard and Cartwright 2014; Rossetto 2014; Kitchin 2010; Kitchin and Dodge 2007) have identified as a post-representational turn in cartographic theory: a shift in focus from the narrative displayed *in* the maps to a narrative *of* the maps. In particular, Sébastien Caquard and William Cartwright posit that in post-representational cartography, "the focus is more on the process of mapmaking and map use rather than on the cartographic form" (2014, 104). Luiselli embeds the conditions of the creative process into the outcome of the visual map and, while the surface of the inner pages does not feature a map, "Swings of Harlem" is the only piece in *Where You Are* that is encased in a dust jacket of its own, where the reader encounters a low-contrast, grayscale satellite map of

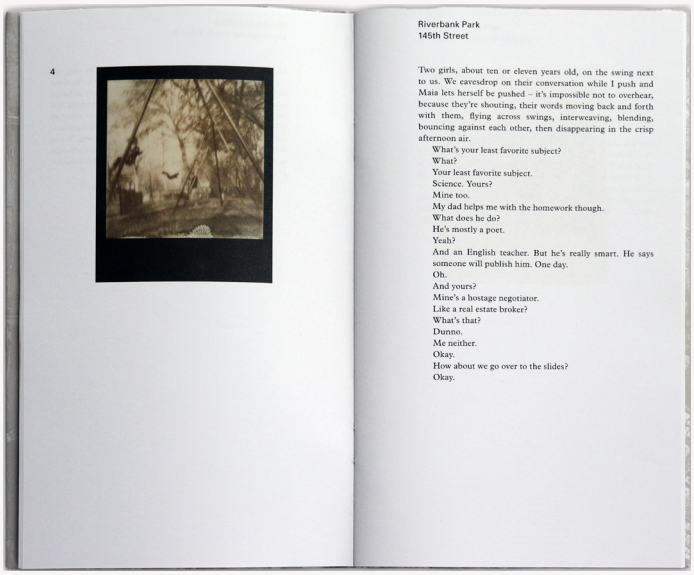

Figure 5. Polaroid photographs and verbal writing in Valeria Luiselli's "Swings of Harlem."

Figure 6. Grayscale satellite imagery and pinned reproductions of Polaroid photographs on the dust jacket of Valeria Luiselli's "Swings of Harlem."

Harlem, overlaid with Polaroid-shaped pins that highlight the places mentioned in the narrative (Figure 6).

In addition, the front and back flaps of the jacket are sealed along the top and bottom, and are wide enough to "house" a Polaroid. Luiselli and the publisher, Visual Editions, have collaborated to use clever design in order to draw attention to the capacity of the dust jacket to function not

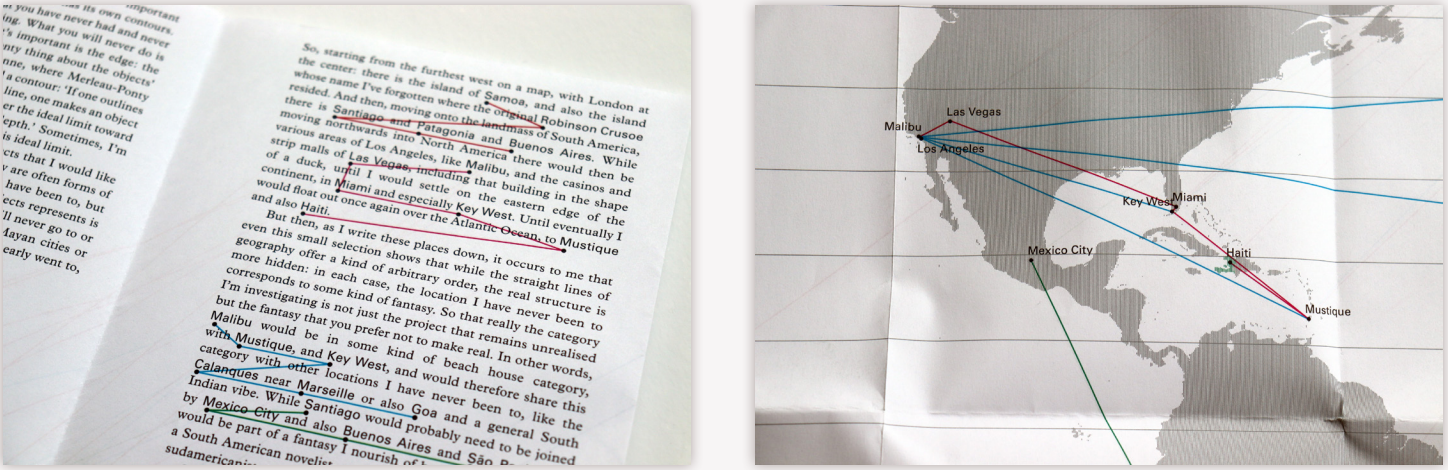

Figure 7. The use of color in Adam Thirlwell's "Places I've Nearly Been to But Have Not."

only as an informative (and protective) surface, but as an integral narrative element. This example suggests wider possibilities for print-based narratives.[13] Luiselli's creative interplay of dust jacket, Polaroid photography, and satellite imagery, yield a site where cartography, the literary, and photography inform as well as confront one another, shaping an intriguing multimodal landscape. "Swings of Harlem" can be placed in different categories of my proposed taxonomy, as it involves a pre-existing map (first category) that is present in the published outcome in processed form (third category), and features a combination of different meaning-making resources (fourth category) as composite elements of its multimodal character.

The creative engagements with maps encountered in *Where You Are* not only involve material from technologically advanced ecologies such as satellite imagery, but also pay tribute to the traditional format of the printed road map, which is employed in the design of Adam Thirlwell's piece, titled "Places I've Nearly Been to But Have Not."[14] Thirlwell's contribution is particularly inventive, an unbound piece that unfolds as a large-format print map, designed to operate in a space wider than that of the typical page in *Where You Are*. When opened completely, blocks of verbal text run horizontally above a world map, creating a deceptively rigid segregation of modes. However, Thirlwell utilizes the transparency of the printed page in order to link the verbal text and the world map: colored lines connect the names of cities mentioned in each trip, superimposed upon the verbal text, while the same colors are also employed in the lines that connect the respective cities on the world map, color coding them (Figure 7).

The colored lines breach the separation of text and map by adding a further layer of inscription. They invite the reader's eye to navigate the surface differently, away from the rigid structure of the map and verbal text, and show how color can not only "frame and highlight" (Kress 2010, 1), but also operate as a cohesive device. The design of "Places I've Nearly Been to But Have Not" harnesses the potential of the material page, engineering a creative interplay, in yet another way: the back side of the piece features colored lines against a white background. Held up to the light, the semiopaque paper permits the visibility of both sides, and the reader sees the colored lines directly connect the verbal text with the cities located on the map, enabling a transition from conjuring specific locations verbally to visually substantiating the route across them (Figure 8).

In terms of its classification in my proposed taxonomy, the map-based story that Thirlwell has created can be said to belong to the second and third categories, as it involves a map embedded in the creative process, and which is present in the published outcome, respectively. The multimodality of "Places I've Nearly Been to But Have Not" (fourth category) is evidenced not only in the presence of the world map and that of verbal text, but also in the use of color.

13. In the last few years, attention has been given by scholars and authors to this area. George Thomas Tanselle (2001) has urged the field of book history to cease disregarding book jackets. Nina Nørgaard (2019) investigates them from a multimodal stylistics perspective, while Peter Mendelsund and David J. Alworth (2020) explore dust jackets in conjunction with book covers and art. Moreover, the deep integration of covers into the narrative of several multimodal novels reveals their significant narrative potential, one that Luiselli's "Swings of Harlem" emphasizes.

14. Joe Dunthorne's "Ghost Pots" also appears in this format, adopting a metafictional tone in the verbal text as well as in the map drawn.

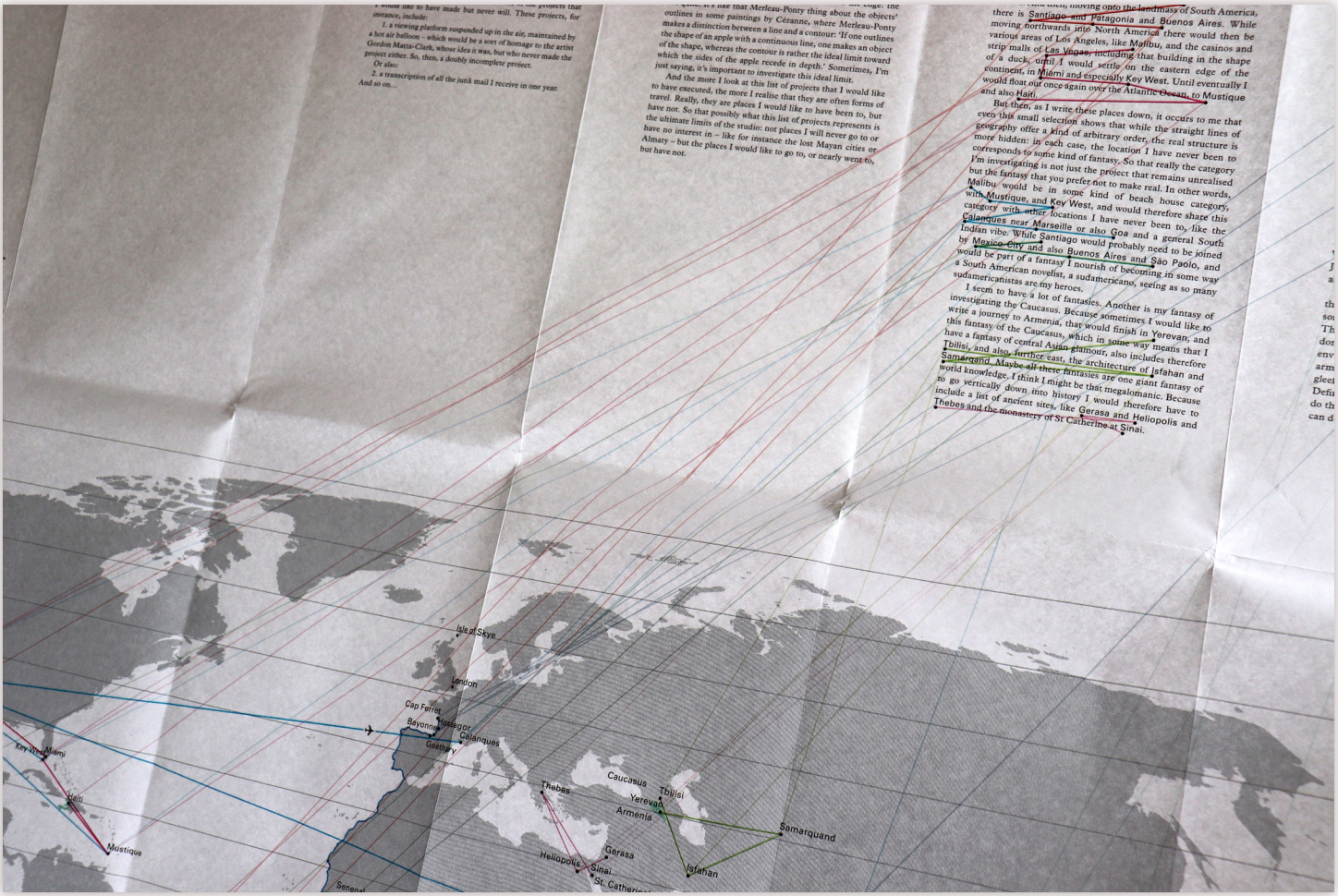

Figure 8. Design connecting verbal text with locations on a world map in Adam Thirlwell's "Places I've Nearly Been to But Have Not"

These three selected pieces from the collection *Where You Are* bring to the fore the significance of book design in the conceptualization and production of a multimodal literary text. Approaching a map-based narrative from varying perspectives, Aridjis, Luiselli, and Thirwell compose stories that sustain collaborations between different artistic forces, invite cross-discipline scholarly work, and push the boundaries of experimentation in literary cartography.

CONCLUSION

As the intersections between literature and cartography increasingly manifest themselves in digital media and platforms, the collection *Where You Are* highlights the significant potential that print-based literary texts hold as terrains of creative experimentation. Positioned within the framework of multimodal literary texts of the early twenty-first century, *Where You Are* allows cross-disciplinary critical observations to emerge while it opens up avenues for artistic collaboration that seemed foreclosed. The growing genre of multimodal novels adds new dimensions to the long tradition of literature's engagement with maps, and conceptual publications such as *Where You Are* challenge conventions and push the boundaries of how that engagement takes place. As a consequence, they herald a change in our understanding of maps in literary texts, one predicated on two fundamental principles: that the role of maps is integral to the literary narrative, and that the design practices employed in such texts impact significantly upon the representation of the map that the reader encounters.

In this article I have proposed a refinement of existing taxonomic classifications for the relationship between maps and literary texts. In particular, I have identified five categories: maps as inception, maps that are embedded in the creative process, maps that appear in the published works,

maps that are present in multimodal literary texts, and literary texts that consider maps as both the foundation and the endpoint of a creative process, of which *Where You Are* constitutes a prime example. In addition, I propose that scholarly work on maps in literature take into consideration the practices that are operative in multimodal literature, and henceforth approach maps in literary texts with principles that derive from this perspective. The phrase found in this article's title, "maps *after* multimodal literature," does not indicate that multimodal literature has reached an end, but rather points to a broader understanding of literary texts and their composite elements (including maps, verbal text, and so on) that is irrevocably affected by the practices and meaning-making strategies encountered in multimodal literary texts.

Within this framework of experimentation and multimodality, the examination of *Where You Are* is relevant as it sheds light on cross-disciplinary sensibilities and collaborations that are operative in the conceptualization, production, and reception levels of the creative process. The diversity of map-based stories that comprise *Where You Are* reveals the untapped potential that cartography holds for literary texts and suggests further critical territories for re-positioning literary texts and storytelling practices in the digital age.

By approaching maps in fiction through multimodality, contemporary literary and cartographic engagements acquire a renewed understanding of their narrative operations in the digital age. And while literary and cartographic narratives interrogate the stability of topographical representations, experimentation in these realms reminds us that our perception of space remains varied, contingent, and multimodal.

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PEER-REVIEWED ARTICLE

Multivalent Cartographic Accessibility: Tactile Maps for Collaborative Decision-Making

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Conventional visual maps present significant accessibility challenges for blind or low vision users, leaving them with few or no options for interpreting spatial data. This need not be the case: tactile maps, designed to be read through touch, have been published for more than a century. But they have most often been categorized as a navigation tool, or mere "tactile graphics" (i.e., not as expressly spatial documents). Tactile maps that allow their users to explore and synthesize thematic spatial data are rare, as are studies evaluating them. As our world continues to face existential threats that are spatial in nature—pandemics, supply chain disruptions, floods, etc.—maps will continue to provide critical information in ways that other media are unable to match. In the absence of accessible thematic maps, blind people will not only be left out of the loop, but their capacity for contributing valuable input will be severely diminished. In response, I describe here a study that evaluates the potential of thematic tactile maps for providing blind users an accessible means of analyzing spatial data when working in collaboration with sighted partners. Findings indicate that while the maps did not prove to be useful tools on their own, they did facilitate collaboration between blind or low vision participants and sighted participants. This suggests that, with some refinements, similar maps could be feasibly distributed as a means for people with visual disabilities to meaningfully participate in an otherwise inaccessible process that requires the synthesis of thematic spatial information.

KEYWORDS: thematic map; design; usability; user experience; blind; low vision; disability; disaster; hazard; mitigation planning; flood

INTRODUCTION

Especially over the past 50 years, advocacy and research has resulted in a variety of accessibility standards for visual media that are intended to benefit people who are blind or have low vision (hereafter B/LV). For example, Section 508 of the Rehabilitation Act provides important technical guidance for creating accessible technology and media (**section508.gov/manage/laws-and-policies**), while the World Wide Web Consortium has compiled Web Content Accessibility Guidelines (**w3.org/WAI/standards-guidelines/wcag**). These efforts provide a useful checklist for improving accessibility for web users with disabilities, covering improvements such as alt text, prerecorded audio, and gesture-based interaction (Kirkpatrick et al. 2018), and are ostensibly meant to extend to web maps as well; however, they do not address the particular qualities of maps themselves, instead categorizing maps as a type of generic image or widget rather than specifically as documents/tools for representing space. This is characteristic of most accessibility guidelines that cover maps. With the exception of region-specific guidelines such as the *Australian National Specifications for Tactual & Low Vision Town Maps* (Goodrick 1984), comprehensive and widely-adopted accessible cartography standards have yet to be developed (for further discussion, see Hennig, Zobl, and Wasserburger [2017]). In response, my research contributes two important perspectives: (1) a multivalent focus that considers the dimensions of accessibility that involve people's lives outside of the technology itself; and (2) a focus on accessible cartography, specifically, rather than accessible media in general. The importance of this latter point to the field of accessibility research is illustrated below.

The term "accessibility," is often used to refer to a technology's usability, especially by people with disabilities. But "accessibility" can more broadly refer to a technology's availability, geographic proximity to potential users, institutional support, reliability, operability by a wide range of users, and so on. Taken together, these goals will be referred to in this article as "multivalent accessibility." In short, "access" here is not synonymous with "accessibility" (Brown 2009). While multivalent accessibility can be examined for any technology, the study described in this paper explores it in the context of mapping.

Current guidance for creating "accessible" maps on the web is to append a type of data to static map images called "alt text," which is essentially a written description of the map that is readable by accessibility software. Alt text is usually a suitable method for increasing the accessibility of simple photographs or diagrams, and it may be appropriate for extremely simple maps (e.g., walking directions between buildings on a university campus). But given the dynamic and scalable nature of vector data, alt text quickly becomes too cumbersome a tool for web map accessibility, and although research is underway to determine how alt text could best be applied to interactive web maps (Hennig, Zobl, and Wasserburger 2017), these approaches are currently largely experimental.

Alt text is not the only tool available for making maps more accessible. Tactile maps, which use physical volume and texture to represent data, present an alternative option for B/LV people. This is a technology that has existed for over a century (e.g., Rumsey 2015), and has proven to be effective for communicating at least basic spatial information. However, though many efforts have been made to improve on this method by way of digital and other electronic components (Cole 2021), high-tech tactile media can be expensive, complicated to use, or both. As a result, more complex maps and/or maps that use more advanced technology tend to be available mostly in settings where institutional funds and resources are available; thus, thematic tactile maps are used primarily by school-age users, while tactile map use among adults is primarily for the purposes of wayfinding (Aldrich and Sheppard 2001; Cole 2021).

In the interest of keeping with the goals of multivalent accessibility, I have approached the design of maps in this study by eschewing cutting-edge (and often expensive) technology in favor of designs using cheaper, proven technology, with the notion that the maps presented here will be deployable more widely and sooner than if research-grade equipment was used.

The maps in this study will represent data about floods. In the United States, the Federal Emergency Management Agency (FEMA) distributes Flood Insurance Rate Maps (FIRMs) in order to help property owners determine whether their property overlaps with a flood zone—in which case they would be required to purchase flood insurance. But FIRMs are also frequently used in the development of natural hazard mitigation plans (NHMPs), which are documents that communities produce by analyzing their vulnerability to various natural hazards and identifying steps that they can take to mitigate damage from those hazards, after which the NHMP can be submitted to FEMA for grants to help carry out the plans. However, FIRMs are visual maps, meaning that B/LV community members are effectively excluded from contributing to major portions of the NHMP process. These are the circumstances into which the research presented here intervenes.

A NOTE ON LANGUAGE

In this article, I will use terms such as "B/LV people/users" or "disabled people/users." This is called identity-first language (IFL; Dunn and Andrews 2015), contrasting with what is known as people-first language (PFL), which encourages the use of phrases like "a person who is blind" or "a person with a diagnosis of blindness," intending to foreground that person's humanity rather than their disability/diagnosis (Snow 2007). An extensive debate surrounds the use of these terms and will not be covered here (cf. Botha, Hanlon, and Williams 2023; Muredda 2012; Streeter 2010). Instead, I defer to the official position of the National Federation of the Blind (NFB), which rejects PFL in favor of IFL, and **has resolved thus**: "We believe that it is respectable to be blind, and although we have no particular pride in the fact of our blindness, neither do we have any shame in it. To the extent that euphemisms are used to convey any other concept or image, we deplore such use" (Resolution 93-01, 1993). Because NFB members constitute the majority of this study's participants and consultants, they and the population that they represent in this study will be referred to using IFL unless grammatically cumbersome.

STUDY GOALS

In this study I aim to meet two goals. The primary goal (*Goal 1*) is to evaluate the *use* of tactile maps by B/LV users to analyze flood risk. This study does not introduce any novel technologies, but rather evaluates how existing resources can be applied to a novel context; specifically, tactile maps being used for flood risk analysis. In terms of a research question, Goal 1 is meant to answer, "Can existing resources be used to create accessible flood maps?" Secondly, map use will be evaluated in a *collaborative* context with B/LV participants working with sighted participants in order to simulate the type of environment that might be encountered in a real-world NHMP process (*Goal 2*). Goal 2 address the question: "Can accessible flood maps foster collaboration between B/LV and sighted community members?" This study is a formative assessment (Buttenfield 1999), meaning that it is one step in a series of design iterations, as opposed to a summative assessment that compares a new design against an existing one.

In the following sections, I first present a brief overview of research on tactile maps, collaborative decision-making with maps, and accessibility in hazard mitigation planning. Next, I detail how the maps used in the experiments were designed. Then, I explain the study methodology and results. Afterwards, I discuss the implications of the results, study limitations, and challenges that I encountered—specifically as they pertain to certain accessibility issues. I then conclude by discussing how this study can inform future research in accessible hazard mitigation planning, but also accessible cartography more broadly.

RELATED WORK

EVALUATING TACTILE MAPS

In terms of scholarly research, tactile maps appear most frequently in the context of orientation and mobility (O&M) studies, whether researchers are evaluating design (Engel and Weber 2021; Jehoel et al. 2006), production methods (McCallum et al. 2005; Rowell and Ungar 2003; Shi et al. 2020), or how those factors affect wayfinding (Toyoda et al. 2020). Especially within the last 20 years or so, it has become much more common to investigate tactile O&M maps that augment their volumetric/texture features with audio feedback (Papadopoulos, Barouti, and Koustriava 2018), haptic feedback (Katzschmann et al. 2018), or interactive multimodal devices, which are often modified touchscreen devices (Giudice et al. 2020). Regardless of the modality, wayfinding is by far the most common use case in tactile map research, which is in stark contrast with visual cartography research that has produced decades of scholarship on the social and scientific/analytical dimensions of thematic and reference maps *in addition to* wayfinding research.

Because this study's design is in many ways rooted in analysis of the social dynamics of disability, carefully considering exactly whom the tactile maps will be made for was foundational. To address this question, a number of researchers and practitioners have adopted the ethos of "universal design" (UD) when conducting tactile map studies (e.g., Coughlan and Miele 2017; Hasan and Gjøsæter 2021). UD advocates that design (of products, environments, media, etc.) should be accessible to everyone regardless of ability, disability, age, size, gender, and so on (Lobben, Brittell, and Perdue 2015). Therefore, a map designed in line with UD principles would be usable whether or not the user is B/LV or sighted. A document that is printed entirely in braille, by contrast, would *not* follow UD principles. Critiques of UD point out that it does not necessarily address issues of justice or the fact that universally optimal design qualities do not, for the most part, exist in practice (Hamraie 2013); in light of these critiques, the study presented here was not designed to follow UD principles. But applying UD to future iterations of this research may prove fruitful.

Another changing research dynamic in the field of tactile map studies has been the rise of *participatory research*, which entails the subjects of scientific research guiding, to varying degrees, the research itself (this is not necessarily related to the move towards referring to subjects as "participants"). In short, it espouses working *with* rather than working *on* or *for* the subjects of research (Vaughn and Jacquez 2020). In tactile cartography research, this

often takes the form of prototyping maps with guidance from B/LV people, O&M instructors, or people otherwise associated with B/LV communities (e.g., Ghodke et al. 2019; Thevin et al. 2019), as opposed to sighted researchers recording feedback from B/LV participants only as experiment data. It should be noted that simply eliciting design feedback from study participants is not, under most sets of criteria, sufficient for research to be considered "participatory."

COLLABORATIVE DECISION-MAKING WITH MAPS

One of the driving principles of this study is that the contributions of B/LV people to NHMP processes will benefit not only the B/LV people themselves, but also the communities that they live in. Enabling these contributions will permit a larger number of people with a greater diversity of knowledge and experience to contribute their insights (Henly-Shepard, Gray, and Cox 2015), in addition to helping ensure consensus amongst community members (Jankowski and Nyerges 2001). For producing and communicating these insights, maps in particular can be of significant benefit, not only due to the spatial nature of disaster planning, but also because they facilitate exploration of data, evaluation of alternative solutions, identification of conflicts, and other crucial decision-making operations (Henstra, Minano, and Thistlethwaite 2019), all in a format that can, under certain conditions, be used simultaneously by multiple users (Koski et al. 2021; MacEachren 2001). All told, a collaborative map-based planning process, for hazard mitigation planning or otherwise, is frequently regarded as a "value-added" approach, especially in situations that involve public input (Pelzer et al. 2014).

Collaborative mapping methodologies are often filed under the heading of "participatory GIS" (PGIS), or "public participation GIS" (PPGIS); these are terms that are generally associated with increased "lay" participation in previously expert-driven processes involving maps, often involving the creation of spatial data in addition to its analysis (Sieber 2006). Some important PGIS research has examined these practices critically (e.g., Elwood 2006), questioning who the "added values" benefit, or who can, in practice, actually participate. Research by Gregory Brown (2012) suggests that advances in (P)PGIS research methods have not actually led to increased public engagement decision-making. There are a number of reasons for this, but the key takeaway is that simply involving more people in a planning process does not necessarily lead to unqualified benefits, but rather introduces additional dynamics that, while they may not be intractable, should be accounted for. The study presented here is meant to provide some initial daylight into these questions: what are some of the dynamics that arise, how are they connected to mapping, and what are some future trajectories? These questions will not be entirely answered of course, but will at least be broached.

ACCESSIBLE HAZARD MITIGATION AND FIRMS

While research on the experiences of B/LV people in disasters is sparse, we do know that disasters are especially challenging for disabled people in general relative to non-disabled people. Among other problems, people with disabilities experience greater difficulty obtaining information or notifications about disasters (Gerber 2009), higher injury and mortality rates, and more difficulty finding shelter during a disaster; they also tend to be neglected by support systems meant to aid disaster victims (Arnör 2014; Stough and Kang 2015). In light of these conditions, disaster risk reduction (DRR) researchers and policymakers have developed a set of guidelines referred to as the Sendai Framework, which aims in part to address these disparities by calling for increased, deliberate attention to the particularities of how people with disabilities experience disasters (UNISDR 2015). On the whole, most recommendations in the Sendai Framework are not especially complex or specific: many, such as maintaining more up-to-date databases or including more stakeholders in disaster planning, arguably benefit more than just disabled people and result in an overall more robust disaster planning process.

In addition to broad policy-level efforts, more targeted work has looked specifically at disability-inclusive DRR processes, and a subset of this work has looked at the role played by maps. Ronoh, Gaillard, and Marlow (2017), for example, address disaster planning's frequent exclusion of children, and especially disabled children, as community stakeholders (see also Good 2015) by using mapping as a participatory risk analysis method. The maps in their study used a variety of materials and ultimately helped the children better articulate what they *already knew* regarding high-risk areas of their community—a level of collective

knowledge that surpassed the expectations of those involved in the study. In a similar vein, Gaillard and Maceda (2009) examined 3D participatory mapping for community-based DRR in the Philippines and found that 3D maps—made from common materials like cardboard and push-pins—are better than conventional two-dimensional at representing a range of scales, are more intelligible to people outside of the planning group, and can communicate more data. This project did not address the participation of disabled people specifically, but, importantly, the collaborative and participatory methods used are also used in a number of B/LV-specific mapping studies.

STUDY METHODOLOGY

I DEVELOPED A COLLABORATIVE EXPERIMENT to evaluate the utility and usability of thematic tactile maps for decision making in the context of flood mitigation. I recruited participants to perform tasks drawn from FEMA's *Local Mitigation Planning Handbook* (2013), which outlines the steps that a community needs to take in order to assemble a NHMP. These tasks required participants to use tactile maps that were provided to them, and the task instructions were given in the form of an online questionnaire. The tasks were all map-based, requiring simple assessment and evaluation, such as counting the number of buildings, or identifying areas of high flood risk. Some of these tasks required participants to work on their own, while others required participants to work collaboratively with a partner: B/LV participants were paired with sighted participants, and each session involved one pair of participants. Participant pairs were also asked to work together to produce a short summary of their "findings" after completing the map-based tasks. Finally, participants reported, using a Likert rating scale, how confident they felt while using the maps to complete the tasks. Because this is a formative assessment, this study was meant to determine whether tactile flood maps are worth pursuing in future research: affirmative results would demonstrate that the maps presented no substantial impediments to collaboration while also being legible to a degree that does not hinder collaboration.

This study was designed to contribute a user-focused perspective on tactile map design to the existing literature, augmenting a body of research that currently focuses predominantly on the maps themselves. While the technology used in this study has been in use for decades, it was not evaluated on its own, but rather in a novel configuration and applied to novel situations. In other words, this study was designed to provide a foundation for future research into tactile flood maps (or other types of accessible maps).

TASKS AND SURVEY DESIGN

The questionnaire consisted of six main sections: demographic information, individual reference map tasks, individual flood map tasks, collaborative assessment questions, collaborative summary, and post-collaboration evaluation (full study instruments can be found in Appendices A and B).

Demographic information was meant to gather basic information about participants. *Individual reference* and *flood map tasks* asked the participants to locate, identify, and measure various features on the map in order to help ensure that participants became familiar with the map's content. They also served as "quality control" questions, checking that participants were able to read at least some of what was being represented on the maps. These questions included counting the number of buildings on the map, counting the number of road labels, and measuring the east-west distance of the map using the scale bar. These tasks did not require comparison between the reference and flood maps.

Collaborative assessment questions were both subjective and objective, with some asking participants, for example, to identify the proportion of buildings overlapped by flood zones, while others asked participants to explain their reasoning for choosing a map quadrant that would be best for establishing an emergency meeting point. The *collaborative summary* section asked participants to develop a written summary of their analysis with regard to how the mapped community could take steps to reduce their vulnerability to flood damage. These collaborative tasks required comparing both reference and flood maps against each other, as well as each collaborator consulting the other. There was no information that was available to one partner and withheld from the other.

The *post-collaboration evaluation* asked participants to report their confidence levels while completing various parts of the questionnaire, both by themselves and with their partner. This section used a Likert scale to measure confidence and asked about each participant's experience using the map as well as their experience working with a partner.

PARTICIPANTS

Blind participants were recruited through a nationwide email listserv maintained by the National Federation of the Blind, while sighted participants were recruited via postings to local listservs and message boards for the State College, Pennsylvania area. People who expressed interest were then paired with a partner based on mutual availability. In all, 20 participants took part in the collaborative experiments: 10 blind and 10 sighted. One participant's questionnaire was left unfinished, so their partner's results were discarded as well, leaving 9 viable sets of results, or a total of 18 participant responses.

Participants were divided into two groups: one using maps of Pasadena, Texas, and the other using maps of Quincy, Massachusetts. These two locations were chosen because they offer a similar variety of features (buildings, roads, etc.) but in different configurations. This division was made in order to reduce any bias that may arise if only one location was represented in the maps.

TACTILE MAP DESIGN

Design conventions for tactile maps do exist; however they are generally presented as guidelines for the broader category of tactile *graphics*, and not specifically maps. For the study presented here, conventions used to design the maps were drawn primarily from the Braille Authority of North America and the Canadian Braille Authority's *Guidelines and Standards for Tactile Graphics* (2010) and *Tactile Graphics* by Polly Edman (1992). While both volumes include sections dedicated specifically to tactile maps, they do not present tactile maps as spatial information documents, and the conventions that are given exist primarily in the interest of legibility instead of articulating spatial data.

With that in mind, the maps I developed and used in this study were created through an iterative design process, incorporating guidelines from the above texts in addition to feedback from tactile graphics users, tactile graphics design professionals, and educators of B/LV students, all of whom reviewed pre-testing drafts of the maps. Then, the maps were used as test stimuli for individually based experiments, where participants worked with the maps alone (preprint available **here**). Early feedback from the individual experiments, along with further input from tactile graphics design professionals, resulted in a second revision of the maps, which were used as stimuli for the collaborative experiment sessions described in this paper.

When designing the maps, I made efforts to minimize my reliance on any technology with a relatively steep learning curve (I considered a 3D printer too complex for this study) or high initial costs (such as professional tactile graphics printers, which start at around $5,000 USD) in order to ensure that these maps, if widely distributed, would be printable in facilities that are not primarily set up to serve people with disabilities, or to produce any sort of specialized media. To that end, microcapsule paper was chosen as the printing medium for the maps. Also referred to as swell paper or swell-touch paper, this is a special type of paper with a layer of embedded chemicals that expand when exposed to heat past a certain temperature threshold. This threshold can be lowered by increasing the thermal conductivity of the paper, such as by applying ink with a high carbon content. Thus, when microcapsule paper with high-carbon ink is exposed to heat (by passing through a small device with a heat lamp called a "fuser," which costs about $1,400 USD), the inked areas expand while the blank areas remain inert, resulting in a textured surface with edges that are well-defined enough to create readable braille cells (Figure 1). Studies have shown microcapsule paper to have high user satisfaction, durability, and tactile-graphical fidelity (Brittell, Lobben, and Lawrence 2018; Rowell and Ungar 2003).

Fortunately, typical consumer inkjet printer ink has a high enough carbon content to create functional microcapsule paper graphics, although using consumer-grade printers poses an issue as well: standard braille documents are usually 11 × 11.5 inches, and most home/office printers are only able to accommodate up to 8.5 × 11-inch US letter-sized paper. In the interest of reducing the amount of specialized equipment that one must invest in to create

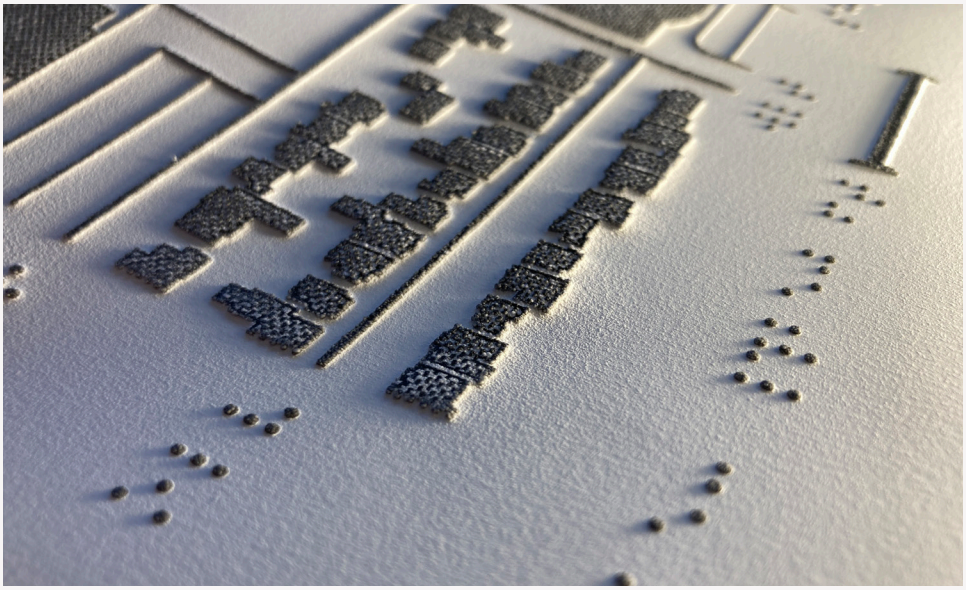


Figure 1. Closeup of printed graphics on microcapsule paper.

these maps, I chose to design the maps at a size of 8.5 × 11 inches. So while a typical FIRM (Figure 2) is meant to be printed on 24 × 36-inch paper, the maps used in this study provide a much larger-scale representation. Importantly, there is a precedent for this scale change: FEMA also produces what they call FIRMettes (Figure 3), which use the same data layers as a FIRM, but on a much larger scale and are sized to be printed on US letter-sized paper. FIRMettes served as the template for initial drafts of the tactile maps, but the layout was abandoned in later drafts.

Figure 2. A FIRM depicting flood risk for part of Suffolk County, Massachusetts. Orthoimagery is included in this FIRM but is not standard across all FIRMs, nor is any particular color scheme. Obtained from msc.fema.gov/portal.

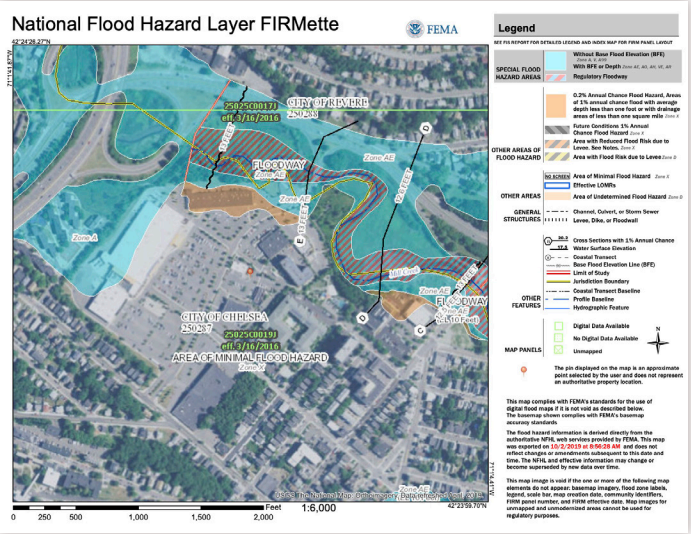


Figure 3. A FIRMette showing flood risk for portions of the cities of Chelsea and Revere, Massachusetts. Obtained from msc.fema.gov/portal.

In subsequent designs, the layout template and road data layer came from TMAP, or Tactile Map Automated Production. This is a website (**lighthouse-sf.org/tmap**) developed by LightHouse for the Blind and Visually Impaired that creates on-demand tactile maps of a chosen area to be printed on microcapsule paper (Miele 2004). There are several advantages to using TMAP: (1) the map scale of 1:5,000 is fairly close to the scale of 1:6,000 used by FIRMettes, (2) maps are printable onto 8.5 × 11-inch paper, and (3) TMAP is being continuously improved, but is fairly well-established and reliable at this point (i.e., it is no longer research-grade software). TMAP maps include a tactile map along with a key on a separate page, along with versions of the map and key that use Latin script for sighted users.

Ultimately, study participants were provided with two maps: a "before" (reference) map that included roads, buildings, and hydrographic features, as well as an "after"

Figure 4. Collaborative experiment map set for Quincy, Massachusetts. Top row: reference map and key with roads, buildings, and coastline marked. Bottom row: flood map and key with roads, coastline and flood zones marked. Note that these maps include non-critical typographic errors.

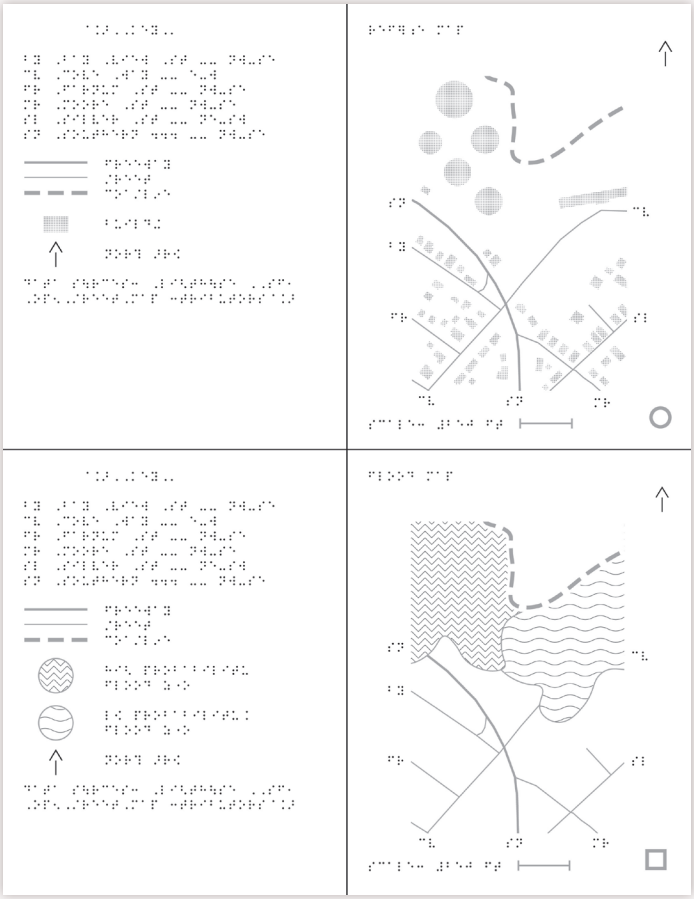
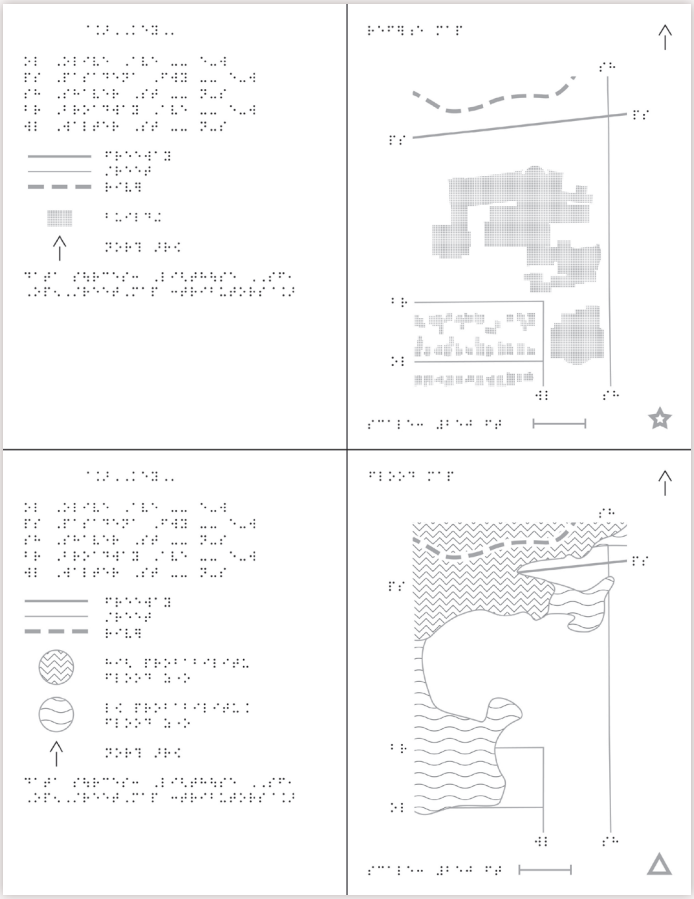


Figure 5. Collaborative experiment map set for Pasadena, Texas. Top row: reference map and key with roads, buildings and coastline marked. Bottom row: flood map and key with roads, coastline and flood zones marked. Note that these maps include non-critical typographic errors.



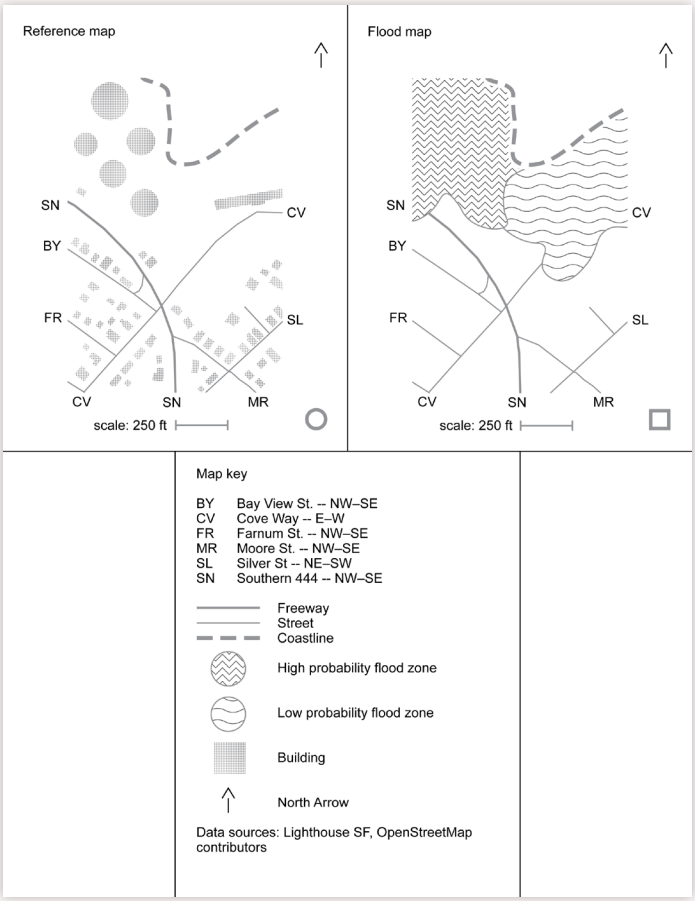


Figure 6. Sighted participant map set for Quincy, Massachusetts.

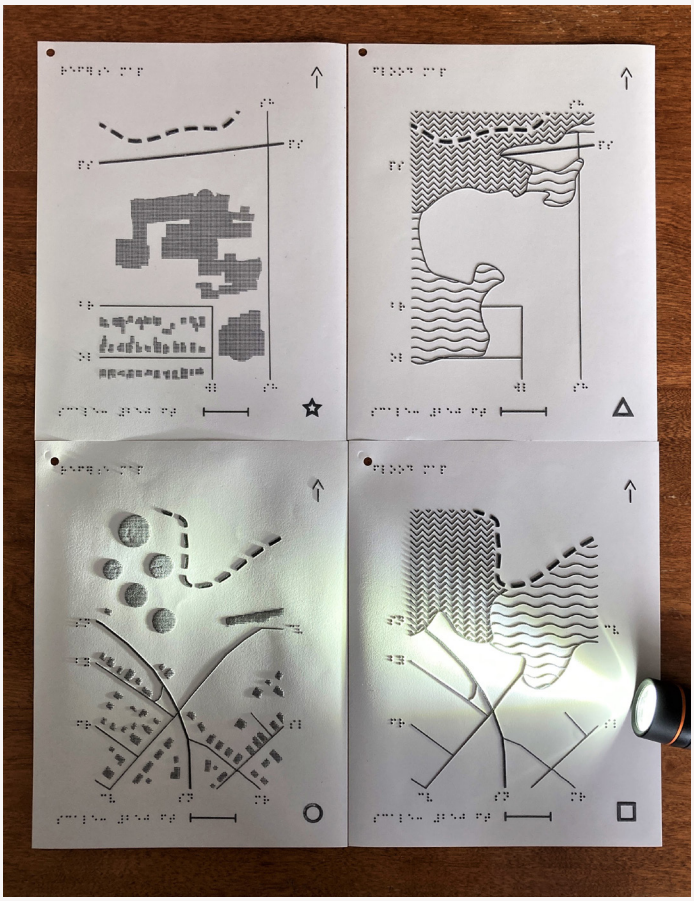


Figure 7. Printed Quincy and Pasadena maps, with flashlight used to emphasize symbol elevation.

(thematic) map that superimposed flood extents (derived from actual flood extent data, but modified for this study) on top of building and road features. Two different locations were chosen to be mapped—Quincy, Massachusetts and Pasadena, Texas—due to the variety of building sizes road types that they offered, and their proximity to flood zones. The features in flood zones were obscured, but users could still reference the "before" map to see what changed.

These two maps were supplemented with two corresponding legends on separate pages, resulting in a packet of four ring-bound pages (Figures 4–5; 7). Each sighted participant received a PDF version of the tactile maps that the B/LV participants received (Figure 6), with the only differences being that all PDF text used the Latin alphabet rather than braille, and because less space was required, the keys were condensed to one page.

STUDY PROCEDURE

B/LV participants were mailed a set of tactile maps while sighted participants were emailed a PDF of the tactile maps with the Latin alphabet replacing any braille text. I then called each pair of participants over the phone and began a conference call, allowing the three of us to speak to each other simultaneously. Participants then opened a link to an online questionnaire.

After joining the call, participants completed the first half of the questionnaire, then notified me when they were done, after which they began the collaborative portion. I gave them instructions for how to complete the collaborative portion, but otherwise gave no guidance to the participants except in the case of providing technical assistance. After the collaborative portion of the questionnaire was complete, participants then left the conference call and answered questions in private pertaining to their respective experiences with using the maps and, importantly, on working with their partner. Upon completion of the questionnaire, each participant was given $20.

RESULTS

DEMOGRAPHICS

Some prevailing demographic themes were present amongst participants (Tables 1 and 2). Most (>50%) participants in both B/LV and sighted groups identified as female, most were younger than 45 years old, most were college-educated, and almost nobody had any previous experience with community disaster planning. Most of the B/LV participants had spent all or nearly all of their lives as blind, and most of the sighted participants had little to no experience working with B/LV people in the past. All of the B/LV participants had at least some familiarity with

Gender						
	Female		*Male*		*Nonbinary*	
B/LV Participants	6		3		0	
Sighted Participants	6		2		1	
Age						
	18–24	*25–34*	*35–44*	*45–54*	*55–64*	*65–74*
B/LV Participants	2	2	3	0	1	1
Sighted Participants	1	2	4	1	1	0
Education						
	Associate's		*Bachelor's*		*Graduate or professional*	
B/LV Participants	1		5		3	
Sighted Participants	0		5		4	
Have you ever participated in hazard mitigation planning for your community, or any other type of community emergency planning?						
	No	*No, but I familiarized myself with the plan after it was completed*	*Yes, but only in a limited capacity*	*Yes, in a significant capacity*		
B/LV Participants	7	0	1	1		
Sighted Participants	8	1	0	0		
How much of your life have you been blind?						
	Less than a quarter of my life	*More than a quarter of my life but less than half*	*More than half my life*	*All or nearly all of my life*		
B/LV Participants	0	1	0	8		
Have you spent time with someone who is blind or severely visually impaired?						
	No, or only in passing	*Yes, but a limited amount (partners on a short project)*	*Yes, a fair amount (casual friends, coworkers)*	*Yes, a significant amount (family, close friends)*		
Sighted Participants	7	1	1	0		

Table 1. Demographic summary of participants.

braille, but several expressed general reservations regarding the use of tactile maps and graphics.

In the following elaboration of results, I largely don't distinguish between the groups that worked with Quincy maps and the groups that worked with Pasadena maps. This is partly because there were no dramatic statistical variations between the two groups (nothing as striking as, for example, the Quincy group hypothetically answering the legibility questions 100% correctly and the Pasadena groups answering them 15% correctly), but also because the sample sizes are very small, thus any difference between the two groups could easily be attributable to individual variation.

LEGIBILITY

For blind participants, the results of legibility tasks were highly varied. When asked to count the number of buildings shown on the maps, answers ranged from 5 to 64 for the Quincy group (the correct answer was 59), and 2 to 35 for the Pasadena group (the answer was 36). Similarly, when asked to use the scale bar to measure the east-west distance being represented by their map and to choose the correct answer from four options (both group's maps used the same scale), participants chose response options between 800 and 1,250 for the Quincy group, and 128 to 1,250 for the Pasadena group. The range of responses given by sighted participants was much smaller: when counting buildings, the Quincy group answered between 54 and 60, and the Pasadena group answered between 26 and 35 (one participant's answer was a single question mark). All sighted participants answered the scale bar question correctly.

When asked the identify the map quadrant with the highest building density, 3 out of 7 of the Quincy B/LV participants gave a correct answer, and 3 out of 6 of the Pasadena participants were correct. Of the sighted participants, 7 out of 7 in the Quincy group gave the correct answer, and 5 out of 6 in the Pasadena group. Nearly all B/LV participants correctly identified the amount of space taken up in the maps by flood zones, but answers were mixed for sighted participants.

COLLABORATIVE DECISION-MAKING

When working together, participants talked through each question with their partner while also recording their

How comfortable are you with reading braille?	
Not comfortable at all	-
Slightly comfortable	-
Somewhat comfortable	-
Mostly comfortable	3
Extremely comfortable	6
What form of braille are you most comfortable with?	
English Grade 1	-
English Grade 2	4
English Grade 3	-
Unified English Braille Code 1	2
Unified English Braille Code 2	3
Other (please specify)	-
How confident do you feel while using tactile maps?	
Not confident at all	-
Slightly confident	1
Somewhat confident	3
Mostly confident	3
Extremely confident	2
How confident do you feel while using tactile graphics?	
Not confident at all	-
Slightly confident	-
Somewhat confident	3
Mostly confident	3
Extremely confident	2
N/A	1

Table 2. Additional information from B/LV participants.

responses in the online questionnaire. The collaborative portion was recorded with their permission. What follows is a collection of themes that emerged from these sessions, including data from both Quincy and Pasadena groups.

Communication: Most participant pairs did not have any significant communication challenges, and several participants explicitly noted that they had fun with the experiment. Pairs tended to work in a truly collaborative fashion: neither the B/LV nor sighted participants were more or less likely to "take charge" by dictating the pace of work, giving final approval for answers, or solving the majority of each problem. After coming to an initial conclusion for a question, participants would ask, "Does that sound right to you?" Or they would describe their own answer, then ask, "but what do you think?" Similarly, neither the B/LV nor the sighted participants contributed any more or less information than their partners. This is to say that insights—or lack thereof—into what the maps represented were shared between partners. Often, if one participant had no insights to contribute, or was confused by the question being posed, then their partner typically shared their sentiments.

Information: Even though most participants, both B/LV and sighted, expressed a desire for more information to work with, every pair was nevertheless able to produce a set of proposed measures that the mapped community could take to further mitigate flood damage. Some participant pairs would propose steps that did not reference data on the maps, like education and outreach campaigns, establishing a registry for disabled people, or establishing evacuation routes without referring to specific roads on the map. However, multiple responses did in fact use the maps to propose measures with specific spatial references, such as, "A meeting place could be established near [the] high density area in the southwest," or "The building in the southeast should be accessible and used for a safe shelter," or "Create more routes to get from the west side of the map to the east side where there is less flooding."

Outreach: Three participant pairs, in their suggestions for community mitigation steps, advocated for the distribution of similar maps to the community. One participant wrote, "Tactile maps like the ones we are using should be made available to community members who experience blindness or visual impairment as printed maps are made available to community members with sight." Also, "having tactile maps available . . . for blind and visually impaired people to assess the safety/potential damage of [surrounding neighborhoods] would be helpful." Five of the remaining pairs either simply recommended that the maps be improved/expanded, or they did not mention maps specifically but did advocate for some sort of geospatial outreach. For example, participants suggested that "The community can help blind people or low vision people become more acquainted with their area or the geographical make up of streets and neighborhoods," or "All the [property owners] need to disclose to their buyers/renters that they are within a flood zone."

Assistance: Sighted participants had a somewhat better grasp on what the maps represented in terms of identification and location of features. This is reflected in their responses to the legibility questions, but it also held true during the collaborative portion. However, if B/LV participants were unclear as to the identity of a feature, their sighted partner would assist them, and afterwards the B/LV participant was able to generate insights about that feature.

CONFIDENCE ASSESSMENT

Following the collaborative tasks, both B/LV and sighted participants were asked to give several ratings of their confidence while performing these tasks, using a 5-point Likert scale (Figure 7), with a rating of 1 representing "Not at all confident" and 5 representing "Extremely confident." Overall, confidence ratings were largely medium-to-high, and the average confidence ratings of B/LV participants were on the whole higher than the sighted participants. In fact, several questions saw B/LV participants give an average rating over 4.0, while none of the sighted participants did (though none of them were below 3.0 either). All participants expressed the lowest amount of confidence in response to the question, "How confident did you feel while using the two maps to complete tasks?" Second-lowest, for both groups, was their confidence in other blind people being able to easily use the maps.

On the other end of the spectrum, B/LV participants expressed the most confidence in learning the meanings of symbols on the maps and in answering questions with a sighted collaborator. Sighted participants had the highest confidence ratings for learning the symbols as well, in addition to using the maps to analyze flood risk. When

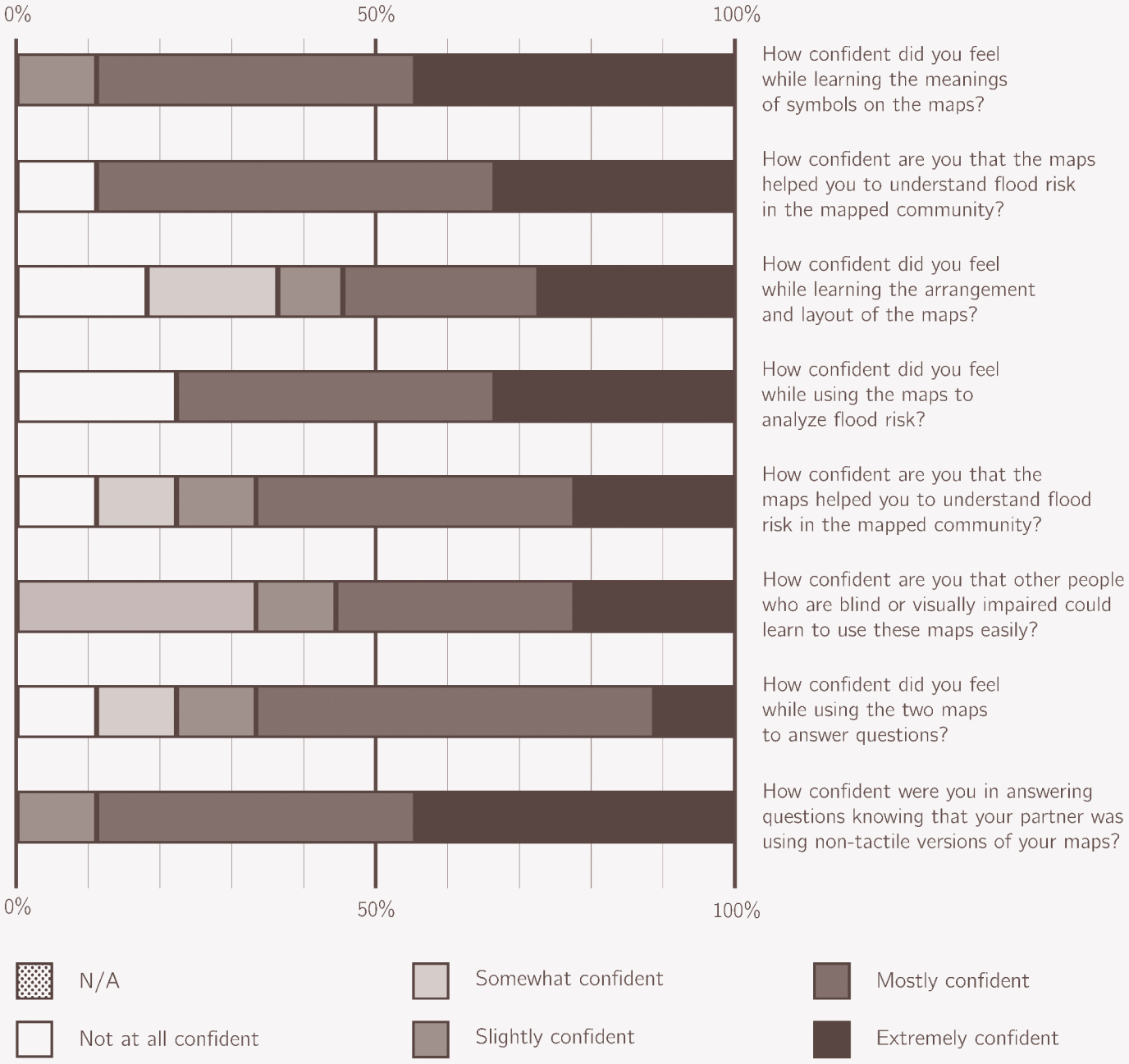


Figure 8. B/LV responses to confidence questions, in descending order according to average reported confidence.

asked what sort of partner each participant would prefer to work with, most participants chose "With any partner," although the second-most popular response for each group was "With a blind partner." Overall, no striking differences were present between the Quincy and Pasadena groups: both total average confidence scores were identical.

DISCUSSION

The results of this study strongly suggest that tactile flood maps are indeed worthy of further development and investigation. Both Goal 1 and Goal 2 were met, with some caveats. In the following, I elaborate on these determinations as they relate to the study findings.

GOAL 1 (CAN EXISTING RESOURCES BE USED TO CREATE ACCESSIBLE FLOOD MAPS?)

Participants reported the lowest average confidence ratings for the first question asked of them: "How confident

did you feel while using the two maps to complete tasks?" Significantly, though, their confidence was not negative—i.e., lower than 2.5. There are a number of possible reasons for this low confidence: (1) simple acquiescence bias, which was accounted for in the survey design but may be present regardless; (2) the question is the vaguest, and thus most likely to elicit the most neutral response; (3) the question was asked first, so participants did not yet have a clear idea as to what sorts of responses were being requested of them; or (4) the notion of "completing a task" does not imply any specific goal, and as a result participants may have a more difficult time making an evaluative judgement.

Also noteworthy is the discrepancy between how accurately participants answered legibility-based questions and their reported confidence in answering those questions. Specifically: as mentioned earlier, B/LV participants were asked to count the number of buildings on their map, and some were off by a factor of more than 15. The same was true when asked to measure the map using the scale bar (the east-west length of the map was 1,250 feet, but some participants answered that it was 280 feet). However, those same participants also reported high confidence ratings regarding learning map symbology.

This study is not designed to identify an explanation for the confidence/performance discrepancy, especially given that the relationship between the two variables is, at best, highly contingent (Moore and Healy 2008), but it is worth noting that while the maps on their own were, at least for this study's participants, unable to provide enough information to be used without external assistance, this issue largely dissipated in the collaborative portion, once the B/LV participants were able to check their answers with a partner. Given that fewer than half of the B/LV participants answered legibility questions correctly, or were very close to doing so, the results seem to suggest that any partner—B/LV or sighted—is much better than none at all.

GOAL 2 (CAN ACCESSIBLE FLOOD MAPS FOSTER COLLABORATION BETWEEN B/LV AND SIGHTED COMMUNITY MEMBERS?)

To reiterate some of the circumstances under which this study occurred: most B/LV participants had little or no experience with disaster planning, tactile maps, or even tactile graphics; most of the sighted participants had little or no experience with disaster planning and none had worked with B/LV people in any capacity previously. And yet, in spite of this almost complete lack of experience with the central elements of this study, participant pairs, with very few exceptions, were able to answer questions in this study without any major breakdowns in communication or fundamental disagreements over their interpretations of the maps.

This could simply be due to the fact that people are likely to cooperate when they stand to benefit from working together, even when the costs of cooperating outweigh the potential benefits (Jordan et al. 2016). In the case of this study, the participants were instructed (repeatedly) to work together, were given an incentive of $20 to finish the study by working together, and no significant penalty was levied for not doing so, except perhaps the consumption of time. This would, at the very least, suggest that tactile flood maps do not hinder cooperation. Indeed, B/LV participants reported that they were much more confident in answering questions knowing that their partner was using a visual version of their maps. One participant said on the phone, "when I was working with [my partner] it started making more sense . . . versus when I was looking at it alone." Their partner agreed, "Definitely. Yes, definitely."

In sum, this study's B/LV participants were able to use even the limited information available to them, despite their lack of previous experience, to perform some basic spatial analysis with their partners and come to agreed-upon conclusions. Despite the maps being radically redesigned in comparison to the original FIRMs, B/LV participants were able to contribute to a simulation of a process that, while meant to engage the entirety of a community, currently does not provide them a viable means of participation for any portion involving spatial analysis. One B/LV participant said on the phone that the maps were "very well put-together, just really fancy. I think that we're so used to seeing rudimentary maps." Natural hazard mitigation planning does not currently include tactile maps a matter of course. However, this study demonstrates that the collaborative potential of even very simple maps warrants further investigation.

LIMITATIONS AND POSSIBILITIES FOR FUTURE RESEARCH

BRAILLE

In terms of braille literacy, this study's participants were less representative of the general B/LV population than they could have been. Recruitment advertisements for this study listed a requirement of at least some braille literacy, and thus every B/LV participant reported that they were at least "mostly comfortable" with reading braille. This is in stark contrast with national braille literacy statistics: as of 2009, as many as 90% of the legally blind people residing in the United States cannot read braille (National Federation of the Blind 2009), and although this exact figure is questioned, the consensus remains that braille is not taught or learned as widely as it could be with additional research and support (Graves 2018).

SAMPLE SIZE AND COLLABORATION

The number of participants in this study was limited due in part to the challenges associated with coordinating the schedules of three different people simultaneously for each session. Future research would likely benefit from a larger sample size in order to reach thematic saturation (Guest, Namey, and Chen 2020) and draw more substantive connections between the qualitative and quantitative results. Additionally, a real-world NHMP scenario would typically entail working with a large group of people, all of whom will have the capacity to influence a user's reading of the tactile map. It is also possible that, in a group with more people who have worked with B/LV individuals in the past, or in a group with more B/LV individuals, or both, the outcomes may have changed.

KNOWLEDGE AUGMENTATION

Some B/LV and sighted participants expressed confusion or even frustration with the amount of information being provided by the maps, compared to the amount of information that they felt was necessary to answer certain questions. As discussed earlier, the choice to give participants maps of communities that they were unfamiliar with was a deliberate one in order to help ensure that study results focused on the maps themselves. However, the ultimate goal of this research is to develop means by which people with disabilities can contribute insights, perspectives, and expertise to the NHMP process, all of which would help to augment any limitations imposed by the tactile format and in the absence of additional modalities (Golledge 2005), so it would follow that research should examine that process of knowledge contribution. Future experiments could also examine the impact of additional modalities such as, for instance, the addition of alt text to be used alongside a tactile map.

Additionally, sighted participants in a real-world scenario would have access to full FIRMs and other maps. Simplified tactile maps and their Latin script equivalents were used here to reduce the number of overall variables under consideration, but future research will need to address the interactions between collaborators using visual FIRMs alongside those using tactile FIRMs, or other visual maps alongside their tactile equivalents.

DOMAIN EXPERTISE

The dynamics of flooding were noted to be confusing to certain participants. This is unsurprising given that flooding is indeed a complex phenomenon, and few participants had any previous experience with disaster planning. Indeed, FEMA supplies 116 information packets for those working to create NHMPs, such as guidance specifically regarding coastal structures, or for analyzing overland wave propagation. While this study gave participants a very broad overview of the flooding dynamics that they would be analyzing in their maps, future studies on the topics presented here could give participants additional information on flood dynamics and/or more time to learn this information, or even the chance to practice flood analysis.

PERSONAL INVESTMENT

Because the maps that were used by participants did not actually represent the communities that they live in, the participants did not necessarily have anything at stake personally that might have influenced their decision making. While outside experts may be called upon to work on real-world NHMPs, most people involved will be local officials, stakeholders and other residents (Federal Emergency Management Agency 2013), meaning that the people working with flood maps will have personal investments (financial, emotional, political, etc.) in whatever is being represented on the maps, almost certainly influencing

their decision-making calculus. An experiment similar to what is described in this paper, wherein participants are given maps of their own communities—perhaps gamified so that the outcomes of their plans would be consequential in some regard—could prove to be highly generative.

CONCLUSION

The fact that participants had relatively low confidence in other B/LV people being able to use these maps suggests that further research should be conducted not in symbol *legibility*, but symbol *learning*. Theoretical frameworks for map use and cartographic communication, especially DiBiase's "swoopy" diagram (1990), or MacEachren's "cartography cubed" diagram (1995), have become extremely influential in cartographic scholarship (Çöltekin, Janetzko, and Fabrikant 2018), but these frameworks assume a visual mode of interaction. It may be possible to reconfigure them simply by removing any instances of the word "visual" given that the remaining elements (exploration, synthesis, interaction, etc.) certainly remain pertinent to tactile map use. Future research could investigate how models of visual map use apply (or do not apply) to tactile map use, potentially generating frameworks specific to tactile map use. As of now, we simply do not know.

So how do B/LV map users acquire, process, and deploy knowledge about tactile maps? For visual maps, Roth (2012) summarizes and synthesizes a set of cartographic interaction primitives, meant to taxonomize the ways in which people interact with maps—for example, "identify," or "compare," or "correlate." Semi-equivalent work does exist for non-visual maps, especially by the team of Simon Ungar, Mark Blades, and Christopher Spencer (e.g., Ungar et al. 1997; Ungar, Blades, and Spencer 1997; Ungar, Blades, and Spencer 2002), which provides a substantive foundation for future research. What the study described in this paper contributes to this earlier work is the addition of *thematic* spatial data as well as a collaborative context.

In addition to better understanding spatial learning through tactile media, we may well benefit from a "multivalent" approach to accessible tactile cartography research, as was done in this study, given that the resources needed for accessing and producing tactile maps are still very much constrained by a number of social, political, and logistical factors (compared to equivalent visual maps which are more or less unburdened by any significant barriers to access).

Ensuring the autonomy of B/LV individuals remains a worthwhile goal, and better understanding how tactile maps are used can aid in pursuit of that goal. There are so many instances in which maps serve as the focal point of a communal event, whether it's readying a community for the next natural hazard, designating a wildlife preserve, or building a house. This study demonstrates that tactile maps likewise have this capacity to bring people together, especially those that may otherwise be left out.

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Improving Detail in Shaded Relief

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The standard "hillshade" tool included in most GIS software suites implements a simple model of lighting with a set of assumptions that make the tool fast and easy to use. This simplified lighting model can visually degrade steep terrains, producing over-dark areas and removing important terrain detail. The underlying model can, however, be manipulated to output displays without these drawbacks. This mimics the effect of ambient light without complicating the lighting model by introducing additional light sources. This article will briefly describe the underpinnings of Lambertian shaders, then demonstrate how the traditions and assumptions built into most GIS tools can be removed to give more flexibility and control over results. Finally, shadows will be discussed as a separate addition to shaded relief.

INTRODUCTION

The stock "hillshade" tool in a typical GIS toolkit operates on a simplified model of light behavior, and generalizes its output to 256 shades of gray. It gives useful results at low computational expense, with an appealingly simple interface. However, critical assumptions built into this tool have the unfortunate side effect of removing detail in steep areas.

Consider the sample scene in Figure 1. Both panels stretch their grayscale ramps across the same range, with no adjustments to brightness or contrast. The top panel is the output of the standard hillshade tool. Note the fully saturated black areas in the steep caldera rim, and also the blackened southeast slope of the island. The bottom panel, with the same lighting conditions and underlying lighting model, includes much more detail in these steep areas. The effect is as if we've added an overhead fill light to help illuminate the scene, so that all parts of the terrain get a little ambient light.

This is an illusion, but a useful one. We can't easily make the standard hillshade algorithm properly model ambient light, but we can manipulate the underlying reflectance model to mimic the effects of ambient light without adding computational load. We're going to look at a few ways to preserve and accentuate detail in areas which are typically shaded as black using the standard hillshade. These

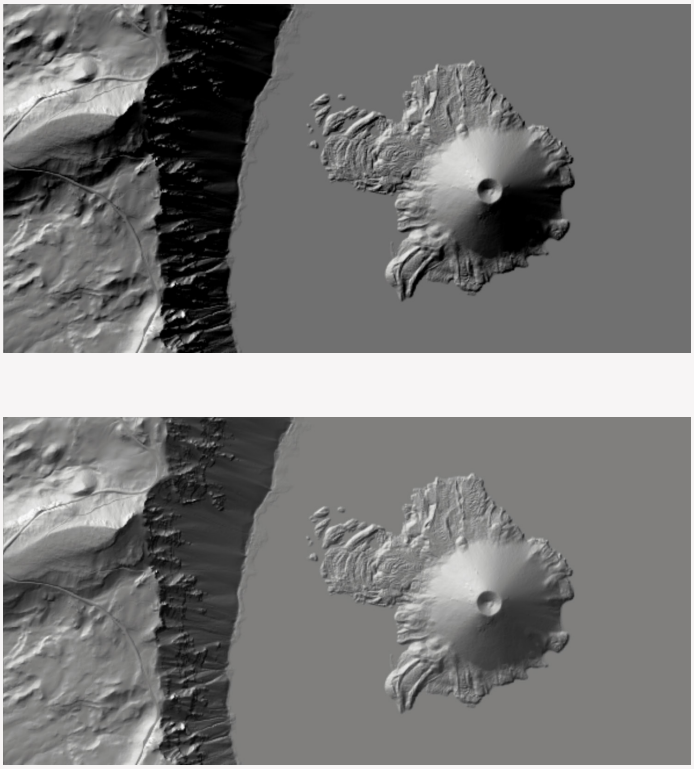


Figure 1. Traditional/standard vs "Half-Lambert" hillshade methods. Light from the northwest at 45° altitude. Note the heavy shadow-mass on the top compared with those same areas on the bottom.

methods will not make your shaded relief look like the output from Blender, but they will give you a little more control over the detail available in the darkest corners of the terrain.

To do that, we'll need to take apart the hillshade tool, breaking its function into the separate concepts of shade and shadow. We're going to need to get a little theory under our belts before we start making shaded scenes.

SURFACE REFLECTANCE

The brightness levels of a shaded relief symbology are a way of representing the degree to which a surface reflects light back to a viewer. This *surface reflectance* is modeled based on some set of assumptions about light behavior and the properties of the surface itself, which varies according to the relief method. Light that is scattered or refracted by the atmosphere or light reflected from other objects in the environment is not considered when determining surface reflectance. See Horn (1979; 1981) for a thorough discussion of reflectance in the context of cartography.

The traditional GIS hillshade tool implements a *Lambertian* shader as its foundation to compute surface reflectance. The Lambertian shader models idealized reflectance based on how well aligned the surface is with the light source—and it assumes that all light is reflected, with none absorbed by the surface. A point on the terrain surface will be brightly shaded if it "faces" the light. A point which faces "away" from the light source will have low reflectance and thus a low brightness value (BV). Lambert quantifies this idea of alignment using the *cosine emission law*: The cosine of the angle between a light vector and the surface normal vector is proportional to the BV.[1] The surface normal vector is a unit-length vector emitting from a plane tangent to the surface at a given point, which completely encodes the orientation of the surface at that point. It is roughly synonymous with a combination of the more GIS-familiar measures of slope and aspect.

THEORY VS. PRACTICE

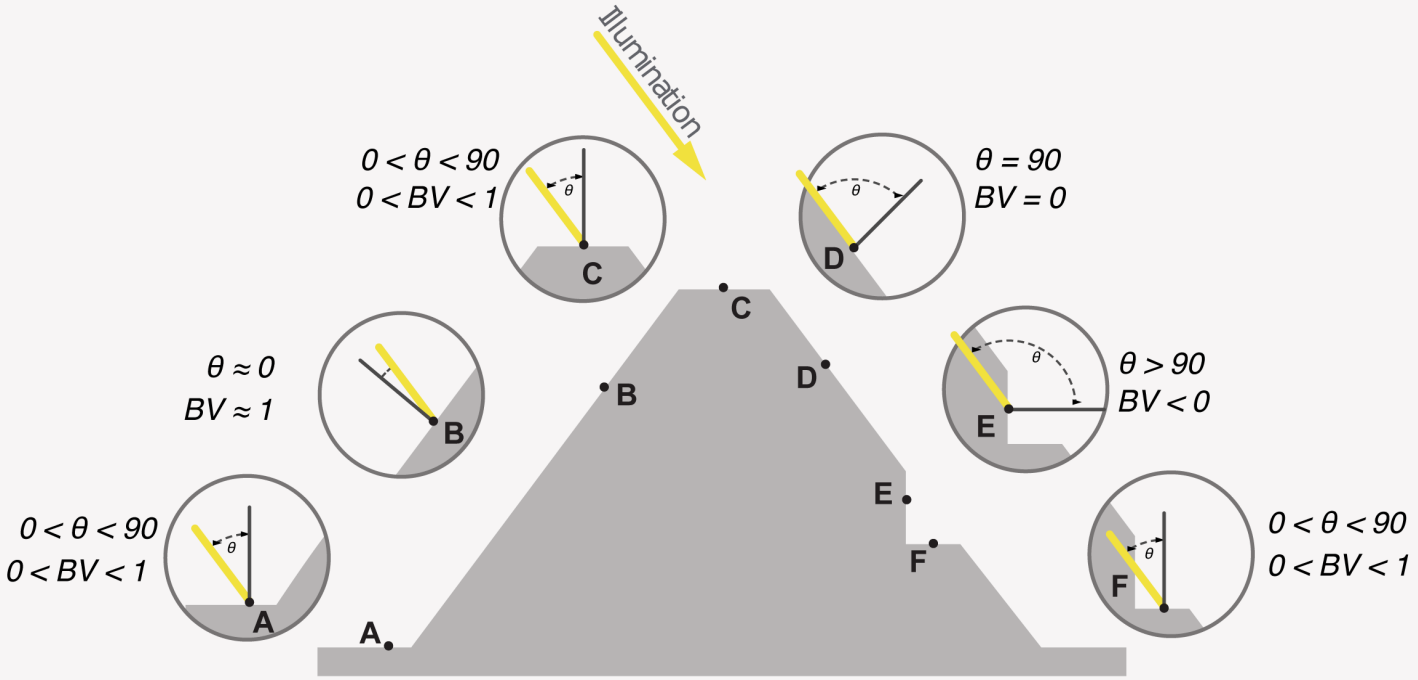
Lambert's cosine emission law provides the theoretical BV for a point on the surface. We will refer to this as the "pure" or "raw" Lambert BV. Because Lambert's brightness value is tied to the cosine function, its BVs fall between [-1, 1] as a floating-point number. However, the GIS hillshading tool you are probably familiar with produces brightness values between 0 and 255 as an 8-bit unsigned integer. The transformation between the raw Lambertian brightness value to the traditional 8-bit hillshade value is important to understand, because we are going to re-wire it to achieve different results without changing the underlying Lambertian shader.

In an unrestricted 3D space, the light and surface normal vectors could be separated by as much as 180 degrees, although this would be unusual in a cartographic context. We are often using DEMs which cannot encode overhanging terrain, and the light is always modeled to come from above the horizon. Let's look at these vectors in the context of a demonstration terrain. Figure 2 is a profile view of a cross section through a roughly pyramidal terrain to illustrate subtle differences in BVs for key points.

High BVs (typically symbolized as bright) are associated with small angles between the surface normal and light vectors. A small angle implies close alignment; the closer θ is to zero, the brighter the BV. In Figure 2, point B is an example of a brightly lit point. Point C has a slightly larger angle, so will be a fraction darker, but still relatively bright.

It is tempting, but misleading, to think of areas with high BV as being *illuminated*. Consider point F, for example. Should that point be bright or dark? Lambert examines only the angle between surface normal and light vectors, so this point has the same surface reflectance as points A and C. The urge to darken point F comes from considering shadows, which is a *viewshed* property, completely different from surface reflectance.

1. This angle and its cosine can be computed a few different ways, which we're not going to get into. The result, $\cos(\theta)$, is the BV.



Point	θ	BV = cos(θ)	Notes
A	0 < θ < 90	0 < BV < 1	The closer θ is to zero, the brighter the BV
B	0 < θ < 90	0 < BV < 1	Brighter than point A, as θ is smaller
C	0 < θ < 90	0 < BV < 1	Same brightness as point A
D	θ = 90	BV = 0	θ is exactly 90; cos(θ) = 0
E	θ > 90	-1 < BV < 0	BV is negative
F	0 < θ < 90	0 < BV < 1	Same brightness as points A and C

Figure 2. Profile view of pyramid.

The tendency to conflate shade with shadow is misleading in another important respect—the "self-shaded" points on the surface. Consider points D and E. At D, the angle between light and surface normal vector is exactly 90 degrees, leading to a BV of zero (the cosine of 90° is zero). At E, that angle is larger than 90, leading to a BV below zero.

Negative BVs from Lambert are sometimes described as "self-shaded" areas, where the surface seems to block the light which might fall on that point. However, using terms like "block" and "fall" for light are misleading in this context, because we are not considering the light's viewshed. The point of transition between positive and negative Lambert shade values occurs when the surface normal and light vectors are separated by 90 degrees (e.g., point D).

This transition is sometimes called a *terminator*.[2] It is clear that point E in Figure 2 should be dark, but should it be darker than point D, or should it be shaded the same as point D? Lambert says they should be different, with E being darker than D. The standard hillshade tool you probably use treats these as having the same BV, namely

2. This terminology is borrowed from astronomy. The line where the dark side transitions to the lit side of the moon, for example, is the terminator. This is a slight misuse of the term, given that it includes both shade and shadow, but it is very useful to describe this transition point, so we will keep it with the understanding of its limitations here.

zero. Specifically, the tool *clamps* Lambert's raw output to discard all negative values (setting those values to zero). The main problem to address with clamping is that it is a *surjective* function, meaning that it is **not reversible**. Many input values (all of the negative pure Lambert outputs) are mapped to zero. There is no way to take all of the hillshade's zero values and recover any information to differentiate points on the dark side of the terminator. Points D and E from Figure 2 are assigned the same BV after clamping—there is no way to recover any difference between these points by "un-clamping." No amount of fiddling with contrast or brightness will reveal any detail in these areas, because they all have the same BV.

If we could keep Lambert's full output range, and manipulate it without discarding values through clamping, we can give a more nuanced representation of these parts of the scene without having to add extra lights and the extra computations they will require. This is the main concept behind what Preppernau (2020) calls a "soft hillshade."

MANIPULATING LAMBERT OUTPUT

Our strategy is going to be to take the Lambert output directly, before the stock hillshade tool clamps and otherwise manipulates the shader values. Unfortunately, the way this tool is built doesn't permit us to intercept shade values at the correct point. We will instead use a simple home-grown Lambert shader to experiment with its results.

The math-curious and persistent reader could certainly build a pure Lambertian shader using existing GIS tools (see Preppernau [2020] for guidance on how that might be done in Python). To keep our focus on what to do with Lambert instead of how to calculate it, I have developed Lambertian shaders for ArcGIS Pro and QGIS which are available for download alongside this article, and which will form the basis of the following examples.

All of the examples here will examine the area around Wizard Island in Crater Lake National Park in Oregon, USA. The data source for this study area is extracted from the Crater Lake sample DEM available at **shadedrelief.com/SampleElevationModels** (Kennelly et al. 2021).

PURE LAMBERT

Lambert's canonical output, spanning the range [-1, 1], is what we have been calling pure or raw Lambertian brightness values. It is the cosine of the angle θ between the illumination and surface normal vectors. If we apply a grayscale ramp to this output, with our colors spanning the entire theoretical range, the result (in Figure 3) shows maximum detail across the terrain. No areas are flattened into darkness via clamping. Note from the histogram that this shader includes BVs below zero.

This study area and the lighting conditions have been selected to draw attention to the terminator and the terrain behind it. These examples will use an azimuth of 315°, and an elevation of 30°. The result in Figure 3 and the top panel of Figure 1 were both made with the same light conditions, yet they look quite different. The cause of this difference is the effect that clamping (removing detail) has on the range used on the final color ramp.

The histogram of BVs in the pure Lambert output in Figure 3 shows a bimodal distribution, with an obvious spike indicating the large flat area of the lake surface. This spike shows the BV for generally flat terrain under these lighting conditions. The much smaller peak centered on zero in Figure 3 draws attention to where this example terrain begins to self-shade with the chosen lighting

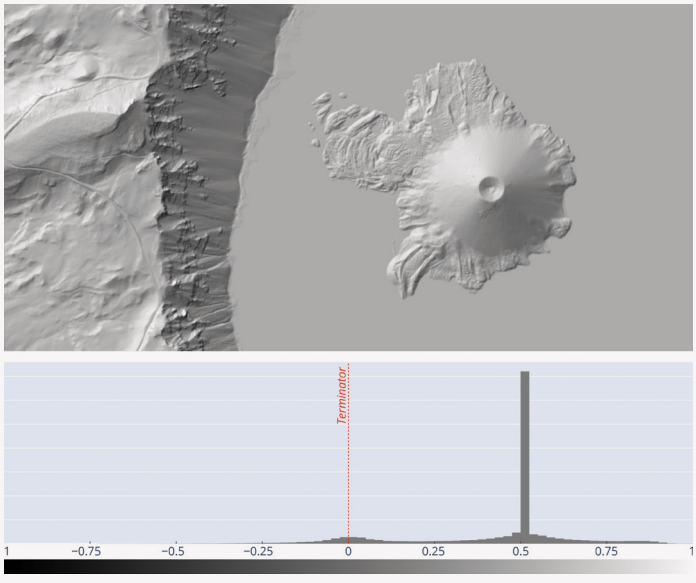


Figure 3. "Pure" Lambertian output.

angle. This demonstration/sample configuration makes it easy to see where the terminator BV lies, just by looking at the histogram. The terminator is always at 90° between surface normal and light vectors. For pure Lambert, that angle is mapped to BV=0.

You can use the tools available for download alongside this article to apply a pure Lambertian shader to your own terrain. If your terrain is not especially steep, or if you define a light high in the virtual sky relative to the steepest parts of your terrain, then you may not get many negative BVs. Try with a relatively low altitude of 30° above the horizon to start.

Use the pure Lambert tool (or your own version) to shade a terrain, saving the output as a new raster which we'll call `PureLambert`. Update the symbology for this layer to ensure that the color ramp stretches from -1 (black) to 1 (white). That ramp is useful for these examples, but in practice you might choose to restrict this color ramp using a percent clip or a standard deviation pattern to focus the ramp on where most of the action is. With careful color ramp control, you can precisely define just how dark the terrain behind the terminator should be. We'll get deeper into color ramps shortly.

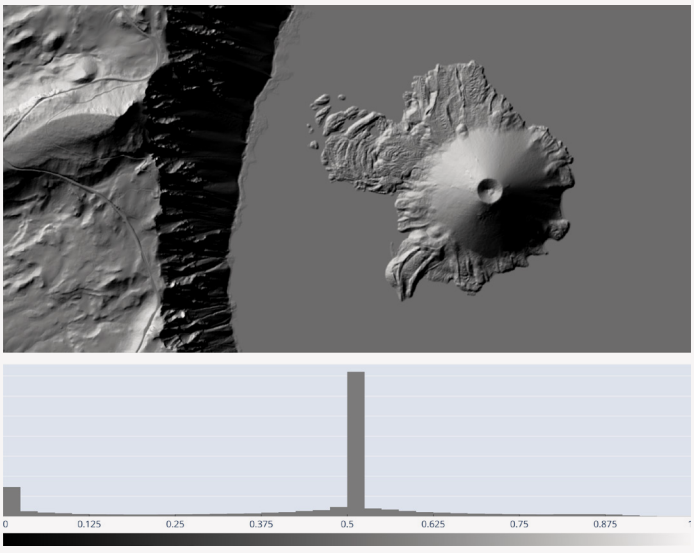
This `PureLambert` output can be used as-is in contemporary GIS software. Its negative values are not inherently problematic, nor are floating point data values. There is no need to clamp or to re-range to [0, 255] as the standard hillshade tool does.[3] It would be useful, however, to re-range our [-1, 1] data into a more broadly accepted range of [0, 1].

There are real advantages to putting output in this range, the most important of which is compatibility with general-purpose image editors outside of GIS. Conceptually, there is also an advantage to thinking of brightness values as a *percentage*. If we manipulate the BV into a [0, 1] range, it becomes exactly that: percent brightness. There are a few approaches to fitting the raw output range into this more universal [0, 1] range. The options we will look at are: clamped, soft, and Half-Lambert.

CLAMPED LAMBERT

Clamping the pure output to [0, 1] will remove negative values, promoting them to zero. We've already examined at length why this is destructive and undesirable. Unfortunately, this approach and the associated data loss is the behavior of most GIS hillshade tools, as previously described. The raw Lambert data is clamped and then stretched across the color ramp spanning this narrower range (0–1) as seen in Figure 4.

For these manipulated outputs, I've included an output curve to illustrate how the full theoretical range of input angles maps to BV output. The x axis is the angle between



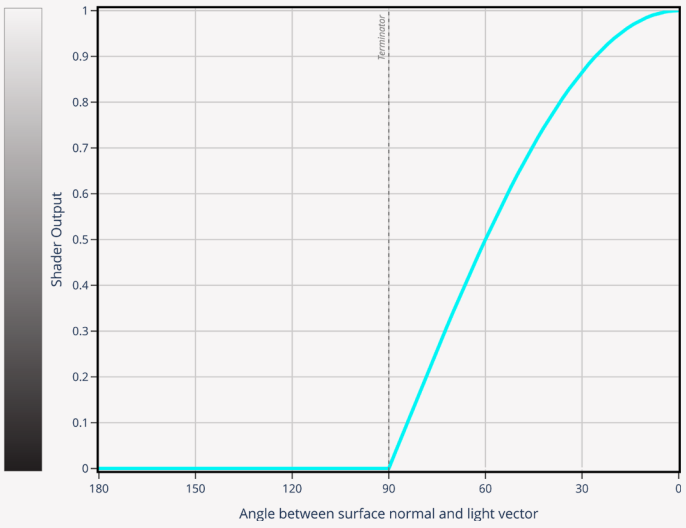


Figure 4. Clamped Lambert output.

3. This practice has more to do with the history of image file formats than it does with any intrinsic need to limit the range of the output.

the light vector and surface normal vector. Note that all possible angles are given, even those behind the terminator (90–180°). The y axis is the output BV. The curve indicates how this clamping scheme relates the two.

You can create a clamped version of your Lambertian output using your preferred GIS's raster calculator/map algebra tool. The **con** operator in ArcGIS Pro is one easy way to do this (see Figure 5) with this expression, which checks whether `PureLambert` is less than zero and outputs 0 if that condition is met, or else it outputs `PureLambert`:

```
Con("PureLambert" < 0, 0, "PureLambert")
```

In QGIS, the raster calculator uses a slightly different command. Conditionals are specified with an **IF** statement:

```
IF("PureLambert@1" < 0, 0, "PureLambert@1")
```

Again, be sure to set the color ramp on the result to cover the entire output range, which in this case is [0, 1].

The effect of clamping is to make the output very dark, with many areas set to fully saturated black. The nuance/detail is scrubbed from areas behind the terminator, flattening the dark areas to a uniform BV.

Note in the histogram that there is now a spike at zero, representing all the cells which were negative (or zero) in the `PureLambert` output. Contrast and brightness can be manipulated to lighten the dark cast, but the detail that was originally below zero in the `PureLambert` output is gone with this approach.

SOFT HILLSHADE

The detail available by leaving the output unclamped allows a "soft" hillshade (as described by Preppernau 2020). Preppernau's soft shade is easily achieved using the `PureLambert` output directly. But we're modeling maximum compatibility here, so we'll rescale the values with some light algebra:

$$BV_{soft} = (\cos(\theta) + 1) / 2$$

Note that this is not a clamping operation as above. This is an *affine transformation* in which the raw output is scaled (multiplied by ½) and translated (increased by ½) to fall

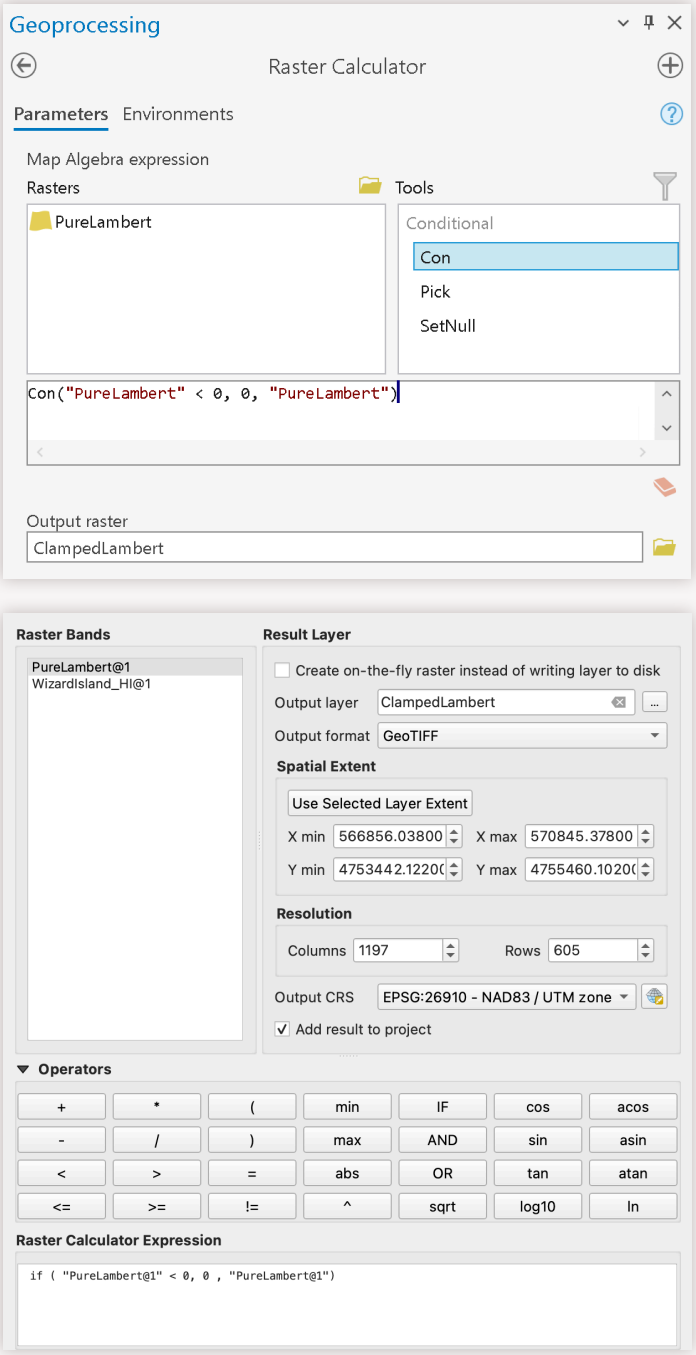


Figure 5. Clamping with the Raster Calculator in ArcGIS Pro (top) & QGIS (bottom).

between zero and one. A GIS raster calculator is again an easy way to do this, given that we already have pure Lambert values:

```
("PureLambert" + 1.0) / 2.0
```

Let's save this output as `SoftLambert`. The entire output detail from `PureLambert` is preserved, but it is squeezed into a smaller range. So long as the output shade values are

stored as floating-point numbers, the precision of that data type will retain all detail and nuance among shade values.

Notice the location of the terminator at 90° on the x axis of the output curve in Figure 6. This `SoftLambert` output, if on a linear color ramp, will map to 50% gray at that point, which is unrealistically bright for an area which is supposed to be just slipping into darkness behind the terminator.

One way to improve this display is to apply a non-linear color ramp to the output, where BVs [0, 0.5] (those areas behind the terminator) occupy very little of the color space—say, from black to 80% gray—with the remaining shade values (BVs [0.5, 1]) taking the rest of the ramp between 80% gray to white. The results for this 80/20 split are shown below. Feel free to adjust the grayscale ramp until you get a shading effect that brings out details in the darkest areas of your map while still displaying an overall pattern of gray shading that you find representative of your terrain.

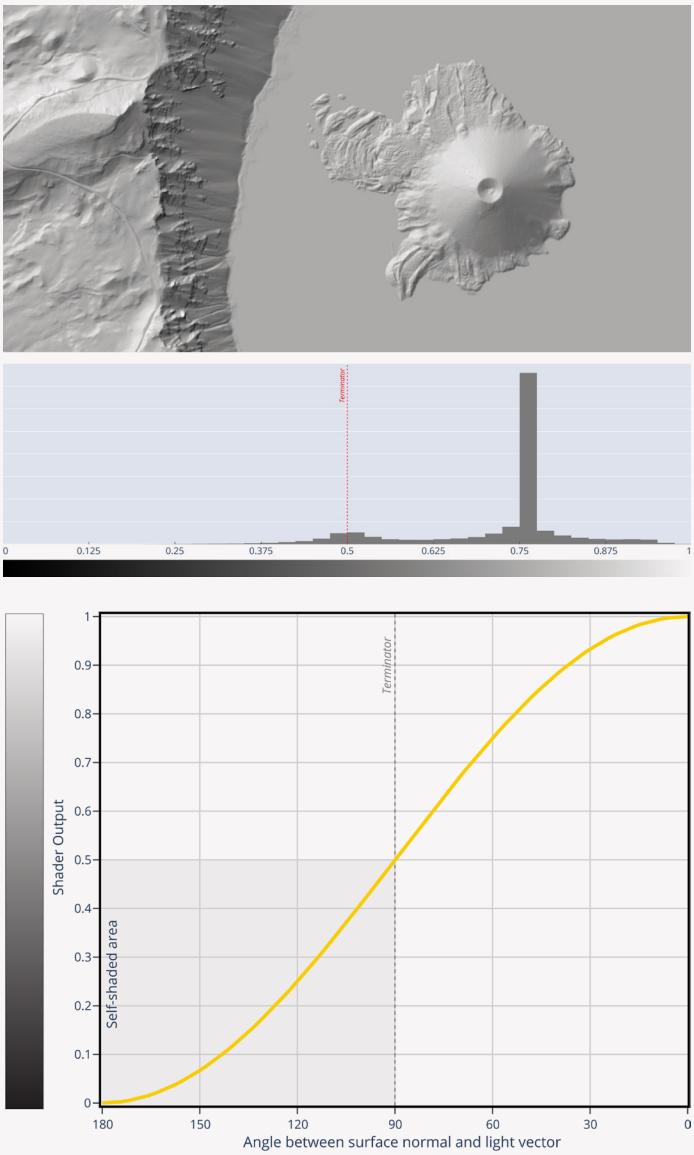


Figure 6. Soft hillshade output.

The same `SoftLambert` output with this segmented color ramp is shown in Figure 8. Note that the steep areas of the caldera rim are now quite dark but are not completely black. By changing the color value of that mid-point color stop, you can adjust how dark the areas behind the terminator will be.

Because the Lambertian output contains all detail for all areas, the visual effect can be manipulated entirely with color ramp adjustments.

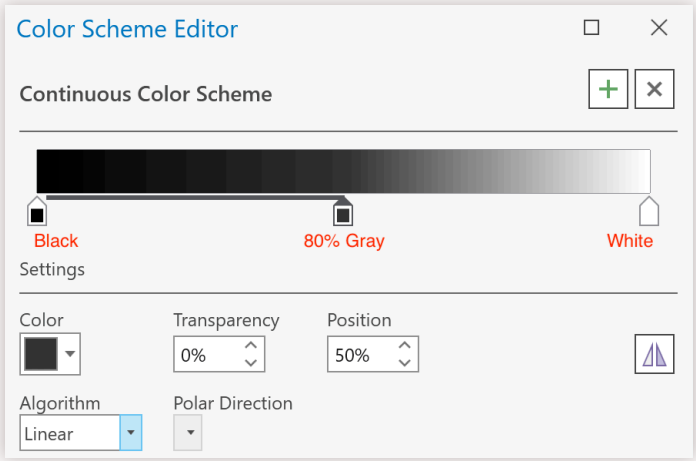


Figure 7. 80/20 color ramp.

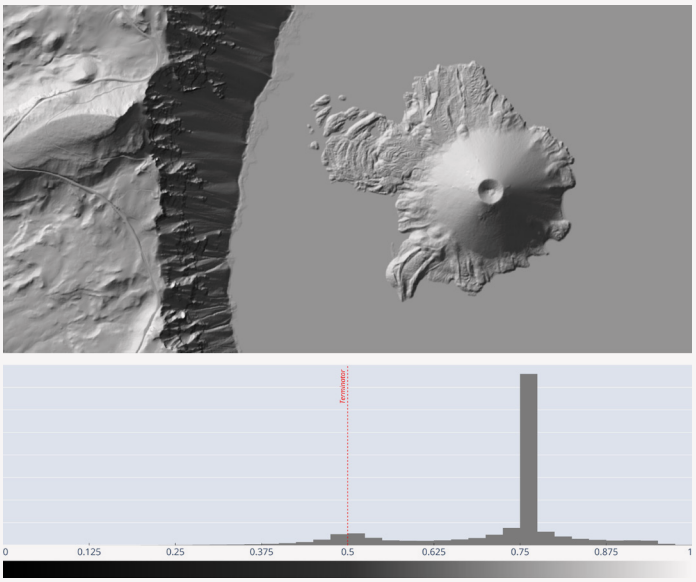


Figure 8. Soft hillshade with custom color ramp.

HALF-LAMBERT

The soft hillshade above is a little finicky, in that the color ramp needs to be tweaked for best results. One way to avoid this limitation is to use the Half-Lambert shader, which performs quite well with a linear color ramp applied to its full output range of [0, 1]. It can be thought of as a hybrid between the soft hillshade and the clamped hillshade, taking the best characteristics of each.

The Half-Lambert squares the output values from the `SoftLambert`. Squaring this value changes the shape of the output curve, notably flattening it on the dark side of the terminator:

Within the ArcGIS Raster Calculator, use the **power** operator to do this:

```
Power("SoftLambert", 2)
```

In QGIS, the Raster calculator implements the exponent with a separate operator:

```
"SoftLambert@0" ^ 2
```

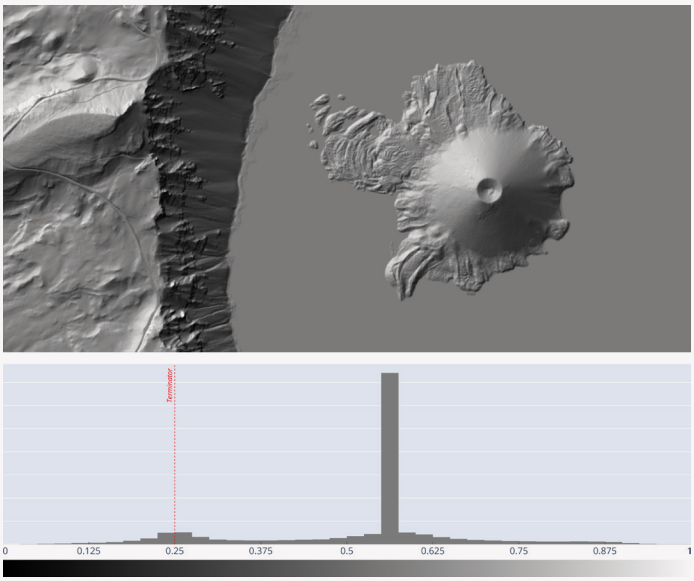
Set a linear color ramp to span the full theoretical range of [0, 1]. The effect here is to keep output quite dark, but not uniformly black (Figure 9).

A few details are worth noting here:

- The terminator at 90° maps to a quite dark (but not fully black) value.
- The shape of the output curve on the dark side of the terminator gives most of the BV output range to those values nearest to the terminator. Meaning: areas within the dark side, but close to the terminator, get the most variation of the output color ramp behind the terminator.
- The two peaks in the histogram are worth mentioning. The lake surface is quite noticeable. The second, smaller peak (indicating the terminator in this example) lies at BV=0.25. This matches the output curve, which shows the terminator (θ of 90°) at BV=0.25.

The default linear color ramp gives reasonable results, but it can also be fine-tuned, much like we did above with the soft Lambert. In that case, however, the terminator lies at 0.25 rather than at 0.5, so your terminator color stop should be placed 25% along the ramp rather than halfway.

The three options for coercing Lambert into [0,1] are plotted together in Figure 10, so that their output curves might be directly compared. Stacked on the same graph, it is easy to see why the clamped Lambert is generally darker than the other options. For most inputs, its output BV is the same or lower than the other two options.



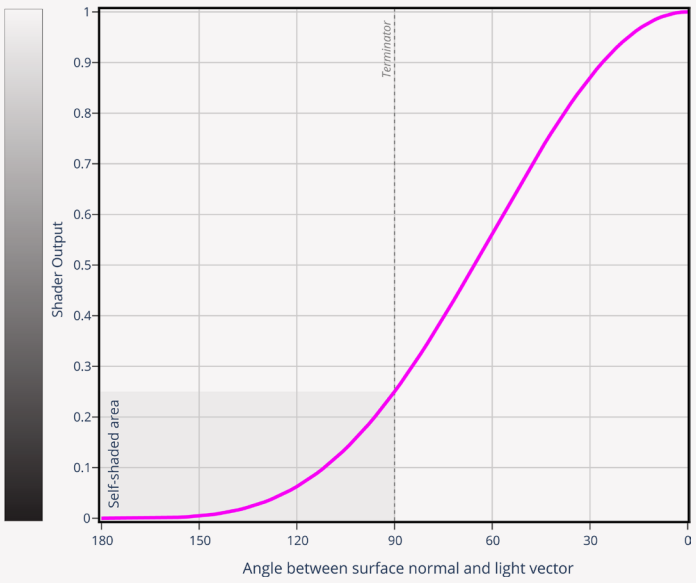


Figure 9. Half-Lambert hillshade.

SHADOWS

In the discussion of shaded relief so far, we've intentionally set aside shadows. The Lambertian shader and its variations described above symbolize a *surface* property only. One could easily argue that this is unrealistic, if not unfair, because the light we are simulating would not necessarily reach every pixel in the DEM. So, let's now look at shadows—a viewshed analysis—to take into account where the light actually lands on the surface.

The GIS tool you have probably used for shadows is limited in its nuance or subtlety: shadows are symbolized as a binary operator: a pixel is either in shadow (and thus fully blackened) or not (where the shade value is unmodified). Doing so will erase a lot of the work we just did above to keep that detail in the darker corners of the terrain. A more flexible workflow is to treat the shadow layer as an influence that darkens, rather than blackens.

To give the most flexibility and control over how strong this darkening influence is, we will keep shadows as a separate layer and use it as a semi-transparent layer on top of the scene. Even better, it can be effectively used with one of the darkening blend modes now available in most GIS software.

The trick, then, is to generate a layer which represents shadows only. The typical method recommended for doing this is to compute a conventional hillshade with shadows modeled (using **the stock hillshade tool**), then using the raster calculator or a reclassify tool to discard all non-zero values. While that does work, I find it a little

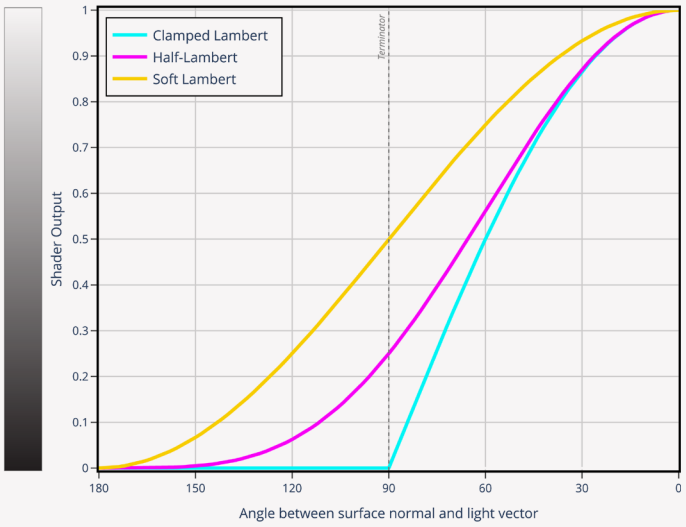


Figure 10. Comparison of output values for different Lambertian shader transforms.

long-way-around-the-barn, when shadows can be computed directly in one go. The shadow algorithm I'll be illustrating here, adapted from Ware (1989), produces a binary raster image indicating yes/no for enshadowed pixels. Yes is represented as 1, no is represented as NoData. This tool for calculating simple shadows is included in the downloadable tools previously mentioned.

Figure 11 shows how a shadows-only layer might be applied to a plain Half-Lambert scene, using the "multiply" blend mode. The exact method for darkening under the shadow is now under the complete control of the cartographer: the color of the shadow, its transparency, the exact blend mode, and more. Compare this with the more

Figure 11. Shadows-only and shade layers.

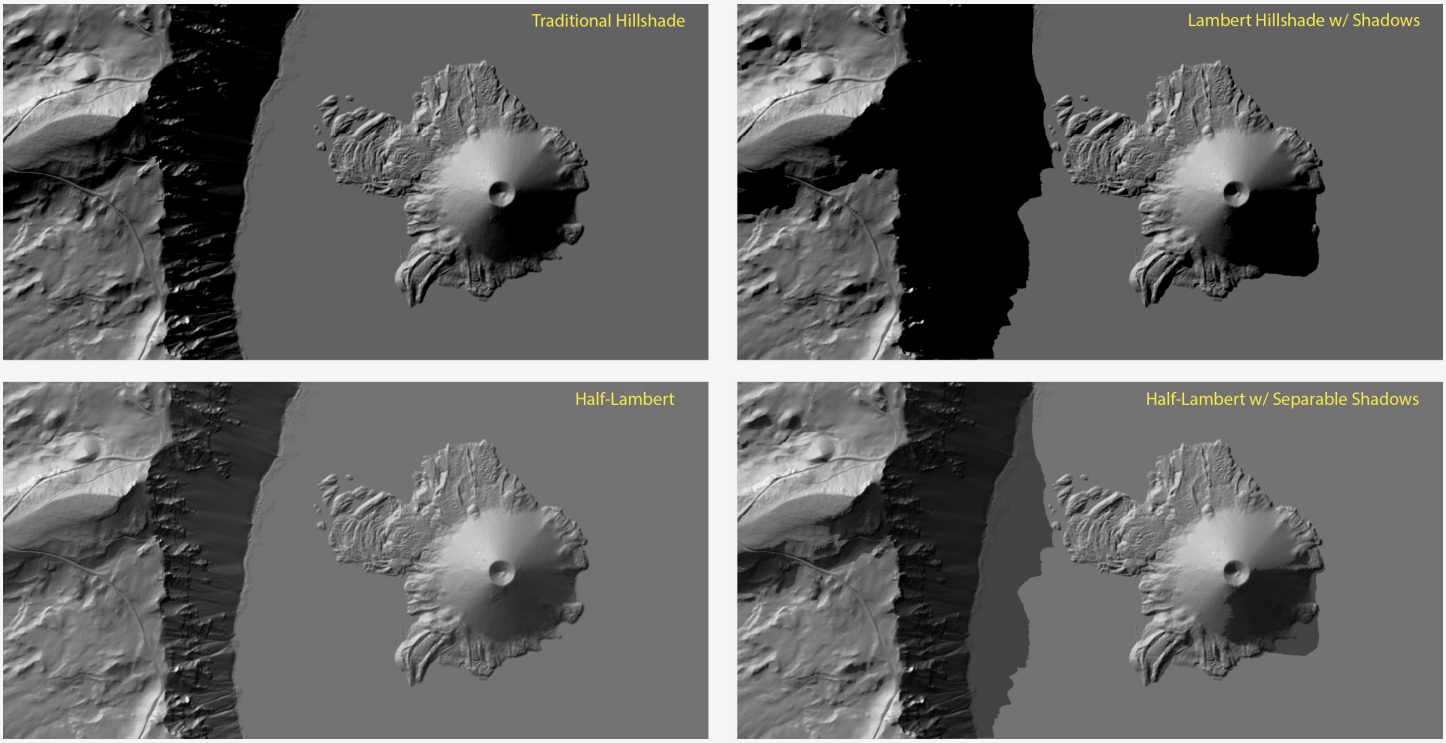


Figure 12. Traditional vs. "separable" shadows. In this figure, I've lowered the light source to lengthen shadows and show their impact.

conventional shadow mechanism available as the default option with the standard tool in Figure 12.

Note the difference between the flat, dark shadow mass in the traditional method, compared with the very dark, but not fully blackened, areas in the Half-Lambert with separate shadows. The effect mimics ambient light behavior. It is important to understand that this is not actually accounting for other light sources, reflections in the environment, or other real-world light behaviors. We are merely lending that impression by manipulating a simplified lighting model.

Because it is not casting additional light rays from other light sources, the tool used to produce these scenes runs at the same speed as the traditional tool. This subtlety and control can be added to scenes without incurring any additional computational cost.

SHADOW EFFECTS

A shadow-only layer can be manipulated in other interesting ways before being blended with the shade layer underneath. Suppose you find the shadow line is too crisp: Blurring the shadow-only layer with a standard low-pass filter will give a softer edge between enshadowed and illuminated areas.

Adding multiple shadow-only layers from slightly different azimuth directions will allow you to build up a penumbra-like effect. Consider changing the color of each layer to construct an atmospheric effect (see Nelson 2019).

CONCLUSION

Each of the above shader options is derived from a Lambertian shader—the same basic shading algorithm used in the standard hillshade tool—yet the soft Lambert and Half-Lambert options offer different results with greater control. The main source of those differences is a consequence of "clamping," a destructive, irreversible manipulation of the Lambertian shade value. The loss of detail is most noticeable in very steep terrain or with low lighting angles.

With non-destructive transforms, Lambert can be squeezed into a standardized range, expressible as a percentage, without loss of detail in areas behind the terminator. For both soft hillshade and Half-Lambert, the key

to showing detail in the display, yet keeping areas behind the terminator appropriately dark, is the color ramp. With a carefully partitioned color ramp, the cartographer has full control over how dark these areas will render.

Maintaining shadows as a separate layer offers even more control when composing the scene. A shadow-only layer allows for variation in color, intensity, edge crispness, and more. The blending of this layer with a detailed surface shading can yield an effect very similar to ambient lighting models, without the computational complexity required to render ambient light realistically.

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Ungrading for Cartographic Education: Reflections from Small Undergraduate Classes

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Conventional grading has been shown to be fraught with problems. For one, it thwarts intrinsic motivation to learn in favor of motivation to simply earn a score (Blum 2020). It also exacerbates structural discrimination, having been shown to be biased in terms of race and class (Shelton and Razi 2021). Moreover, even when instructors provide detailed feedback alongside grades, research shows that students tend to look only at the grades and ignore the feedback (Blum 2020).

One alternative to conventional grading is *ungrading*. When ungrading is used in a traditional college or university setting, students do still receive final grades. However, the focus throughout the semester is on formative feedback: feedback on maps that is both present- and forward-looking. It is intended to be helpful for reflecting on an existing map as a draft, as well as for revising it and for making later maps (this contrasts with summative feedback, which is on a final draft). Instructors will give this feedback, but not points or letter grades. Ungrading creates a supportive learning environment which encourages the development of metacognition, or reflection on learning. Students are asked to reflect on their strengths, interests, and areas for improvement, and to develop plans to improve and grow throughout the semester. As a result and despite its name, ungrading is not simply a lack of grades. Rather, it is a different system—one that has been found to address the above problems, among others (Blum 2020; Stommel 2020).

This paper outlines the hows and whys of ungrading, as I've practiced it in the cartography classroom. What I offer here are anecdotal reflections from two semesters of using ungrading in cartography-oriented mapping classes. I write "cartography-oriented," because neither was only about cartography, although cartography was a major theme. In the first course, "Theory and Technology of Maps," at Tufts University, students came in with no significant cartographic training at the college level, although all of them were certainly map enthusiasts. The second course was "Critical Cartography and Environmental Social Movements," at Smith College. Students in this course had either taken a semester-long GIS course or had other GIS experience, but this prior training or experience did not emphasize cartography. Each course met twice a week for 75 minutes. One day per week was devoted to interactive lectures and discussions about critical approaches: counter-cartography, feminist cartography, inclusive design, and more. The second day each week was mapmaking. In the first class, we primarily used ArcMap. In the second, we used ArcGIS Pro and Adobe Illustrator. With the exception of short reflections, the assignments were all about mapmaking: students made five maps in each.

In the weeks leading up to teaching Theory and Technology of Maps, I was introduced to ungrading during a late-night conversation about pedagogy. The practice seemed compelling, and I saw several potential advantages for using it in a cartography class—advantages which, since teaching that course, have been proven and ultimately inspired this paper. So, I pitched the idea to my students. Although I was new to ungrading,[1] I decided to poll the students: were they up for trying it? I handed out quarter-sheets of paper and asked them to write a few sentences on their thoughts and feelings about the possibility. This exercise also included asking them to discuss

1. Including the name. I use the word "ungrading" throughout this paper for the sake of consistency, but the first semester I just talked about it as "feedback instead of grades." Months after the class ended, I learned that there was a name for it. And while I've pointed out that ungrading is more than not grading, the simplicity of the word and the common language it offers is, for me, a compelling reason to use the term.

whether they wanted to do a mid-semester one-on-one check in to mitigate grade-related anxiety. The mid-semester check-in was initially my own idea, though I later learned that it is common in ungrading for a variety of reasons (Stommel 2020). Student responses were handwritten without names, making them confidential but not fully anonymous. I had promised that if anyone strongly objected, we wouldn't go ahead with ungrading, but the results of the poll showed that everyone was either in favor of or neutral to the practice. For Critical Cartography and Environmental Social Movements, I made the choice to go ahead with ungrading without polling students, as at that point I had ungraded several other classes.

In the following sections, I discuss how ungrading works in my cartography classrooms. I then discuss what, in my experience, are its advantages for teaching cartography. Skeptics of ungrading may want to skip ahead to the why—the discussion of ungrading's advantages—before reading the how sections. That said, ungrading as I practiced it is likely not perfectly transposable to all cartography classrooms. Toward the end, therefore, I reflect on some practical and potential limits to ungrading for cartographic education, and potential workarounds or alternatives. Throughout the paper, I alternate between discussing each of the two classes without specifying which, unless there is a comparison or lesson learned in between that I want to point out.

HOW: INSTRUCTOR AND PEER FEEDBACK

One of the most important pieces of ungrading is feedback, given to students throughout the semester. For simple maps and shorter activities (e.g., a projections activity and a book report on an atlas), I provided formative feedback on the final product. For longer activities (e.g., maps that were more time-consuming for students to create), I gave them feedback on intermediate drafts as well as the final version. In the first course, formative feedback was intended to inform their subsequent assignments. In the second course, students integrated their feedback into both their later maps and their final portfolios. Final portfolios were revisions of all their previous maps.

In my comments, I distinguished formative feedback that was more normative (e.g., missing classes in a choropleth legend, label placement that was unclear, or an accessibility issue with text or color) from that which was more subjective (e.g., using a specific color palette that I liked, adding a particular callout or inset, adding a watercolor texture). Of course, to some extent, all feedback on maps is subjective (Huffman 2018; see also Blum 2020). Given that, I tried to make clear that they should *probably* address all of the more normative suggestions, unless they had a good reason not to, but that the others were ideas I was recommending based on my experience and preferences. In addition to making clear that they should prioritize the normative feedback in their revisions and future maps, I made this distinction to model to students how *they* could give feedback. Even before they knew cartographic norms and techniques, they would still have their own perspective and subjective preferences to draw from. Of course, as the class went on, they would also be able to offer more feedback in terms of cartographic norms.

In addition to formative feedback from me, both classes included peer feedback. Peer feedback carried the same importance as my comments did in terms of the students' growth as cartographers. I gave them some guidance on giving feedback, in terms of the normative and subjective distinction I mentioned above. I also suggested that they start with what are known as feedback "sandwiches"—a technique in which more critical feedback is sandwiched in between more positive feedback, while also emphasizing that positive feedback should be relatively specific (e.g., "I like how this river label follows the curve" rather than "I like your text"). We devoted one whole class session and several partial class sessions to peer feedback, in which everyone would look at and comment on each other's maps—usually printouts, but sometimes we just walked around and looked at each other's screens. Most peer feedback occurred before the final versions of the maps were due, giving recipients time to incorporate it. As early as the second map assignment, students' suggestions included normative comments along the lines of what I would have noted, as well as subjective ideas that only partly overlapped with my own. Additionally, by seeing one another's maps, students were able to recognize that others were facing similar challenges and addressing them differently. The second map assignment, for instance, was to create a locator map associated with an environmental

justice organization's work, primarily using Natural Earth data. Students struggled with wanting to find and add more data layers—which can be a huge rabbit hole to fall into! However, when they saw that one student had instead added callouts about their organization, and another had used visual hierarchy to emphasize relevant features (e.g., water, specific towns), their anxiety about needing "more data" was assuaged: many copied one another, in the best way.

HOW: SELF EVALUATIONS AND MINI-CONFERENCES

A second major feature of my version of ungrading was the self-evaluation. Self-evaluations were accompanied by one-on-one mini-conferences.

The first time I taught with ungrading, students were asked to reflect on the following questions at the middle and end of the semester:

1. What's working?
2. What's not working?
3. What do you want to make sure we cover in the rest of the semester? (mid-semester)
   Is there something we didn't cover that you are wondering about? (end of semester)
4. What grade would you give yourself at this point in the semester, and why?

The second time I taught cartography with ungrading, I continued to use my original third and fourth questions, but I also took inspiration from Jesse Stommel's mid-semester and end-of-semester questionnaires (Stommel 2020) to create an online form that expanded the first two questions as follows:

1. What aspects of the course have been the most successful for you so far? Is there something that you've done or learned of which you are especially proud? If so, what is it?
2. In what areas (assignments, readings, etc.) have you struggled? How so?
3. How do you want to improve in the rest of the semester?
4. What are you most excited about for the rest of the semester?

The end-of-semester questions were similar, but I asked for more of a retrospective reflection, in addition to asking them to assign themselves a grade:

1. Write a short (~1 paragraph) reflection on your work in this class, using specific examples. Consider the labs; the final portfolio; your participation; the peer reviews offered and received; course objectives; your progress since the first evaluation; and your own goals as a student. This can be in the form of bullet points or a narrative.
2. What are you especially proud of (a map or anything else)?
3. Is there anything you think you should have done differently?
4. What skills do you want to continue improving on?

In both classes, students signed up for a 10–20 minute mini-conference timeslot to talk with me about their answers to the questions and generally check in about the semester. Mini-conferences were partly a grading check in, given that we were part of institutions in which they would ultimately be graded, and grades were important to many[2] of them. In the grading part of the discussion, I expected to and most often did see evidence presented for why the student self-assigned the grade they did. Evidence could be directly from the rubrics, the student's application of formative feedback into revisions or later maps, their participation, or from something else in the class. We would discuss this, along with discussing areas in which they excelled and in which they should improve—in short,

2. I write "many" but not "all" because some students said that they didn't care very much about their grades. This likely went alongside the assumption that they would pass the course, based on my feedback and their self-assessment thus far and the work they seemed prepared to put into the rest of the course. However, I take it as a signal that the exact grades mattered significantly less to at least a few students.

turning the results of their formative feedback and their work based on it into summative feedback.

However, most of the conversation was devoted to discussing in more detail what they thought was working for them and where they were struggling. In many of the mini-conferences, part of what I did was simply validate their struggles—e.g., that Illustrator takes time to learn, but that they were improving, and that sharing one's work with others is hard but rewarding for everyone. I offered suggestions for working through roadblocks and sometimes went over technical issues with the software. I also took many of their suggestions and requests, such as when one student asked for an Illustrator "cheat sheet" of common tasks. More peer feedback was also a student request. While I had planned to include peer feedback in a few class sessions, as discussed above, many students mentioned finding it challenging but useful and wanted to do more of it. In the second half of the semester, I therefore added peer review to more class sessions than originally planned.

The end-of-semester mini-conferences also allowed us to talk about cartography resources beyond the class. With some students, I talked about other courses or about NACIS. Others, especially those who were graduating, were interested in free and open-source software once they left the university (I mostly pointed them toward QGIS, but also mentioned Inkscape).

WHY: ADVANTAGES OF UNGRADING

Instructors and students have seen many benefits of ungrading (e.g., Blum 2020). In my experience, ungrading has four specific benefits for the cartography classroom. It encourages student agency, promotes thoughtful risk-taking, promotes technical community care, and can contribute to dismantling imposter syndrome.

First, ungrading provides structures that give students agency over their learning, ones that are not always present in other systems. Multiple pathways to success are built in: students can set their own priorities and self-assess based on them (and when writing their self-evaluations, as long as they offer good reason for their assessment, it is acceptable). This gives students more agency over what is important to them. Several students were interested in maps that looked like they had been created with watercolor paints, for instance, and each came up with different ways to implement them (one student scanned in pages she had painted by hand; others used Illustrator entirely). This sort of independence could be accomplished with open-ended assignments, flexible rubrics, different options for earning points, or other pedagogical techniques, but with ungrading, student agency is built in. Likewise, ungrading creates space for recognizing students' knowledge and experience. Some students came in with graphic design experience that they were easily able to apply to map design; others were good at troubleshooting software; and everyone had different stylistic preferences and cartographic interests. With ungrading, students are encouraged to build on and share this knowledge and follow their interests, rather than being treated as identical blank slates to be filled with knowledge (the latter is often called the "banking model" of education; Freire 1970; Blum 2020).

Second, ungrading allowed students to take cartographic risks and have their intentions validated. One student, in thinking about the hegemonic legacies of cartography and GIS, asked "Should we make ugly maps?" and experimented with this. Another student told me that the map of a South American country they submitted was incorrectly centered. The student told me, and I confirmed that they had re-centered the map for their final portfolio. That candor is enabled by ungrading. Another student turned in a map with a lot of red squiggles that I couldn't read. During a workshopping session, she said that it was in 1.5pt font and was to tell a story about colonialism. We were able to workshop her idea and desired message, changing the page dimension requirements and adding an inset to enable her to effectively communicate her design. In this way, ungrading created space for recognizing the difference between intention and actuality, and better bridging the two.

Third, ungrading promoted what I call technical community care: students supported one another in learning the software and making their maps. As mentioned in my discussion of feedback, I encouraged students to copy techniques and ask each other about their design processes. Technical community care therefore emerged from this process of sharing maps with one another and giving and receiving feedback. During the first check-in, many students reported being anxious about this, but excited to see

each other's maps. They found validation in seeing others having the same struggles they had, visibly and verbally appreciating how their peers had found such different solutions to the same struggles. By the second check-in, many reported that looking at each other's maps and giving and receiving feedback were among their favorite things about the class. Especially in the pandemic age, where feelings of isolation linger and students struggle with internalizing and mobilizing information, this technical community care was not only technically productive in terms of students creating better maps, but also developmentally productive, by promoting a reparative culture. The first course was in the spring of 2020, which meant that the second half was online. The second course was in the spring of 2022 and almost entirely in person, but during a semester in which ongoing pandemic-related mental health struggles were widespread. As with the benefit of student agency, technical community care is something that could be incidentally common in other types of courses—particularly those that include collaborative or creative assignments. However, again, the peer feedback sessions and orientation away from competitive grading created structures to particularly encourage it.

Fourth, skeptics of ungrading speculate that students will simply give themselves "A"s and slack off. In a few cases, I have indeed assigned students lower grades than the student indicated that they would give themselves, but never by more than a letter.[3] More frequently, students graded themselves more harshly than I would have, and the "grades" part of the mid- and end of semester conversations were opportunities to dismantle imposter syndrome. This was particularly the case for female, nonbinary, and working-class students. In these cases, I gave students grades that were higher than those they had suggested—usually by a half letter. In both cases, these grades discussions were a small part of our mid- and end of semester conversations. At the same time, my summative perspective on their work was scaffolded into these conversations, so that by the time we got to the grades part, it was hopefully apparent that the student's grade should be somewhat different than what they had suggested.

LIMITATIONS AND CHALLENGES OF UNGRADING

Based on my experience with ungrading in these two classes, three challenges emerged. First, there is a level of time commitment. Core to my ungrading practice were one-on-one mini-conferences with each student. This was especially feasible because my classes were small: each had fewer than 15 students. These one-on-one conversations could become unwieldy in terms of instructor labor with large class sizes or high teaching loads. In some of these cases, I could see including the self-evaluations but skipping the one-on-one conversations as being a reasonable solution, one that has been implemented by other ungraders who teach large classes (e.g., Stommel 2020). Other forms of alternative grading could also work (Blum 2020). Standards-based grading, for example, entails assessing student work based on the extent to which it meets specific course-long standards. Students can expect that their earlier attempts at certain standards will be less successful, but that as the semester progresses, they will improve. While standards-based grading does not emphasize metacognition or student agency to the same extent as ungrading, it still makes feedback and assessment more meaningful and oriented toward learning (for more information on standards based grading and other forms of alternative grading, see David Clark and Robert Talbert's *Grading for Growth* blog at **gradingforgrowth.com**).

A second challenge is that ungrading, as with other pedagogies designed to democratize the classroom, can be emotionally draining for instructors. Mini-conferences encourage relationship-building with students, which can lead to instructors doing more emotional labor. For example, in developing metacognition, students identified and shared the struggles that prevented them from finding focused time to work on their maps. While developing metacognition is excellent for a learner, talking through and, when possible, working through barriers to learning can be exhausting. It can also disproportionately impact instructors of color, instructors who are not men, and contingent faculty (Pittman and Tobin 2022). While I was happy to support my students' growth as cartographers

3. Again, this was rare. I would say that it happened about as often as students disagreed with me about grades in traditionally graded classrooms. When it did happen, I made sure the evidence for suggesting a lower grade was scaffolded into the rest of our conversation. For example, if a student and I had agreed that their mid-semester grade was a B but that they had assigned themselves an A at the end of the semester, I would remind them of the mid-semester grade and note that their work had not improved per normative feedback they had received. I would also remind them that a B was still good, and that if they had evidence that I hadn't considered about their improvement or their work, I would be happy to hear it and reconsider their suggested grade. However, no student took me up on this, and instead they would accept my suggestion of their final grade.

and as people, and overjoyed to witness this growth, I also wished and still wish that that work was more equitably distributed.

A third challenge for me was that it was challenging to communicate to students and colleagues specifically what ungrading involves and what are its goals. In another class in which I used ungrading, I learned that one student thought I was grading assignments but just not sharing those grades. Likewise, fellow instructors often ask me how I am assessing students if I am not giving grades—as though assessment were the main point of education. As I have mentioned, ungrading is not simply a matter of withholding grades for most of the semester. It is also a reorientation away from grades and toward learning, through centering feedback and activities that ask students to reflect on their learning. In the second course, especially, I gave time in class and space in course materials to emphasizing this, and to helping students reorient themselves. When I provide feedback, for example, I am not thinking "this is an A map relative to others in the class" or "this projection issue makes the map lose ten percent." Rather, I am thinking: how does this map meet or not meet the requirements and learning objectives of the assignment, as introduced to the students? Could anything be better executed? What is especially exciting about this map? What design techniques, based on this map and the student's interests, might they be interested in when they revise or make their next map? But I am not thinking about how any of this translates into a grade, and when I started ungrading, I had to rewrite my assignments and recalibrate the feedback I give to emphasize learning more than grades. This mental reorientation takes significant work on the part of the instructor—to get over our own training in order to not think in terms of grades, to communicate to students that they are there to learn, and to give students tools with which to disentangle grades and learning.

CONCLUSION

I INCLUDED THE PRECEDING SECTION in part to recognize that ungrading is not a panacea; it has real challenges. However, one way to address some of them is for more instructors to take up ungrading! Doing so could normalize the practice for instructors and students. It could also contribute to the intellectual community about ungrading and alternative grading in cartography.

Moreover, these challenges and limitations do not negate the real advantages of ungrading—both as I have described it for cartographic education and as others have in many other fields. Almost all of my students seemed incredibly intrinsically motivated, even as other instructors around me told stories of high percentages of their students not showing up to class and being unable to complete much of their work (as a reminder, I taught ungraded cartography during the COVID-19 pandemic). They reflected on and set their own priorities as learners and creators, took risks, practiced technical community care, and made great maps. I hope readers will consider trying one or more of the practices I've described—whether fully switching to ungrading for a semester, including ungraded assignments, or simply adding more peer feedback or self-assessments.

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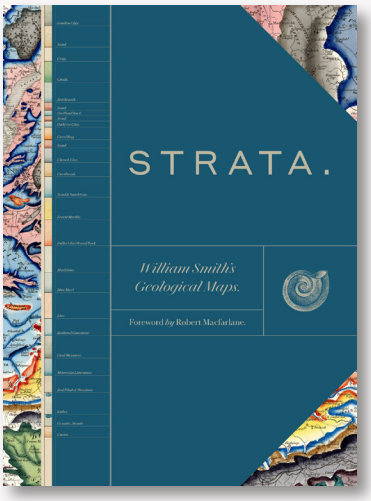

STRATA: WILLIAM SMITH'S GEOLOGICAL MAPS

Edited by the Oxford University Museum of Natural History

University of Chicago Press, 2020

256 pages, 500 color plates

Hardcover: $65.00, ISBN 978-0-226-75488-8

Review by: Christopher A. Badurek, State University of New York at Cortland

How can cartography spawn an entirely new scientific discipline? Reading through this beautifully illustrated volume provides abundant answers. A detailed history of the life and work of William Smith (1769–1839), *Strata* explores the pivotal role cartography played in establishing his reputation as the "Father of English Geology." Eight expert authors have contributed to telling Smith's story, and their essays are accompanied by a well-designed balance of cartography, scientific illustration, and artwork. The objective of this volume is to illustrate the science and artistry underlying Smith's concept of geological strata as he came to understand it around the time of the 1790s.

This book traces the origins of geology in the context of the transition from the era of what we now call the "gentleman scientist" to the scientific community model of today. It also presents Smith's cartography as a contribution to scientific advancement in general, particularly in moving forward from the Biblical creation story to a field-based geoscience. Maps of strata were Smith's primary contribution to the development of geology, employed to illustrate his concept that continuous strata, such as clays and shale, could be connected and defined by field collection of fossils. The book highlights the evolution of Smith's mapping efforts beginning with his first (late 1700s) map—a copy of which is housed today in the library of the Geological Society of London—of the Somerset Coal Canal located just south of Bath. Perhaps his most widely regarded work was his 1815 map *Delineation of the Strata of England and Wales, with part of Scotland*, drawn at five miles to the inch and published in fifteen sheets covering an area eight foot by six. It was also hand colored in over twenty tints, making for a cartographic product impressive to a wide array of scientists and map enthusiasts. Strata divides Smith's life and work into four phases, grouped in order by the area of England where he was then working, the geology he encountered there, and the fossils he took as indicative of the stratification he saw manifested. These phases are each addressed in a separate section: "Borders and the North" (London Clay to Greensand), "Wales and Central England" (Brickearth to Clunch Clay and Shale), "East Anglia and the South East" (Kelloways Stone to Fuller's Earth Rock), and "The West" (Blue Marl to Redland Limestone). Each section contains one or two essays addressing some of the roles Smith undertook along the way: apprentice, mineral prospector, field worker, cartographer, fossil collector, well sinker, and mentor. In addition, there is a "Foreword" and an "Introduction," plus a "Table Detailing William Smith's Fossils Featured as Photographic Plates in This Book," a "Bibliography and Sources of Illustrations," and an "Index."

The first section, "Borders and the North," focuses on his activities mapping tunnels and canals for moving coal in the English countryside, highlighted by his map of the Somersetshire coal canals. It was during this period of work that he first observed that various rock layers were always be to found in the same relative orders, with similar dips, and that each particular stratum could be identified by the fossils it contained—a discovery that led, around 1801, to his earliest maps of this phenomena. "Wales and Central England" highlights Smith's efforts to extol the

virtues of his maps for industrial applications, including for agriculture and mining. This chapter provides fulsome context of the coal technology of the era and its relation to the genesis and development of strata mapping. Smith later promoted himself as a "mineral surveyor" in order to provide mapping services and information to wealthy investors. This section provides an excellent overview of the minerals exploited during the Industrial Revolution—particularly coal, in its industrial application in the manufacture of dyestuff—and is a precursor to what is today termed economic geology.

The "East Anglia and the South East" section comes third, and focuses on the next stage of Smith's career: that of agricultural consultant. His promotion of the use of water meadows—areas of grassland subject to controlled irrigation that kept them evenly damp without flooding—to increase agricultural productivity was typical of his focus on the systematic application of scientific principles for practical ends. That he is humbly referred to as "the drainer" in Garrard's 1811 painting of the 1801 Woburn Sheep Shearing, an illustration of the leading gentlemen and scientists of the time, shows that this practicality was not always admired.

The fourth section focuses on his cartographic contributions. Early on, Smith worked with John Cary, a leading cartographer of the era, and later became known for his own cartographic innovations; including his employment of ornate, almost-pastel color schemes in many of his maps of regional strata. For many years, the established societies of gentleman scientists—focused on pure academic work—failed to appreciate the groundbreaking discoveries, presentational innovations, or the necessary self-promotion of the man they often disparaged as "Strata Smith." Nonetheless, in the long run, Smith's works helped to advance the concept of practical applications of geology that persists to this day.

In addition to reviewing Smith's methodological contributions, this book provides a history of his life through the maps he made. From humble beginnings and years of limited success, it was only late in life that he took his place among the other famous scientists of the era, including Charles Lyell, author of *Principles of Geology: Being an Attempt to Explain the Former Changes of the Earth's Surface, by Reference to Causes Now in Operation* (1830–1833), and Richard Owen, founder of the Natural History Museum in London. He was never considered a gentleman scientist—due to his stout size, applied expertise as surveyor and artisan, humble education, lack of social status, and his exclusive focus on practical geology—and this was a formidable handicap in that age of genteel, amateur scientific societies. It was only in 1831—at the age of sixty-two, and only eight years before his death—that Smith was awarded the first Wollaston Medal from the Geological Society in 1831; an occasion upon which he was first referred to as the "Father of English Geology" by Adam Sedgwick, President of the Geological Society of London. His story is one of a man's labor of love, despite the fact that his efforts to prosper financially from his labors were so completely unsuccessful that he was forced to spend time in debtor's prison before eventually reaching a modest retirement.

This volume provides a stunning visual history of earth science and of the contributions of cartography to the overall development of the scientific enterprise through its rich description of the cartographic methods and settings of Smith's field work. It should be noted that Smith's 1815 map is today considered so significant to the field of geology that a field trip to the Academy of Natural Sciences in Philadelphia (ANSP) Library & Archives was hosted by the Geological Society of America's 2015 Conference in Baltimore just to view it. In fact, having personally examined Smith's map at the ANSP, I firmly believe the description of the fossil collections and drawings found in this volume can add significantly to one's understanding of Smith's work. *Strata: William Smith's Geological Maps*, however, is not a text for amateurs or neophytes. A solid grounding in earth science knowledge is required to understand many of its contributions, and, without that grounding, the sheer volume of material contained in it could easily be so overwhelming; much of the rich linkage between the maps, annotation, and scientific illustrations of fossils could be missed. It is, perhaps, a book best suited to readers with interests in the history of geology, cartography, and of the sciences in general. On the other hand, this book does provide a rich illustrative complement to Simon Winchester's (2001) *The Map that Changed the World: William Smith and the Birth of Modern Geology*. All that said, I strongly recommend this text, and suggest that it is a required acquisition for collections on natural history, and reading for natural history museum enthusiasts.

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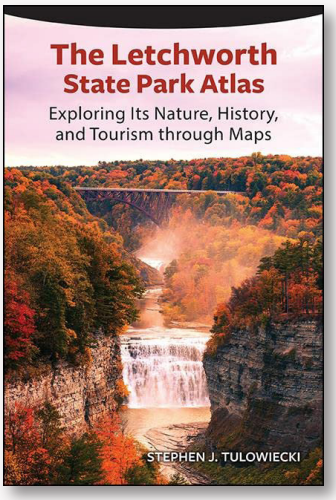

THE LETCHWORTH STATE PARK ATLAS: EXPLORING ITS NATURE, HISTORY, AND TOURISM THROUGH MAPS

By Stephen J. Tulowiecki

State University of New York Press, 2022

239 pages, 90 maps, 35 photos

Softcover: $29.95, ISBN 978-1-4384-8950-6

Review by: Daniel G. Cole, Smithsonian Institution

New York's Letchworth State Park, often referred to as the Grand Canyon of the northeastern United States, follows the course of the Genesee River as it flows north through a deep gorge and over several large waterfalls in the western part of the state. This year, the State University of New York (SUNY) Press has brought forth the first comprehensive atlas of this 116-year-old park, authored by geographer Stephen Tulowiecki. While the author lists ninety maps, many of the individual items listed are time series maps, overlapping large scale maps, or comparisons between different features at the same scale, so the number of individual maps assembled is in actuality quite a bit larger than claimed.

In his preface, the author points out that his creation of this atlas both "addressed an absence of maps that explore the many facets of the park" (xx), and involved other professional and personal reasons, such as his memories of past visits to the park (xix). He sees the "collection of thematic maps" that make up the atlas as providing a "geographic perspective on the nature, human history, and tourism of Letchworth State Park" (1). This review will evaluate how well he succeeded in that effort.

The first 11 maps in the book appear in Chapter 1, "Overview of the Park" (10–17), and consist of a sequence of four overlapping air photos from 2019 (Maps 1a–d) facing four topographic maps (Maps 2a–d) of the same areas, with their contents trimmed to the park boundary. The parts of the air photos outside the park boundaries are lightly masked, focusing attention on the park lands themselves and echoing the hard edges of map information shown on the topos. Given that the course of the Genesee River differs slightly between the air photos and undated topo maps (see especially 1c versus 2c), the two sets may not be quite contemporary. A bar scale that appears in the lower right of the images might have been better placed on the reference maps, but otherwise the cartography is clear and easy to read.

The next several maps locate the park in a variety of manners and contexts, and at different scales. Map 3 (18) is a simple map of the Earth in an orthographic projection (i.e., as seen from space), with Letchworth positioned in the center. Map 4 (19) zooms in to the state of New York and nearby areas, presenting a five-class rendering of population density using 2018 Center for International Earth Science Information Network (ciesin.org) data, effectively illustrating how close various population centers are to the park. The next six maps are illustrated in grayscale. Map 5 (20), at a scale of 1:500,000, shows hamlets, villages, and cities with major highways around the park; and Map 6 (21), at 1:200,000, displays additional populated places, minor roads and county boundaries in the park's vicinity. Map 7 (22) includes a five-class set of toned dots indicating driving times, in hours, from cities in the northeastern US and southeastern Canada to Letchworth; while Map 8 (23) is a larger scale, stylized rendering of driving times, in minutes, between selected points within the park itself. Map 9 (24) compares the dimensions of this park to New

York City's Central Park and to an American football field. Two skyscrapers are illustrated for comparison as well, but it is a bit unclear why: there is nothing of comparable height shown from Letchworth State Park. Map 10 (25) provides areal comparisons between Letchworth and a few other state and national parks, and with a few cities as well; for example, the island of Manhattan is shown to be nearly equal in size to Letchworth. Maps 11a–b (26–27) are two larger scale overlapping maps of the north and south portions of the park, with selected place names and lightly toned topography.

Chapter 2, "Physical Geography," has thirty-three maps (twenty-nine in color and four in grayscale) supporting discussions of the geology, geomorphology, hydrology, and biogeography of Letchworth. Maps 12a–b (36–37) combine a ten-class color scheme of elevation within the park with a light shaded relief background, and with points of interest, trails, roads, and railroads. The map causes some minor confusion about the location of the park's point of highest elevation: the hypsometric tint uses white for the highest altitude class, but there are two areas of the park that reach that level. A spot height or two would have clarified the situation. Maps 13a–b (38) illustrate the position of Letchworth in the context of archaic landmasses that existed three hundred fifty million, and three hundred million, years ago, using data from Scotese and Wright's 2018 PALEOMAP project (**scotese.com**); and Map 14 (39) depicts seven classes of sedimentary bedrock formations in the park. Maps 15a–i (40) show, in B&W, the positions of the Laurentide Ice Sheet and sea levels at various stages ranging from eighteen thousand to two thousand years ago; however, it looks like last three periods (six, four, and two thousand years ago), are identical and thus redundant. Map 16 (41) clearly illustrates the pre- and post-glacial Genesee River valleys with seven classes of elevation.

Maps 17–30 (42–67) provide a series of graphic displays at a variety of scales of soils, current and historic agriculture, forest composition, and ecological communities using data from USDA, New York State Office of Parks, Recreation and Historic Preservation (**www.parks.ny.gov**) and the 2020 US Geological Survey (USGS) Gap Analysis Project (**www.usgs.gov/programs/gap-analysis-project**). Map 30 employs some very light areal colors, and unfortunately the very light yellow chosen for American Indian lands gets lost against the white background. In Maps 31–37 (72–79), the author provides a series of past and predictive climate maps (temperature, precipitation, etc) from a variety of sources covering Letchworth, western New York and eastern North America. Tulowiecki next turns to the watershed of the Genesee River, the park's backbone. Maps 38–44d (84–91) show the various water flows through Letchworth and surrounding areas, including its many waterfalls, along with variations in land cover within the watershed, and the changing size of the reservoir created by the Mount Morris Dam. Map 40 displays water flows through Letchworth using two tones, which works quite well, and leaves me to wonder why Tulowiecki didn't also employ them in place of the patterns he used on Map 38.

Chapter 3, "Human History," with twenty seven maps (eleven in color and sixteen in grayscale), begins with a timeline of human activities in Letchworth from 1779 thorough 2021. This is followed by four overlapping large-scale maps, Maps 45a–d (101–109) showing forty-nine keyed sites, two former Indian reservations, the original and current park boundaries, and the neighbouring floodplains, canals, roads, and railroads. Unfortunately, no scale is provided with these maps. Following that are Maps 46–49 (112–119) on the evolution of the park's infrastructure, nearby historical populations, and activities. It is somewhat disturbing commentary on affairs that the actual locations of each archaeological site have been randomly shifted on Map 50 to protect them from looting. Map 51 (127) identifies seven Native American settlements near what later became Letchworth (plus two noted as lying off the map), showing their population in 1790 using four classes of graduated circles. The author notes that more than one-third of the park was formerly reservation land, but, through fraud and various land purchases, the indigenous Seneca were systematically dispossessed. Map 52 (128) shows how this process progressed across all of western New York.

Maps 53–56 (129–142) deal with historical county boundaries western New York, schools and other buildings erected in the mid-nineteenth century, birthplaces of residents within Letchworth for the same time period, and railroads present in the area circa 1900. Map 57 (143) abstractly illustrates the movements of two individuals, both of whom lived within the present-day park. The first, Mary Jemison (1743–1833), was a Scots-Irish woman who became known as the "White Woman of the Genesee." As a young girl, she was adopted into a Seneca family, and, from 1779–1831, lived in Gardeau Indian Reservation. By

contrast, William Pryor Letchworth (1823–1910) was a businessman whose 1906 donation of one thousand acres to the State of New York became the core of Letchworth State Park. Maps 58a–d (144–147) show schools, mills and other buildings in 1902, affording comparison with the depiction of the same information for 1852 found in Maps 54 a–d (136–139). Maps 59 and 60 (152–153) zoom in and display the growth of Letchworth's Glen Iris Estate from the 1850s through to the 1890s, and portray the forested versus non-forested areas of the estate in 1907.

Map 61 (162) illustrates land acquisitions in Letchworth from before the 1920s to after the 1970s, and Map 62 (163) identifies the ten largest landowners (amongst other, smaller, holdings identified in light gray) whose acreage was purchased for, or donated to, the park. Maps 63 and 64 (164–165) show camps, projects, and tree plantings by the Civilian Conservation Corps (CCC) in 1939–1942, and note the locations and year of completion for twenty eight historical structures erected by the CCC and others. Maps 65a–b (166–167) enumerates forty one notable areas and roads constructed before and after 1945 in the park. Maps 66a–67d (168–175) provide four sets of air photo mosaics depicting parts of Letchworth in 2019 and 1938, while Maps 68a–d (176–179) zoom into the 1938 photos to identify nineteen features. Maps 69a–b provides four classes of land cover derived from 1945 USGS topographic sheets. Map 70 (182) gives the rainfall distribution across New York and Pennsylvania from Hurricane Agnes in 1972, and Map 71 (183) shows the depth of the Mount Morris Reservoir during that period.

Chapter 4, "Tourism," (with nineteen maps: nine in color and ten in grayscale), concerns the different aspects of attendance at Letchworth. Here, Tulowiecki provides maps comparing attendance between Letchworth and other New York state parks in Map 72 (192), as well as various national parks in Map 73 (193). Maps 74–77 (194–197) both show the contiguous United States with southern Canada, supplemented with closeups of the New York/Pennsylvania/New Jersey area, to depict, respectively, the origins of historical guests, and current online reviewers and visitors of various venues within the park, by county, into five class bins. Map 78 (198) displays the numbers of individual Google searches that were made for "Letchworth State Park" between 2004 and 2019, grouped by state and metro area; and Map 79 (199) compares searches in the years 2015, 2020, and 2021 for Letchworth to searches for other "best state parks" around the country in the same years. Maps 80a–b (200) depict the cabins, campsites, inns, and day use pavilions available for rental at the north and south ends of the park; and Map 81 (201) shows the locations of other accommodations relatively nearby. Map 82 (208) effectively illustrates where photos of the park have been taken with a "heat map" using geotagged data from Flickr, although no date is given for this compilation; and Map 83 (209) uses proportional circles to compile which landmarks appear most often in all online photos, based on a Google Images search in 2020. Maps 84a–e (210–211) display trails available for hiking, mountain biking, skiing, horseback riding, and snowmobiling. Map 85 (212) identifies geocache locations in the park.

Map 86 (213) identifies hunting areas access and restrictions and fishing access points. Maps 87a–b (214) show bear and deer harvests per town in the surrounding four counties, and Map 88 (215) uses proportional pie charts to depict the four species of fish stocked in the Genesee River watershed upstream from the Mount Morris Dam. Maps 89 and 90 (216–217) uses data from the Cornell Ornithology Lab (**www.birds.cornell.edu/home**) to note the number of bird species identified at various points within the park over the years 2012 to 2019, and give bird sightings for six different species over the same time period.

The author finishes the atlas with a bibliography section that includes a list of frequently used data sources, references keyed to each chapter, and the software used to create the maps and process the data.

Overall, I find that Tulowiecki has created a very nice, well-researched atlas that should interest any local residents, visitors, and others interested in this unique park. He gives the reader ninety maps with a good mix of color and grayscale, so he certainly doesn't use color excessively. While I have noted several minor criticisms of the work, they are all, essentially, quibbles and will not deter me from recommending that this book be made widely available in western New York tourist, gift, and book stores, and anywhere else it would come to the attention of anyone interested in this mini-Grand Canyon of the northeastern US.

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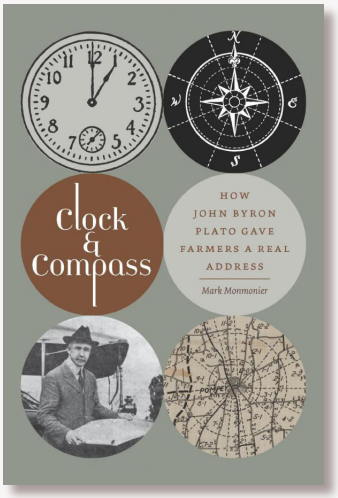


CLOCK AND COMPASS: HOW JOHN BYRON PLATO GAVE FARMERS A REAL ADDRESS

REVIEW 1 OF 2 FOR THIS TITLE

By Mark Monmonier

University of Iowa Press, 2022

181 pages

Paperback: $19.95, ISBN 978-1-60938-821-8

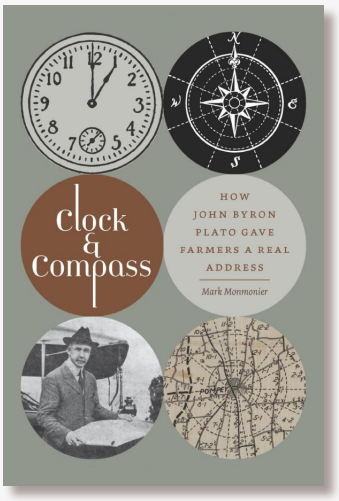
Review by: Russell S. Kirby (he/him), University of South Florida

The scholarly practice of contributing books and monographs to the literature has deep roots in the culture of academia, but relatively few professors author books nowadays. Mark Monmonier is a notable exception, a professor of geography and cartography who has written twenty books that, both individually and collectively, have shaped the way we think about maps, their uses, and their abuses, as well as their meanings in the world of business, international politics, and our everyday life. While some of his books focus on issues central to the discipline of cartography, such as *How to Lie with Maps* (1991) and *Mapping It Out* (1993), Monmonier's more recent work deals with narrower topics, including, among others: how maps are used in the news media and weather reporting, and on the origins of place names.

In *Clock and Compass*, Monmonier delves into an aspect of American cartographic history that was given brief mention in his previous book on *Patents and Cartographic Inventions* (2017), but has otherwise been a historical footnote. Faced with the challenge of how to give farmers and rural residents identifiable addresses in the early twentieth century, and presumably also looking for a path to his economic livelihood, John Byron Plato developed and patented a scheme that he called the Clock System to identify locations based on direction (as hours on a clock face) and straight line distance from a market town center. Plato proceeded to market his invention to local citizens, using advertising on printed Clock System maps to generate income. His business endeavors lacked the major investment necessary to become statewide or national, although other entrepreneurs continued to market county maps based on the clock (and the related compass) idea into the 1940s.

Monmonier's book consists of ten relatively short chapters, the first of which sets the stage while the last seeks to place the topic of Plato's Clock System in perspective. In between, Plato's life and entrepreneurial career are chronicled, with chapters focused on the various locales in which he resided, including Colorado, New York, Ohio and Washington, DC. While Plato had an intriguing idea for mapping addresses in rural America, he lacked the business acumen to market his product, as well as the ability to identify trustworthy and useful partners for his business endeavors.

Clock and Compass places the work of John Byron Plato in historical context and makes for an engaging read. The text is well written and illustrated with numerous maps and diagrams, along with detailed notes. While it is in some sense a biography of Plato himself, the main focus of the monograph is on the practical problem of how to define locations and provide directions to specific addresses in rural America, in the era of transition to the widespread use of trucks and automobiles. However, due to its relatively narrow focus, only those with specific interests in its topic or the history of twentieth century American cartography are likely to read this book. While interesting and informative, like its principal subject, this book on the Clock System is also likely to remain a footnote.



CLOCK AND COMPASS: HOW JOHN BYRON PLATO GAVE FARMERS A REAL ADDRESS

REVIEW 2 OF 2 FOR THIS TITLE

By Mark Monmonier

University of Iowa Press, 2022

181 pages

Paperback: $19.95, ISBN 978-1-60938-821-8

Review by: Matthew Hampton, Oregon Metro

Mark Monmonier's *Clock and Compass*: *How John Byron Plato Gave Farmers a Real Address* is a comprehensive and engaging look at the life and work of John Byron Plato, an early twentieth-century American cartographer and entrepreneur who revolutionized rural addressing in the United States. The book provides a detailed account of Plato's innovative Clock System, a geographic addressing scheme that gave rural residents a physical address like their urban counterparts. This system, an early form of georeferencing, was based on a location's distance and radial direction from a nearby town or village, and contrasted with the ofttimes-cryptic Rural Free Delivery (RFD) system used by the post office at the time. RFD routes were designed to optimize a letter-carrier's rounds, while the Clock System centralized location finding.

The narrative of *Clock and Compass* is rich in detail and is driven by Monmonier's expert knowledge of cartography, as well as his ability to tell an interesting story. The book is filled with interesting anecdotes, maps, and diagrams that serve to illustrate the key concepts of Plato's Clock System and provide readers with a deeper understanding of its impact on rural addressing. The book begins with an overview of Plato's early life and career—a life characterized by a series of entrepreneurial ventures that included a lumber dealership specializing in veneers, a teaching position, and a manufacturing business specializing in a safety horse hitch for which he held three patents. Despite his varied professional background, Plato is best known for his invention of the Clock System, which was born out of a personal experience he had as a dairy farmer in Colorado.

As the story goes, a customer wishing to purchase one of Plato's Guernsey cows set up an appointment but after looking for hours, failed to find the location of the farm and instead sent him a polite apology that they didn't have time to follow the postal worker the next day. This locational quandry provided Plato an "a-ha moment," and he came up with the idea for the Clock System for rural addressing. Under this system, land was partitioned into districts separated by twelve evenly spaced lines radiating outward from a well known place, such as a town center. Each district was numbered in clockwise succession from one to twelve, and subdivided into one-mile zones radiating outward from the local center. Any rural place was identified by its direction (hour) and (crow flight) distance from that local center.

Much of Plato's ingeniousness is reflected in the business structure he developed to implement his system, which involved securing the confidence of rural residents and local businesses, and employing energetic local school kids to do much of the labor. Children would scout locations for Plato, while he worked to earn endorsements from local farm bureaus and other respected sources. These endorsements, along with the promise of being more easily found, induced residents to agree to having address signs hung on their fences. While the children did the work of placing the signs, Plato got local businesses to buy into the system

by offering them opportunities to advertise on his free and widely available address maps.

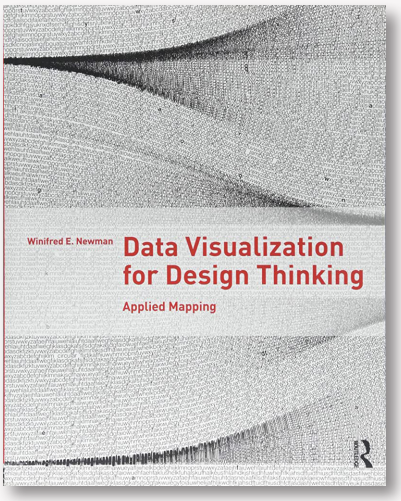
Plato continued to use his "lost sale" narrative over the years to promote his publications and subsequent business creating rural indexes in Colorado, New York, and Ohio. It was in Ohio that Plato experienced the rough shoulder of the Great Depression—forced to declare bankruptcy, he lost his company and had his property repossessed. Plato eventually moved to Washington, DC, and found work at Census Bureau.

It is significant to note that in 1936, six years after Plato's patent expired, a new unrelated group of investors saw an opportunity and re-worked his system—switching from a clock to a compass—and re-mapped the counties in which he had previously created markets. This form of spatial indexing was very popular until the pervasiveness of the telephone and its printed "telephone guide" helped to supplant the investment in printing individual rural index maps. Monmonier, though, leaves no doubt in the reader's mind that it was John Byron Plato who fathered rural index mapping, and that his conceptual fortitude helped to illustrate the need humans have to find locations.

Among the highlights of *Clock and Compass* are the numerous maps and diagrams included throughout the book. These visual aids help to illustrate the key concepts of Plato's Clock System and provide readers with a deeper understanding of its impact on rural addressing. Additionally, the book includes a wealth of notes and references that will be of interest to historians, cartographers, and anyone interested in the history of rural addressing. This is the second book by Monmonier that mentions John Byron Plato, and readers interested in more background information should read *Patents and Cartographic Inventions* (2017) as well (**reviewed** in *CP* 90).

The idea of a location framework that measures distances from a central location is regularly used in modern digital form of a dynamically segmented network. While I doubt we can ascribe that particular idea to John Byron Plato, we can, thanks to the documentation of his life and work in this field provided by Mark Monmonier, recognize Plato's important place in the history of rural addressing.

In conclusion, *Clock and Compass*: *How John Byron Plato Gave Farmers a Real Address* is a well-written and informative book that provides an in-depth look at the life and work of one of the pioneers of rural addressing in the United States. It is filled with diagrams, maps and reproductions showing the development and spread of Plato's locational ingenuity. This book is a must-read for anyone interested in the history of cartography, geographic information systems, or rural indexing.



DATA VISUALIZATION FOR DESIGN THINKING: APPLIED MAPPING

By Winifred E. Newman

Routledge, 2017

283 pages, 229 color figures

Hardcover: $200.00, ISBN 978-1-138-95834-0

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eBook: $58.45, ISBN 978-1-315-66127-8

Review by: Mike Wissner (he/him), The Pew Charitable Trusts

The propagation and increased accessibility of mapmaking technologies has drawn many people to explore their cartographic abilities without formal education or training in recent years. At the same time, traditionally trained cartographers have recognized a lack of attention given to cartographic design in university-based geography and GIS programs. This concern was discussed by Siewe Siewe and John McIntosh in their 2021 NACIS presentation, *The Disappearing Art of Cartography*. The overlap of design and mapping is the world where *Data Visualization for Design Thinking*: *Applied Mapping* lives. The book's stated intention is to help "designers make better maps" (x). The author aims to present mapmaking as applied research in order to elucidate the interconnections of "representation, thinking, technology, culture, and aesthetic practices" (x), and the discussions in the book span this vast spectrum. **Dr. Newman's website** describes her research interests as concentrating on "space perception, ecological psychology, and neuroaesthetics with active research in neuromorphic architecture, mapping and data visualization, STEM learning environments and histories of technology and science." The reader should know in advance that *Applied Mapping* goes to great lengths to incorporate all these elements within its pages.

The book has an introduction and four main chapters. The introduction runs forty-two pages and begins with a section on some historical theories of map production. The author acknowledges the importance of geographic data representation and its increasing relevance in the field of design: "if the number of recent books on maps, graphics for maps, and software used to produce them is any indication, maps are quickly becoming a significant representational technology in the design arsenal" (6). But the ideas immediately go deeper, touching on both the epistemology and ontology of mapping, as well as debating image versus representation in photography. It only briefly comes back around to maps before introducing ideas on semiotic structures, in one example, utilizing "B.W. Betts' representations of human psychology through geometrically abstracted figures resembling flowers" (10) . The subsections throughout the lengthy introduction reach across topics one might expect in a text on data visualization and mapping, ranging from the familiar—like "Complexity and Legibility" and "The Role of the Mapmaker"—to others that are less intuitive, such as "Socialist London(s)" and "Revolutionary France."

In Chapter 1, "Maps as Objects of Explanation," Dr. Newman delves into "maps as artifacts: semiotic, representational, social, historical and otherwise" (44), detailing some of the design decisions cartographers must make. In describing one major challenge of cartography, she writes that:

> Part of the challenge in using maps as tools in design is paying attention to their *intertextuality* broadly considered in so far as the terms of a given map allow. Mapmakers shouldn't be expected to manage this with ease or as a syncretic procedure

> without residual traces, but designers making effective maps hone their observations and direct their desires. (48)

Further along in the chapter, subsections discuss "Mathematical Correspondence" and "Philosophical Correspondence." In "Mathematical Correspondence," the author sets the tone by explaining that "often cartographers use correspondence and index as synonyms referring generally to the key in a map" (57), while then admitting that "a robust definition of correspondence admits to a special complexity when correspondence is applied to a spatial milieu" (57). This is not typically the experience of practitioners of cartography, yet the author expounds that

> in order not to get caught in the web of relativism where agreement is possible, or realism/materialism where a general rule of nature is given priority over mind (physical over the biological), I opted for a mathematical and then proto-phenomenological approach looking carefully at Husserl on the problem of correspondence and intersubjectivity. (57)

As we can see, the reader is assumed to already be familiar with the works of Edmund Husserl (a German philosopher who is credited with establishing the school of phenomenology), whose ideas are discussed further along in the chapter, in the "Philosophical Correspondence" subsection.

Chapter 2, "Terms of the Map," is probably the part most approachable to a practicing cartographer. The subsections in this chapter stay more in the lane of defining, translating, and describing concepts of applied mapmaking, in the traditional sense. This portion of the book is most akin to what a student of geography may learn in undergraduate or introductory courses on cartography or geographic information design. There are, for example, ample figures depicting how projection is relative to purpose. Interesting discussions of perspective drawing tie in a bit of art history: "Perspective drawing is a form based in the rules of geometry allowing us to represent spatial depth on a two-dimensional surface, in short, a map" (90). Some impressive and intricate images of Dr. Newman's former students' work in this realm are included here.

The third chapter is titled "Maps as Power, Identity, and Utopia," and touches on many of the critical topics concerning equity, identity, power dynamics, and inclusion/exclusion that NACIS members have increasingly explored in recent years. Much of this chapter harmonizes well with the ideas in Mark Monmonier's *How to Lie with Maps* (2018). Discussions here utilize visual examples such as Betty Ng's *Disneytopia*, a representation of spaces designed for consumption, and Jeremy Bentham's *Panopticon*. The cartographer's familiar comparison of the Gall-Peters projection to Mercator is made in Figures 3.12 and 3.13 (148).

The first actual case study in "Case Studies," the book's final chapter, does not appear until the reader is more than twenty pages in. The initial portion is dedicated to a background discussion that, while relevant and interesting, not only assumes a substantial baseline knowledge about architecture, but makes numerous digressions into art history as well. There is, for example, a deep dive into the use of perspective by the Renaissance architect and surveyor Filippo Brunelleschi, and its relation to spatial projection. It is discussed as a form of mapping, through "a closer examination of the instrumentality of one of the views Brunelleschi constructed in the Piazza della Signoria looking toward the Palazzo Vecchio" (194). The author appears to assume these architectural landmarks are well known to the reader—and although a photograph of the palace is provided some pages later, it is not referenced in this discussion. In fact, the photo only comes after a detailed description of how Fibonacci's rod method of measurement contributed to perspective painting. This involved measuring building height via measured strips of parchment along a vertical rod—in much the same way an artist will eyeball proportions of a figure or scene against their pencil or brush handle—and contributed towards greater accuracy in spatial representations.

The first case study presents an interesting data visualization exercise where a student uses a photograph taken in the Florida Everglades and converts it to a series of representative mesh grids that are distorted on different axes based on pixel values derived from their color value. Newman explains that "The final mapping informed the design of an artificial canopy intended to mitigate or augment the natural canopy of the Florida site" (213). This useful example was a welcome reprieve from the meandering esoteric theoretical discussions tightly packed into the principal chapters. The other case studies are also intriguing, and lay a concrete foundation for understanding the author's broad definition of "mapping."

Dr. Newman's goal with *Data Visualization for Design Thinking* is, as she writes in her preface, "to help designers working with built environments make better maps" (x). Judging as an applied geographer and cartographer who has worked wholly in two-dimensional space, I recognize that the book provides a loose framework for understanding foundational concepts of mapping and cartography. However, despite the provision of a substantial number of inspiring figures, graphics, and data visualizations, this book is, at its core, a dense, scholarly text that is aimed at a niche audience well-versed in architectural and physical design concepts, and with the theoretical underpinnings of perception and representation.

There is much inspiration to be found in the well-documented descriptions of the historical advancement of different approaches to mapping varied perceptible phenomena. However, despite the thoughtful lessons contained within its pages for anyone looking to do applied graphic design and data visualization, the book seems to land somewhere between a historical reference/instructional manual for (spatial? graphical?) designers, and a coffee table book for data visualization nerds.

The reception and effectiveness of this book depends heavily on the audience and the context in which it is read. It contains substantial jargon with lengthy sentences of highly abstract theorizing. As a curious geographer with a background in spatial research, I could easily see myself digging into individual subsections with highlighter and pen in acute anticipation of heady discussions at the following week's seminar with fellow graduate-level colleagues. But to try to read this book individually and ruminate on the theories presented here is like trying to act out Shakespeare alone in a windowless room. *Applied Mapping*'s cerebral topics are ripe for dissection and debate amongst groups of practitioners of different types of spatial representation with certain knowledge prerequisites or experiences already fulfilled. Cartographers will find much interesting fodder for discussion here, but without an active and engaged book club to return to each week, the takeaways from this book are fleeting and amorphous.

For NACIS members who regularly attend the annual conference, this book is the opposite of Practical Cartography Day. In fact, the use of the term "Applied Mapping" in the title is only a nominal reference to the geospatially intensive work many NACIS members focus on. This is not meant to indicate that Dr. Newman's work is without merit for a working cartographer—only that the reader should understand that in this book "map" is a loosely defined design term rather than something from the more concrete and orthodox definition. While there is no doubt that any number of NACIS members embrace the many-sided idea of mapping central to Newman's book, and enjoy "thinking outside the neatline," any potential reader should be forewarned that this is strong medicine.

As already mentioned, this is not a book easily read in isolation (during a global pandemic, for example). There is a clear need for extended discussion section by section to really absorb the knowledge and concepts within these pages. Each subsection is thoroughly detailed and assiduously researched. However, for someone not immediately entrenched in the theory, the introduction is a slog and many of the sections feel exceedingly digressive. For example, perspective drawing in art is brought up as a precursor to map projections in Chapter 2 and then again given a thorough accounting in the introduction to the case studies in Chapter 4. Many ideas pertaining to mapping are repeated at seemingly random points throughout, then left in the dust of the barrage of philosophical argot. Arriving at Chapter 4's case studies section feels a relief. As a reader with zero background in design, it would have been useful to have started here.

However, the case studies chapter are also demonstrative of a more pervasive design issue that I didn't recognize until the very end. *Applied Mapping* is clearly a textbook meant to be accompanied by guided conversations and informed instruction, but on its own it seems to ignore some of the basic design principles that are discussed in the book itself. Organization, taxonomic hierarchy, and visual perception are all topics given specific attention throughout the nearly three hundred pages—yet the actual presentation of the material is rigidly uniform and difficult to navigate from a UX perspective; bolded subsection headings are the lone blazes along *Applied Mapping's* labyrinthine trail. I think most people can easily conjure memories of grade school science textbooks chock full of images, diagrams, and other visuals of the scientific world. Those texts frequently utilize a variety of not-so-subtle graphic design strategies to better organize and present what would otherwise be crowded text too opaque for most students. For example, color-coded call-out boxes with micro-examples are one way to break up text while providing on-topic reinforcement to the subject matter. No such visual cues are provided to orient the reader in this book.

That a more approachable experience might be achieved breaking up the individual chapters into graphically distinct sub-sections is exemplified by the discussion of *The Geological Investigation of the Alluvial Valley of the Lower Mississippi River* map on pages 92 and 93. As it stands, the body of the chapter's text, which includes a thoughtful and nuanced discussion of the map, runs on the left hand page, while on the right is a full page graphic and its description. The lessons, takeaways, and other interesting observations are buried—some in the text and others in the graphic's description. Had this discussion been broken out as a distinct block, it could have been more coherent and complete, and more easily assimilated as a package.

Most of the figures and diagrams have brief descriptions, but many (like Figure 4.41 on page 230) have substantial discussions that take up to a half page of space. There is clearly much valuable information and interpretation within the lengthy figure descriptions, but why one graphic gets a deeper exploration than another is never clear. I would contend that each chapter would benefit from a deep dive on a few figures rather than the rarely interrupted river of graphics we are given—with no hint as to which deserve real focus and reflection, and which are merely a visual reference. That this design strategy is deliberate is demonstrated by a visit to the book's companion website that provides little insight into the learning objectives of the subsections, meager links to online examples, and a few paragraphs selected from the introduction by way of explanation.

The visuals provided throughout the volume are often quite intricate, but in many cases they are oddly placed and their text is illegibly small. While I acknowledge that the author and layout designer were working within the confines of tight two-dimensional page real estate, the way that so many figures were crammed into so small a space does a disservice to both the work and the book. Actually mapping out the pages so that figures print on pages adjacent to the relevant text would make the book a lot more user friendly. For example, the text on page 91 refers to Figure 2.8 (a beautiful map of Amsterdam by Joan Blaeu) which is located and captioned a full ten pages later. Similarly, the reader is left to wonder why the Blaeu map (Figure 2.8) is discussed before Figures 2.1 and 2.2 are even mentioned (91). Absent a more user-centric layout, the reader is required to make an extremely meticulous examination of the text in order to make it referable over time. This lack of organizational flow is present throughout the book and can be stultifying. Perhaps the book's next edition could benefit from some restructuring around a more deliberate visual "mapping."

There is no doubt that putting together *Data Visualization for Design Thinking*: *Applied Mapping* was a monumental effort, but, to this geographer and cartographer, the result is clearly flawed. While it is totally possible that students of architecture and design may find some of my observations irrelevant, as someone who makes maps without any formal design instruction, I found the book an impressive piece of work that is overly complicated and intellectually baroque. I would love to one day take a class with Dr. Newman and pick apart some of the ideas contained within *Applied Mapping*. Until then, the concepts of applied mapping for data visualization design thinking will continue to reside mostly below my subconscious.

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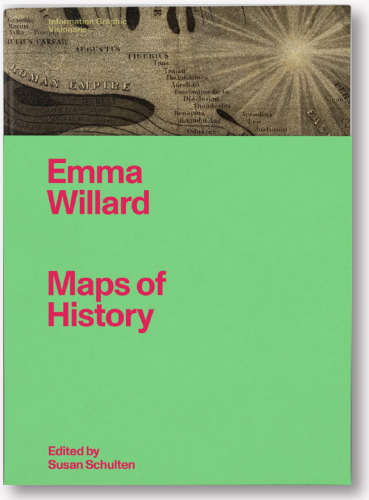
Monmonier, Mark Stephen. 2018. *How to Lie with Maps*. Chicago: The University of Chicago Press.

DOI: 10.14714/CP101.1829



EMMA WILLARD: MAPS OF HISTORY

Edited by Susan Schulten

Visionary Press, 2022

248 pages, 139 maps and graphics, plus a folded 100 × 67 cm poster

Hardcover: $98.00, ISBN 979-8-9861945-0-9

Review by: Mark Monmonier (he/him), Syracuse University

Perhaps best known as a women's rights activist, Emma Hart Willard (1787–1870) was also an elementary and secondary educator and a successful creator of instructional materials: endeavors to which she directed most of her energy, with impressive results. Willard's specialties were geography and history, and she believed that to learn history properly, students needed a systematic presentation of facts, processes, geographic settings, actors, and impacts. To these ends, she relied on her skill as an illustrator. Because her experiences and accomplishments were distinctive, Willard is rightly praised as a graphics pioneer: a visionary, if you will. Some of her presentations were maps, but many were data graphics, typically two-dimensional or perspective time-series graphs, in which the time axis was paramount.

The publisher, aptly named Visionary Press, has also recently released two other volumes, celebrating graphic visionaries Florence Nightingale and Étienne-Jules Marey. All three volumes are part of the *Information Graphic Visionaries* series founded by R. J. Andrews, the series editor. With degrees in mechanical engineering as well as an MIT MBA, Andrews is an accomplished designer, "data storyteller," and entrepreneur. Credit also goes to Lorenzo Fanton, the skilled designer and freelance art director who oversaw production.

The overall look of *Emma Willard: Maps of History* is impressive. Although the front matter makes no claim to acid-free paper, its sturdy Fedrigoni Arena pages (white paper with a rough finish), large trim size (19.9 × 27.9 cm), and pleasingly patterned dark rose endpapers strike a note of elegance and durability. Bracketing the pages are stiff boards embellished with a black-and-brown facsimile excerpt from Willard's iconic poster "The Temple of Time" that is (according to the publisher's website) "printed on book cloth with gold foil stamp lettering." No less impressive is the book's internal design, in which a narrative essay on Willard's life, work, and impact (15–114) precedes a facsimile section with examples of her key cartographic works, mostly atlases. Reproduced in full color, these facsimile pages are either full-size or only slightly reduced, with a single fold-out page replicating a fold-out in the original.

Captured from holdings in the David Rumsey Historical Map Collection, now in the Stanford University Library, many of the facsimile pages are framed by portions of their original atlas's binding and nearby pages, laid flat for the camera. Warts-and-all facsimiles connote authenticity by capturing the foxing of the paper, irregularities in inking, and unprinted facing (versa) pages, which avoid annoying read-through and attest to the complexity of double-sided hand-colored map reproduction in the early nineteenth century. It is useful for the reader to see, as representatively as possible, the works analyzed in the essay.

The cover identifies Susan Schulten as the volume's editor, which suggests that she played the dominant role in selecting specific works for the facsimile section as well as

the illustrations that accompany her long essay "A Graphic Mind," on Willard's life and work. As she makes clear in the "Acknowledgments," Schulten was approached by Andrews to develop a short book on Willard's graphics. She was an obvious choice, having analyzed Willard's work in a July 2007 article in *the Journal of Historical Geography* (Schulten 2007) and devoted three decades to exploring the interconnections that existed between mapping, public education, and academic scholarship in America during the nineteenth and early twentieth centuries. That Andrews did not recruit her until late 2020 confirms both her readiness for the endeavor and the efficiency of Andrews, Fanton, and their Visionary Press colleagues in setting an efficient production schedule and maintaining outstanding quality control.

Map historian Matthew Edney, who guided the massive History of Cartography Project after David Woodward's untimely death in 2004, contributed an incisive three-page Foreword that positions Willard in the intellectual context of the nineteenth century's discontent with traditional descriptions and explanations. Edney underscores the difficulties women educators faced in carving out a fuller and more influential role in children's education as well as the importance of improved technologies of graphic reproduction that allowed a closer integration of verbal and graphic discourses. Though Willard took full advantage of these technologies, by century's end her innovations were submerged by intellectual currents she had helped promote.

Schulten's essay—its title, "A Graphic Mind," is fully appropriate—explores Willard's substantial contributions to the education of girls in nineteenth-century America and to visual learning more widely. Visual explanation, Willard argued, was an effective way to engage students, who, by making their own maps, could better assimilate and understand spatial relationships. Although some educators saw student maps largely as decorative art, Willard believed that maps could challenge simplistic chronologies by illustrating evolving stages of historical knowledge.

Over the years, Willard played multiple roles in elementary and secondary education. She opened her own schools, the Middlebury Female Seminary, in Vermont in 1814, and the Troy Female Seminary, in New York State in 1821; her use of "Seminary" in their names signaling an eagerness to experiment with new approaches. Willard's own pedagogic repertoire included moral philosophy and advanced mathematics, as well as geography and history. Her textbooks and school atlases were pitched toward a national audience, and, as an entrepreneur, she struck a collaborative endeavor with pedagogic author William Channing Woodbridge (1794–1845), whose contribution focused on modern geography while Willard emphasized the ancient world.

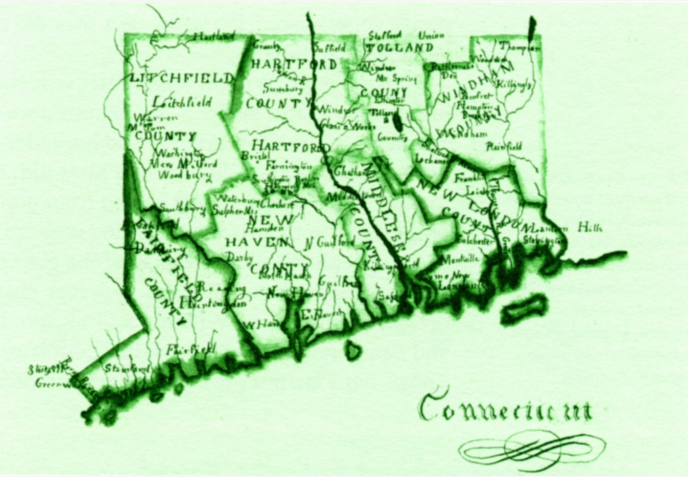
The book's facsimile section provides numerous illustrations for Schulten's long essay. Repeated at appropriate points as excerpts or in their entirety but at a smaller size—alongside student maps and illustrations from other textbooks of the period or shortly thereafter—these images enhance her discussion of the creation, purpose, or impact of Willard's more important graphics. This purposeful redundancy obviates the need for readers to flip forward to the facsimile section to appreciate the structure and symbols of exemplars presented in context in the second half of the book. Facilitating this integration of text and graphics are thoughtfully designed pages with abundant white space. And because images in the essay section are redundant, they are efficiently reproduced in black and flat-green inks, rather than in full color.

Green, the reader quickly discovers, is a leitmotif tint for the Willard volume, distinguished from the robin's-egg blue used for the Nightingale book and the medium blue used for the Marey volume. Section and subsection titles, with white lettering on a green background, introduce the key parts, and surrounding the elegant binding is a detachable green wrapper, only 70 percent as tall and lettered in crimson (though it seems intended as a dust jacket of sorts, it might more accurately be described as a dust vest). My key criticism is of the designer's obsession with green, which creates a distinctive look and reinforces the design devised for the series, but also undermines the legibility of images in the essay section, which would work better in simple black and white.

The facsimile examples section, which follows the essay, has three parts. "Atlases" (117–190), which spans the eleven years between Willard's thirty-ninth and fiftieth birthdays, consists of three atlases, from 1826, 1827, and 1836, each designed to accompany a specific geography textbook. These three relatively thin atlases are reproduced completely, cover to cover, at actual size or 75-percent of the original size. The second and third parts are shorter segments focusing on "Classroom Charts" (192–209) and "Textbook Graphics and Graphic Appendix" (210–233).

The "Atlases" section begins with *Willard's Atlas to Accompany Geography for Beginners* (1826), *Geography for Beginners* being her own textbook—the atlas's large-page format nicely complements the textbook's small-page format. Between the second and third atlases is "A Series of Maps to [accompany] Willard's History of the United States," published in 1829 and reproduced at 80 percent of actual size. A two-page "Introductory Map" highlights the "Locations and Wanderings of the Aboriginal Tribes" before the advent of Europeans in 1492. On the nine maps that follow, flow lines representing specific trans-Atlantic voyages complement labels and colored boundaries for specific land grants, colonies, states, and territories to describe "epochs" dated 1578, 1620, 1645, 1692, 1735, 1763, 1776, 1789, and 1826. The succession of epochs portrays Willard's conception of the country's evolution as a natural, inevitable process—a "Manifest Destiny" that accords with her strong nationalism and devout Christianity. And as Schulten notes, an earlier edition, released in 1828, was in effect the first historical atlas of the United States.

The "Classroom Charts" that follow are reductions of larger images, one of which is inserted loosely in the book as a folded, full-size poster. Appropriately named "The Temple of Time," this huge 1846 poster (100 × 67 cm) is a perspective drawing of a classic temple with ionic pillars topped by scrolled capitals supporting a pediment and ceiling, and an implied temporal axis advancing toward the viewer from a wall at the center labeled "The Creation 4004" and surrounded by parts progressively less temporally distant—an obvious rejection of science's emerging sense of geologic time. Willard's intricate drawing reflects a biblical chronology whereby progressively larger pillars representing specific centuries emerge toward the left and the right. Pillars on the left are named for events or specific people. More recent centuries with larger pillars are in the foreground, and on each pillar the names of more ancient people or events are placed toward the bottom and the more recent are toward the top. Dates accompany names, for example, "Continental Congress, 1776, Independence" and "1492 Discovery of America." Pillars on the right, which also represent centuries, include names of persons and for more recent individuals, their years of prominence, for example, "David" in the eleventh century BCE, "Jenghis [*sic*] Khan, 1206–27," and "Napoleon, 1804–14." On the temple floor next to the columns on the left are events such as "Charles I executed, 1649" and "Alexander dies 323 [BCE]," and on the floor on the right are significant battles, for example, Hastings and Antioch



Although a full-color reproduction of this map, by a fourteen-year-old student at the Middlebury Female Academy, appears later in the book (on page 231), this slightly smaller green-and-black version is inserted on page 31, near Schulten's discussion of artistic styles prevalent in the early 1820s. Although other illustrations in the long-essay section are similarly muddled by the green leitmotiv adopted for the Willard volume, their useful proximity to the relevant part of the essay makes them more than a graphic conceit.

in the 11th century. Between these peripheral streams of events are channels for individual countries, in pink, yellow, orange or blue, and dividing or merging through time. More names appear in the ceiling, divided into rows of tiles for "Statesmen," "Philosophers, Discoverers &c," "Theologians &c," "Poets, Painters &c," and "Warriors." An orange inverted U spanning pillars for the first century CE is labeled "Jesus Christ" on the ceiling. For readers who find this paragraph confusing—I imagine this might include nearly all of you—**a zoomable graphic** at the Stanford University Library website invites exploration of the poster's details. Close inspection of the facsimile will reveal that apparent flaws in its printing were inherited from the original, in the David Rumsey Map Collection. Visionary Press's Italian printer did an outstanding job reproducing this and the book's other facsimiles, all from the Rumsey collection.

A somewhat smaller version of The Temple published three years later is similar in perspective but with vertical sections rather than the larger diagram's classical ionic pillars. Reproduced across facing pages (204-205) at about a third its original dimensions (62 × 86 cm), "Willard's English Chronographer" (1849) focuses on Britain's saints, heroes, and royalty. Although the framework of a temple is apparent, historic time begins markedly more recently

than the biblical 4004 BCE. Indeed, at the center, history emerges from a darkly mysterious "Roman Empire" that resembles a subway tunnel, and the ceiling's ten categories of personal prominence includes "Remarkable Women." Below the three-paragraph introduction, a much-reduced photo (6.3 cm wide) offers a concise summary of the poster's temple-like structure, while on the facing page (recto) a full-size detail excerpt encompassing only 10 percent of the Chronographer's area provides a sense of the original print's aesthetics and information content. Schulten calls the graphic a "labor of love" as well as a reflection of Willard's appreciation of "Anglo settlement in North America." Her assertion that it "has long been assumed to have been lost" and is "republished here for the first time" raises questions about its publication, promotion, and dissemination, as well as this particular artifact's provenance. It would be good to know more.

The scholarly apparatus at the back includes a 140-item "Endnotes" section, a one-page "Selected Bibliography," and a page and a half of "Image Credits." All are reasonably complete and useful, but can the absence of an index be a new trend in scholarly publishing? Indeed, I can hardly complain insofar as my own publisher, a fully competent university press, just last year released my book sans index. I was told none was needed, which I believed at the time—before it occurred to me that an index can be particularly useful to a reviewer intent on some last-minute fact-checking.

The back matter also includes three pages of "Acknowledgements," two of which applaud the generosity of several hundred contributors to a crowdfunding campaign organized by Andrews and Fanton. Though I regret my name is not among them—the appeal must have slipped beneath my radar—I can at least recommend the book strongly. Not only well written and carefully edited, *Emma Willard: Maps of History* is a joy to hold and peruse.

And as a publishing event, if you will, it is a noteworthy departure from today's typical medium-length scholarly map history burdened with a price tag that will confine it to a small sale, mostly to libraries. Might crowdfunding be the new subvention?

REFERENCE

Schulten, Susan. 2007. "Emma Willard and the Graphic Foundations of American History." *The Journal of Historical Geography* 33: 542–564. **https://doi.org/10.1016/j.jhg.2006.09.003**.

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- Type sizes below 6 point should be avoided.
- Captions should not be part of the illustration. Instead, please supply captions within the text of the article.

For questions on specific guidelines for graphics, please contact Assistant Editor Daniel P. Huffman for more information: **daniel.p.huffman@gmail.com**.

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TITLE: The title serves as the author's invitation to a diverse audience. It should be chosen wisely. The title section should include the full names of the authors, their email addresses, and their academic or professional affiliations.

ABSTRACT: An abstract of 250 words or less should summarize the purpose, methods, and major findings of the paper.

KEYWORDS: Five to ten keywords should be listed at the end of the abstract.

REFERENCES: References should be cited parenthetically in the text, following the author-date system found in *The Chicago Manual of Style,* 17th ed. (**chicagomanualofstyle.org**). When making a direct quote, include the page number. Example: (Doe 2001, 38).

Books: Invert the first author's name (last name, first name, and middle initial). Middle initials should be given wherever known. For books with multiple authors, authors' names are listed in the order in which they appear on the title page, with the last author's name preceded by a comma and *and*. Note: With more than ten authors, invert first author's name and follow it with a comma and the words et al. without italics in the reference list.

The general format is: Name of author(s). Year. *Title in Italics*. City of Publication: Publisher Name.

Robinson, Arthur H., Joel L. Morrison, Phillip C. Muehrcke, A. Jon Kimerling, and Stephen C. Guptill. 1995. *Elements of Cartography, 6th Edition*. New York: John Wiley & Sons.

Articles in Periodicals: Author's or authors' names as in *Books,* above. Year. "Title of Article." *Title of Periodical,* volume number, page numbers, DOI if available. Follow punctuation and spacing shown in the following example.

Peterson, Michael. 2008. "Choropleth Google Maps." *Cartographic Perspectives* 60: 80–83. http://doi.org/10.14714/CP60.237.

Articles in edited volumes: Name of author(s). Year. "Title of Article." In *Title of Edited Volume*, edited by [Editor's or Editors' names, not inverted], page numbers. City of Publication: Publisher's Name.

Danzer, Gerald. 1990. "Bird's-Eye Views of Towns and Cities." In *From Sea Charts to Satellite Images: Interpreting North American History through Maps*, edited by David Buisseret, 143–163. Chicago: University of Chicago Press.

Websites: Websites may be generally referenced in running text ("On its website, the Evanston Public Library Board of Trustees states…") rather than with a URL listing. If a more formal citation is necessary, use: Name of author(s). Year. "Title of Document." *Title of Complete Work (if relevant)*. Access date. URL.

Cartography Associates. 2009. "David Rumsey Donates 150,000 Maps to Stanford University." *David Rumsey Map Collection*. Accessed January 3, 2011. http://www.davidrumsey.com/blog/2009/8/29/david-rumsey-donates-150-000-maps-to-stanford.

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A Plan of the City of New York and its Environs. P. Andrews, sold by A. Dury in Dukes Court, St. Martins Lane, surveyed by John Montressor, 1775.

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TABLES: Tables should be discussed in the text and denoted by call-outs therein, but the meaning of a table should be clear without reading the text.

Cartographic Perspectives

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