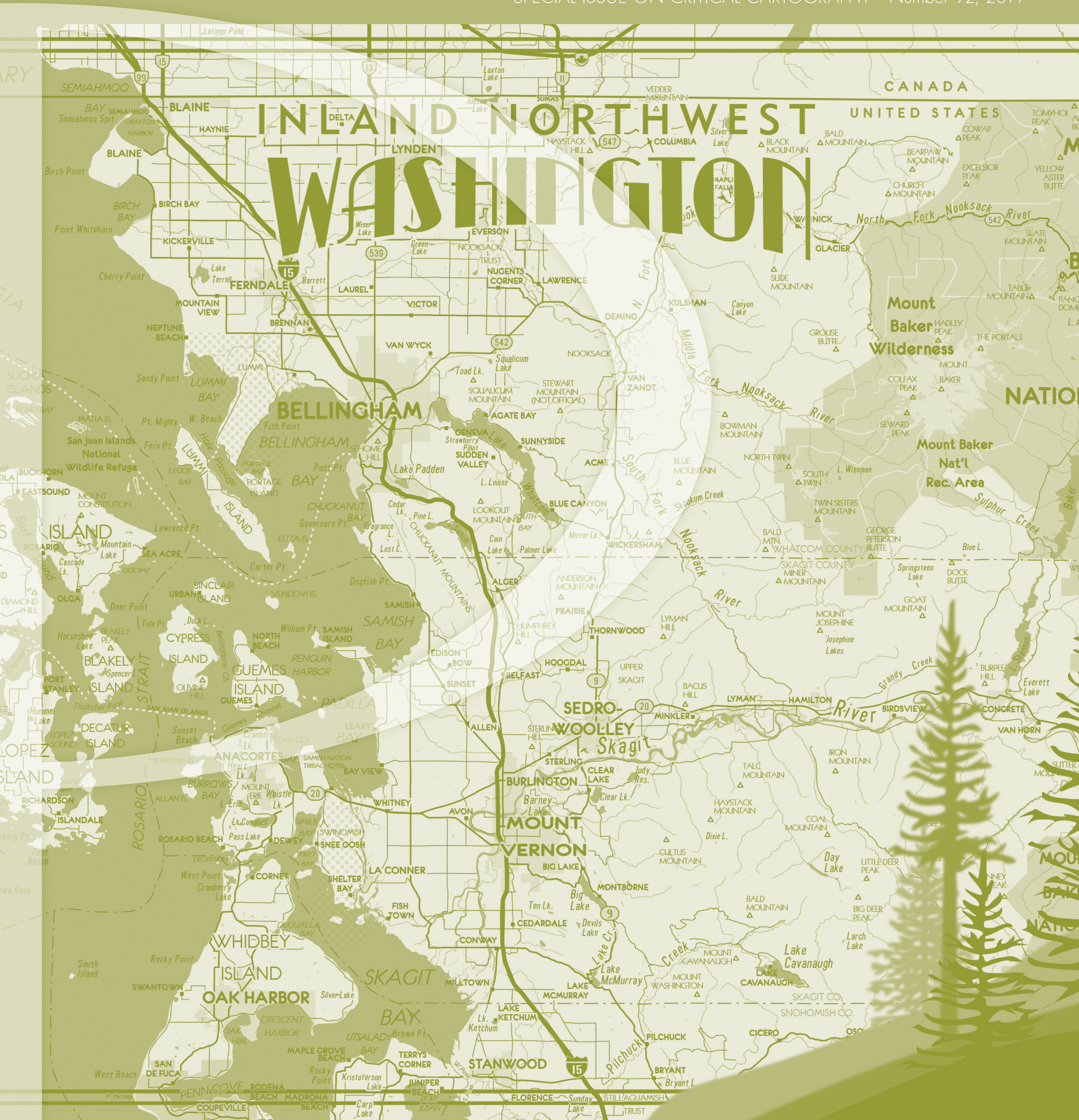
Cartographic Perspectives

The Journal of **nacis**

SPECIAL ISSUE ON CRITICAL CARTOGRAPHY Number 92, 2019



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ABOUT THE COVER: *Detail from* Inland Northwest Washington, *by Sarah Bell. You can find more of Sarah's work at* behance.net/sarahbellmaps.

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LETTER FROM THE PRESIDENT

Thank you all for giving me the opportunity to serve NACIS, both as your Program Chair for our Annual Meeting in Norfolk, Virginia, and now as your President. I've always felt that NACIS was my professional home ever since my first meeting in Jacksonville, Florida in 2003. I've seen the organization, and its members, grow and evolve in so many positive ways over the years and I'm proud to be part of a community that is healthy and thriving.

More than 275 people attended our 2018 Annual Meeting in Norfolk, and I would like to thank all of the presenters, contributors, and volunteers who helped make it a success. Our field is ever-evolving, and the greatest challenge in putting together the schedule each year is to ensure that our content is relevant, fresh, balanced, and—dare I say—entertaining. It's exciting to see the mix of submissions we receive each year, often influenced by the localities we reach. I love that our meeting is held in a different city each year, which gives us the opportunity to explore new places and make new connections.

Practical Cartography Day continues to be a popular and well-attended event. Thank you to organizers Leo Dillon, Elaine Guidero, and Katie Kowalsky. In 2018, we had the highest ratio of PCD attendees to total conference attendees since PCD was first introduced in 2001.

The 2017–2018 Corlis Benefideo awards winners, James Cheshire and Oliver Uberti, opened the main conference with an inspiring **keynote on imagination and collaboration**. Linking these two concepts, Oliver defined creativity as "… an exercise in surprise. It's about making unexpected connections and unexpected conversions." So many of their themes resonated with what NACIS stands for, and I like to think that our organization provides a venue for creative connections, imagination, and the unexpected.

Thanks to all of you that answered the post-conference survey. I'm pleased to report that no one indicated that they were dissatisfied with the overall conference experience. That said, we're always looking for ways to improve, and we take your comments, feedback, and suggestions very seriously. Please be sure to share your ideas with the Board in these surveys or in person at our Annual Meeting. You are also welcome to email me at **prez@nacis.org** with your thoughts.

Congratulations to our student award winners, who were announced at the Friday night Banquet. Alexander Fries, of the University of Alabama, won the Student Map and Poster

Competition award for Design Quality. The SMPC award for Research Quality was given to both Jai Ryan, of RMIT University, and Humboldt State University's Brian Murphy. The Individual award from the Student Dynamic Map Competition was won by Kerry Gathers of the University of Kentucky, while Johnathon Pantzlaff and Alicea Zelesny of the University of Wisconsin–Madison took home the Group award.

The highlight of the Norfolk 2018 meeting was the release of the *Atlas of Design*, Volume 4. We are so fortunate to have had Alethea Steingisser, Lauren Tierney, and Caroline Rose contribute their talent and expertise to this amazing publication. The *Atlas of Design* project continues to be one of the most influential collections of cartographic design and content in our field, and reflects the innovative work being done by contributors around the world, including many of our members.

Alas, while not unexpected, Volume 4 has sold out. But, we're happy to announce that we have reprinted the first three books! Volume 1 has also been redesigned to match the format of the others in the set, so that's an added incentive to make your collection complete. Many thanks to Daniel Huffman, who is our *Atlas of Design* Ambassador spearheading the reprint efforts. Reprints for Volumes 1, 2, and 3 may be ordered at **atlasofdesign.org/reprints**. Mark your calendars for the release of the *Atlas of Design* Volume 5, in 2020—the 40th anniversary of NACIS.

The NACIS community welcomes Nick Martinelli as our new Director of Operations. Nick's first NACIS conference was in 2007, and he has served NACIS in various roles since then, including judging and facilitating the Student Dynamic Mapping Competition, chairing the Corlis Benefideo Award Subcommittee, and serving as a Board member for the 2016–2018 term. Nick will be involved with the day to day operations of our organization, as well as certain roles related to the Annual Meeting.

In particular, Nick will also organize our efforts to continue streaming and recording the conference. In 2019, NACIS plans to continue offering video of the entire conference as a benefit to our members and the cartographic community at large. Many of you donated money last year to support this effort, and we thank you very much for helping make it possible. Member donations alone, however, won't be a sustainable funding solution for the long term, so the Board will be looking into an alternative funding stream so that we may continue to provide this valuable resource to you into the future. NACIS is seeking corporate sponsorships and investigating an increase in membership dues and/or conference fees to cover the costs. If you think you or your employer would be interested in sponsorship, please email our Executive Director Tom Patterson at **tom@nacis.org**. The Board is cognizant of the need to keep conference fees and membership dues low and affordable.

A significant initiative underway this year is an update to our existing nacis.org website. Our website functions not only as our outward face to members, but also handles meeting registration, presentation submissions, and elections, amongst other things. At the time of this writing, we are working on securing a contractor to help with some much needed fixes and improvements to the backend infrastructure that will make our processes work more smoothly in the future.

Our Board committees have a few projects underway. We have merged the Membership Committee and the Analytics Committee into one committee called, unsurprisingly, the

Membership and Analytics Committee. Chaired by Brooke Harding, the committee will be focusing on Annual Meeting attendance retention trends and metrics on how our conference presentation content has evolved.

The Membership and Analytics Committee is working hand in hand with the Communications and Outreach Committee, chaired by Rosemary Wardley. The committee is working to identify areas where our membership doesn't reflect the composition of our field, and making targeted outreach efforts toward underrepresented groups. This will involve studying diversity and inclusion, and identifying changes in the field. The committee is also looking into mentoring programs at the college and high school level in order to bolster participation in local cartographically related events.

Leo Dillon and Mamata Akella will be your Tacoma 2019 meeting hosts and are busy putting together another great conference for you all. The Call for Participation will go out in March, with submissions due May 31st. Please consider sharing your work with your NACIS community in Tacoma, Washington, October 16–18, 2019.

Many many thanks to everyone who has volunteered their valuable time to fulfill NACIS's mission. NACIS-driven initiatives occur year round and we are reliant on an all-volunteer team to bring our projects and Annual Meetings to fruition. If you are interested in dedicating your time, and have a project you'd like to work on that fits with our **objectives**, please contact me (**prez@nacis.org**) or anyone on the Board. Our organization thrives on new ideas, with the future in sight.

Wishing you all a great year,

Ginny Mason
NACIS President

CHECKING IN ON CRITICAL CARTOGRAPHY: NEW DIRECTIONS AND OPENINGS, WHAT WORK REMAINS, AND HOW WE MIGHT PURSUE IT

Craig Dalton
Hofstra University

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University of Washington Tacoma

For many geographers and cartographers, the term "critical cartography" evokes a particular period of geographical discourse. What began with a series of appeals to consider the aporias and silences in maps, and to situate them within the cultures that produce and interpret them (Harley 1989), became the strong polemics of what's now referred to as the GIS wars (Schuurman 2000). Interpreting maps to show their social, political foundations using linguistic and discursive concepts undoubtedly is and has been a productive form of critical cartography, particularly with the inclusion of theoretical concepts beyond the limited English-language translations of Foucault available in the late 1980s (Rose-Redwood 2015). However, focusing on that period, those tools, and those sources limits our view of what critical cartography can be, and more significantly, what it can do.

Critical cartography, even when narrowly defined as a self-identified practice, has changed over the last thirty years, spreading to new fields and engaging with new and previously neglected forms of mapping, such as indigenous mapping, art mapping, and counter-mapping. It has also deepened in its conceptual foundations, examining the many identities and subject formations of mapmaking, questions of participation and democracy, and the roles technologies play in the production, dissemination, and interpretation of maps. In light of these shifts, Crampton (2010) has cast critical cartography as an explicitly productive enterprise, one in which the meaning of critique rests in finding the limits of a discourse and a search for alternatives. Within critical cartography, maps themselves are no longer seen as static, produced objects, but rather as objects processually and continuously (re)produced in both their creation and consideration (see Edney 2019 and Rossetto 2019 for recent discussions).

It is fair to ask then, what is critical cartography now and what might it become? This collection explores the contours of those questions. While no means intended as a definitive corpus, the collection instead serves as a series of signposts for the praxis of critical cartography writ large. Through these pieces and others, a few broader trends emerge.

POLITICAL ECONOMY

One trend is the increasing role of political economic questions and approaches in critical cartographic work. Tracking broader trends in geography, critical cartography has long engaged questions of inequity and empire, but current work is breaking into new fields involving labor, value, space, and maps. In this special issue, this is apparent to some degree in all of the articles. Alvarez León's article on street maps by and for self-driving cars tackles new questions of the production of space for self-driving cars and the associated questions of power and access to newly emerging technologies. What are the terms of service and access when the map is made to be read by a machine? Wilmott's article takes up a related theme in exploring what it means to map lands in nominally open-source ways, opening space for questions over the gap between ownership of data produced and the act of mapping-with those whose lands are being represented. Our article posits that the economic strategies of major technology companies may be impacting how smartphone users know where there are and where they are going. Cowart and Powell's piece on Guerilla Cartography graphically articulates struggles involving class and capital accumulation in multiple contexts.

EVERYDAY

A second trend that runs clearly through these pieces is an eschewing of arcane or purely historical cases in favor of the everyday processes and experiences of maps and mappings. Wilmott entwines everyday, embodied practice with theory. The Guerrilla Cartography maps discussed by Cowart and Powell's touch on a myriad of issues that are part of everyday experiences—maps of water, food, housing, and the lack thereof. Our own article engages the mobile map applications used by students, and billions of others, for the banal task of navigating their local environments. Alvarez León's piece takes those quotidian maps into the realm of automated driving, as an emerging technology aimed at daily transportation practices.

RESISTANCE

Third, critical cartographic work increasingly engages forms of cartographic resistance, by confronting dominant or hegemonic geographic knowledges and/or through efforts to create alternatives. Guerilla Cartography's call to map is an unmistakable case of mapping in self-conscious, critical ways, particularly empowering people to make maps of and for themselves. Likewise, Alvarez León engages questions of access to street map data and hacking practices that repurpose its utility in other contexts, and Wilmott's concept of "mapping-with" opens up a new performative, theoretical praxis for constructing alternative visualizations and data ontologies.

These themes—of the political economic, of the everyday, and of resistances to the normative visualizations and knowledges said visualizations impart—are but a few of the present, exciting trends in critical cartography. Others include feminist approaches, privacy and surveillance, volunteered vs. contributed geographic information, indigenous mappings, and a myriad of other cartographic knowledges that receive little attention in mainstream scholarship. The articles in this collection touch upon many of these themes: Wilmott's process of "mapping-with" as a means of engaging indigenous mapping in a nominally volunteered context, Cowart and Powell's guerrilla approach echoing some of the calls found in feminist mapping praxis, and so on.

These vibrant themes pulse across an *existing* critical cartography that offers alternative paths to understanding and living amidst the continual swirl of new technologies and techniques, and new embeddings of maps and visualizations into our daily and professional lives.

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Counter-Mapping the Spaces of Autonomous Driving

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In this article I provide an account of key tensions shaping the development of autonomous driving technologies, and explore how such tensions can open up avenues for counter-mapping the data spaces produced through these navigation technologies. The design and massive commercialization of autonomous vehicles implies the production of new models of space, generated through the integration of data collected through technologies such as lidar scanning, machine learning, and artificial intelligence. This production of space is bounded within the confines of the technological black boxes of the vehicles themselves, as well as the corporate black boxes of the companies that design and deploy them. However, there are key sources of tension surrounding the creation of these black boxes: those between market competitors; between the state and the private sector; and between civil society, the private sector, and the state. In this article I explore these tensions by focusing on the potential for counter-mapping as a means of critique, transparency, and political action across three separate aspects of the autonomous driving space-making process: (1) legislation, by examining the emergence of Right to Repair laws across the United States, beginning with the Automotive Right to Repair Law passed in Massachusetts in 2012; (2) design, through open source projects for building self-driving cars, exemplified by Udacity, a pioneer in this area; and (3) hacking, specifically interventions designed to open, critique, or disrupt autonomous driving technologies. These examinations are embedded in a political economic account that interrogates the ownership and control over the spaces produced through autonomous driving, as well as the economic value associated with such production of space.

KEYWORDS: counter-mapping; autonomous driving; automated mapping; Right to Repair; hacking; artificial intelligence; machine learning; open-source design

INTRODUCTION

Over the past five years, autonomous vehicles have gone from one of many in an expanding constellation of innovations to the touchstone technology upon which a particular vision of the future is articulated. Autonomous vehicles represent a significant step in the integration of the digital information economy with the automobile industry (Gao, Hensley, and Zielke 2014; Lipson and Kurman 2016)—perhaps the archetypal industry of twentieth-century capitalism. While there is some evidence that younger cohorts prefer ride-sharing as a means of transportation—which could in principle be satisfied by self-driving cars—(Krueger, Rashidi, and Rose 2016), there are fundamental questions about how (by, and for whom) this technology would be deployed. For all the potential benefits of autonomous vehicles, the corporate push favoring them over existing modes of public transportation exceeds any current demand, while simultaneously advancing an emerging digital urban capitalism that is predicated on the rhetoric of "smart" or "data-driven" cities and the intensified privatization of services (Cugurullo 2018; Shelton, Zook, and Wiig 2015; Wiig 2018). At the heart of autonomous navigation is the production of new cartographies that allow automated vehicles to be deployed through physical spaces—and, in the process, influence economic processes as well as the organization of urban systems and transportation infrastructure (Schlossberg et al. 2018). These maps are created through sophisticated, and often proprietary, combinations of sensing and mapping technologies, which feature continuous, multimodal, and extensive data collection and processing. Thus, in navigating, and potentially transforming, space, autonomous vehicles effectively produce new virtual spaces through processes enclosed within technological as well as corporate black boxes. In combining pre-existing digital maps with continuously updated spatial databases that respond to the vehicles' navigation of space, the maps at the core of autonomous driving enact both the representational and performative possibilities of cartography: they are both object and process.

Given the magnitude of the resources invested in autonomous vehicles, their expected knock-on effects,[1] and their potential to reshape cities and socioeconomic organization, the mechanisms underlying their navigation of space should be more open to public scrutiny, deliberation, and regulation. My goal in this article is to expand the emerging conversation on the politics of autonomous vehicles (Bissell 2018; Boeglin 2015; Brodsky 2016; Stilgoe 2018) by advancing counter-mapping as a means to open up the spaces produced by, and for, autonomous driving. I will examine three separate possible avenues for counter-mapping: (1) *legislation*, specifically the emergence of right-to-repair laws across the United States, beginning with the Automotive Right to Repair Law passed in Massachusetts in 2012; (2) *design*, through open source projects for building self-driving cars, exemplified by Udacity, a pioneer in this area; and (3) *hacking*, specifically interventions proposed or designed to open, critique, or disrupt autonomous driving technologies.

I have identified these three aspects because they exemplify significant nodes of interaction between various actors in society, such as the public, interest groups, and legislators (legislation); firms, advocate groups, and consumers (design); and counter-cultural groups, regulators, information security advocates, and the media (hacking). After exploring these avenues, I will embed them in a political economic account that interrogates the ownership and control over the spaces produced through autonomous driving, as well as the data-harvesting and economic value generation associated with such production of space.

COUNTER-MAPPING

In her foundational contribution describing the struggles over forest resources in Kalimantan, Indonesia, Nancy Peluso (1995, 384) characterizes counter-mapping as a strategy used by local activists and allies to "appropriate the state's *techniques* and *manner of representation* to bolster the legitimacy of 'customary' claims to resources." Harris and Hazen, in turn, provide a more extensive conception of counter-mapping that incorporates "any effort that fundamentally questions the assumptions or biases of cartographic conventions, that challenges predominant power effects of mapping, or that engages with mapping in ways that upset power relations" (2005, 115). As suggested by these definitions, counter-mapping exists and evolves through a symbiotic relationship with established, accepted, and conventional technologies of mapping and modes of spatial representation, construction, and performance.

Over the past two decades, counter-mapping has closely tracked new developments in geospatial data, media, and technologies with the aim of turning them on their head and critically interrogating their established uses. Counter-mapping has been used by students and activists speaking against university policies (Counter Cartographies Collective, Dalton, and Mason-Deese 2012), indigenous peoples staking claims to land and resources (Wainwright and Bryan 2009), critics challenging architectural orthodoxies (Cattoor and Perkins 2014), researchers seeking to make conservation more equitable and effective (Harris and Hazen 2005), migrant advocates identifying routes into Europe (Casas-Cortés et al. 2017), activists reclaiming queer spaces and lived experiences in the city (Gieseking 2016), and scholars exposing privacy violations and passive data collection (Propen 2005). As these wide-ranging examples demonstrate, counter-mapping is less defined by any one technology, method, or mode of spatial representation, and more by an ethos of challenging power asymmetries in (and through) the mapping and appropriation of space.

Today's informational environment is increasingly characterized by the ascendance of technologies that bring order-of-magnitude increases in the speed, volume, and sophistication of data collection and processing (Kitchin 2014; Mayer-Schönberger and Cukier 2013). Three well publicized, trendsetting examples are social computing, blockchain, and artificial intelligence. While these and other influential technologies can be identified by their technical specifications and capabilities, they should also be understood through their linkages with and functional integration into the dynamics of digital capitalism. In this context, counter-mapping has a crucial role to play—mobilized through a variety of new tools and approaches that reflect the very technologies used to exert power through mapping.

1. A study commissioned by processor maker Intel, and conducted by the firm Strategy Analytics in 2017, estimates that the widespread adoption of fully automated vehicles will catalyze a new global passenger economy worth $7 trillion USD by 2050 (Lanctot 2018).

Counter-mapping can be a productive approach in checking and contesting new technical and political-economic regimes because its range and generative potential transcends the realm of spatial products (and processes) narrowly defined as "maps." As a way of thinking, acting, and producing spatial and political knowledge from a critical standpoint, counter-mapping not only deals with spatial objects that are immediately visible; it can also help excavate them from places that are hidden from plain view, or re-enact them through different perspectives. One example of this is the realm of "big data" and its emerging disciplinary counterpart, "data science." By counter-mapping "data science" itself, Dalton and Stallman (2017) elucidate the spatial relations involved in, and produced by, established modes of data production and interpretation—which are often in the service of powerful actors, such as corporations, states, and academic elites. In order to challenge the power-inflected spatial representations found in big data and data science, we can mobilize counter-mapping to connect theory and practice, and re-situate it in a bottom-up perspective:

> Counter-mapping offers both theorists and practitioners a way to connect careful, situated approaches to data . . . to the enacted practices of social organizing and change-making. It can combine critical thought and practice to draw on data science sources and methods (often developed by or for large corporations), yet does so in a situated, bottom-up manner to realize different ends. (Dalton and Stallmann 2017, 3)

Along similar lines, Shannon Mattern (2017) has argued for the need to question and challenge the new spatialities intertwined with emerging technologies of navigation and automated transportation. The growth of automated vehicles—as an industry, as a transportation paradigm, and as an ideology of mobility—has been fully embraced by the Silicon Valley elite (as well as counterparts in China and other countries) and is already transforming the global automobile industry. In the same way that medieval towns bear the imprint of horse-drawn carriages, and twentieth-century cities were (re)organized to accommodate (and often privilege) cars, it seems increasingly likely that the urban forms of the twenty-first century will be deeply influenced by the expansion of automated vehicles. In light of this world in emergence, it is imperative to ask, as Mattern does,

> . . . critical questions about how machines conceptualize and operationalize space. How do they render our world measurable, navigable, usable, conservable? We must also ask how those artificial intelligences, with their digital sensors and deep learning models, intersect with cartographic intelligences and subjectivities beyond the computational "Other." . . . There are a lot of *other* Others—including marginalized and indigenous populations and non-human environmental actors—who belong on the map, too, and not merely as cartographic subjects. They are active mapping agents with distinct spatial intelligences, and they have stakes in the environments we all share. (Mattern 2017)

Asking such questions requires prying open the black boxes that contain new mappings underlying automated vehicles. This is not only a technical exercise, but also a political act, since such black boxes are the means by which new modes of spatial representation, navigation, and performance (and, by extension, new articulations of power in space) remain hidden from public deliberation. Inflected by power and capital as they are, these mappings embody the asymmetries at the core of digital capitalism: while they use public spaces, personal information, and common-pool resources as inputs to generate economic value, they remain closed to deliberation or input from those who will bear the consequences of their deployment.

Accordingly, actions such as examining, disrupting, repairing, distributing, or reproducing the mechanisms and information underlying autonomous navigation often constitute infringements due to their proprietary nature, and legislation that reinforces it. These restrictions are part and parcel of a growing economy of information and digital technologies fueled by data collection, and dependent upon closed ecosystems as a way of ensuring profits.

Counter-mapping, as an ethos that can be put in practice though myriad techniques, actions, and perspectives, offers a promising opportunity to take apart the spaces produced within the black boxes of autonomous vehicles and the corporations that own them, in order to reconstruct them for other means. A provocative potential outcome, suggested by Manaugh (2016), is to make use of spaces of misdirection that, instead of making a robot-readable world, create one that is illegible to them. While the precise nature of the world we build should be the product of collective deliberation and participatory decision-making, a necessary step is to reclaim agency from the technical and economic assemblages (such as autonomous vehicles) that are currently redrawing the very spaces where we circulate and inhabit. The mapping conducted by autonomous vehicles follows two general approaches, each of which relies on particular technological configurations, and carries with it potentially different space-making consequences:

> One aims to create complete high-definition maps that will let the driverless cars of the future navigate all on their own; another creates maps piece-by-piece, using sensors in today's vehicles that will allow cars to gradually automate more and more parts of driving. (Bergen 2018)

Each of these approaches captures the world in a particular way, representing and recreating it in a manner that is suitable for a specific array of navigational technologies—often backed by a collection of corporate interests and alliances betting on the "winning" combination (Bergen 2018; Evans 2017; Hook and Bott 2018). Once captured, this three-dimensional re-creation of the world then becomes the setting for action of the vehicle itself, as well as those who make decisions about its navigation (including the human passengers who input directions, the engineers who design how the car will determine its path, and the advertisers analyzing new data streams for optimal placements along the way). However, the potential for action embedded in these mappings transcends the immediate navigational needs of the vehicle, since they can be used for decision making in other realms, such as managing traffic patterns, conducting street repairs, surveillance, marketing, urban planning, and even infrastructural upgrades. Yet, these activities are tied to, and would depend directly on, the type, quality, and characteristics of the spatial information collected and presented by the navigational technologies that produce such mappings—all of which are secretly guarded within technological and corporate black boxes.

In this article, I propose three specific avenues through which counter-mapping can be mobilized to open the black boxes of autonomous driving for deliberation, contestation, and transformation. In the next section I show how legislation, design, and hacking can challenge the technical, legal, and corporate barriers that guard the production of spaces at the core of autonomous driving. In the subsequent section, I integrate insights from these avenues into a political economic account centered on the ownership and control of spaces in the context of automated vehicles, and the generative potential (along with potential ramifications) of counter-mapping to facilitate alternative orders. The final section suggests future directions of inquiry and political intervention.

AVENUES FOR COUNTER-MAPPING

LEGISLATION

Starting in the 1990s, auto manufacturers positioned themselves as gatekeepers of the information required to repair (increasingly computerized) car systems, as well as who is authorized to do so. A practical consequence of this has been the funneling of repair work to manufacturer-authorized car dealerships, to the disadvantage of independent mechanics and auto repair shops (Kessler 2017). As cars become digitally networked to auto manufacturers, other cars, or even infrastructure, the issue of access to car data by third-party repair services will become a more salient point of contention both for mechanics and for consumers. However, these discussions can also inform debates on broader issues about ownership and access to any sort of digital information collected by, and stored within automobiles. In light of the ongoing computerization and networking of cars, repair data constitute a useful (legal and conceptual) precedent for the expanding data ecosystems of automated vehicles.

The high barriers and costs to repair automobiles have galvanized grassroots movements that aim to broaden access to repair capabilities. Cars have become a focal point in the emerging Right to Repair movement due to their intensified computerization, the growing momentum of automated vehicles, and the size of the aftermarket for third-party repair services. As one mechanic put it, the survival of the trade is contingent on "fair and equal access to data, information, and training" (Kessler 2017). Furthermore, calls for the right to repair are symptomatic of broader contestations challenging restrictive notions of ownership and closed access that have come to define digital capitalism (Perzanowski and Schultz 2016). Thus, organizations representing users of smartphones, computers, printer cartridges, and other electronics—such as the Electronic Frontier Foundation (**eff.org/issues/right-to-repair**), the Institute of Electrical and Electronics Engineers (**spectrum.ieee.org/green-tech/conservation/why-we-must-fight-for-the-right-to-repair-our-electronics**), and iFixit (**ifixit.org/right**)—have expressed their discontent with what they see as restrictive (and wasteful) practices by the corporations that seek to control, not only the manufacture and distribution, but also the use, transformation, and resale of products.

These informational enclosures have catalyzed a legislative movement in the United States aimed at making repair information available to consumers as well as independent shops. At the federal level, the first Right to Repair bill was introduced in 2001, but was not adopted. In 2013, after reconciling two separate laws enacted the previous year, Massachusetts passed the first Right to Repair legislation (An Act Relative to Automotive Repair 2013). In 2017, the state's Consumer Protection and Professional Licensure Committee heard legislation that would expand the Right to Repair to cover all types of electronics sold in the state. As it continues to be considered by the legislature, this expansion is actively opposed by manufacturers in the appliance, video game, electronics, and medical device industries, along with others that have a financial stake in maintaining control of the repair services market (Metzger 2017).

The original Massachusetts Right to Repair legislation led to a Memorandum of Understanding between automakers (represented by the Alliance of Automobile Manufacturers and the Association of Global Automakers) and third-party service providers (represented by the Automotive Aftermarket Industry Association, and the Coalition for Auto Repair Equality), in which the former committed to provide the necessary information for repairs to the latter, beginning with 2018 car models across all 50 U.S. states (Bassett 2016). However, while at the time of this writing eighteen states[2] have introduced legislation on the Right to Repair electronics and other devices (**www.theverge.com/2018/3/8/17097256/california-right-to-repair-bill-apple-microsoft-service-replace-parts**), it remains unclear how the Right to Repair movement and ensuing legislation will inform the governance of data collected by automated vehicles once their use is more widespread. An important point to consider is the changing nature of technology, and its slippery relationship with legislation, which is often less dynamic. In the case of automobiles, the 2014 agreement to share car data with repair shops represents a step in the direction of a more open informational environment. However, next-generation vehicles, which are both automated and connected to digital networks, bring qualitative changes in the collection and storage of data, well beyond what is covered in existing Right to Repair agreements (Kessler 2017). While the contentions over car data have heretofore focused on repair codes, the mappings produced by self-driving cars are made of data captured from their surroundings, including people, places, and communications along their path. The contentious history of Google cars intercepting wifi communications while capturing Street View images highlights the implications of this emerging technological debate for privacy and security, among other fundamental issues (Burdon and McKillop 2013).

The experience of the Right to Repair movement, and legislation it has pushed in the United States, illustrates that it is possible to open the closed informational environments that have come to dominate digital capitalism. The Right to Repair addresses a fundamental imbalance of data access between manufacturers, on the one hand, and consumers and third-party service providers, on the other hand. However, the data collected by connected and automated vehicles are both harder to access by non-authorized parties (as they circulate through closed networks under manufacturer control), and more valuable for purposes beyond car repair. Indeed, as cars come to rely completely on a vast array of sensors for navigation, the possibilities for profit multiply through the marketization of collected data about user habits, preferences, identity, locations, routes, and surroundings, as well as subscription services such as navigation guidance, emergency assistance, and onboard entertainment systems. This portends a more thorough reconfiguration of spatial information (and space itself) towards the logic embedded in applications like Yelp and

2. These are: Washington, Massachusetts, Vermont, New York, Hawaii, Illinois, Iowa, Kansas, Minnesota, Missouri, North Carolina, Nebraska, New Hampshire, New Jersey, Oklahoma, Tennessee, Virginia, and California.

Google Maps, which are designed to facilitate consumption in, and of, space, as a primary activity.

In this respect, the Right to Repair presents an avenue that addresses the data pipeline of the car only inasmuch as it concerns the repair of the vehicle itself. Yet, with cars becoming increasingly sophisticated collections of computers, "car repair" only covers what is already a shrinking aspect of the car data environment. In fact, automated vehicles are no longer merely cars, but are instead, as one commentator has called them, "data harvesting machines" that are connected to a diverse assortment of services (Kaminska 2017). In turn, these data harvesting machines rely on spatial representations to navigate space, while creating economic value out of such representations, and potentially transforming space itself in the process. In this emerging environment of pervasively commodified spatial data flows, it is necessary to have a more open and deliberative process informing the public what data are collected by automated vehicles, what is done with said data, and who can appropriate and profit from them.

As Right to Repair movements and legislation have already demonstrated, grassroots movements can be successful in exerting the pressure necessary to open the closed data pipelines under corporate control. While initially this success has been aimed at repair activities, more attention should be directed to tracing the flows of vehicle data and accounting for their expanding uses and applications. In particular, as increasingly automated cars come to rely on complex mappings to navigate, the process of how these are assembled and commodified should be made transparent and open for public deliberation. Concomitant with lobbying efforts for new legislation on this front, below I discuss the possibilities presented by two additional avenues of potential intervention: design and hacking.

DESIGN

Udacity is an online, STEM-focused, education company co-founded by Sebastian Thrun, who led the development of the Google self-driving car and won the 2005 DARPA Grand Challenge—the foremost competition of autonomous vehicles, funded by the US Department of Defense. Udacity's aim is to prepare students for jobs in the information technology industry. Given this focus, and the interests of its founders, one of the first courses it offered was titled "Building a Robotic Car," taught by Thrun in 2012. This has expanded into a "nanodegree" entirely devoted to providing students with skills to "complete the journey to a Self-driving Car career" (Udacity 2017).

In parallel to expanding the formal courses and certificates focused on self-driving cars, Udacity is building its own version of this technology as an open source project. After outfitting a 2016 Lincoln MKZ with lidar, radar, cameras, and other equipment, Udacity configured the Robot Operating System (ROS), and opened the code "to build and refine an open source self-driving car with the help of students from around the world" (Cameron 2016). This project consists of various discrete tasks, which address individual components of the autonomous vehicle, and are open for public participation. The code is managed through a GitHub repository, and users can communicate through the Slack messaging platform, using an account dedicated to this project. At the time of this writing, the open source project page on the Udacity website (**udacity.com/self-driving-car**) redirects to the Self-driving Car Nanodegree page, suggesting a pivot back to the company's core mission of selling online educational services.

While Udacity has leveraged its partnerships with top academic institutions such as Stanford and Carnegie Mellon, as well as leading companies in the automobile (Mercedez-Benz, Honda), ride-sharing (Uber), and information technology (IBM, Nvidia) industries to entice students with an inside track into high-paying engineering jobs, another open source self-driving car initiative is developing on the outside of this environment, and with a different set of goals: the Open-Source Self-driving Car Initiative, or OSSDC (**ossdc.org**). The differences between these two open source projects are illustrative of the range of orientations that can develop through open source projects, and can point to the possibility of future initiatives explicitly aimed at critiquing and contesting the collection, use, and commodification of self-driving car data.

Marius Slavescu, a Toronto-based inventor, started the Open-Source Self-driving Car Initiative in 2016 after he joined Udacity's Open Source Self-driving Car Challenges. According to OSSDC's Mission and Vision statement, this initiative was created, "to bring together the best open source technologies and open research to allow anyone (not only experts) build affordable self-driving cars and autonomous mobile robots in a DIY manner [*sic*], from toy size (RC cars) to full size (full size cars)"

(Slavescu 2017b; 2017c). The basic structure of OSSDC largely mirrors that of Udacity's project: code is shared through a GitHub repository, and communication between members takes place through Slack. While OSSDC is still in its infancy, and many of its core components are in flux (such as its website, which is still missing important content, or its logo—an upside down car that is the topic of much discussion by contributors), its divergence from the corporate orientation of Udacity (as a feeder for the self-driving car industry) has been made clear from the outset. For example, in the context of a discussion about the design specifications of the logo for OSSDC, Slavescu expanded on his outlook for the orientation of this initiative, explicitly looking to transcend commercial goals:

> I'm looking for people that really want to contribute to Open Source Self-driving Car Initiative, and make it applicable to many SDC and robotics projects, instead of just looking to build next Uber (not that is anything wrong with that [*sic*]).
>
> In my opinion, OSSDC.org is an organization that should be a model for the future, where people join to Learn, Teach, Invent, Make, participate and contribute their expertize [*sic*] in open ways (through OSSDC GitHub Organization), for the good of everyone, not just for their employees or investors. (Slavescu 2017a)

Whether OSSDC will survive with this outlook (if at all), or mutate to adopt a different ethos, is too soon to tell. However, this initiative's existence illustrates a viable form of non-commercial organization to tackle the development of an emerging and particularly complex technology. On the other hand, OSSDC also exemplifies, through its tentative beginnings and lack of clear organization, the difficulties of existing and expanding in the self-driving car technology environment without the explicit support from, or integration into, a corporate pipeline.

As shown by Udacity, opening the code and development of a self-driving car can be beneficial in identifying potential job candidates for the industry, and even developing innovative technological solutions through collaboration. This strategy has also been embraced by Baidu, the leading search engine in China, which has taken it one step further. Baidu has announced the gradual opening of its entire self-driving technology stack, named Project Apollo, starting in a limited environment in 2017 and releasing full self-driving software by 2020 (Muoio 2017). In this case, Baidu's goal is to drive the development of the self-driving car industry through community input, while retaining the position to commercialize a finished product.

The different strategies embraced by Baidu and Udacity, on the commercial side, and OSSDC on the not-for-profit side, illustrate how the emerging landscape of self-driving cars is colored by the enormous economic rewards promised by this technology. While open source as a practice has the potential to disrupt asymmetric power arrangements in the self-driving car environment, it can also be leveraged as a strategy to reinforce them. OSSDC is meaningful as precedent for a self-organized open source initiative focused on self-driving cars. Yet, it does not directly address the issues surrounding collection, use, and appropriation of data by these vehicles. This is particularly important in the context of the pervasive, multimodal data collection enabled by automated vehicles. Open source design can offer a window into understanding, critiquing, and checking the specific mechanisms by which these vehicles capture highly granular, personal (and potentially illegal) data on location, routes, and user behavior, and integrate them into virtual spatial representations.[3] Such a window would provide the opportunity for public scrutiny into concerns central to the deployment of self-driving cars, such as the relationship between a vehicle's software, data, and technological configuration, on the one hand, and the assessment of questions of liability, reliability, and safety, on the other. It is through the window offered by open source design that potential counter-mappings can then advance alternative spatial representations.

Thus, in a similar way that targeted movements are required to promote legislation that explicitly addresses the power asymmetries shaping the self-driving car data pipeline, new open source initiatives will have to emerge that are geared towards demanding data transparency, proposing alternative technologies, and building frameworks for contestation. An element that can position open source initiatives as an alternative, and counter, to the

3. Many of the data collection methods that are present in self-driving cars have previously been subject to litigation and government investigation in the US and various European countries during their deployment by Google Street View vehicles —in particular the collection of Wi-Fi network data along photographed routes. For an overview of these cases, see Blitz (2012), Electronic Privacy Information Center (2010), and Geissler (2012).

corporate-dominated self-driving car ecosystem, is hacking. Both as a technical practice, and an ethic of disruption, hacking can be an avenue for critiques of self-driving car development, as well as a tool to open the black boxes of technical and corporate control that contain the data collected by self-driving cars. In the next subsection, I examine two recent instances of automated vehicle hacking and explore how these can be used to inform a counter-mapping movement in the context of self-driving cars.

HACKING

In 2015, Charlie Miller, a security researcher at Twitter, and Chris Valasek, Director of Vehicle Security at the information security firm IOActive, remotely hacked the computers of a 2014 Jeep Cherokee, gaining control of the vehicle's steering, transmission, and brakes. This was a significant leap from their hacking of a Toyota Prius and a Ford Escape in 2013, which took place with their computers physically connected to the cars' onboard diagnostic ports (Greenberg 2015). The progression towards wireless hacking is both indicative of the auto industry's trend of making vehicles more connected, and a serious warning ahead of the massive deployment of fleets of networked autonomous vehicles. Miller and Valasek shared their findings with Fiat Chrysler, the maker of Jeep Cherokee, and published a comprehensive guide exposing its security vulnerabilities (Miller and Valasek 2015), with the aim of alerting automakers of the potential security flaws while simultaneously putting pressure on them by stoking public opinion.

In the process of remotely hacking into the Jeep Cherokee, Valasek and Miller relied on the car computer's capabilities of communication, location, and automation, and exploited their vulnerabilities over cellular data networks (Miller and Valasek 2015). Through this exercise, they showed that, by gaining access to a vehicle, hackers can directly manipulate its trajectory and actions, as well as track its user's movement patterns, location, and behavior from long distances. While this is already a significant issue due to the large number of digitally connected vehicles in the market, the widespread adoption of autonomous vehicles will only worsen the implications for privacy, cyber-security, and public safety.

The work of Valasek and Miller, though initially downplayed by auto manufacturers, has gained the attention of some US legislators, who have proposed legislation specifically aimed at addressing the flaws exposed by remote vehicle exploitation. The Security and Privacy in Your Car (SPY Car) Act of 2015 was sponsored by Senator Ed Markey, with the aim of

> [directing] the National Highway Traffic Safety Administration (NHTSA) to conduct a rulemaking to issue motor vehicle cybersecurity regulations that require motor vehicles manufactured for sale in the United States to protect against unauthorized access to: (1) electronic controls or driving data, including information about the vehicle's location, speed, owner, driver, or passengers; or (2) driving data collected by electronic systems built into a vehicle while that data is stored onboard the vehicle, in transit from the vehicle to another location, or subsequently stored or used off-board the vehicle. The regulations must require vehicles with accessible data or control signals to be capable of detecting, reporting, and stopping attempts to intercept such driving data or control the vehicle. (Security and Privacy in Your Car Act 2015)

The bill was read twice on the Senate floor and eventually referred to the Committee on Commerce, Science, and Transportation. Two years later, in 2017, Senator Markey reintroduced the bill, which to date has repeated its path through the Senate, having been referred to the same Committee, where it remains. Thus, while many legislators have stated that vehicle cybersecurity is a top priority, to date no new legislation has materialized (Armerding 2017). Episodes of remote vehicle hacking, such as that carried out by Miller and Valasek, or the Tesla car hacks in 2016 and 2017 by researchers from Keen Security Lab, part of Chinese technology leader Tencent (Weise 2017), have informed legislative discussions on improving security by pinpointing specific, and exploitable, flaws. However, the slow legislative pace and the competition between automakers towards increasingly interconnected vehicles constitute serious obstacles to a more secure environment. Furthermore, these hacking instances demonstrate the importance of location data, as well as other forms of spatial data collected and processed by cars, since they can be used (among other applications) to identify, as well as disrupt and control the movements—and potentially the safety—of car passengers.

In another instance of hacking that has significant ramifications for self-driving cars, George Hotz (who became famous for being the first person to "jailbreak" an iPhone in 2007) recently pioneered an open source self-driving platform called openpilot (spelled in lowercase on their GitHub page, **github.com/commaai/openpilot**). With the help of a smartphone, this platform can enhance existing car systems (such as lane detection and assisted parking), endowing them with "semi self-driving" capabilities. Developed through Hotz's company, comma.ai (also lowercase), the platform was originally set to be an aftermarket kit, commercially available for $999 USD. However, after receiving a letter from the National Highway Traffic Safety Administration, which threatened fines for selling untested self-driving technology to the public, Hotz decided to release it publicly as open code (Zaleski 2107). While Hotz has stressed the research purposes of this release, he has also outlined a commercial strategy for openpilot, which distances itself from the hardware, and focuses on the data network underlying self-driving cars:

> Hotz compared Open Pilot [*sic*] to Android, and said that it's really aimed at "hobbyists and researchers and people who love" self-driving technology. "It's for people who want to push the future forward," he said. When asked how or if Comma.ai [*sic*] plans to make any money off of this project, Hotz responded: "How does anybody make money? Our goal is to basically own the network. We want to own the network of self-driving cars that is out there." (O'Kane and Goode 2016)

In effect, if adopted massively, openpilot would assist people in hacking into their own vehicles for the purpose of transforming them into (at least-partial) self-driving cars and connect them to a network of car data flows that comma.ai would be in a position to monetize. To this end, the next iteration of comma.ai's efforts has been the development of a "decoder" that lets users monitor and interpret the data collected by their cars. The goal is to "democratize access to the decoder ring for your car" (comma.ai 2017). According to Hotz, his technology gives users access to all the same car data that manufacturers can access, from fuel use, to RPMs, to driver behavior—thus leveling the playing field and allowing individuals to train their own self-driving cars. As cars become increasingly autonomous, this type of technology can potentially allow users to examine the data pipeline that feeds into the mappings underpinning automated navigation. This, in turn, can empower individuals, user communities, grassroots organizations, or regulators to construct alternative narratives, arguments, and representations in order to hold car manufacturers accountable, demand transparency, or check the quality of the data-driven services they receive. On the other hand, a more open car data environment can also expose existing security vulnerabilities in networked and automated systems, or even create new ones that endanger the users of such technologies and the public in general.

Yet, while giving users the tools to view and interpret their vehicle's data may constitute, in and of itself, a democratic exercise in the eyes of Hotz, it is fully subordinated to the logic of an emerging market for car data. Not coincidentally, comma.ai's innovations are well positioned to successfully exploit the potential profits from said market. As he suggested in a recent interview with the libertarian outlet *Reason*, Hotz's idea of openness is characterized by a form of collective sharing that comes with a profit imperative; this imperative is necessarily fulfilled through market action:

> I don't want to have a monopoly on data. This is the old way of thinking. What if we could open our data up more, and really think about it, not as like, "Facebook owns this data, Google owns this data," but we all collectively own the data and you're contributing to a big collective pool of data. . . . Now it's a market, it's not like, "Oh we're all going to do this for smiles and roses," or whatever communists have, but no we're going to do it for you know, [inaudible] the market. Create this data, contribute to this, all the data combined is a whole lot more powerful than any piece of the data alone and I think we can do incredible things with these sort of data sets, right? (Monticello 2017)

The double-edged sword of empowering users to access and interpret their own vehicle data, while creating a market for it, exemplifies one of the defining tensions of digital capitalism. Therefore, in light of technological advances, such as those put forth by comma.ai and various other open source initiatives, a fuller political economic examination of self-driving car data must be conducted. This examination should read the dynamics of legislation, open source design, and hacking (among other elements) in a political economic context that considers the power asymmetries and monetary incentives inherent to the entire self-driving car ecosystem, and its integration into digital capitalism. It is only through such analysis that we can have both a clearer understanding of how new data spaces are being created inside self-driving vehicles, how they contribute to reshaping the physical and social world, and how we can build initiatives that question, regulate, and open this process to public deliberation.

COUNTER-MAPPING THE DATA SPACES OF AUTONOMOUS DRIVING

As AUTONOMOUS VEHICLES CONTINUE to improve, they are raising important questions of ownership, security, privacy, liability, and even competition. Yet, the conversations around this innovation and its consequences have so far been centered on the cars themselves, as well as the technologies that can allow them to become autonomous. This is for good reason, since the widespread deployment of self-driving cars has enormous societal consequences, the most immediate of which have to do with how safely they perform on the roads. However, underlying—and enabling—this technological development, is an emerging data ecosystem generated by the massive collection of fine-grained vehicle data about the cars themselves as well as the landscape they navigate, and even the users that drive them. This data ecosystem—much of which is assembled into highly complex mappings through lidar point clouds, photography, GPS-enabled navigation, image recognition, and other technologies—constitutes a core component of the political economy of automated vehicles.

Self-driving cars constitute an extension of an established industry—the automobile industry—into digital capitalism through intensified exchanges with other cutting-edge industries such as those of information, geospatial technologies, and robotics. On the other hand, the structures underpinning the collection, use, and monetization of data harvested by self-driving cars are made in the crucible of the digital economy. The business models of Google and Facebook shape the emerging autonomous vehicle data ecosystem to a greater degree than existing strategies of the automobile industry. Bringing cars into a digital, networked environment of monetized data flows realigns the auto industry's economic incentives and articulations of power with broad ramifications. The emerging automated navigation landscape is assembled through new configurations that include both incumbents and new entrants across information, robotics, geospatial, automobile, and other technology industries, along with subnational and national authorities across various countries, grassroots organizations, and communities of users.

As the previous sections illustrated, the development and deployment of autonomous vehicles raises, among others, important questions about ownership, privacy, and security—of vehicles, as well as data (with an increasing emphasis on spatial data). Consequently, new movements and initiatives, spanning a number of domains, are contesting the closed structures of access and ownership upon which the automated vehicle order is premised. However, as the Right to Repair movement and legislation in the US also show, while these have achieved success in pushing back against restrictive practices from automakers, they have done so in large part because this pushback is aligned with the interests of another powerful industry, which is that of the aftermarket for car products and repair services. A similar situation can be seen in the open source movement for self-driving cars, where the leading initiatives are those that are either training people for employment in the self-driving car industry (such as Udacity), or using open source as a new strategy for technological innovation and ensuring a leading position in the market (Baidu).

While hacking can potentially bring more agency to users and mobilize regulation aimed at increasing security, transparency, and accountability of manufacturers, these same practices can pose important security risks to drivers, pedestrians, and the public in general. Public infrastructure can be endangered, and hackers can potentially compromise sensitive information while feeding underground data markets. Yet, in spite of these significant implications, legislation on this front has so far been stalled, while the most dynamic hacking initiatives (such as Geoge Hotz's openpilot) are—in Facebook-speak—"moving fast and breaking things," embracing the liberating rhetoric of open source and spurred by the promise of rewards from a leading market position to monetize car data flows. This should be no surprise, given the system of incentives that undergirds digital capitalism, which privileges innovation over security, and monetization over privacy and other users' rights. As Miller and Valasek's car hacking demonstrations have shown, the race for automated navigation leads automakers to compete over the release of new technical features, and new revenue streams, while paying secondary attention to the possible negative externalities for consumers.

Carefully assessing the risks brought by each of these avenues, I suggest that we can also explore their potential to open the black boxes of autonomous driving under the umbrella of counter-mapping. This can encompass, through a self-reflective approach, the technical analysis, the ethics of contestation, and the construction of alternatives necessary to provide a much-needed counterbalance to the capitalist imperative driving the self-driving car industry. In particular, it is essential to open for public debate, and achieve a broader understanding of, how autonomous vehicles re-create and navigate space. This is crucial because the mappings underlying autonomous navigation are also the mappings underlying potential transformations of space, since the rise of self-driving cars cannot be divorced from the economic logics and incentives that define digital capitalism, nor can it be understood separately from the technocratic promises (and perils) of the corporate-driven smart city rhetoric (Luque-Ayala and Marvin 2015; Wiig 2015). This ongoing counter-mapping can involve a critique and a re-creation of the virtual spaces made by (and for) autonomous navigation. Attending to the data spaces collected by cars (as they become "data harvesting machines") and tracing how these data spaces are assembled, used, and appropriated, counter-mapping can provide an integrative perspective that allows us to consider, monitor, and deliberate over the entire data ecosystem, while identifying opportunities for concerted political action.

CONCLUSION

As counter-mapping has shown in instances ranging from indigenous land claims to data privacy, the structures of power underlying technological and informational paradigms can be contested by turning these paradigms' mapping technologies onto themselves. Counter-mapping, as an ethos and an evolving set of practices, can achieve this by developing in parallel to the very tools used by those actors who have the power to "map." The epistemological and political tasks enabled by counter-mapping are thus necessary to hold mapping powers to account precisely because mapping is not just a representation of particular visions of the world, but also a means of enacting them. In this respect, the mappings performed by autonomous vehicles not only create a vision of the world suitable for navigation, but also for the capital imperative of monetizing those spatial representations. Beyond this, once massively deployed and adopted, autonomous cars could have the power to reproduce their internal spatial representations onto the physical world by exerting change on transportation systems, flows of capital, industrial organization, policymaking priorities, and social practices.

In light of these vast ramifications, it is imperative to develop strategies to critically examine the production of space within autonomous vehicles, and open up this process for wider participation. I have argued here that counter-mapping represents an integrative perspective that can incorporate several avenues through which autonomous vehicle data collection, use, and appropriation can be critiqued and contested. Legislation, open source design, and hacking represent a subset of the potential avenues for counter-mapping the data spaces produced and networked by autonomous vehicles. However, each of these has to be critically evaluated for how they are positioned with respect to the systems of incentives that structure digital capitalism. Mobilizing these practices for the purposes of contestation requires a pushback against the imperatives towards profit and corporate control that so often shape their trajectory. Counter-mapping, as an ethos and an evolving set of practices, can thus contribute to the building of alternatives to the black-boxed construction of new data spaces, often hidden from public input and deliberation, and which underpin what is often advertised as the inevitable, automated, order of things to come.

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PEER-REVIEWED ARTICLE

Seeing by the Starbucks: The Social Context of Mobile Maps and Users' Geographic Knowledges

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Locating places using maps on mobile devices is an increasingly common practice in modern life. Such maps, including Google Maps and Apple Maps, inform and shape users' geographic understandings. Existing research finds that those who navigate with mobile devices tend to recall landmarks rather than more comprehensive forms of geographic knowledge. However, most of that research gives minimal consideration to social context. Utilizing a qualitative approach and drawing on critical work on vision, maps, and digital data, we explore the contextual, economic circumstances that partially shape the production of users' geographic knowledge through their consumption of mobile device maps. In a focus group experiment, mobile device map users frequently referred to a particular business, a Starbucks location, in a location-finding task. This indicates that social, contextual considerations are important to informing geographic knowledges; the map application providers' business strategies, chiefly advertising, lead to an emphasis on business-type points of interest in mobile maps, which could shape users' subsequent geographic knowledges. This has implications not only for mobile device use, but how technology companies' maps potentially affect everyday understandings of the world around us.

KEYWORDS: wayfinding; navigation; smartphone; geographic vision; critical data studies; Google; mobile device; landmark

> I found the Starbucks. That's the library. Does it count if I didn't exactly [find] Andruss Library, but I got Starbucks?
>
> Focus group participant

Maps on consumer-grade mobile devices increasingly mediate how people see, understand, and navigate geography. The Pew Research Center has estimated that 64% of adults in the United States, and 43% globally, own smartphones (Poushter 2016). Among US smartphone owners, 90% use their device to get directions, geographic recommendations, or other location information (Anderson 2016). The popularity of mobile map applications, particularly those with turn-by-turn directions, drives news stories about inattentive travelers being directed hundreds of miles off course, into rivers, or toward a "death-by-GPS" (Milner 2016; Darlington 2015). Such stories feed a moral panic about mobile map users being "sedated by software," inhibiting their ability to interpret geographic information or to navigate without GPS assistance (Royal Institute of Navigation 2015).

New technologies frequently spark moral panics, but recent research on mobile devices and users' geographic knowledge has found that these systems do have drawbacks when compared to paper maps (Ishikawa et al. 2008). Several researchers have found that users tend to conceptualize space only in simple terms, primarily as multiple discrete landmarks (Willis et al. 2009; Münzer, et al. 2006). While these are valuable insights, they lack the contextual considerations that have been highlighted in both cognitive geography and cultural geography debates. Mobile device technologies are neither neutral nor isolated from social influences. Technologies' effects reflect the context of their development, design, and distribution, as well as users' standpoints in practice (Haraway 1991; Feenberg 1999).

Prompted by unexpected research participant responses in a study on cartographic scale, this article explores one important social dimension of mobile map applications that has not been sufficiently examined in research thus far. Specifically, we investigate whether the economic context of mobile map production by companies such as Google and Apple might influence the kinds of geographic features that users employ to determine if they have accurately located a place on the map. Incorporating existing research on the social, economic processes that surround the design and use of mobile data and maps, we use qualitative methods to explore the accounts of mobile map users, gaining a richer understanding of how they see the world via mobile maps. We examine how points of interest on the map may come to be used as landmark points of reference by users, apparent in how they think about and communicate geography and location.

Previous geoweb and data science research has found that the features appearing on commercial web maps, such as Google Maps, produce geographies of data both on the map and in practice (Kitchin 2014; Shelton, Zook, and Wiig 2015; Willis 2016). Specifically, these maps are structured around businesses as points of interest. Google, for example, makes money primarily through advertising, so its maps and its algorithms that rank map features are designed to serve that business plan (Zook and Graham 2007a; 2007b; Dalton 2013). Google even recently began placing ads for businesses directly on its maps and using businesses as landmarks in turn-by-turn directions (Dickey 2018; Inhnat 2018).

Users see and understand geography partly in terms of the maps they use (Kitchin 1994; Tversky 1993), and Willis et al. (2009) and Münzer, Zimmer, Schwalm, Baus, and Aslan (2006) make it clear that landmarks are central to users' navigation with mobile devices. In this case, users produce one form of geographic knowledge—landmarks—by seeing cartographic points of interest that are framed and presented to fit the mapmaker's economic imperatives. Thus, this combination of map use and social context may have implications for their understanding of a geography.

As the focus group participant's quote about Starbucks and the library begins to indicate, the underlying social context of mobile map use may affect how users understand the world through mobile technologies. The first half of this article outlines how geographic cognition is contextual and how the production of visual geographic knowledges is socially situated, and from that angle engages the results of existing studies on mobile device use and geographic knowledge production and navigation. The second half employs the results of a study of mobile map users and existing work on the business of web maps to demonstrate the potential role of economic processes in the production of mobile device users' geographic knowledges.

PRODUCING GEOGRAPHIC KNOWLEDGES

Geographic knowledges and associated material practices have been studied and theorized by many geographers and allied scholars. While this realm includes a wide variety of theories and methods, foundational work in both cognitive geography studies and cultural theory points to the importance of contextual constructions of geographic knowledges in practice, regardless of the underlying neurological structures or networks involved (Montello and Freundschuh 2005). While most research indicates that device use facilitates impoverished or simplified spatial knowledges, it has rarely incorporated these contextual considerations, particularly economic ones, such as the business imperatives and designs of the phone- and mapmakers.

COGNITIVE GEOGRAPHIES AND MAPS

Cognitive research on geographic knowledges offers a variety of frameworks, ranging from the construction of knowledge through learning, to connected neural networks, to linguistically influenced situated cognition, to evolutionary development. Most spatial cognition frameworks involve both underlying neural structures, with individual variations, and culturally situated learning as we orient ourselves and navigate every day (Montello and Freundschuh 2005). Regardless of the neurological structures involved, how geographic features are ontologically recognized, categorized, communicated, and used varies between cultures (Montello 2009). Within, or at times, despite, those cultural variations, most cognitive research on geographic knowledges tends to be structured around of three kinds of geographic features: landmarks, routes composed of a series of landmarks in order, and survey or configurational knowledge of interconnected landmarks and routes across scales (Montello and Freundschuh 2005).

Within the range of cognitive research on geographic knowledges, researchers advance cognitive maps as a framework for conceptualizing landmarks, routes and surveys features in concert. Again, researchers highlight the contextual, constructed nature of cognitive maps, noting how they change and are partly based on subjective knowledge. "[C]ognitive maps are not independent of time and space" (Kitchin 1994, 3) "since each environment exists in a time-space context, so too will cognition of those environments" (Moore and Golledge 1976, 11). Using linguistic constructions, Tversky (1993) illustrates the limitations of cognitive maps and calls for more flexible frameworks that could include recollections of journeys and verbal directions, memories of maps, geographic facts, and even linguistic families. Such frameworks could certainly include memorable corporate branding, and Kitchen (1994) even posits advertising as a potential application for cognitive map research.

Cognitive geography approaches are also used in cartography and GIScience to improve map design. This work focuses on schemata, "mental structures that the map users employ to mediate between what s/he already knows and what s/he sees in a map. In other words, they are the means by which the map users construct information from visual representations like maps" (Griffin 2017, 50). Better understanding a schema, for example a learned categorization of types of surfaces on which "we walk, lay, and sit," can help inform how map data should be symbolized and included in a map or GIS (Freundschuh and Egenhofer 1997, 363). Thus, schemata draw on both a map-reader's direct experience as well as culturally shaped, learned conventions, such as water being commonly symbolized with blue (MacEachren 1995). Cognitive geography research indicates that geographic knowledges are at least partly contextual and constructed, particularly in practice and when involving maps and geographic communication technologies.

SOCIAL VISIONS

Using a cultural approach to a similar topic, Haraway (1991) warns of the limitations of disembodied, technologically mediated visual knowledge, for it obfuscates how technologies and associated knowledges are inherently shaped by social circumstances and power relationships. Embodied, situated knowledges constitute a productive alternative approach, open to multiple ways of knowing and thus more possibilities for better understanding the world. For researchers, this means being open to and taking seriously the accounts and technologically inflected standpoints of subjects to better understand their perspectives and what their knowledges make possible. "Situated knowledges require that the object of knowledge be pictured as an actor or agent, not a screen or a ground or a resource…" (Haraway 1991, 198).

In geographic cases, viewing subjects are co-produced with visual geographic knowledges through embodied viewing practices driven and shaped by broad social processes (Cosgrove 1998; Rose 2003; 2007). Today, mobile devices are powerful tools for producing visual geographic subjects and knowledges, for they can travel with a user and act as a resource on-site. For example, Wilson (2011) describes the use of mobile devices as city residents conducted a visual neighborhood assessment survey in Seattle. Through their social context and the structure of a mobile application, users became trained to see some things, such as signs of urban decay, and not others. In this way, the governmental terms of the survey, mediated by the mobile device, facilitated the production of neoliberal viewing subjects and their knowledges (Wilson 2011).

The emphasis on the production of situated knowledges through practice is also apparent in recent work on maps. Critical cartography articulates how maps are always produced within social contexts, part of powerful cultural projects such as state-building, consolidating private property, or profit-seeking by businesses (Crampton 2010; Schulten 2012; Sutton 2015). These political contexts inherently involve multiple subject positions and political economies of geographic technologies (Stephens 2013; Alvarez León and Gleason 2017; Thatcher, O'Sullivan, and Mahmoudi 2016; Dalton 2018). Economic considerations are vital to the development of new technological innovations and use practices. For example, according to mobile technology expert Brian Profitt, geographic data from mobile device use is a "hot commodity," based in large part on the perceived value of targeted advertising (quoted in McBride and Oreskovic 2013). Choices made about which data are or aren't incorporated into a mapping service for business or functional reasons delimits how that service can best and most easily be used (Haklay 2013). Moreover, it is through use that a map's purpose and economic value is realized by helping to produce a viewing subject's knowledges and spatial actions. Thus, maps are not just political and culturally situated, but facilitate the recursive production of knowledges through practice (Pickles 2004; Dodge and Kitchin 2007). In the case of mobile devices, mapping technologies facilitate location-aware services and conspicuous displays of users' geographic behaviors that provide revenue for the company providing the service (Wilson 2012; Pink and Hjorth 2012). Only a few recent qualitative studies engage the contextual nature of geographic knowledges and navigation or place-finding, highlighting the importance of everyday cartographic practices to underlying social processes (Brown and Laurier 2005; Wilmott 2016).

GEOGRAPHIC KNOWLEDGE AS ACQUIRED WITH MOBILE DEVICES

In contrast to these contextual studies, a growing number of researchers are attempting to assess the impact of consumer-grade geographic mobile technologies on geographic knowledge acquisition. Tests measure research participants' directional error, travel time, time stopped between moves, subsequent memory of places and landmarks, and the accuracy of their survey knowledge on sketch maps. Most of the studies that compare mobile device navigation with navigation supported by other methods, such as paper maps, indicate some kind of lesser performance by mobile users. Ishikawa et al. (2008) found that research participants using a GPS-enabled mobile map on a phone travelled slower, made larger directional errors, drew sketch maps with poorer topological accuracy, and finally, rated navigation as harder, than those using a traditional paper map. Other studies have found similar results (Münzer, Zimmer, and Baus 2012; Waters and Winter 2011), including with augmented reality hardware (Huang, Schmidt, and Gartner 2012).

Two factors may explain the disappointing results of mobile device maps within the frame of successful geographic knowledge acquisition. First, some mobile device studies were performed while mobile maps were quite new (Münzer et al. 2006; Ishikawa et al. 2008). The maps and user interfaces lacked touchscreens and were neither intuitive nor easy to work. Furthermore, research participants may not have had experience with using maps on such devices. In fact, a later study showed some improvement in participants' travel speed and time spent stopped, possibly owing to users' increased familiarity with mobile maps (Field, O'Brien, and Beale 2011). Users' professed confidence in navigating with mobile devices (Wang, Park, and Fesenmaier 2012; Ricker, Schuurman, and Kessler 2015) may indicate that user-interaction designs are improving.

A second factor has less to do with the specific design of mobile maps than the form of attention that they require of the user versus a paper map. Wayfinding research has long illustrated that passive navigation practices make for poor geographic knowledge acquisition, facilitating simplified forms of geographic knowledge that are often focused on landmarks rather than a mixture of landmarks and other more complex features and connections (Held and Hein 1963; Parush, Ahuvia-Pick, and Erev 2007; Willis et al. 2009). In this way, mobile maps discourage users from thinking and learning about the area around them. As Willis, Hoelscher, Wilbertz, and Li argue: "A mobile map with automated position information (i.e., self-localization) essentially enables and possibly even encourages someone using it to stop active engagement and to become the passive receiver of information…" (2009, 108). Within that passive practice, what geographic knowledge mobile device users do retain tends to be based on landmarks. For example, in Münzer, Zimmer, Schwalm, Baus, and Aslan's (2006) study, research participants were asked to navigate between two points in an unfamiliar zoo using a paper map or a mobile device. Researchers tested participants' acquisition of spatial knowledge in terms of route knowledge, defined as a series of visual landmarks and impressions from a person's egocentric perspective, and/or as survey knowledge of the zoo's layout, a "map-like representation from an allocentric perspective" (Münzer et al. 2006, 301). After navigating the zoo, mobile device users scored markedly better at landmark-based route knowledge than survey knowledge, while paper map users scored substantially better than device users in both categories. Willis, Hoelscher, Wilbertz, and Li describe similar findings, concluding that "mobile map users acquire a more fragmented and regionalized knowledge representation based on strong connections between locally clustered landmarks along the route" (2009, 100). This tendency may be exacerbated by the ways that map readers tend to ignore task-relevant information in what they perceive on maps unless it is visually salient (Fabrikant, Hespanha, and Hegarty 2010). Mobile map use does not encourage users to develop complex schematic or configurational networked understandings of an area. Instead, landmarks are vitally important to mobile map users, even in device-assisted passive use.

Within wayfinding scholarship, landmarks are traditionally understood as external objects that are "easily identifiable" as a "point reference" (Lynch 1960, 78). Thus, an important question for wayfinding research is: what makes a geographic feature relevant and prominent enough to serve as a landmark? To answer that question, researchers have attempted to develop a comprehensive theory of what makes a feature sufficiently "salient" to be a landmark. Sorrows and Hirtle (1999) and Raubal and Winter (2002) propose a combination of visual novelty, cognitive meaning or cultural and historical importance, and spatio-structural centrality or connectedness. However, these proposals give relatively little attention to how or why a landmark accrues or loses cultural meaning, and therein salience, over time through its social and economic context. For example, Raubal and Winter categorized cultural and historical importance by scoring standardized formal qualities of aesthetic novelty. Others forgo such considerations entirely by focusing on wayfinding and geographic knowledge acquisition in decontextualized, purpose-built virtual environments (Bartie et al. 2015; Basiri et al. 2016; Hamburger and Roeser 2014). These approaches presume a static, always already existing form of landmark salience. Without accounting for the cultural production of landmarks and how their meaning changes over time, it runs the risk of overlooking landmarks that social and economic processes make meaningful, but that appear banal.

GEOGRAPHIC KNOWLEDGE PRODUCTION IN A SOCIAL, TECHNOLOGICAL CONTEXT

As Montello and Freundschuh (2005), Kitchin (1994), Brown and Laurier (2005), and Wilmott (2016) demonstrate, research on maps and their use can take many forms. Both cultural and cognitive geography research show the many potential forms of situated or contextually dependent, constructed geographic knowledges. However, most research thus far on how people use geographic services on mobile devices uses the conceptually limited framework of spatial knowledge acquisition: a universal, external set of generic geographic characteristics or features waiting to be imperfectly acquired and applied by research subjects. While findings on the limitations of navigating with the assistance of mobile devices and the importance of landmarks for wayfinding and navigation are valuable, these analyses categorically set aside many contextual considerations, overlooking how situated processes shape geographic knowledges. They do not consider who made the mobile map and why, and few consider what research subjects think of using the map.

Studies that focus on users' accounts offer additional considerations. When asked, mobile device users report increased confidence when navigating, meaning they may be more navigationally adventurous, at least in the right context (Wang, Park, and Fesenmaier 2012; Ricker, Shuurman, and Kessler 2015).[1] Using qualitative approaches, Speake (2014) and Axon, Speake, and Crawford (2012) demonstrate a strong preference among young people for mobile maps over paper maps and multiple accounts of feeling reassured by smartphone navigation and anxiety at the prospect of losing it. Their participants also saw the financial cost of devices as a significant downside to digital navigational tools.

Speake (2014) and Axon, Speake, and Crawford's (2012) findings about costs are singular in that they reference economic circumstances. The uneven nature of economic costs and related user concerns, as well as the business imperatives of the companies that offer mobile maps and smartphones, are factored out of assessments of landmark salience and spatial knowledge acquisition with mobile devices. Yet contextual social influences, such as the design and branding of mobile devices and maps, are significant in shaping users' feelings towards and practices with them. Approaching geographic knowledges as produced by subjects situated within social processes allows for consideration of these socially contingent factors. The subjects who produce their geographic knowledges with mobile maps do so from multiple situated, embodied standpoints across a broad, uneven constellation of races, ethnicities, classes, languages, and gender identities (Wilmott 2016; Graham 2015; Taylor 2015; Stephens 2013).

One shared aspect across these contexts is the role of the mobile map service provider. Technologies are designed to fulfill social purposes, not just for the end-user, but also the company offering the hardware or service. Users have some flexibility in what they do with a technology, or a

1. These studies were based on users' accounts, not observation of their practice.

map, but their actions are delimited by the built-in material structure created by the designer (Feenberg 1999; Thatcher 2017). Developers at Google and Apple design consumer-grade mobile map services and the map algorithms that prioritize which geographic features to symbolize (Graham 2005; Zook and Graham 2007a). Market forces drive the current development of geospatial technologies and media, including mobile maps (Dalton 2015; Thatcher, O'Sullivan, and Mahmoudi 2016; Alvarez León and Gleason 2017). As a result, there are stark differences around the globe and within many countries in the service provision of mobile maps and the extent of geographic data available (Taylor 2015; Graham 2015). Access to data describing an area is not guaranteed to produce a social good; navigational technologies can use data about an area in ways that are not positive for its inhabitants. For example, a technology patented by Microsoft attempted to utilize local data to route travelers around undesirable neighborhoods, reinforcing such areas' "ghettoized" status (Thatcher 2013).

The political economy of geographic data is an inescapable part of current mobile maps and associated user practices. The ultimate purpose of Google Maps is to advance Google's business strategy: providing a free-to-use service that fosters more and more web (and map) usage flowing through Google's servers, which in turn provides more user data that facilitates targeted advertising (Battelle 2005; Gundotra 2008; Hillis, Petit, and Jarrett 2012). Businesses are ideal points of interest to include on mobile maps because they are typically associated with a discrete street address, generally need to advertise (Dalton 2013), and users often wish to locate them. Finally, map services are a rich resource of location data, which is very valuable for targeting subsequent ads (Swift 2011). Consequently, Google offers maps that are materially designed to facilitate advertising, with geographic features that are practical and that also suit that focus. Zook and Graham (2007a; 2007b) have illustrated how companies shape the algorithmic selection of features on digital maps, particularly in search results. At an extreme, reliance upon this type of search-based navigation has been proposed as a type of "teleological navigation," wherein users only move through—and therefore come to know—environments in terms of end-point considerations for a particular trip (Sutko and de Souza e Silva 2011, 816).

Given the complex interplay between map designer, mobile interface, and the map user, understanding the role of economic processes in geographic knowledges that involve mobile devices requires us to consider the social contexts in which these maps are designed and used. As the scholarship on these technologies makes clear, these devices, services, and maps are designed by private companies to advance their business plan. Thus we cannot consider mobile map use in isolation from consumption. Businesses frequently show up on the map even when they are not the focus of the search. In the following sections, we analyze how users employed mobile maps to identify a location on the map in focus groups, revealing a strong reliance on a business point of interest—a particular Starbucks location—on the map. That branded point of interest serves as a landmark point of reference, perhaps because it is far more prominent on the map than it is on ground.

RESEARCH QUESTION AND METHODS

The popularity of mobile maps means it is important to consider how they impact their users' understandings of the geography around them. Research to date identifies serious drawbacks and complications to their use in terms of geographic knowledge acquisition, so it is important to focus on additional considerations: are technologically mediated social and economic processes also shaping users' production of geographic knowledges as they attempt to understand and communicate about geography, and in particular about landmarks?

To begin to answer this question, principal investigator Craig Dalton and a research assistant, Karen Wilwol, utilized a series of focus groups. The primary and original research aim of the focus groups involved users' conceptions of cartographic scale; the themes engaged here only emerged as we began to evaluate the data. Focus groups are used in both cartographic design/usability (Monmonier and Gluck 1994) and wayfinding (Axon, Speake, and Crawford 2012) research to explore and engage users' attitudes, understandings, and behaviors in larger numbers than individual interviews allow. The method allows direct questions (with follow-ups) that can be qualitative and open-ended, focusing on how and why. Furthermore, participants are not "on the spot" for the entire session, reducing pressure and possible intimidation and allowing researchers to observe how participants use maps on their phones and interact with each other when doing so. When conducting focus groups, it is vital to make sure that no single participant, or subset of participants—especially men—dominates the conversation. In this case, we took special care to make sure everyone had the opportunity to participate, repeating questions and sometimes posing them directly to each participant to ensure that all could respond if they chose (though it was not required). The focus groups themselves were video-recorded in a conference room and each lasted approximately one hour. Research participants were recruited from general education courses in the Department of Environmental, Geographical, and Geological Sciences at Bloomsburg University of Pennsylvania. They were required to own and bring a mobile device with at least one mobile map application. A total of 62 students participated, a number that is comparable to similar research studies (Axon, Speake, and Crawford 2012, n=46; Willis et al. 2009, n=24; Ishikawa et al. 2008, n=66; Münzer et al. 2006 n=64). Of the participants, 43 were women and 19 were men, and all were undergraduate college students in their late teens and early twenties. Each was given a $10 bookstore gift card for their participation. The thirteen focus groups ranged in size from three to six participants.

Most studies of the geographic use of mobile devices utilize a standardized device and map in an unfamiliar area to assess how participants learn and retain geographic knowledges using different media or design variables. In contrast, participants in our study used their own phone and a mobile map of their choice, to better reflect their actual everyday behavior. Most participants (81%) used iPhones and nearly all the rest had Android phones. All participants stated that they used either the Google Maps or Apple Maps applications, though we observed some participants mistaking the default (Apple) Maps application on their iPhone for Google Maps.

Each focus group involved general questions about participants' geographic use of mobile devices, two scale-related cartographic tasks accomplished with their phone, and questions about their actions with the phones and the results of the tasks. In the task relevant to the research we report here, we asked participants to locate the Bloomsburg University library in their preferred mobile map on their own smartphone. We observed their actions and how they engaged each other, and asked questions such as "How did you go about trying to locate the library?" and "If you located it, what makes you think you found the right place?" Focus group participants frequently talked in unprompted ways to one another about their phones, the map, and previous experiences as they performed the task, as they would in actual everyday practice. These conversations were recorded and included in the transcript of each focus group. Most Bloomsburg students already have a well-informed understanding of the campus and know where the library is located. The purpose was to better understand how they used their local experience to approach mobile maps on their own in an easy, low-pressure environment before proceeding to a more complex, scale-oriented task focused on preparing to navigate to an unfamiliar location.

Once we completed the focus groups, we transcribed them and coded the responses by task and topical theme. Given Münzer, Zimmer, Schwalm, Baus, and Aslan (2006) and Willis, Hoelscher, Wilbertz, and Li's (2009) findings, we also coded responses in terms of mentions and discussions of landmarks, sub-coded by which landmark, mentions of routes, and expressions of survey knowledge such as recognizing campus by the shape of the road network. Coding categories were not mutually exclusive. We also qualitatively engaged common themes expressed in the participants' accounts to understand their perspectives and what led them to say and do what they did.

RESULTS

Despite their familiarity with campus, the vast majority of participants used a search function to find the library, either within the mobile map application or by searching the web and then copying and pasting the name and/or address into the mobile map. A few started with their phone's GPS-derived current location and panned and zoomed over to the library.

When we asked participants what made them think that they had located the library correctly, 48 of the 62 (74%), including at least one person in each of the 13 focus groups, referred to landmarks of some kind, most often buildings or parts of buildings, some of which were auto-labeled. Thirty-five (56%), including at least one person in every focus group, provided information that indicated they possessed survey knowledge of the area, such as the organization of campus, or the structure of nearby streets. Thirty (48%) mentioned both landmarks and spatial configuration, including 86% of those who mentioned the spatial configuration. These results are somewhat consistent with Willis et al.'s (2009) conclusions that mobile device users have a tendency to understand space in terms of landmarks. While research participants were already familiar with the area (unlike in many similar studies), almost half did not mention spatial configurational knowledge. The most commonly referenced landmark was, unsurprisingly, the library, which was named in the task directions and questions.

Interestingly, the underlying social context of mobile mapping is apparent in the other landmarks participants referred to. By far the most commonly identified landmark, other than the library, was Starbucks, which has a

	Number (out of 62)	Percent of total
At least one landmark (including the library)	48	77%
Spatial configuration	35	56%
Both	30	48%
At least one mention of Starbucks	15	24%
At least one mention of a landmark other than Starbucks or the library	13	21%

Table 1. *Study participants' mentions of landmarks and spatial configuartions.*

Focus group	Number of participants	At least one mention of a landmark (including the library)	At least one mention of Starbucks	At least one mention of a landmark other than Starbucks or the library
1	5	4	0	1
2	4	2	0	0
3	5	2	0	1
4	4	3	1	0
5	6	3	3	2
6	5	3	1	1
7	6	6	2	1
8	3	2	0	1
9	3	3	2	2
10	6	6	1	1
11	6	6	3	2
12	5	5	1	0
13	4	3	1	1
Total	**62**	**48**	**15**	**13**

Table 2. *Number of participants who mentioned landmarks.*

franchise in a corner of the university library amidst multiple other notable features. Fifteen (24%) of the participants, in 9 of the 13 focus groups, referred to Starbucks, more than all the references to other landmarks on campus together other than the library itself. Other mentioned landmarks included other buildings and parking lots, though none were referred to frequently.

Qualitative analysis of research participants' accounts show that Starbucks-as-landmark served several roles. Participants referenced it most often as confirmation of the library's location when researchers asked what made participants think they had the right place:

> Even though it doesn't say [library], but I see the Starbucks symbol for it being inside of the library, so that's how I know that's where the library would be.

> I just scrolled over to see where it was from my location. The actual—on the Maps app, it doesn't say where the library is, it just says where Starbucks is, so from Starbucks.

Instead of using it as confirmation, one participant entered "Starbucks" directly as the search query.

> I searched for Starbucks because I knew that would probably come up faster than the specific library.

In several cases, Starbucks was such a strong point of reference that participants misidentified the library's location because they located the other Starbucks franchise on campus and assumed it was the library. That second Starbucks is on the other end of campus, near where Apple's Maps app pinpoints the university's campus-wide street address.

At least two participants, possibly more, caught that error.

> Well now I'm confused because I thought it was bringing me to the [library]. I had the Starbucks icon pop up as well, and I thought it was the Starbucks in the library, but then I saw the hospital now, so it's totally not.

> The pin is on the Starbucks that I think may be in the Commons? Because I know that the library is more up here. (*indicates where by pointing to phone*). Not down here… I know that the Bloomsburg Hospital is on lower campus, lower on the campus, and the library is up more.

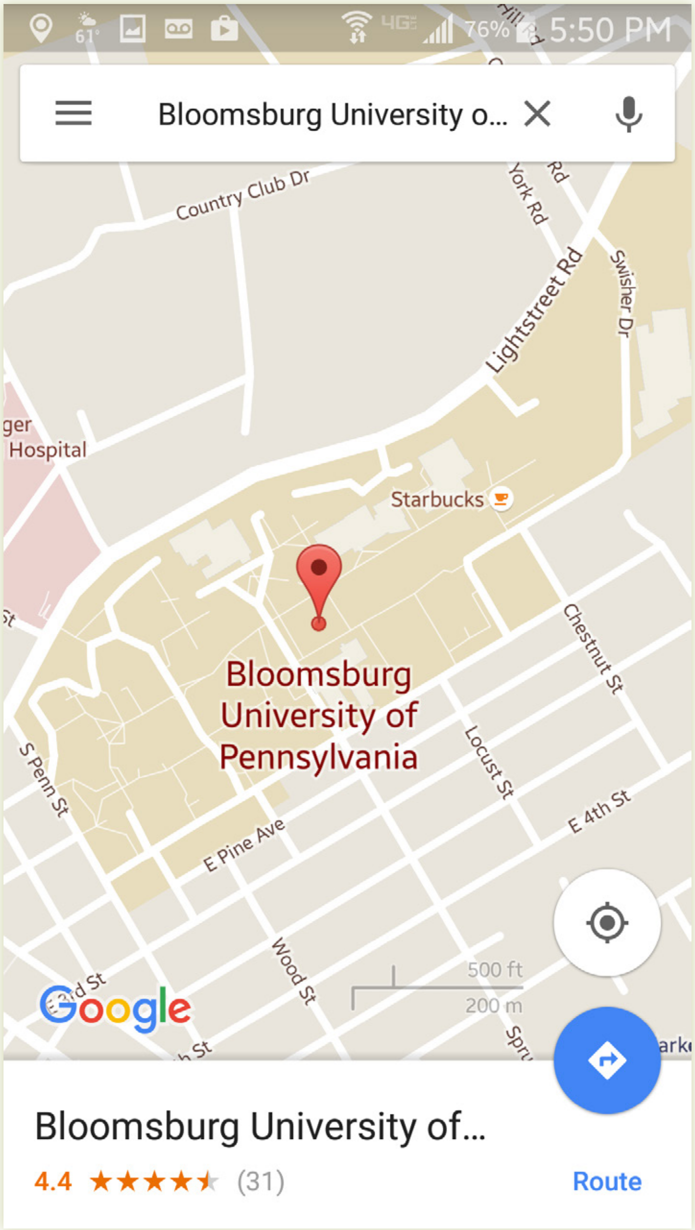


Figure 1. *Starbucks-as-landmark in the Google Maps mobile app.*

Researchers also observed two other participants who didn't catch the error, and there may have been more; exact numbers are difficult to determine because participants may not have admitted or even known they had the wrong location, at least initially. While there did not appear to be many cases of misidentified Starbucks locations, it is noteworthy that such a problem is even possible and

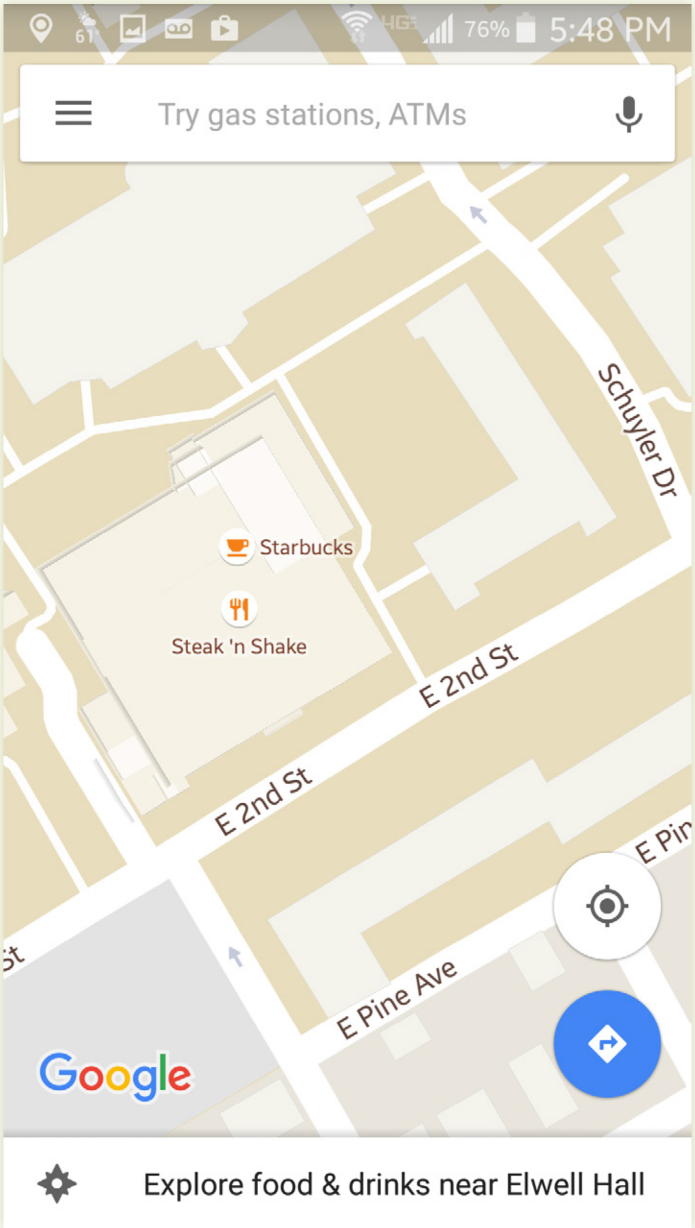


Figure 2. The other Starbucks on Bloomsburg University's campus in the Google Maps mobile app.

was common enough to appear repeatedly across multiple focus groups in a study of this size.

STARBUCKS' SALIENCE

Of all the non-library features on Bloomsburg University's campus, Starbucks appeared most often as a conceptually salient landmark for students using mobile maps. While this study used a location-finding task, not a wayfinding task, it does align with the findings of Münzer et al. (2006) and Willis et al. (2009) on the significance of landmarks for mobile map users. Given the prominence of the Starbucks point of interest on the maps, this is also consistent with Fabrikant, Hespanha, and Hegarty's (2010) findings that, when presented with salient map features, map readers may ignore less conceptually salient, but still task-relevant information such as the spatial configuration of streets or building footprint outlines.

Employing an open-ended, situated approach focused on knowledge production allows us to highlight a new consideration: the potential impact of contextual social processes in making some features more conceptually salient than others. Many study participants used Starbucks as visual confirmation and one even specifically searched for it to locate the library. Furthermore, a large majority of research participants used a search function to locate the library, as opposed to panning and zooming. This indicates a reliance on the search function even when it is neither strictly necessary nor efficient. It also stands in contrast to the panning and zooming vision described by Kingsbury and Jones (2009) for Google Earth. In that formulation of Google Earth, the ability to move around the digital map virtually offers a playful, Dionysian contestation of the top-down, hegemonic vision implied by global mapping. Here, despite having this ability, users engaged with digital maps as banal tools for accomplishing a specific (prompted) task. Relying on search reinforces the power of algorithmic place-ranking (Zook and Graham 2007a) and technologically focuses on point-locations. This point-oriented geographic practice fits with and facilitates the landmark-orientation of participants' geographic knowledges, bypassing the surrounding spatial configurations that may be seen through panning and zooming across the map.

It is clear why Starbucks is conceptually salient for participants. It is a well-known entity on campus and a common meeting place, identifiable to and frequently visited by many in the community. However, Starbucks is not alone in these qualities. Several other sites, including other food franchises, the student services center, dining halls, and the student union also enjoy that status. There are even several comparable geographic features or meeting places next to or within the library, including the library lobby/lounge, outdoor benches and tables, sculptures, a fountain, and the campus quad. What was different about Starbucks in this context was its prominence as a point of interest on both the Google Maps and Apple Maps mobile applications.

At the time of this research, Starbucks was the only point of interest to consistently appear on the Google Maps application with both an icon and a label at the auto-zoom level of search results for "Bloomsburg University" and the library, aside from a placemark for the search results themselves (see Figure 1). Both the coffee icon and the Starbucks label also appeared when participants panned and zoomed to see the entirety of BU's lower campus. Other business and university landmarks appeared when users zoomed in further. Similarly, in the Apple Maps search results and panning/zooming, the other Starbucks franchise on the opposite end of lower campus (the location mistaken for the library by some participants) was the only location with a label and an icon, aside from a point of interest for the university as a whole. Zooming in on Apple Maps revealed only a redundant generic Bloomsburg University icon and additional businesses near campus. These features appeared across multiple research participants' devices, indicating a general design that was not presenting individually tailored points of interest, which both Google and Apple provide to users at times. Alternatively, Google and Apple may have been tailoring their maps to all focus group participants in the same way possibly because they were connecting via the university's network or companies identified them all as associated with Bloomsburg University.

POINTS OF INTEREST AS LANDMARKS

Research participants' use of Starbucks as a landmark point of reference cannot be entirely explained by traditional theorizations of landmark salience such as visual novelty, cultural or historical novelty, formal aesthetic quality, or geographic connectedness (Sorrows and Hirtle 1999; Raubal and Winter 2002). This Starbucks franchise is not visually notable in the landscape, lacking even exterior signage. Neither is it historically noteworthy nor culturally unique. Its location is on the back end of campus, near but not on several major campus paths. It is a frequent meeting place on campus, imparting it some cultural importance in the campus community, but it is only one of several such places, even in that immediate vicinity.

Starbucks' salience does fit neatly with the prominence of business-type features in web maps (Zook and Graham 2007a; 2007b; Dalton 2013). Due to the size of worldwide mobile map datasets, points of interest are selected for display through automated, algorithmic processes. Multiple studies have reported on the development of such processes, though without business-oriented considerations in the algorithms' design. Strategies include systematic rating of photographs for semantic characteristics; crowd-sourced volunteered geographic information; and scraped social media data, such as geolocated tweets and Foursquare check-ins (Binksi, Zhang, and Dalyot 2016; Quesnot and Roche 2015; Zhu and Karimi 2015). The extent to which Google or Apple employ similar methods is harder to know. These companies keep their algorithms for choosing points of interest as trade secrets, akin to the code that prioritizes search results. What outside researchers can know is, first, what companies say about how they design map services to serve their business strategies, and, second, the outputs that those map services provide.

A GEOGRAPHIC BUSINESS STRATEGY

As private companies, corporations like Google and Apple are driven to design technologies—including maps and geographic algorithms—that advance each company's business strategy, though that process is not as simple as prioritizing businesses that pay for ads. Instead, it reflects a broader strategy of collecting geographic data cheaply from a variety of sources and emphasizing features that potentially provide economic value. Google, for example, makes the lion's share of its revenue by collecting data from users and using that data to target advertisements to them. Google's and Apple's capital imperatives drive the collection of cheap, publicly available geographic datasets and the design of algorithms that pull information from those datasets. Crucially, however, showing businesses that might advertise with Google is only one part of Google's comprehensive business strategy. Broadly speaking, Google attempts to make as much information as possible searchable and usable online, including geographic data. Increasing the total amount of usable online information increases the amount of data that is commercially valuable for their targeted advertising business, as well as increasing the use-value of Google (or Apple) services for users (Battelle 2005; Gundotra 2008; Hillis, Petit, and Jarrett 2012). More useful data make for more successful uses of the company's services, providing consumers a good reason to use same services again and again, becoming a technological ritual practiced many times a day. At least some of these uses are commercially relevant, even if the initial use was not (Hillis, Petit, and Jarrett 2012). Moreover, on a technical level, businesses are easy, and therefore cheap, points of interest to include in map datasets, for they must have registered, point-based street addresses. Culturally significant locations, such as monuments or nature preserves, may not.

Given this general strategy, even if the Starbucks location on campus doesn't buy ad space, the map application as a whole is structured around data that bear street addresses, such as businesses and residences. Much like Google's internet search results and their associated ads, the map application and the points of interest it presents are structured around regular, everyday use and the presumption that at least some of those uses can be monetized with advertising, even if the search location hasn't been connected to an ad thus far.

MAP SERVICE OUTPUTS

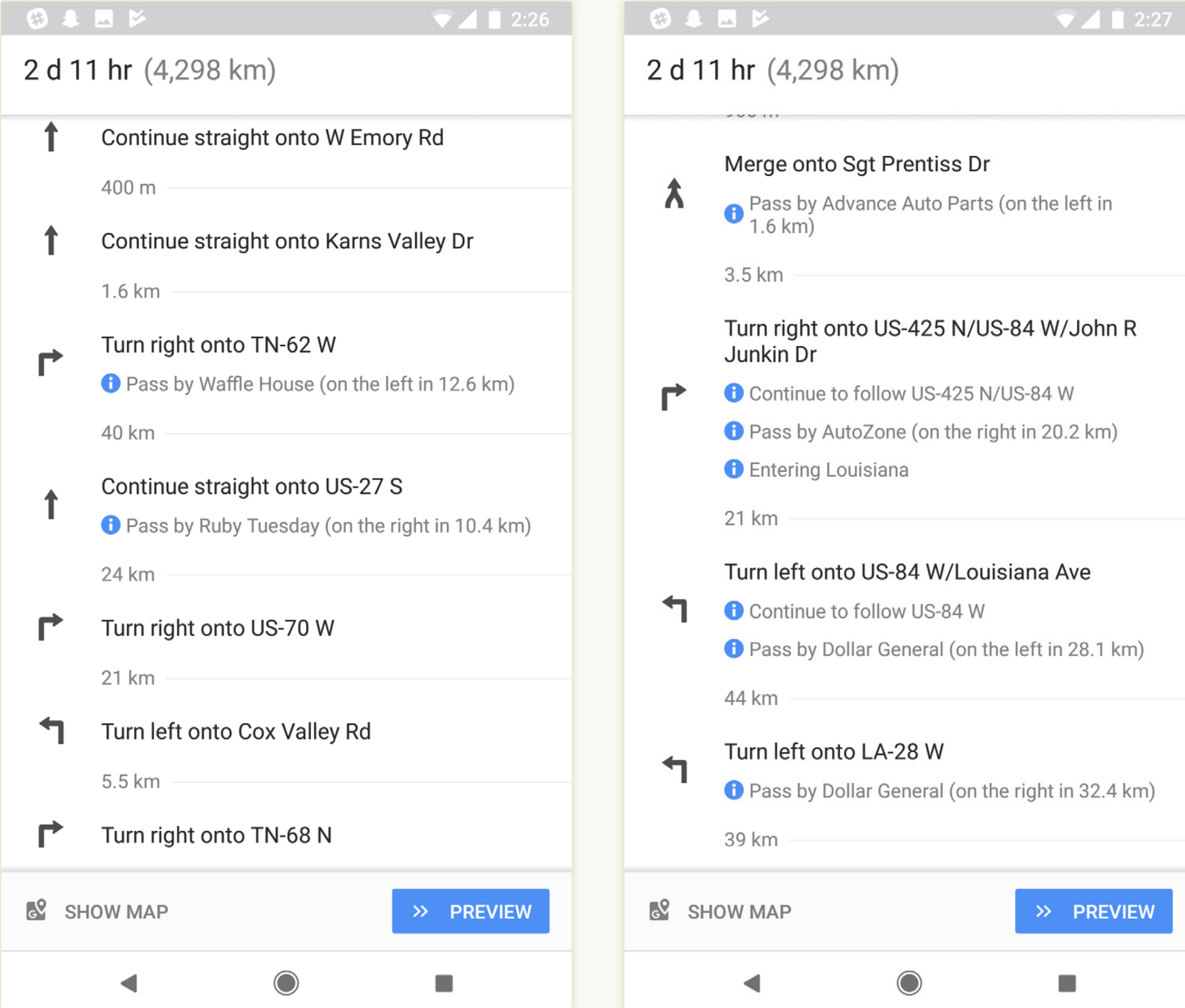
While the specific mechanisms by which Google's and Apple's business strategies are implemented in code are secret, we can examine the outputs of those processes on public-facing map services in the form of search results, points of interest, and the maps themselves. Existing research demonstrates the centrality of businesses to Google Maps, particularly in the context of ranking algorithms, de facto urban racial segregation, third-party software developers, and geodemographic targeting (Zook and Graham 2007a; Crutcher and Zook 2009; Dalton 2015; Thatcher 2017).

This emphasis on businesses is also apparent in the points of interest symbolized and labeled on the maps of Bloomsburg University. At the time of research (early 2015), Starbucks was the most prominently marked point of interest on the Google Maps mobile app, but a user could also zoom in to see a label and icon for the Steak 'n Shake franchise, two snack bars serviced by Aramark, the library, the bookstore, the campus police office, two stadiums, a point of interest for the university as a whole, a mislocated Western Union franchise, and the private hospital next door. Apple Maps shows fewer points of interest, but in a similar vein. From the standpoint of someone finding their way around campus, there are hundreds of potential landmarks including dining halls, the student center, dorms, academic buildings, administrative buildings, the university's performing arts center, unique architectural features, monuments, sculptures, fountains, picnic areas, emergency phones, and—most significantly—the campus quad.

Another map-based mobile application, Pokémon Go, provides a useful counterpoint to what kinds of features can appear as points of interest on a mobile map. Unlike Google or Apple Maps, Pokémon Go is a location/map-based game, which includes in-game features, "Pokéstops," at noteworthy, real-world locations. Initially, those locations were derived from databases of culturally significant sites and crowdsourcing. Locations tended to be post offices, monuments, churches, unusual architectural features, and even graffiti art. Unlike Google Maps, the game is not designed to facilitate finding and navigating to businesses. Relatively few businesses appear in the game and those that do are often well known and locally owned. At Bloomsburg University, this differing set of priorities is immediately apparent in the game, as most Pokéstops on campus are public art pieces. As of July 2016, almost none of the important sites in Pokémon Go appeared as discrete points of interest in Google Maps or Apple Maps. More recently, however, the game has begun to include "sponsored" location features, including Sprint Mobile stores and Starbucks (Perez 2016).

After we conducted our focus groups, Google announced that it would begin putting "promoted places" advertisements on its mobile device maps, including brand logos for Walgreens and Starbucks (Marvin 2016). Other, smaller geographic technology companies that provide business reviews and ratings, such as Foursquare and Yelp!, have long employed such cartographic advertising strategies. Similarly, location-based ads are common in non-cartographic applications including other Google services, Facebook, Snapchat, Lyft and many other mobile device applications, because location is thought to be a very strong predictor of a user's consumer preferences (Swift 2011). Until recently, ads within the map view itself were uncommon in general-purpose web maps from Google and Apple. In practice, these changes mean that advertisements will appear in Google Maps at the location of that business, even if they are irrelevant to the user's search terms. For example, if someone were to search for "Bloomsburg Park," the Starbucks logo and/or name would still appear on the map.

In addition to placing ads directly on maps, in 2018 Google began to test incorporating points of interest as



Figures 3 & 4. *Business locations used as landmarks in Google Maps directions.*

points of reference in its turn-by-turn directions. Such landmarks appear both as waypoints along a route and turning points in both the written and audio directions in the United States. If someone were following Google Maps' turn-by-turn directions, the map application might say "turn right at the McDonald's" instead of "in a quarter-mile, turn right." Of those points of interest that we observed or that have been reported as being used as landmarks in turn-by-turn directions, all have been chain businesses, including: Bank of America, AutoZone, Pet Valu, Rite Aid, Liberty Tax Service, Dollar General, Sleep Inn & Suites, Chipotle, McDonald's, Pizza Hut, and, inevitably, Starbucks (Ihnat 2018; Dickey 2018).

Through map services designed to serve Google's and Apple's business plans, the Starbucks in the Bloomsburg University library became a cartographically prominent point of interest. For many research participants, that prominent point of interest served as a landmark, connecting the map to their experience, confirming their understanding of the area and allowing them to find the library. As points of interest become used as landmarks, they may shape users' ways of seeing, producing geographic knowledges that are functional, but that are also shaped by the business plans behind the maps they use. Starbucks may have been a noteworthy place for students before they looked at the map. Once they use the map, however, it becomes a landmark point of reference with which to connect their experience, particularly due to the limited number of other features that appear. Participants' geographic knowledges "are not stable entities, but are dynamic: constantly changing and evolving" (Kitchin 1994, 6; Webber, Symanski, and Root 1976). Research participants' use of and repeated spoken references to Starbucks both indicate that their knowledges are being (re)produced in the map's terms, in part reflecting the business priorities of the mapmaker.

CONCLUSIONS

It is safe to assume that branded businesses have long served as landmarks in both locating places and wayfinding practice. The role of such locations as landmarks on mobile maps constitutes something deeper. Starbucks appears alone on the map, which has the effect of reifying and strengthening Starbucks-branded locations as landmarks. Given the hundreds of millions of mobile map users, these sorts of landmarks and the social conditions that created them are now part of the production of everyday geographic knowledges.

Social context matters in analyses of map use and geographic knowledge. Political economic processes are influential, defining the purpose for most mobile maps and leading developers to design maps that function in some ways and not others, that prioritize certain kinds of features at the expense of others. Down the line, that purposeful design limits a user's point-of-reference options when reading the map. In this case, the business imperative underlying the design of the Google Maps and Apple Maps applications prioritizes business points of interest. In practice, as users connect their personal experience with the map, potential landmarks are thus likely to be businesses, shaping how their geographic knowledges are produced and, potentially, their actions.

Cognitive and cultural geographic approaches that conceptualize geographic knowledges as contextual have a great deal to offer research on mobile device use. Without approaching mobile map users and their knowledges as situated amidst powerful, ongoing social processes, we would have overlooked the role of companies in shaping the design of mobile maps and not seen the importance of Starbucks as a landmark among research participants. Taking a situated approach to understanding the geographic uses of mobile devices offers new insights and opens navigational questions as a productive field for data scholarship.

On a societal level, it seems likely that the prevalence of businesses as landmarks will become more common. Mobile phones and maps are already key data sources in smart city projects (Kitchin 2014), which poses questions about privacy and the commodification not only of data, but also people's individual movements. As Google's preliminary use of point of interest landmarks makes clear, companies are increasingly focused on providing turn-by-turn directions based on landmarks (Duckham, Winter, and Robinson 2010; Ihnat 2018; Dickey 2018). The next logical step is placing location-based ads within directions. Much like ads on the map, businesses could pay to place an advertisement within your directions whenever you happen to be driving by a franchise.

Given the focus of mobile map users on landmarks, these directions might facilitate more effective wayfinding. Nevertheless, such a system would also facilitate advertising branding strategies that bank on repeated encounters with a name or logo, even if there were no explicit sales pitch. It could also cause navigational problems when a business closes, disappearing from the landscape but persisting in the turn-by-turn directions. Finally, it raises issues involving the uneven nature of markets and subsequent mapping. Would such maps favor chain businesses over local shops (Zook and Graham 2007a)? Will such geographic knowledges perpetuate the digital divide in poorer neighborhoods and poorer countries? Areas with less data and fewer businesses might be harder to navigate. Some might be avoided altogether as in Microsoft's notorious "avoid the ghetto" application (Thatcher 2013). Whatever the outcomes, analyzing the production of geographic knowledges through mobile technologies will be important to knowing how we see and understand the world around us.

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PEER-REVIEWED ARTICLE

"Mapping-with": The Politics of (Counter-)classification in OpenStreetMap

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In this paper I consider how debates in critical cartography about the classificatory and calculative logics of the map might be renegotiated through the concepts of "making-kin," "sympoesis," and the chthonic. Between Haraway's (2014) Staying With The Trouble *and Foucault's (2002) writings on* mathesis *and* taxinomia *in* The Order of Things, *I argue that a more situated understanding of mapping—as an entanglement between people, tools, landscapes, cultures—might realise a more open, and more attentive, way of mapping. I return to the popular case study, OpenStreetMap, to excavate how the use and misuse of taxonomic and mathematical logics through its collaborative and amateur affordabilities shed light on different ways of sorting-with the world. I argue that, in the unexpected emergence of proposed classifications (and despite the disciplining power of cartographic discourses), roots of a new and more inclusive cartography linger in the archive, waiting to be fertilised.*

KEYWORDS: mapping; critical cartography; digital geography; counter-mapping

THE TROUBLE OF MAPPING

In the introduction to *Staying With the Trouble*, Donna Haraway (2016) asks us to "make kin" in turbulent times. As Western structures of knowledge and space are undergoing a global liquefaction, neither technological panaceas, apocalyptic imaginaries, nor critical fatalism are privileges afforded to those who have something at stake in our combined futures. "The task," she argues, "is to make kin in lines of inventive connection as a practice of learning to live and die well with each other in a thick present" (Haraway 2016, 1). "Making kin" requires us to stay with the trouble, to map with, rather than against, complexity and paradox, and to understand ourselves as "mortal critters entwined in myriad unfinished configurations of places, times, matters, meanings" (Haraway 2016, 1). This approach requires a timely re-encounter with the study and practice of cartography as it becomes increasingly awash with critical debate over the production of spatial knowledge (Elwood and Leszczynski 2013).

As such, this short article is an attempt to stay with what Matt Wilson (2017) has called "the trouble of the map," or, as I prefer, the "trouble of mapping." While the "trouble of the map" takes up the politics and economies of representations—criticality, digitality, movement, attention, and quantification—staying with the trouble of mapping requires us to return the murkiness of representing as an active engagement with, in, and of the world. There is a crucial distinction here: if the trouble of the map might be understood as the trouble of the sign, the trouble of mapping is the trouble of arranging, translating, and negotiating, as mappings draw knowledge into, through, and from the world. Moving away from the object (the map) or the subject (the mapper), we might instead follow a path that Massey (2005) has previously called "coformation," and which Haraway (2014) terms "sympoesis." This radical framework of "sympoesis" emphasises the politics, but also the potential, of "becoming-with" other processes, animals, people, materials, concepts, and matter in what she calls a "compost."

Thus, in this article, to stay with the trouble of mapping is to resituate cartographic practices on the disturbed ground of ongoing debates (Leszczynski 2009), and to re-embrace the tools of cartographic classification and calculation that we find there. Hence, the trouble of mapping is to be found in the trouble of arranging relations between things—whether physical or social objects, landforms, lines on a page, or pixels on a screen. In terms of mapping, this means reconnecting and reinvigorating old representational alliances with lines, numbers, and names, while mapping-with new digital capabilities and tools. Often, these arrangements are seen as "god tricks" (Haraway 1998), where powerful mappers are cast as puppeteers above the stage, arranging the limbs of the world into strange and absolute cartographic choreographies. Counter-mappers turn the tools of cartography towards uprooting this power, realising the potential of mapmaking for political resistance (Peluso 1995) through counter-mapping (Counter Cartographies Collective 2012), participatory mapping, and volunteered geographic information (VGI; Elwood 2008). Yet, critical cartographers have suggested that cartographic tools—the calculative and classificatory logics underpinning the scientific authority of the map—are interminably and politically flawed, drawn as they are from an Enlightenment desire for absolute objectivity and universality. Both the stances of the counter-mappers and the critical cartographers have their drawbacks—between necessary evils and stuck-in-the-mud constructivism—and so the maps with which we live are at once emancipating and confining. Rather than trying to escape this conflict or constantly revisit, as Leszczynski (2009) writes, an ontological impasse, I argue here that perhaps this trouble—as compost between people, environments, and meanings—might instead be fertile ground for rethinking what counter-mapping, and digital mapping more generally, could be.

By unpacking the theoretical work of Donna Haraway, I also argue for a return to the critical potential of feminist science and technology studies within cartography, signposted by the ongoing work of feminist and queer geographers such as Pavlovskaya (2018), Giesking (2018), Leszczynski and Elwood (2015), and Kwan (2007)—not simply as a tool for a feminist critique, but a way of remaking worlds, rather than just remaking maps. That mapping has troubles is not a new argument: significant empirical research has been undertaken documenting and advancing our understanding of the technopositional (Wilson 2017), tacit (McHaffie 2002), institutionalised (Gekker 2016), and politicised (Thatcher and Imaoka 2018) practices undertaken by cartographers, educators, and geographic information scientists. Furthermore, that the politics of mappings are based in situated knowledges (Wilmott 2016), embodied (Lin 2006), vernacular (Gerlach 2015), and taken up in the everyday (Del Casino and Hanna 2005) is also well documented within cartographic research. The tension between the role of classification and classificatory logics embedded in top-down GIS practices and the (counter-)classifications (re)produced by publics has also been described as a complicated translation between scientific and lived knowledges which, through mapping, challenge the assumptions often made invisible in cartographic processes (Cidell 2008). What I seek to do in this article is make a theoretical argument that trouble provides us with alternative foundations—diffractive fix-points, if you will—for counter-mapping, and that the potential of these for what O'Sullivan (2006, 783) has called a "critically informed GIS" is powerful. This is supported by Haraway's arguments about feminist entanglements with technology since *A Manifesto for Cyborgs* (1985), which present an ongoing campaign to build "ironic political myth[s]" (65), to make "an argument for *pleasure* in the confusion of boundaries and for *responsibility* in their construction" (66), beyond a positivist/post-structuralist dichotomy. In the context of cartographic science, this means not only to recognising and critiquing mapping's troubles, but to embrace and take pleasure in cartographic confusions as productive tools to find different ways of making worlds—scientifically, socially or otherwise.

To do this, I return to a classic question in the digital cartography canon: the case study of OpenStreetMap (OSM). Understanding OSM as sympoetic is to see a muddle of alliances across material-semiotic landscapes, rather than a battlefield or a poisoned chalice. While some scholars have lauded OSM for its role in producing a democratising "neogeography" (Goodchild 2009), others have been cautious of the power which it affords, inscribes, and reinscribes (Haklay 2013). Yet, even though the politics of the tools of OSM are embedded in the necessities of scientific communication—specifically, classification—their enactment is deeply political, dependant on translations between the semiotic and the material (Glasze and Perkins 2015), as well as the ethical (Gerlach 2010). Thus, where some politics in OSM might be powerfully fixed (Perkins 2014), others might also mobilise at the margins and in the fragments. The task before us, then—to stay with the trouble of mapping—is wilfully optimistic. "Mapping-with" is to understand cartography as deeply political, but also not necessarily weighed down by its power. Rather, mappings are inventive arrangements between digital tools, social forces and diverse landscapes. Staying with the trouble of mapping, then, is negotiate the ethics of rendering and arranging between signs and senses, marks and matter, and to recognise that we can and do have some power over our cartographic entanglements.

MAKING KIN WITH MATHESIS AND TAXINOMIA

Like most (or perhaps all) digital mappings, OpenStreetMap is founded on calculative and classificatory logics (Crampton 2011)—or, in Foucault's (2002) terms, *mathesis* (mathematics) and *taxinomia* (taxonomy). These twin logics are crucial cartographic arrangers, producing nests of order and hierarchies at the level of representation and scientific abstraction. As Foucault states:

> *Mathesis* is a science of equalities, and therefore of attributions and judgements; it is the science of truth. *Taxinomia*, on the other hand, treats of identities and differences; it is the science of articulations and classifications; it is the knowledge of beings. (Foucault 2002, 81)

Mathesis and taxinomia are dangerous ideas—partly because they are old ideas—but mostly because of the way in which they have been purposed in colonial and capitalist agendas to undermine situated knowledges or erase them entirely. The trouble with mathesis and taxinomia is that within them they contain the desire to eliminate contradictions and paradoxes—to become a universal system of knowledge, based on numbers or classifications, somewhere between philosophy and empiricism. However, while mathesis occupies a theoretical realm of pure, objective mathematics, for Foucault (2002), it is in taxinomia that the abstraction of mathematics becomes applied to the material or lived world. Thus, where mathesis asks *how*, taxinomia asks *what*. Taxinomia—the process of classifying—orders objects, ideas, and lives into discrete objects and hierarchies. Sorting though, gathering, and tying together, the process of taxonimising inscribes what kind of object or being is coherent, repetitive, and regular enough—both on a material and a conceptual plane—to exist. At what point does a street become a path or a road, and what colour should it be on the map? These questions of classification are at the crux of mapping. While capitalist-colonial, and, increasingly, digital cartographic enterprises have tended towards cohering the world into generalisable systems of (sometimes worldwide) classificatory representation (Ryan 1996), indeterminate landscapes do not always adhere well to the categories imposed upon them. With the increased interest in more participatory forms of mapping (such as "neo-geography," participatory GIS, counter-mapping, etc.) and the cartographic tools used to enable them (such as OSM) these categories become further muddied. In part, this is because the cartographic gaze—which Wilson (2011) describes as a triad between perspective, projection, and accuracy—is now composed of multiple experiences, from multiple mappers who map with multiple purposes in mind.

Much like the relationship between ghosts and hauntings (Gordon 2008), the map is merely the sign that a mapping has taken place. Mappings are material-discursive (Barad 2007): matter and meaning entangled; form and function hybridised. As cartographic (infra)structures become more complex, and mappings are mapped-with more and different people, tools, landscapes, and knowledges, more *oddkin* join the muddle. The kinships formed by *oddkin* are unexpected collaborations, required in order to exist, and which accord mutual responsibility for both how these entanglements occur, and to whom they are accountable: "We become-with each other or not at all" (Haraway 2016, 4). In digital entanglements, oddkinships become more complicated: objects and subjects are muddied as agency is dispersed across algorithms, machines and IT critters (Haraway 2016, 32), and questions about who the mapmakers might be are transformed into questions about human-technology relations and cyborg cartographies. Here, in OSM, the politics of mapping refracts in unexpected ways, deep in the chthonic vaults of data, instruction manuals, wikis, proposals for features, redrafts, expansions, and updates (Perkins 2014). OpenStreetMap has over one million contributors. Through this single platform, millions of lives and localities come into contact, creating frictions between the universal classificatory system of OSM, the more particular knowledges of desk-based mappers working with satellite imagery, and the specific situated knowledges of the mappers who have traversed or live in the landscape. Along with computers, cameras, images, GPS devices, and landscapes, these sets of oddkin enter into negotiation over the terms of mapping through what should and should not be expressed on the map (features) using an ever-changing collection of "tags."

At the time of this writing in 2019, there were at least 3,048 tag descriptions in OpenStreetMap (Figure 1). A brief overview of the tag set for what OSM calls *highways* reveals a surprising number of distinct classes, including motorways, trunks, primary roads, service roads, pedestrian highways, raceways, and even bridleways—with clear rules and descriptions for each. How—and where—these tags should be applied by individual mappers is outlined in exacting detail. For instance, the `highway=motorway` tag specifically delineates:

> a restricted access major divided highway, normally with 2 or more running lanes plus emergency hard shoulder. Equivalent to the Freeway, Autobahn, etc. (OpenStreetMap Wiki, n.d.)

Here, the specificity of the classification rests on the highway's controlled access and, generally, its size. Of course, while this gives a general impression of how we might conceptualise and apply `highway=motorway` to controlled-access highways across a variety of landscapes (i.e., between the USA, Germany, Australia, and Canada), there are also some important cultural, social, economic, historical, and indeed, governmental distinctions about how this class of roads might be integrated into their specific situated locales—as Merriman's (2007) cultural history of the M1 in the United Kingdom suggests. Similarly, `highway=livingstreet` (a space that prioritises pedestrian or cyclist activity) has multiple iterations across languages and cultures as a "shared space," "home zone," "*zone residentielle*," etc. The original Dutch term *woonerf* becomes translated and reified into English as "living street," but in doing so, the elements of cultural specificity in the Dutch context are erased from the map, and so too is the lineage of the turn away from automobile spaces towards residential shared zones (and their history in Dutch urban design, canal networks, and architecture; see Guttenberg 1982).

Pages in category "Tag descriptions"

The following 200 pages are in this category, out of 3,048 total.

(previous page) (next page)

A

- Tag:abandoned=yes
- Tag:abandoned:amenity=prison
- Tag:abandoned:amenity=prison camp
- Tag:access=customers
- Tag:access=designated
- Tag:access=exclusion zone
- Tag:access=license
- Tag:access=no
- Tag:access=official
- Tag:access=private
- Tag:access=restricted
- Tag:actuator=electric motor
- Tag:actuator=hydraulic cylinder
- Tag:actuator=manual
- Tag:actuator=pneumatic cylinder
- Tag:admin level=2
- Tag:advertising=billboard
- Tag:advertising=board
- Tag:advertising=column
- Tag:advertising=flag
- Tag:advertising=poster box
- Tag:advertising=screen
- Tag:advertising=sculpture
- Tag:advertising=sign
- Tag:advertising=tarp
- Tag:advertising=totem
- Tag:advertising=wall painting
- Tag:aerialway=cable car
- Tag:aerialway=canopy
- Tag:aerialway=chair lift
- Tag:aerialway=drag lift
- Tag:aerialway=gondola
- Tag:aerialway=goods
- Tag:aerialway=j-bar
- Tag:aerialway=magic carpet
- Tag:aerialway=mixed lift
- Tag:aerialway=platter
- Tag:aerialway=pylon
- Tag:aerialway=rope tow
- Tag:aeroway=taxilane
- Tag:aeroway=taxiway
- Tag:aeroway=terminal
- Tag:aeroway=windsock
- Tag:airmark=beacon
- Tag:ale supply=limited
- Tag:allotments=plot
- Tag:amenity=administration
- Tag:amenity=advertising
- *Tag:amenity=alm*
- Tag:amenity=animal boarding
- Tag:amenity=animal breeding
- Tag:amenity=animal shelter
- Tag:amenity=animal training
- Tag:amenity=architect office
- Tag:amenity=archive
- Tag:amenity=arts centre
- Tag:amenity=artwork
- Tag:amenity=atm
- Tag:amenity=audiologist
- Tag:amenity=baby hatch
- Tag:amenity=baking oven
- Tag:amenity=bank
- Tag:amenity=bar
- Tag:amenity=bbq
- Proposed features/Bell
- Tag:amenity=bench
- Tag:amenity=bicycle parking
- Tag:amenity=bicycle rental
- Tag:amenity=bicycle repair station
- Tag:amenity=bicycle trailer sharing
- Tag:amenity=biergarten
- User:Mackerski/Tag:amenity=bikeshed
- Tag:amenity=bird bath
- Tag:amenity=boat rental
- Tag:amenity=boat sharing
- Tag:amenity=boat storage
- Tag:amenity=brothel
- Tag:amenity=bts
- Tag:amenity=bureau de change
- Tag:amenity=bus station
- Tag:amenity=crematorium
- Tag:amenity=crucifix
- Tag:amenity=crypt
- Tag:amenity=customs
- Tag:amenity=dancing school
- Tag:amenity=dead pub
- Tag:amenity=dentist
- Tag:amenity=device charging station
- Tag:amenity=disused
- Tag:amenity=dive centre
- Tag:amenity=doctors
- Tag:amenity=dog bin
- Proposed features/Dog Poop Area
- Tag:amenity=dog toilet
- Tag:amenity=dog waste bin
- Tag:amenity=dojo
- Tag:amenity=dressing room
- Tag:amenity=drinking water
- Tag:amenity=driver training
- Tag:amenity=driving school
- Tag:amenity=dryer
- Tag:amenity=education
- Tag:amenity=embassy
- Tag:amenity=emergency phone
- Tag:amenity=events venue
- Tag:amenity=ev charging
- Tag:amenity=exhibition centre
- Tag:amenity=fast food
- Tag:amenity=feeding place
- Tag:amenity=ferry terminal
- Tag:amenity=festival grounds
- Tag:amenity=financial advice
- Tag:amenity=fire hydrant
- Tag:amenity=fire station
- Tag:amenity=fish spa
- Tag:amenity=food court
- Tag:amenity=fountain
- Tag:amenity=fridge
- Tag:amenity=fuel
- Tag:amenity=gambling
- Tag:amenity=game feeding

Figure 1. *A sample of tag descriptions for the letter "A" from the OSM wiki, 2019.*

The argument that cartography is a homogenising force states that, when situated knowledges are stretched into platforms like OSM through *mathesis* and *taxinomia*, the bespoke and the unique (like the *woonerf*) are gradually erased (Pickles 2004). As global mappings with global datums emerge, knowledges that are exterior to popular or dominant ways of thinking become subjugated, eviscerated, or suppressed (Foucault 2003). Hence, universality comes to its position as a dominant, hegemonic desire. The critics of the truly emancipatory power of participatory GIS make their arguments here (Perkins 2014). Certainly, the opening up of mapping to the amateur, the public, the citizen, and the counter-mapper through participatory and collaborative projects has, to some degree, challenged more "traditional" cartographic authority over spatial knowledges (Liu and Palen 2010). At the same time, it is also true that these new, more open, cartographic tools and platforms also demand an adherence to their own pre-determined rules and hierarchies of classification—places, features, objects, attributes, tags, nodes, etc.—that are dominated by the collaborators' most common needs, perceived universalities, and cartographic traditions (Haklay 2013).

At the same time, situated knowledges are not entirely erased from the process of mapping, even where they may disappear from the map. In the friction between global systems of classification and local contexts (with their historical, geographical, and cultural specificities), the trouble of mapping percolates in both the drawing of the map and the reading of the map. In the first instance, a two lane country road linking two towns, with no verge and a moderate speed limit, might be translated into either `highway=primary` or `highway=secondary`, depending on the population of the country, the number of cars which drive along it, how well it is known, or how many other places it travels through. It might also depend on the width of the road (for someone who has visited it) or how significant it appears on a satellite image (for those who map from afar). For the second instance, how a map reader understands `highway=primary` or `highway=secondary` will also depend on their local experiences. Roads with narrow hedgerows typical of Europe are vastly different to dust tracks in Australia, though both might be `highway=secondary` roads. This matters: choice of transport, the impact of weather events, the length of journey, the difficulty of the drive, or how crowded the road might be are intensely local factors which shape a journey, even if they are not encompassed within this particular system of classification. Here, the reading of a map is as troubled as its making.

This is not to say that "trouble" is troubling. One way to view mapping is as hegemonic—a top-down or majoritarian enforcement of certain cartographic gazes over others through classification (see, for instance, Ryan 1996). But this viewpoint is necessarily limiting, based on critique of the fundamental principles of representation. As Borges (1964) wrote, there cannot be an exact science with rules for *every* possible eventuality, and so, some level of interpretation is always necessary in the act of cartographic representation. I rather view the concept of trouble as opening up possibilities, where the ambiguities of classification might make alternative spaces of action, rather than destroying them. These spaces could be made through specifically political efforts—such as counter-mapping, Indigenous mapping, participatory mapping and GIS, or propaganda mapping. But they also are made incidentally in the process of all mapping—even as we have seen in classifying and tagging highways on OpenStreetMap. This is evident, as Leszczynski and Elwood (2015) describe, when the participatory and the hegemonic come into contact. In the trouble of mapping, we must choose: whose language, whose culture, and whose discourse should we use? Whose experiences, what objects, or what moments count hegemonically, so they may be countered? Then, crucially, we must ask what *does not count*? Who do we forget, or what do we hide, ignore, secret away, dull, or mask—how do you counter that which is absent or invisible, and what are the lines across which we argue?

This kind of questioning, I argue, is a space brimming with "speculative fabrication" (Haraway 2016, 134). In this space, we might explore different ways of countering, beyond simply providing new tags for existing classifications, towards a sustained experimental and critical engagement with the process of classifying itself. This space requires reconciliation between the past of mapping and its future, "mapping-with" classification, rather than against it. Thus, the question we can return to is if it is possible to embrace the process of classification and see if classificatory practices can work with, rather than against, a menagerie of voices—heterogeneity rather than universality? In the rest of this article, then, I will work to reposition our critical focus towards a more sustained critique of the desire (and indeed, requirement) for universalism (*universalis*). Is it possible to pay heed to the ephemeral, contradictory, transient, and local on a global platform like OSM—to "make kin" with classification and develop different taxonomic systems based on situated knowledges, partial descriptions and local environments? Here, a different kind of politics emerges—where the architectures of calculation and classification do not have to be prisons, but instead may form kinships with technologies, people, and landscapes as heralds of possibilities and champions of the vernacular.

TROUBLE AND HOP GARDENS IN THE CTHULHU-OSM

I like to read the proposed features on the OpenStreetMap wiki. A junkyard of cultural treasures, they make a very different map to the more official one we see and to which we contribute. When Haraway (2007) writes of the *cthulhucene*, she is describing a way of understanding the world as "tentacular." Rather than hierarchical, or historical structures of knowledge, the tentacular has multiplicitous zones of contact between ideas, critters, plants, and other oddkin, which loop outwards and inwards, around and through. Furthermore, as Haraway suggests, "the tentacular are also nets and networks, IT critters, in and out of clouds" (Haraway 2007, 32). Across the OSM wiki, different entries, edits, and comments compost the tentacular networks of the formulations, discussions, negotiations, and (re)tracings into a co-production of the cartographic surface of OSM. Each classification becomes manifest through code, collaborations, and the different kinds of considerations which become abundant when multiple lives, technologies, landscapes, and languages connect through tentacular contact zones.

In theory, platforms like OpenStreetMap can refract these multiplicities of experiences and stories made by oddkin in our complicated world. The magnification of thousands of landscapes, features, habits, and stories should point to the heterogeneity of space—as Massey (2005) sees it—and make trouble, rather than resolve it. Ideally:

> OpenStreetMap's free tagging system allows the map to include an unlimited number of attributes describing each feature. The community agrees on certain key and value combinations for the most commonly used tags, which act as informal standards. However, users can create new tags to improve the style of the map or to support analyses that rely on previously unmapped attributes of the features. (OpenStreetMap Wiki, n.d.)

OSM does not have the same material representational limits as physical maps. Every point on a paper map, atlas, or globe can only be defined by as many inscriptions, carvings, or ink marks that can fit on its immutable surface (Lammes 2017). Since OSM is not limited by the materiality of paper, multiple mutable digital inscriptions might overlay the same point *ad infinitum*, limited by server rather than canvas space. It might be possible—in theory and with a toggle function—to represent a road as *both* `highway=primary` and `highway=secondary` (although it might not be very useful). Furthermore, as has been widely documented, digital maps like Google are easily able to adjust toponymic and border information to mirror the social and cultural contexts of the viewer (Gekker 2016). Thus, in theory, the digital map may also house and display information that is not only contradictory, but occupies fundamentally different systems of classification (`highway=primary`, `surface=bumpy`, `landscape=haunted`). The development of feature sets in OpenStreetMap is managed through a rigorous, but sporadically applied, peer-review process of discussion, questioning, and voting. Sometimes a feature makes it onto the list (such as `amenity=grit_bin`), others are rejected (`amenity=skyhook`), others are cancelled (`amenity=bicycle_tube_automat`) and some are abandoned (`amenity=husainiya`).

These multivocal mappings linger in the archives of the OSM wiki as snapshots of the heterogeneity of lives, landscapes, practices, services, and cultures that exist across the world. For instance, `amenity=grit_bin` is only needed for climates that are cold and icy, where the roads and footpaths may need to be gritted. This brings to the fore Haraway's use of "chthonic"—or Chthonic Ones—as a way of describing that which is earthly, embedded in *terra* and terrain. From the depths, they emerge like gorgons, but the chthonic ones are allies too, even though they disrupt harmony and the smooth façade of universality. The chthonic ones, in the case of OSM, emerge in the entanglements of mapping with deep space and deep time. Put simply, the features proposed on OSM are embedded both in contemporary geographies *and* historical mapping practices. For instance, in one of my favourite feature proposals (Figure 2), I learn that in Czechia some older cadastral maps mark where hops—primarily used for beer—are grown. As large fields featuring tall poles which protrude into the sky, `landuse=hop_garden` kinships are apparently useful for navigation due to their plant-human-technology-cartography sympoesis.

hop_garden

Status:	Abandoned (inactive)
Proposed by:	chrabros
Tagging:	`landuse=hop_garden`
Applies to:	area
Definition:	A piece of farm land where hops are grown.
Rendered as:	A green-brown area with repeating symbol $
Drafted on:	2014-03-05
RFC start:	2014-03-05

Figure 2. Status: abandoned. *"landuse=hop_garden" by chrabros (wiki.openstreetmap.org/wiki/Proposed_features/Hop_garden).*

The proposer of this particular feature, OSM user "chrabros," writes that they (whoever they may be) are undertaking a large import of Czech cadastre data into OSM, which includes hop gardens as a feature. As a consequence, they would like to set up some classificatory compatibility between the two mapping systems. Precisely how this classificatory compatibility might emerge becomes the substantive body of the proposal's rationale, with considerable consideration of other ways of classifying the hop gardens, including how to add hops as a specific crop to different `landuse` tags: `landuse=farmland+crop=hop`; `landuse=orchard+crop=hop`. They additionally propose that these zones appear on the OSM surface as "a green-brown area with repeating symbol $."

The discussion by chrabros raises a principal set of motivations for the proposal: hop fields are extremely stable and are not usually adapted for any other kinds of agricultural production (such as wheat or canola); as culturally significant spaces of production in Czechia, they are distinct from other kinds of agriculture (such as the general "farmland" or the specific "orchard"); and, given the approval of features such as `landuse=vineyard`, why should hop fields be less distinguished than other agricultural land uses? The concept of the chthonic—within the chthulu-OSM—gives us a different way of understanding OSM, and the role that the earthly (i.e., terrains like hop gardens, practices like farming, or people like chrabros) plays in the sympoesis of open mapping platforms. These are cultural, as well as cartographic, commentaries about scaling between situated and specific knowledges and practices, and broader, global, cartographic categorisation. They are also critiques of uneven attribution of features across different social, cultural, and physical geographies, national boundaries, languages, etc., that emerge throughout the conversation on OSM:

> "Czech cadastre differentiates between farm land and hop garden so why should not we?"

> "`landuse=orchard`, `landuse=vineyard`, `landuse=plant_nursery` - . . . if these deserve their own tags then hop garden should have it too. They are not that much different."

And,

> "It is named 'chmelnice' in Czech, 'Hopfengarten' in German and in Egnlish [*sic*] several terms are used. But I believe, and hope that someone approves it, that 'hop garden' is a proper UK English term for this feature."

These explanations engage a cultural politics of the different global value attributed to wine production through vineyards, against beer produced through hop fields. They also point precisely to the trouble of mapping—specifically of translating and making equivalences between places, maps, and cultures—and chart how debate moves towards consensus (that is, approving the feature).

Across terrain and maps, another rationale points directly to a curious relationship between material stability and cartographic stability. Orchards, farmlands, and hop fields appear differently *in situ*. Orchards, as rows of trees in grass, or farmlands, as variable crop fields, chabros argues, are not as continuous and consistent as hop fields, which have a specific physical earthly appearance. When wandering through rural farmlands, being able to correlate the specific appearance of different agricultural crops with map data could be extremely useful. With tall poles that rise into the air, chabros makes a strong claim that hop fields are excellent landscape tools—allies even—for navigation and orientation, and so are worthy of being included as their own category on the map.

`landuse=hop_garden` ended up "Abandoned (inactive)." It's difficult for a lurker in the chthonic like me to know why chabros gave up in the end. But the subsequent discussion by other users gives us some idea of the complexities of working between classificatory logics and situated knowledges. This discussion expands the comparison between hop fields and vineyards to rice fields (which don't change, `landuse=farm+crop=rice`) and eggplant fields (`landuse=farm+crop=vegetable`). The regional specificity of hop gardens is a major stumbling block: user johnw writes that "I've never seen (or up until now heard of) a hops [*sic*] garden . . . the other landuses seem pretty universal and well known, while hops garden (or eggplant trellis) seems to me region specific AND easily represented by other tags." At the same time, while hops production is often localised to specific geographies, it is still found across the world—from China, to the US, Europe, South America, Africa, and Australia, depending on the climate. These conversations reveal a careful negotiation between the politics of attending to perceived regional specificity but not creating a plethora of feature tags. This is a discussion about what mapping means and what classifications are important to different people: a mapping muddle between general and local knowledge, between the universal and the earthly.

Returning to Haraway, and the framework of sympoesis or "mapping-with," it sometimes seems as if rather than embracing the mess inherent in working with (agri)cultures, landscapes, and local-global knowledge translation, the general idea is to clean it up. In terms of OSM, this means fewer classifications, simpler categories, and the hegemonic reassertion of assumed universalities regardless of their basis in everyday practices. The issue here is not the practice of taxonomy itself, but the hegemonic structures of power/knowledge that determine what is worthy of its own classification. `landuse=hop_garden` challenges those structures. This is a particular kind of kinship between bio-geographies, cultures, and cartographies, which, though specific, is extremely pertinent to the process of mapping itself, and also underscores the importance of platforms like OSM being able to "speak to," or "map-with" local geographical practices, cultures and cartographies. It redefines how we might cartographically understand continuity according to the durability of specific cultural practices like hop growing, rather than the breadth and commonality of spatial distributions, like farming more generally. It also speaks to the attachments to local material landscapes, and how these become embedded in cartographic traditions and situated navigational practices between plants, technologies, landscapes, and people—from the height of poles in hop gardens to the patina of vineyards.

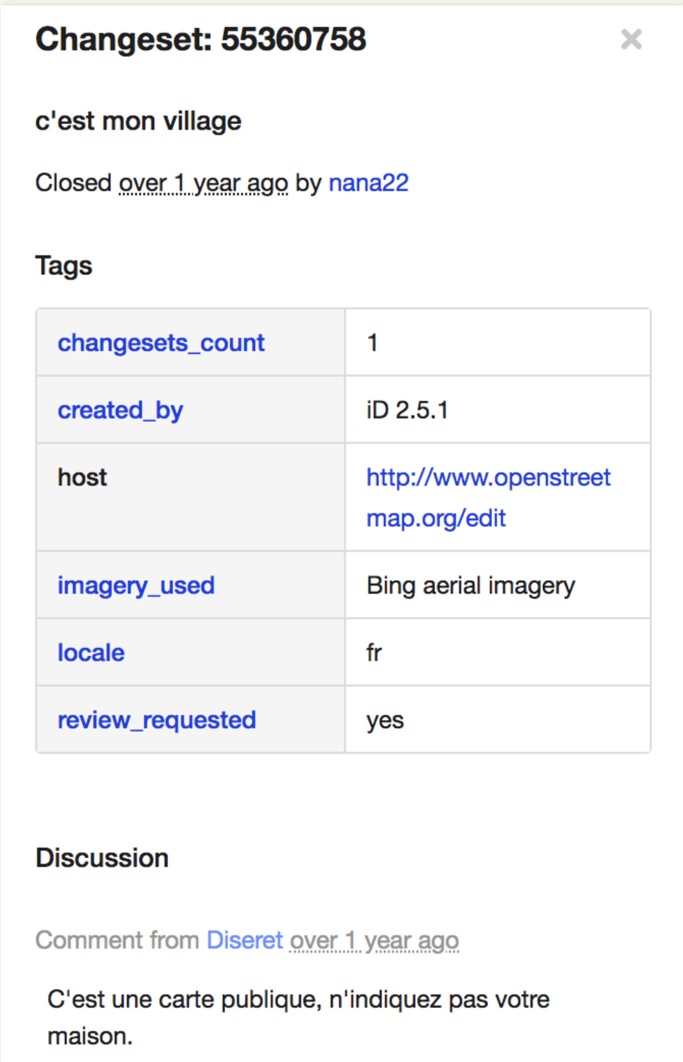
TRICKING THE GODS: PARTIAL PERSPECTIVES AND DIGITAL KINSHIPS

Haraway describes the gaze of the scientist, who stares from an objective nowhere through a lens or screen toward the world, as a "god trick" (Haraway 1988, 581). This god trick requires two components to function: firstly, vision—the act of seeing or staring, especially through technological means such as a camera or microscope; and secondly, the assumption of objectivity—that such a process could approach a total objectivity, or neutral or unbiased manner of getting the sum of the world. While it is arguable that most maps fulfil, in part, the function of this god trick, in OSM—with its chthonic and tentacular systems of participatory negotiation between people, technologies, terrains, and cultures—it is possible to see how the myth of total objectivity is somewhat farther away. Staring back at the god trick are the situated knowledges of mappers new and old, who make their own offerings to the datasets, in new places, taxonomies, and systems—knowledge from the ground up.

This is particularly evident in the changeset archives, where traces can be found of mappers attempting to shape different possibilities *within* classificatory logics. Here, points, lines, and polygons are reoriented towards lived earthly experiences, moulding while resisting OSM's cartographic logics. For instance, the residues of nana22's village lingers in the map, even though they closed the changeset over a year ago (Figure 3).

Marking one's home—as nana22 does—is perhaps an unsurprising act on an open map. It is, perhaps, also a strike against the god trick, a situated mapping from the ground earth rather than the satellite eye. "This is a public map," Diseret reminds us, "don't put your house." A discussion emerges in mapping-with across spaces and experiences, with other people, the oddkin of villages and aerial imagery, social (but not essential) rules of universal taxonomic practice, and the slippages of mapping from afar and from nearby.

What is the impulse, then, to sort through the trouble, and order alliances into formations that are more universal than emancipatory? Either as a cartographic impulse to order the world, or a counter-mapping impulse to re-order it, as thousands of databases are fertilised by alliances between specific landscapes, cultures, practices, critters, and people, the only certainty—the only stable rock, the only predictable refraction—is heterogeneity. This is where Haraway (1988) might chime in again and speak of the privilege of partial knowledge or perspective. Partial knowledges, she argues, are objective because they are finite and situated, with less interest in creating distances between subjects and objects than resolving them as inextricably intertwined. In the context of OSM, partial perspectives underscore the boundaries of our gaze and although the eye of the satellite-cartographer-camera might float above the world, our own positionality limits what we can see. To embrace a partial perspective means that we become grounded in our own responsibility towards who, what, where, and how we map.



Changeset: 55360758

c'est mon village

Closed over 1 year ago by nana22

Tags

changesets_count	1
created_by	iD 2.5.1
host	http://www.openstreetmap.org/edit
imagery_used	Bing aerial imagery
locale	fr
review_requested	yes

Discussion

Comment from Diseret over 1 year ago

C'est une carte publique, n'indiquez pas votre maison.

Figure 3. "c'est mon village": *"this is my village," by nana22.*

There is no *real* rule that means that we cannot speak of `hop_gardens` or villages. If we can speak of these, then, in the dust of democratic mapping, *oddkin*—for instance, sacred sites or Aboriginal lands—appear to remind us of our political problems. This example makes an incidental case for the translation of local knowledges into a broader mapping platform that could, in theory, be defined by heterogeneity and diversity:

> we are all members of many communities of practice. Multiplicity is in play with standardizations, and no one is standard or ill fitted in all communities of practice. (Haraway 2018, 38)

This would be a "mapping-with," rather than a "mapping-against." In doing so, it could also make room for speculative fabrications on how specific landscapes might engage a different, but possibly more effective, politics of mapping (both making and reading) based on kinships with and celebrations of material and cultural worlds, rather than generalisations towards cartographic coherence. Must we be passive about these encodings? `landuse=*` could, in theory, easily be `landuse=sacred_site` or `landuse=aboriginal_lands`. There are projects across OSM that are attempting to map, articulate, reclaim or protect First Nations, Indigenous, or Aboriginal lands—but are continually stalled at the point of classification. One proposal, `boundary=aboriginal_lands` (Figure 4) makes one suggestion.

`boundary=aboriginal_lands` is a multi-perspective proposal. It provides two snapshots of the boundary, in almost oppositional duality. The first perspective is cartographic, as a "heavy dashed line," which might be imagined from above as a geopolitical tool designating different kinds of territorial claims. The second is as a terrestrial road sign, viewed from below, as a threshold is crossed between one person's land and another's. This duality between the

Figure 4. boundary=aboriginal_lands proposal by Acrosscanadatrails.

top-down governmental and administrative understanding of what territory is, and a situated and local sense of ownership and lived experience is reflected throughout the proposal as a major impasse. It becomes translated into the difference between classifying land according to administrative levels (i.e., city, province, region) and governmental logics or being attentive to colonial presents and pasts, Aboriginal title claims, and First Nations' lived experiences. Throughout the discussion, tiptoeing around complex issues ensues, as subject and object are pushed and pulled apart, imagined kinships are inscribed into the conversation and present kinships ignored. Acrosscanadatrails, who made the intial proposal, writes:

> "Suggestion: First Nations and Indian Reservations should be boundary=administrative; admin_level=1; border_type=first_nation; as they are international."

To this suggestion there is a series of responses, likening Aboriginal lands to national territories, national parks, international conglomerates, and nations without statehood. For instance:

> "Should borders like this really be administrative? Certainly using admin_level=1 for this just looks wrong to me... --Eimai 17:22, 25 June 2008 (UTC)"

and

> "It can also apply to other native people, such as the Masaai in Kenya/Tanzania or the Samii in Norway/Sweeden/Finland/Russia [*sic*]. boundary=native_reserve or boundary=native_nation is probably better. But I fully support removing them from boundary=administrative. Let admin_level=1 be reserved for supernational administrative borders such as the European union.--**Skippern** 13:15, 3 December 2008 (UTC)"

These conversations map the complex landscape of postcolonial geopolitics across the world against one simple question: is it possible to universalise the territorial conditions of Indigenous peoples and First Nations across the world under a single system of spatial classification? Eighteen months later, Acrosscanadatrails comes back with another attempt:

> "All, ok how's this boundary=native_reserve; border_type=territorial; place=region; name=*; admin_level=2 May be this should cover all grounds .--Acrosscanadatrails 12:37, 11 March 2010 (UTC)"

The conversation gets muddier. Skippern responds at 13:14 on 11 March 2010 (UTC) with a counter-proposal and some clarifications, arguing against the use of admin levels for reserves, for the broadening of place=region to place=region/country/city, and the inclusion of "description," as well as the reserve's "website" and/or Wikipedia article, its population, and "source=*." Two months later in May, Acrosscanadatrails revisits the proposal with a different suggestion—`boundary:type=aboriginal_lands`—and renewed arguments for the administrative role of the boundary, this time further grounded in both terrain and territory, using contingent objects like signed treaties and checkpoints:

> "admin_level=4-- because it has its own jurisdiction which is similar to a 'state/province' level, where it is still within a country

(generally) more times than not. There are special cases (just like countries that are in transition & dispute). In some countries there are signed agreements with members of each group

...

boundary=administrative -- because this is an 'administrative' boundary. Where it's known, and sometimes signed, as it would be trespassing if there is no implied visiting (there is no security check to go/through the area)

...

--Acrosscanadatrails 16:02, 12 May 2010 (UTC)"

Here, the trouble of an ongoing social haunting erupts into the OSM platform through contingency (Bittner, Glasze, and Turk 2013). Effectively, the politics and processes of the classification reveal threads of tension between knowledges and unresolved colonialities. Significantly, it is the desire for universality in taxonomic structures that yields this conflict, as entanglements are often contradictory: is `aboriginal_lands` a use of the land, is it an ownership of the land, a territory, an administration? Or is it all of these things at once—or none of these things, depending on who is looking? Here, partial perspectives come into contact with one another, negotiating how and to what degree different realities translate and do not translate through the process of classification.

As the conversation continues, Hai-Etlik tries to map the structure of the Cowichan tribes against the administrative levels of the OSM classifications, and the structures of the Canadian state:

"I disagree, This would imply that, for instance, Cowichan 1 is not part of British Columbia and is a province in its own right. It doesn't even have its own government but is rather just one of 9 reserves in the Cowichan Tribes, and Cowichan Tribes as a whole is more comparable to a municipality in its scope than a province.

--Hai-Etlik 01:47, 1 July 2010 (UTC)"

Six years go by and the debate picks up again in November 2016, with others reflecting on previous posts with new spatial and temporal contexts. Warin61 argues that Aboriginal Lands get used for multiple purposes, and so the `land_use` tag would erase this diversity. Instead, the vote is cast to `boundary=aboriginal lands`, which "clearly sets this aside from other boundaries as it should be." Similarly, eighteen months later, this suggestion is supported by Arctic.gnome, who adds nuance to the debate over self-governance, with multiple levels suggested depending on which laws are followed.

The conversation on `land_use=aboriginal_lands` and `boundary:type=aboriginal_lands` continued for years, unresolved.

But this is not a wasted effort. The effort to pin down the clear systems of categorisation that comprise and structure our understanding of the world does important political work in revealing tensions, multiple perspectives, and the difficulty of generalising from, rather than paying heed to, situated knowledges. This is one of the major struggles within cartographic practice, and geographic information science more generally. Yet, rather than a cause for regret, this tension is productive: a dialogue across multiple spaces and times about how it is to be in and of the world.

As Haraway writes:

> To see scientific knowledge as located and heterogeneous practice, which might (or might not) be "global" and "universal" in specific ways rooted in ongoing articulatory activities that are always potentially open to critical scrutiny from disparate perspectives, is to adopt the worldly stance of situated knowledges. (Haraway 2018, 138)

And so, such situated knowledges about how multiple boundaries and spatial realities overlap or co-exist in contradiction can indeed also be considered scientific knowledges about the lived realities of tensions between states and nations and peoples, about how land is used versus how it is owned, and what it means to look across the landscape rather than down from the sky. Furthermore, as Haraway (2018, 138) continues, "such knowledges are worth living for."

MAPPING-WITH: LIVING AND DYING

Mapping necessarily conceals and illuminates, it necessarily creates trouble as it eliminates it. The critics of a universal science and a transcendental cartography are not wrong. We cannot fully relinquish the rules and logics of discourses that set the conditions of possibility for mapping, and counter-mapping, in the first place. To map is to engage a philosophy of representation, to at once reduce and extend the possibilities of the world through art, imagination, and science.

What role do we, as cartographers, play in the production of spaces around the world, and the mediation between the situated knowledges and god tricks between which we work? The tendrils of GPS traces span out across OSM (Figure 5).

Chthonic in their layers, and tentacular in their sprawl, I've always found this a far more interesting mapping, seeing the multitude of local practices, situated moments, and journeys across the earth. Less the domain of a universal science and more the residues of mappers as they trail from village to village, emerging with each new upload, this is not so much a map, as a mapping-with.

At the same time, staying with the trouble—for Haraway, at least—is not simply about the process of giving life to new growth. It is not against *mathesis* and *taxinomia* that such mappings emerge. The precisions of triangulation, the calculation of data, and the classification of spaces as they have emerged in these instances carry fascinating stories about the heterogeneity of life in this world. These practices are examples of ways in which we might stay with the trouble, and map-with cultures and landscapes and people; rather than against them, or in spite of them. They do not eschew the absenting power of the ghost or shadow, but rather they get comfortable with ambiguity and make room for the difficult and the uncomfortable, the heterogenous, the unexpected, and the unorthodox to persist in shaping pasts, presents, and futures. Abandoned, or closed, or still under discussion—the trouble does not disappear. Rather, it lingers and haunts, either on servers, or landscapes, or lives.

What might mapping-with look like? This has been a largely theoretical rather than empirical argument. However, just as the making of maps might inform how we think about them, so too can thinking about maps inform how we make them. Haraway draws a critical distinction between those who simply watch and those who harness a critical reflexivity (rather than polemic extremes) to become modest witnesses of the technical and technological shifts that take place:

> So I close this evocation of the figure of the modest witness in the narrative of science with the hope that technologies for establishing what may count as the case about the world may be rebuilt to bring the technical and the political back into realignment so that questions about possible livable worlds lie visibly at the heart of our best science. (Haraway 2018, 38)

In short, do we simply watch—or map—with the categories that we have, or can we embrace new roles as modest witnesses who are more interested in mapping-with, rather than mapping-to, mapping-for, or mapping-because. This is a kind of "response-ability" (Haraway 2016), an ethics that does not sit with the lone cartographer staring at a screen, but rather asks us to acknowledge the collective spaces that we inhabit, and to take care in their construction.

So, while "mapping-with" may currently be a political fiction, there is ample room for potential in the practice of cartographic science to make new categories, create new starting points or redefine what classification is altogether. On a platform like OSM, there has always been opportunity for political as well as practical intervention into the

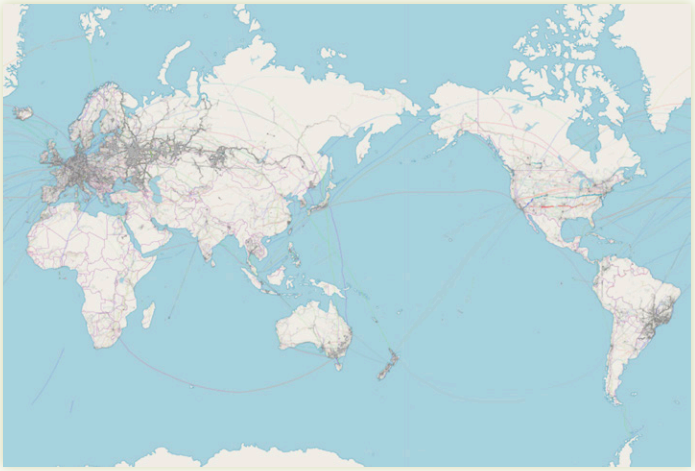


Figure 5. Mapping-with: a cartographic chthulucene? *Public GPS Traces on OSM (June 2, 2019).*

work that cartography does: why should hop fields, villages, and Indigenous lands not have been the starting point for our classificatory systems, rather than fitting them into structures that currently exist? If we make mappings that start from landscapes and people and histories, rather than cartographies, classifications, and computers, it might it be possible to take pleasure in the confusions that mappings bring, and put them to political use. This is the beginning, not the end, of a critical and empirical project that seeks to reengage the classificatory logics and politics of geographic information systems toward different futures. This project is a cyborg cartography that has irreverence for its predecessors in Western epistemologies and is "about lived social and material worlds in which people are not afraid of their kinships with animals and machines, not afraid of permanently partial identities and contradictory standpoints" (Haraway 1985, 72).

And so mapping-with is also about the "relations between life and death" (Haraway 2016, 8): the process of living is also a process of dying. If mapping is the making of worlds, then it is also the unmaking of them. As mappers who are modest witnesses, we cannot be removed from the trouble. Our bodies, as well as our lines, our numbers, our categories, and our knowledges are entangled, mapping-with and unmapping-with. What worlds can we unmake, what boundaries can we erase, what landscapes can we rename from the partial rather than the top-down? In the compost of erasing lines as well as making them, new species flourish. Dying with our mapping is accepting the uncertainty, and the ambiguity, and asking our mappings to be more turbulent and situated. It is also a reconciliation between *mathesis* and *taxinomia* and those upon whom they have inflicted traumas. Where once they lent their power to an absolutism or a universality, or a top-down representation that demanded unflinching obedience, they might work up and demand the same from the top, in refusing to re-categorise, regulate, to homogenise.

I have argued that the tensions, translations, and comparisons produced through processes of cartographic classification offer new pathways for engaging mapping as a political, world-building tool. Rather than simply eliding or critiquing classification—one of the cornerstones of cartography since the nineteenth century—embracing it as fundamental to mapping processes *and* as a conceptual tool of possibility may open up alternative and radical—but also useful—ways of thinking about spaces, politics, landscapes, and environments. Within the case of OpenStreetMap, reencountering feature proposals from the perspective of Donna Haraway, it is clear that already these possibilities are being charted within the mapping structures—from international conversations about what kind of place a hop field is, to whether homes or villages should be mapped at all, to the ideological and assumptive problems of state ownership vs. First Nations ownership inherent in and inherited by the spatial classificatory systems that we use. So, I propose moving our classificatory fix-points, models, and assumptions away from the generalised to the troubled, to the graveyard of lost proposed features and changesets, and dying there, in the hope of fertilising new possibilities. Mapping-with, rather than against, the oddkin proposals set out between people, landscapes, and pasts, perhaps ignored allies will help by adding ambivalence and fuzziness, to our mappings, composting with situated knowledges, and embracing the chthonic—in cooperation, rather than subservience or domination.

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Guerrilla Cartography: Promoting Diverse Perspectives and the Expansion of the Cartographic Arts

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INTRODUCTION

Guerrilla Cartography is an organization that seeks to popularize thematic maps with a variety of styles and perspectives in an accessible and engaging format. Through our projects, we provide examples of diverse narrative viewpoints in map form, allowing readers to expand their ideas of what kinds of stories maps can tell and imagine the stylistic possibilities for visual expression in this medium. Among other activities, we publish crowd-sourced atlases with the aim to widely promote the cartographic arts, and have thus far published *Food: An Atlas* (2013) and *Water: An Atlas* (2017). Because the maps are collected in published volumes, the atlases build legitimacy for marginal or atypical cartographic voices. We promote accessibility by publishing the atlases both as physical books and as free, downloadable PDF documents on our website: **guerrillacartography.org**. Each map, created by a different group on a different topic, is placed in relationship to other maps and information, inviting the reader to think critically about each map's authorship, style, and content.

GUERRILLA CARTOGRAPHY'S ORIGINS

The idea for Guerrilla Cartography has its roots in the *Mission Possible* atlas project (**missionpossiblesf.org**). In 2011, Darin Jensen (then the Cartography Lecturer at UC Berkeley), Molly Roy (former student and freelance cartographer), and Jensen's students partnered with an organization in San Francisco called Mission Loc@l, which wanted to make an atlas about the Mission neighborhood. Jensen's students made maps on whatever topic interested them regarding the predominantly Latino neighborhood, and the atlas thus comprises a variety of themes. The maps are oriented with west toward the top because "… a west orientation brings south and north into equilibrium as left and right, rather than above and below. This may be important to a map of a neighborhood that is living the histories of a region in which the dynamic relationship between South and North would shape the future" (Jensen, Chávez, and Roy 2012, 3; Figure 1). The title page introduces this dis-orienting orientation while also using a series of cascading insets to gradually zoom the viewer into the Mission neighborhood. The topics mapped, and the perspective from which they are viewed,

Figure 1. Mission Possible: A Neighborhood Atlas *(2012), title page (missionpossiblesf.org).*

are multiple and varying. For instance, "Mission: Saturday Sounds" locates and measures noise in the neighborhood on a Saturday night, while "Mission: Airways" upends the usual map perspective by plotting what is over our heads. "Mission: Gangs and Cupcakes" juxtaposes two local gang territories with bakery locations: "You can be paying $4.50 for a cupcake and be standing in the middle of Norteño territory . . . It's up to you to decide what to make of that," Jensen has said (Miller 2013).

The production of *Mission Possible* inspired Jensen and Roy to crowdsource an atlas with international scope and contributors. *Food: An Atlas* was the first Guerrilla Cartography atlas, and went from the call for maps to shipping in the remarkably short time of seven months.

Following the success of *Food* and due to financial and logistical concerns, Jensen and others involved with *Food* decided to establish Guerrilla Cartography as a 501(c)(3) nonprofit in late 2014, providing tax-exempt status and the ability to apply for grants. This move, and the accompanying recruitment of a volunteer board, enabled the group to continue making atlases while expanding the mission to include a broader focus on promoting the cartographic arts through education and outreach.

THE PROCESS OF CREATING A GUERRILLA CARTOGRAPHY ATLAS –

Guerrilla Cartography self-publishes with the aim to be free of traditional publishing constraints. As co-founder Darin Jensen has written, "Guerrilla Cartography does not take direction, or seek approval, or dictate what narrative to create" (Jensen 2017). Self-publishing is expensive but ensures that we are not beholden to the separate editorial control of a publishing house. We work with a local printing press in order to support local businesses and minimize our ecological footprint, and pack and ship all the atlases ourselves in order to minimize costs. We also provide a free PDF document on our website with the entire content of each atlas because we believe in the free and open dissemination of our projects.

Guerrilla Cartography is not in the business of making money, and the majority of our funding still comes from crowdsourcing. We have conducted successful Kickstarter campaigns for both atlases, which covered part of the costs of printing the atlases locally. For *Water*, we applied for and received a publishing grant from Furthermore, a program of the J. M. Kaplan Fund. Sales of our atlases cover the rest of our costs. Everyone involved with Guerrilla Cartography—the board members, researchers, cartographers, and designers—are all volunteers dedicated to this project of bringing the art of cartography to the people. Much like the Counter Cartographies Collective in Chapel Hill, we emphasize "the creativity of labor over that of capital" (Dalton and Mason-Deese 2012, 440).

To launch an atlas, we start by proposing a broad theme (such as Food or Water) and invite submissions from anyone who has created or wants to create a related map. The call for maps has few guidelines, other than that the map submissions be somehow related to the broad theme and convey a narrative. Our primary constraints are those that enable us to put everything together in a physical atlas (such as the sizing of the document or minimum font size for readability) and graphic elements required for basic comprehension (e.g., title and legend).

We circulate the call for maps as widely as possible, to cartography groups as well as subject-specific ones. One of our critiques of *Food: An Atlas* was the disproportionate number of maps of California and North America, despite our hope for greater representation of other geographies. The Bay Area base of our organization unsurprisingly becomes reflected in our networks, and thus the reach of our call for maps. For *Water: An Atlas*, we made it a priority to try to increase international participation by breaking out of our typical networks. Throughout the spring of 2015 leading up to the first call for maps for *Water*, Guerrilla Cartography board members spent hours on the internet compiling the contact information for organizations and individuals across the world who might have an interest in contributing to an atlas themed on water. In addition to our increased outreach efforts, we also recognized that language presents a barrier. To help overcome this dilemma, we translated the call for maps into Spanish, and asked our networks to translate and re-share in additional languages if they were able. However, due to the English-speaking composition of our board, which is responsible for providing editorial comments to cartographers, we made the decision to accept only submissions that were presented primarily in English.

One of Guerrilla Cartography's goals is to enable people to tell their map-based story, even if they do not have the cartographic training, skills, or tools to create that map

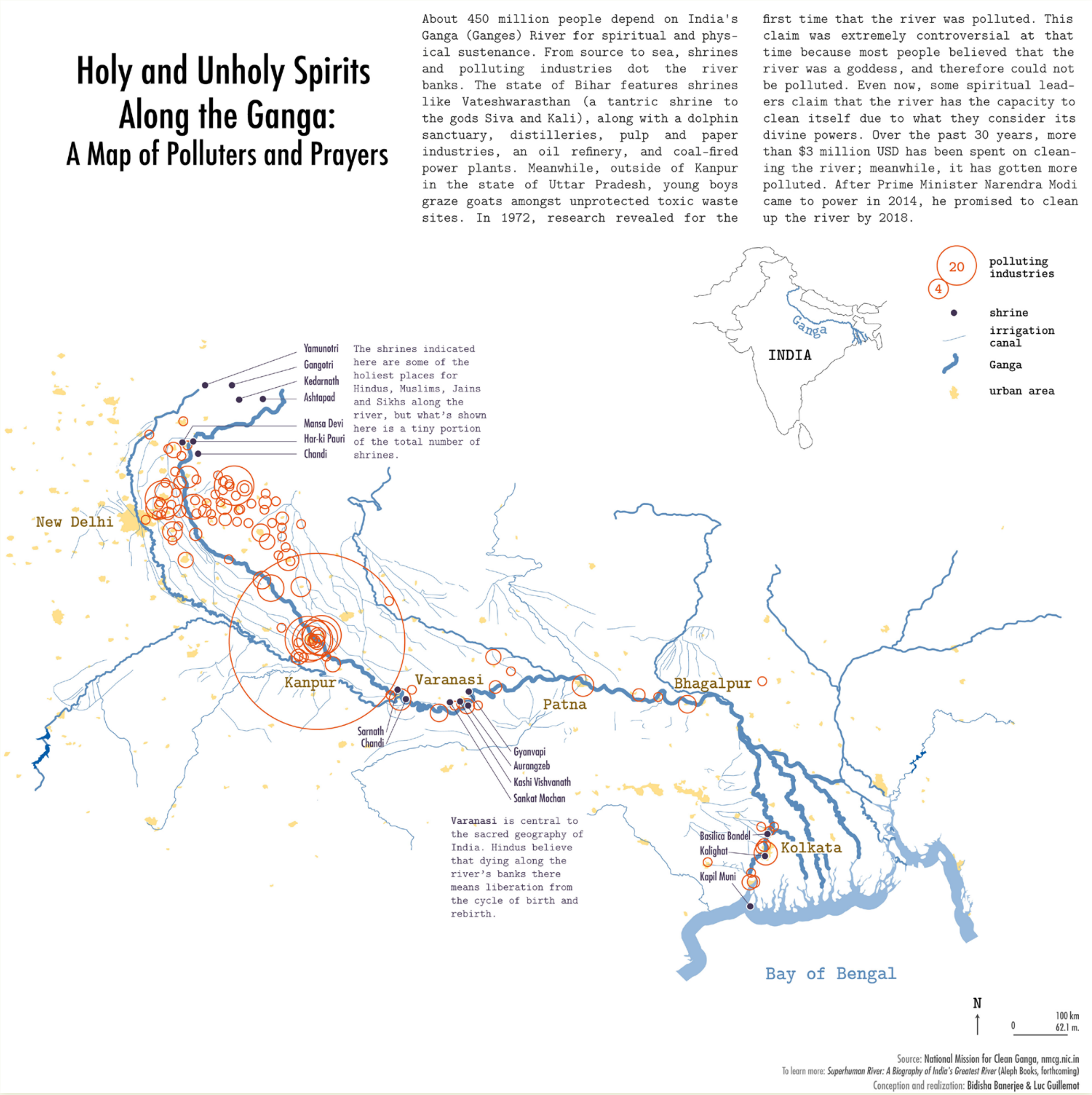

Figure 2. Holy and Unholy Spirits Along the Ganga: A Map of Polluters and Prayers *by Bidisha Banerjee and Luc Guillemot in* Water: An Atlas *(2017).*

themselves. In each of our calls for maps, people are also encouraged to instead submit *ideas* for maps (along with data sources they have identified). After assessing the idea and data for feasibility, we pair the idea creator with one of our many volunteer cartographers. The idea creator and volunteer cartographer work together to create a map that reflects the envisioned narrative.

After maps are submitted, the Guerrilla Cartography board reviews them and recommends edits. Our edits focus on ensuring that maps meet the basic guidelines and that they are communicating their narrative clearly. We help identify confusing or misleading representations, typos, and unclear text. In our edits, we consider maps as full pieces, including all the components and the overall design. Rarely is a map rejected. On those few occasions, the reason has usually been that the submission was a reference map, rather than a thematic one. Although reference maps can be beautiful examples of cartography, our aim with our atlases is to tell stories with maps.

For *Water*, we also conducted a "global" peer review for the second round of edits. We placed drafts of the maps on our website and invited the entire community of mapmakers and researchers to comment. In the spirit of a crowdsourced project, this allowed the editing of the atlas to also be a collaborative process. Once submissions had been revised based on the peer review comments, the Guerrilla Cartography board conducted one final review to identify any lingering typos or glitches.

After each map submission goes through several rounds of review and revision, we work as a board to develop the narrative flow of the atlas from its organic, crowdsourced origins. At the end of the process, the finished atlas contains maps of great variety: at different scales, in different projections, using different color palettes and graphic styles, and drawing on different sets of data. Each map ultimately communicates a different story or message, but also contributes to the whole of the atlas.

HOW GUERRILLA CARTOGRAPHY'S ATLASES PROMOTE DIVERSE PERSPECTIVES

Guerrilla Cartography aims to promote the understanding that there are many views of the world, that how we understand space and place can vary, and that we should think critically about the maps and the graphics we make and consume. Our organization has designed processes for creating our atlases that support these goals.

1) BY FEATURING DIVERSE NARRATIVE VIEWPOINTS

A different person or group of people produced nearly every map in our atlases, each contributing their individual aesthetic and experiences to the broad theme. We can never tell all stories about food or water, but crowdsourcing content allows us to glimpse a few things that we might not otherwise encounter, giving the atlases a variety of perspectives. An example of an unusual narrative viewpoint is the map "Holy and Unholy Spirits Along the Ganga: A Map of Polluters and Prayers," which juxtaposes spiritual sites with polluting industries along the Ganga (Ganges) River in India. This map was a collaboration between social ecologist Bidisha Banerjee and cartographer Luc Guillemot for *Water: An Atlas* (Figure 2).

The atlases also exhibit a variety of literal viewpoints, including different projections and scales. One example is Garrett Bradford's map of "Global Almond Trade and California," featured in *Food: An Atlas* (Figure 3). The central map employs the unusual Peirce quincuncial projection in order to place California at the bottom, so as to better showcase the almond trade that emanates from it. The cartographic choices highlight the narrative of California as the center of global almond production.

2) BY PLACING MAPS IN RELATIONSHIP TO OTHER MAPS AND INFORMATION

The atlases are meant to be both informational and entertaining, readily accessible to anyone with an interest in maps, in the theme, or both. After the call for maps is sent out, the maps that the crowd chooses to make end up creating a narrative for the atlas. We do not prescribe the narrative in advance; it grows organically throughout the process of building the atlas. We are then able to group the maps into narrower themes within the broad theme, giving a structure that makes the atlas more than simply a collection. This is the part of the atlas that is editorial, and that makes the board a part of each map and its story. While each map by itself has a story, that story also becomes contextualized in the order of the maps. We experiment with multiple linear "stories" as we work to pull the narrative thread through the atlas. There are other stories that can be told with these maps and other ways they could be grouped, but due to the constraints of producing a physical atlas, the editorial board decides the final grouping and order for the maps. We hope our arrangement of the maps provokes a response in readers, prompting them to agree with or question the narrative that is being told, and to translate that to their viewing of other maps and atlases.

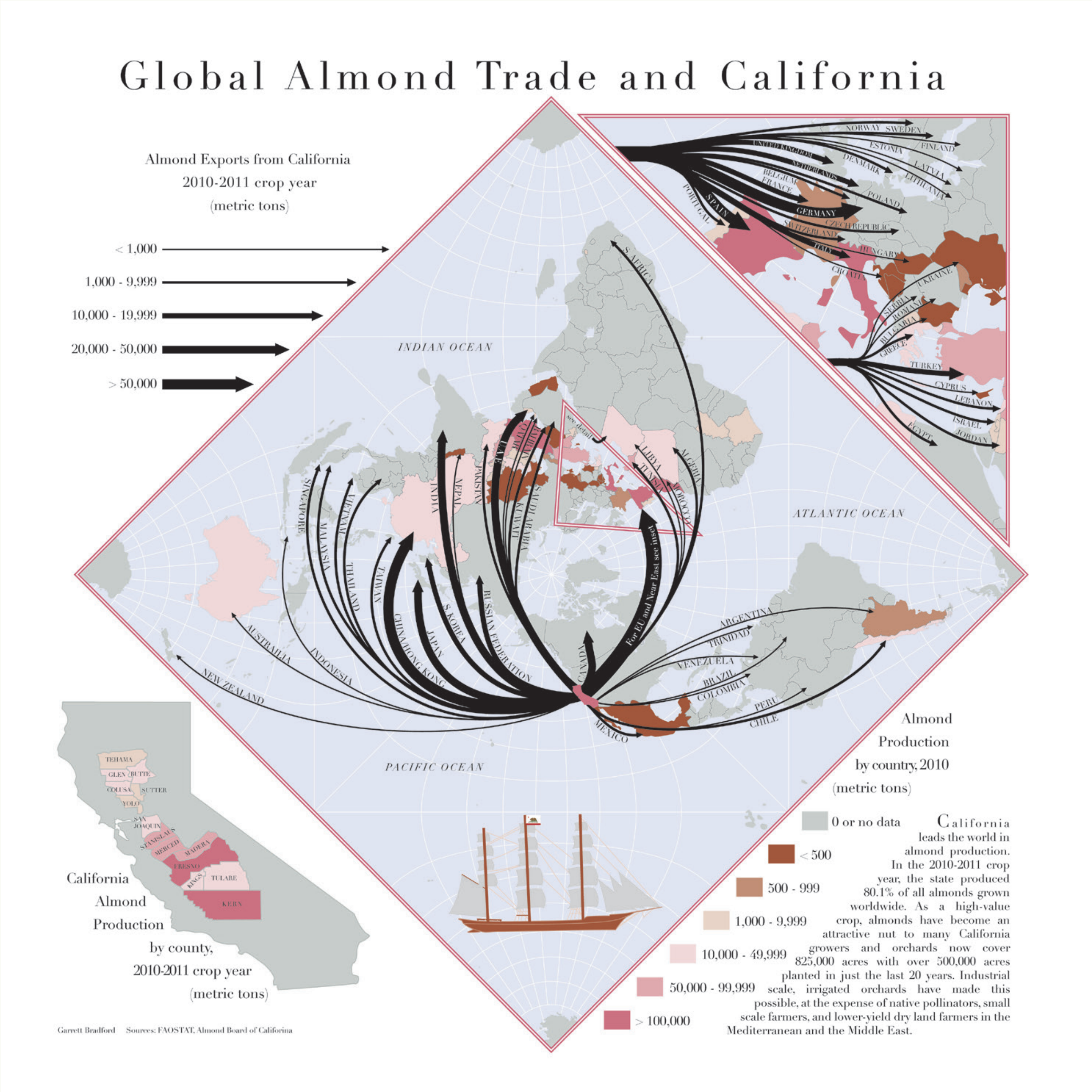

Figure 3. Global Almond Trade and California *by Garrett Bradford in* Food: An Atlas *(2013).*

3) BY BUILDING LEGITIMACY FOR MARGINAL OR ATYPICAL CARTOGRAPHIC VOICES

Among other things, Guerrilla Cartography is concerned with authority—the authority of who gets to produce and distribute maps and why. The narrative construction of the atlas and the editing process itself both help give legitimacy to voices that may not have access to traditional atlas or map publishing venues. Our process of pairing people who have map ideas with our volunteer cartographers is another way that we make space for many different viewpoints, such as the collaboration mentioned above for "Holy and Unholy Spirits Along the Ganga" (Figure 2). Banerjee had been immersed in a project about the Ganga since 2009; after submitting her idea to the *Water: An Atlas* call for maps, we connected her with Luc Guillemot, a Guerrilla

Cartography volunteer. They worked together over email to bring Banerjee's vision to life.

Seeing the ways that a variety of people represent geographic data is informative and instructional. While anyone can publish maps that they have created on the Internet, distribution may be limited. Without a digital home, these maps may also disappear. Guerrilla Cartography's atlas publishing model enables a broader audience and a more concrete presence—both digital and physical. The crowdsourced nature of Guerrilla Cartography's atlases also helps viewers critically examine their assumptions of who has the authority to produce maps.

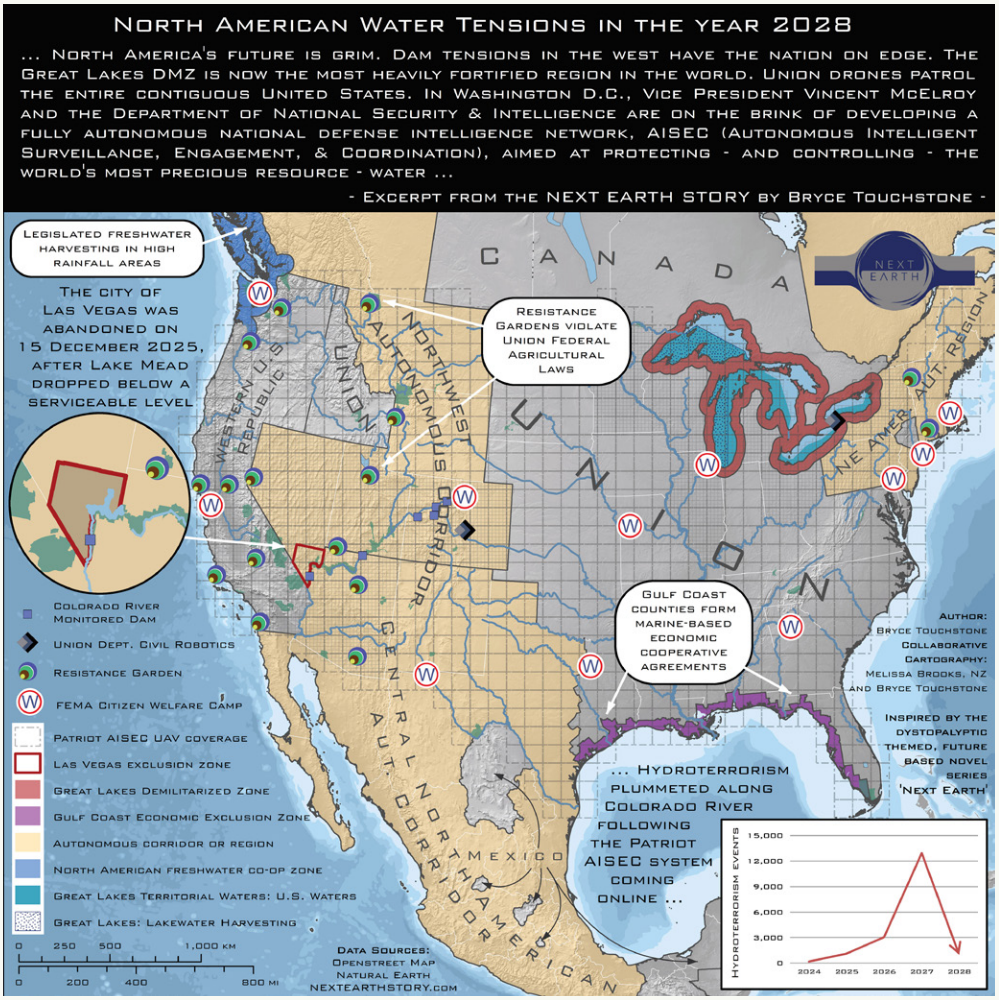

Figure 4. North American Water Tensions in the Year 2028 *by Bryce Touchstone and Melissa Brooks in* Water: An Atlas *(2017).*

4) BY PROMOTING CRITICAL EVALUATION OF CONTENT, AUTHORSHIP, AND AUTHORITY

The myriad styles, narratives, and scales of the maps contained within Guerrilla Cartography's atlases invite readers to question their assumptions about how a map is constructed, by whom, and for what purposes. The atlases also encourage readers to think critically about the very data that the map representations are constructed upon. For instance, in *Water: An Atlas*, we open with a chapter titled "Imagination." Here we are mapping imaginary data, or in some cases actual data on imaginary or legendary phenomena. The map "North American Water Tensions in the Year 2028," for example, depicts a dystopian vision of water scarcity-caused conflicts in the not-too-distant future (Figure 4). For someone to read these maps, they must begin to understand that, while the map portrays a certain authority, the mapped data may not exist in the real, tangible world. Unreal data are being mapped. What does that mean for all the maps we see? Does it make us wonder about the "real" data that are being mapped elsewhere in the atlas?

CONCLUSION

Guerrilla Cartography's future endeavors not only include self-publishing more atlases, but also creating and participating in mapping workshops, developing new methods for encouraging critical thinking, and expanding our organization. We have been invited to participate in a number of mapping workshops, including a session on *Power Mapping of Silicon Valley* with De Anza College, a community college located near San Jose, California, and *Mapping Back: Indigenous Cartographies of Extractive Conflicts* with Concordia University in Montréal, Canada (**mappingback.org**). We are also looking into methods for creating a voluntary repository for the data used by cartographers in our atlases, to allow more people to access the data and to bring more transparency to the mapmaking process. Finally, we are considering expanding our organization to include "chapters" in other locations, furthering our mission to promote the cartographic arts in additional places. We hope these endeavors spark further interest in cartography and the promotion of diverse perspectives on the world.

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Cartographic Pleasures: Maps Inspired by Joy Division's *Unknown Pleasures* Album Art

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INTRODUCTION

Is THE COVER ART for Joy Division's 1979 album *Unknown Pleasures* (Figure 1) the most famous data visualization in popular culture? I suspect so. The image, based on a plot from an astronomy dissertation (Craft 1970), displays radio intensities from the first known pulsar. As designed by Peter Saville, though, all we see is an unlabeled, mysterious landscape. Forty years later the artwork remains both a sublime representation of the band's sound and an icon of commercial art.

Figure 1. *Unknown Pleasures in its natural habitat, the record store. The References and Further Reading section contains links to excellent histories of the album art. Photo by author.*

This type of data visualization, known as a "joy plot" (for obvious reasons) or a "ridgeline plot" (the overlapping lines are suggestive of a mountain ridge), is "quite useful for visualizing changes in distributions over time or space" (Wilke 2018). The plot's Cartesian structure certainly lends itself to mapmaking: longitude along the x-axis, latitude along the y-axis, and the "height" of each line can correspond to a variety of spatial phenomena, such as population density, lightning strikes, or—most appealing to me—elevation.

I enjoy sketching transect lines and terrain profiles (Figure 2), and the *Unknown Pleasures* art has always looked to me like the profile of a mid-oceanic ridge. A few years ago I attempted my first *Unknown Pleasures*-inspired transect maps (Figure 3), but the process was painfully slow and I had to shelve the project. As I was finishing my dissertation, though, Claus Wilke released his R package `ggjoy` (now `ggridges`) and my interest was sparked anew. I spent the better part of the summer of 2018 refining my transect map workflow, and now I present it for your own mapmaking enjoyment.

WORKFLOW OVERVIEW

The workflow demonstrated here moves through three stages: (1) QGIS to create and prepare the transects, (2) R to plot the transects, and (3) Adobe Illustrator or Photoshop to stylize the transects. In the following sections I walk through each stage of producing an 80-line transect map of Crater Lake National Park, and I encourage you follow along. All files are available for download at **github.com/tmacwhite/PracticalCartoCorner**. I presume *Practical Cartographer's Corner* readers have more than a modicum of familiarity with mapping software, so I eschew specific step-by-step instructions such as **Right-click > Save As or Layer > Add Layer > Add Vector Layer** for many basic steps. I also touch on assorted practical and

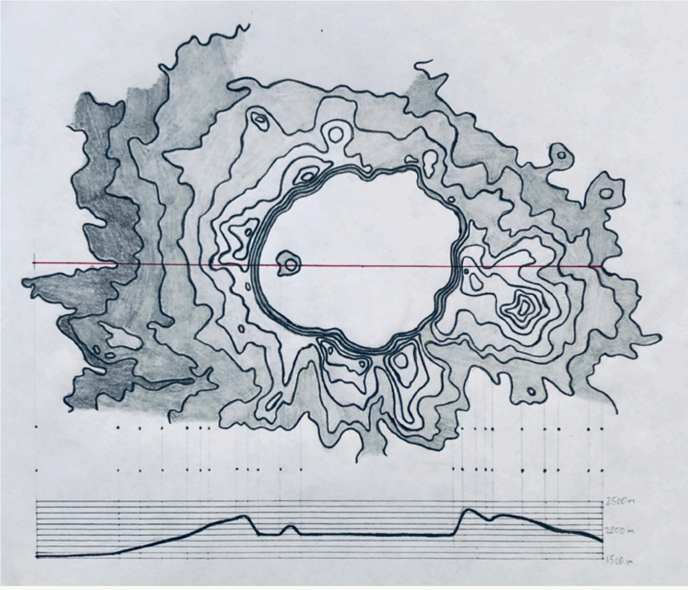

Figure 2. *Elevation samples are gathered along a transect and then drawn in profile. Common terms for the completed diagram include terrain profile, terrain diagram, and transect map. Drawing by author.*

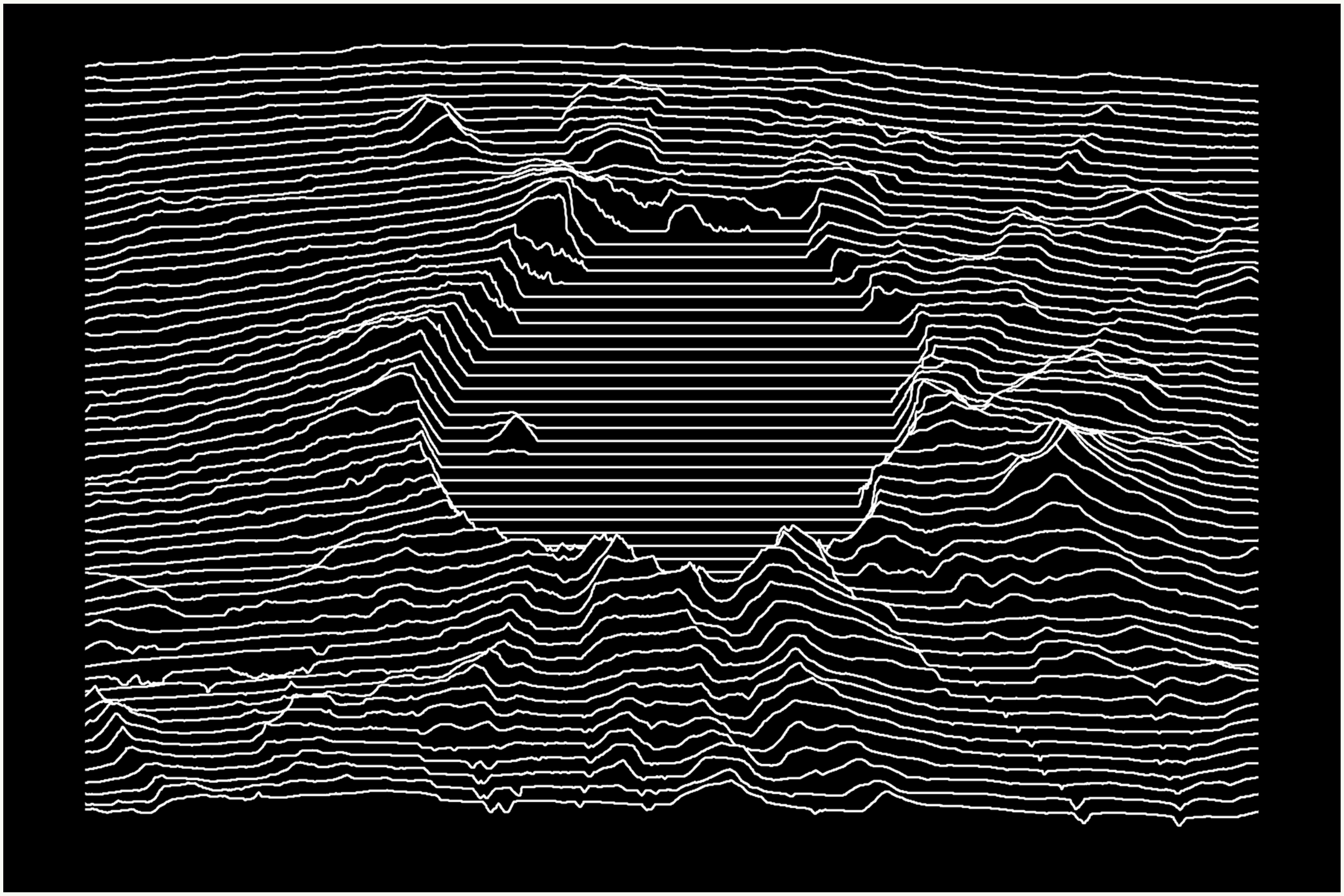

Figure 3. *My first attempt at a transect map, 2015. Transect lines created using Python, profiles using the Create Profile Graph tool in ArcGIS 10.3.*

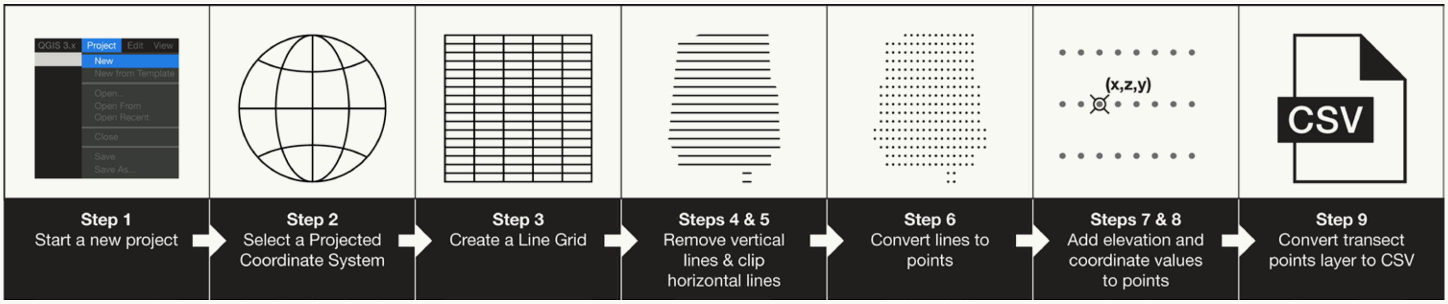

Figure 4. *A flowchart illustrating the nine major steps of Stage 1: QGIS. The output from step nine is used in Stage 2: R.*

aesthetic issues affecting how I produce transects maps, and how I design them.

Before we begin, know that you can achieve similar results if you substitute ArcGIS for QGIS, Inkscape for Illustrator, or GIMP for Photoshop. You can also achieve similar results in R alone—and to a lesser extent, using 3D GIS scenes—thus limiting your workflow to a single environment. However, I find that my three-stage method provides the greatest creative control over the final output.

STAGE 1: QGIS

Figure 4 illustrates the major steps of my QGIS workflow. I use QGIS for data projection and transect creation. These instructions apply to QGIS 3.4, but are adaptable to older releases of QGIS, as well as ArcGIS Pro and ArcMap. Be aware that QGIS contains multiple tools and plug-ins capable of producing transect data, and as a consequence there are a variety of effective workflows. I conclude this preamble with three recommendations: be consistent with your vector data formats (QGIS defaults to shapefiles or GeoPackages depending on the tool); include the location and number of transects in every file name ("CraterLake_80transects.shp"); and use sequential file names for each step in the workflow ("CraterLake_80transects_s1.shp").

STEP 1: START A NEW PROJECT

Start a new project and add two data layers: *CraterLakeNP_boundary.shp*, derived from the Natural Earth 1:10m "Parks and Protected Lands" shapefile, and *CraterLake_DEM*.

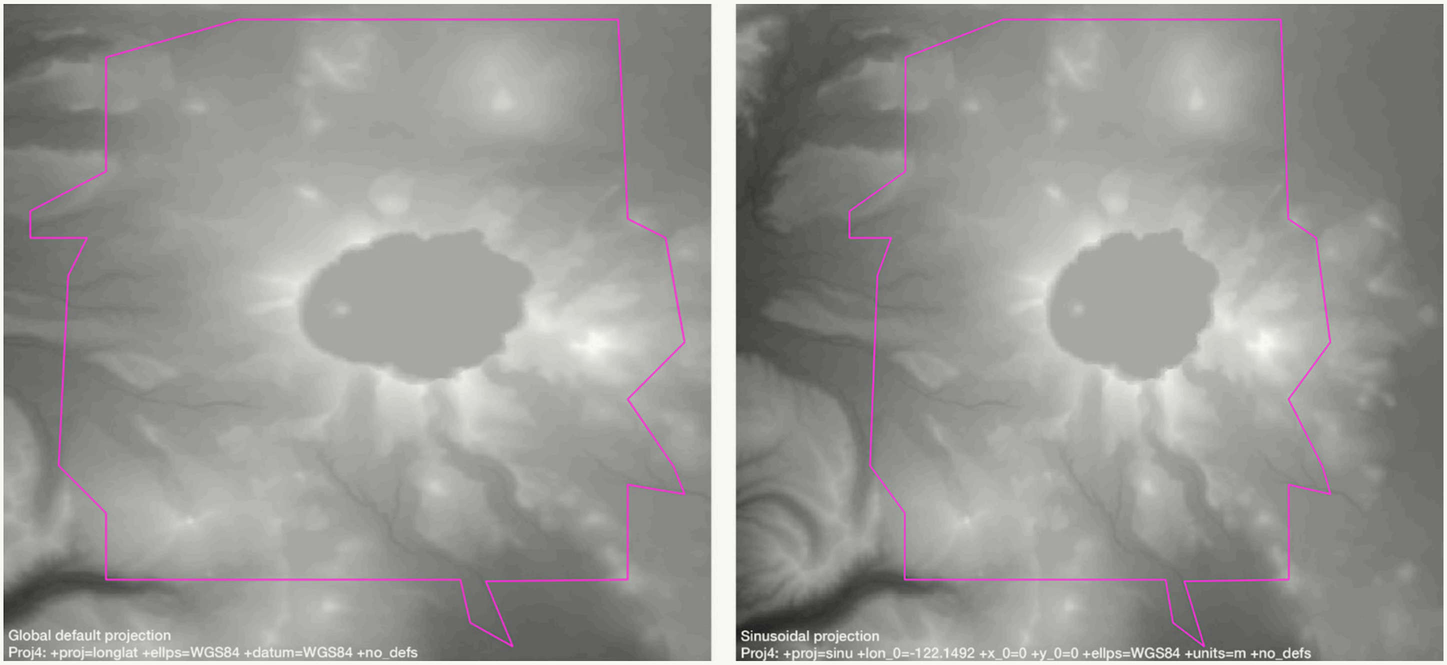

Figure 5. *The default equirectangular projection (left) distorts the shape and size of Crater Lake National Park. A cylindrical or pseudocylindrical projection, such as the Sinusoidal (right), will minimize distortion while maintaining straight, equally-spaced parallels.*

tif, derived from 1-arc second Shuttle Radar Topography Mission elevation data (**dwtkns.com/srtm30m**). Place the park boundary layer on top and change its symbol type to a simple line so you can see the underlying DEM (Figure 5).

STEP 2: SELECT A PCS

The distortion of Crater Lake's circular shape should be immediately obvious, so our first task is to assign an appropriate projected coordinate system (PCS). Your choice of PCS will affect the creation and final appearance of the transects—we are making maps, after all—so consider which projection properties you wish to preserve. I find it logical to draw transects along lines of latitude rather than meridians or obliquely, and a cylindrical or pseudocylindrical projection with straight, equally-spaced parallels will ensure equal spacing between the transects. I selected a Sinusoidal projection whose central meridian intersects Wizard Island (Figure 6). Because the sinusoidal projection is distortion-free along its central meridian, the lake shape is no longer distorted (Figure 5).

STEP 3: CREATE A LINE GRID

Use the Create Grid vector creation tool to produce the transects (**Vector > Research Tools > Create Grid**). The Create Grid tool can be confusing because the number of transect lines cannot simply be assigned. Rather, the grid extent area must be defined, then the desired horizontal and vertical spacing between grid lines within that area must also be defined. Line spacing values use the same units of measurement as the project projection—in this case, meters. Assigning spacing values to create a specific number of grid lines requires a bit of division. For instance, I wanted to use 80 transects in the Crater Lake National Park map, because that is the number of lines used in the *Unknown Pleasures* artwork. To accomplish this, I divided the north-south extent of the park (approximately 35,500 meters) by the desired number of transects (80). Once the quotient is calculated (443.75 meters), enter it into the "Vertical spacing" field of the Create Grid window (Figure 7). Set the grid extent to the park shapefile and the tool will draw the grid within the boundaries of the park. Alternatively, you can draw your own grid extent area; this option is appropriate if you are not mapping a bounded feature such as a national park or country, or you do not need a precise number of transects.

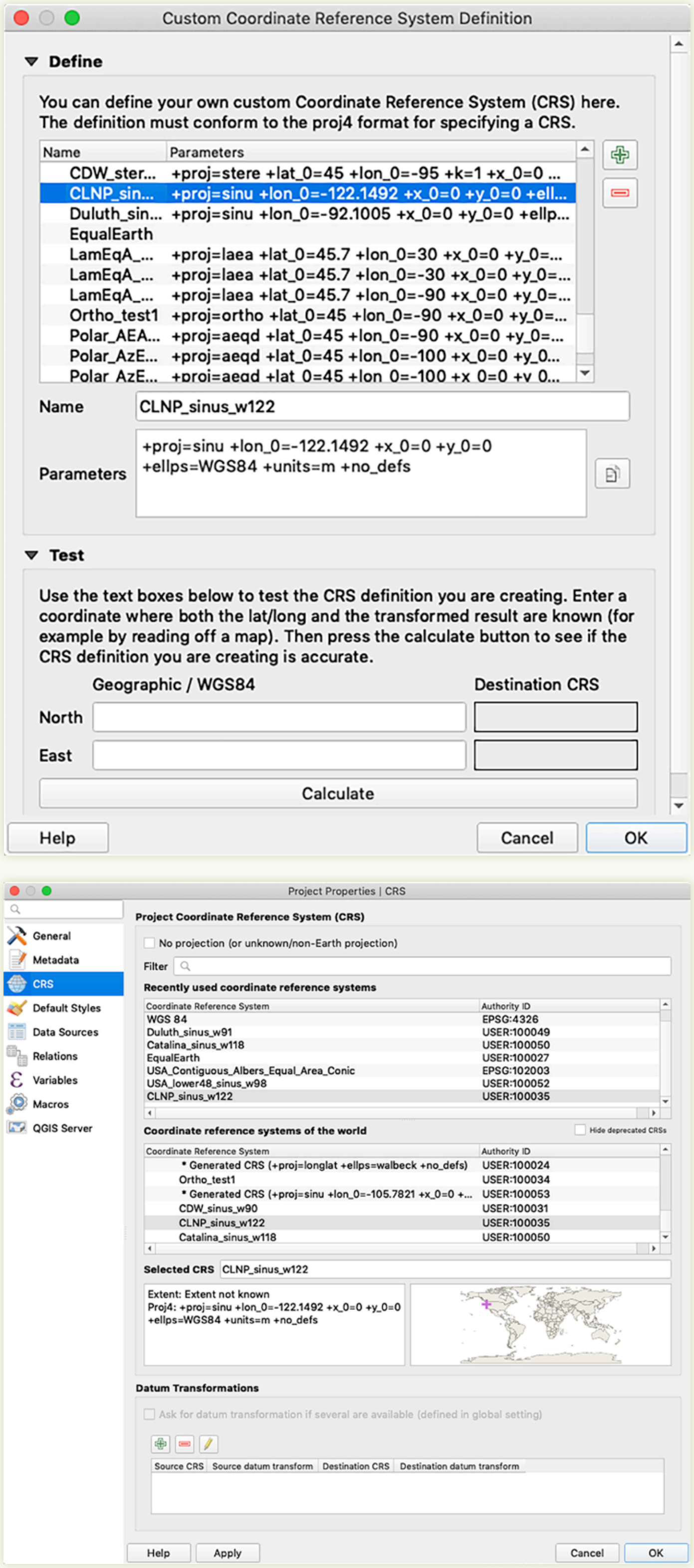

***Figure 6.** To use a custom projection, enter its proj4 string in the Custom Coordinate Reference System Definition parameters field, then assign the projection in the Project Properties menu. For Crater Lake I assigned a Sinusoidal projection centered on -122.1492°, which passes through Wizard Island (Proj4: +proj=sinu +lon_0=-122.1492 +x_0=0 +y_0=0 +ellps=WGS84 +units=m +no_defs).*

Transect placement is the most important—and often frustrating—step of the entire workflow. Ideally, the transects will overlay the most prominent or recognizable terrain features, such as Wizard Island, otherwise the finished map will appear "off." How do you get the grid lines to transect the appropriate terrain features? I recommend two approaches. First, incrementally increase or decrease the vertical grid spacing until the tool draws the grid lines in their "ideal" position; in the case of Crater Lake, I want enough lines to capture the shape of the crater, and at least one line to intersect Wizard Island, which is what makes Crater Lake so recognizable.

Alternately, manually adjust the grid position until it overlaps the desired features (**Layer** > **Toggle Editing**, then **Edit** > **Move Feature(s)**). While the second approach can be more efficient, it also requires additional steps to edit the feature layer, and can cause the grid to fall outside the boundaries of the park.

Another decision to make is the number of transects to use. While there is no "correct" number for any one map or location, the Goldilocks principle is certainly applicable. Too many transects will overcrowd the image; too few and the underlying terrain becomes unrecognizable. The shape and alignment of the mapped feature will also influence how many transects are appropriate. It is up to you to find that happy medium.

STEP 4: REMOVE VERTICAL GRID LINES

The vertical lines in the grid are unnecessary. Select all of the horizontal lines and save them to a new layer (Figure 8). This is a simple step!

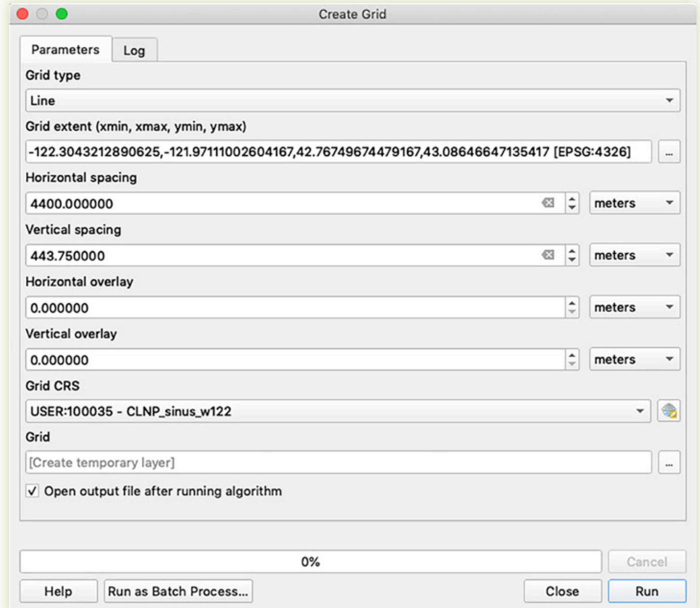

Figure 7. The Create Grid tool. A quirk of the tool is that you cannot enter "0" spacing values, so you must also assign a "Horizontal spacing" value; I typically enter a value one or two orders of magnitude higher than the vertical spacing.

STEP 5: CLIP THE HORIZONTAL LINES

Next, use the Clip tool (**Vector** > **Geoprocessing Tools** > **Clip**) to clip the horizontal line layer to the boundary of Crater Lake National Park (Figure 9). Skip this step if you are not clipping your transects to match the shape of a particular feature, such as if we were mapping Crater Lake itself and not the entire national park. Also, I do not recommend clipping transects to a vector coastline, since coastline vectors are often misaligned with elevation rasters; these situations are better handled in R, as demonstrated below.

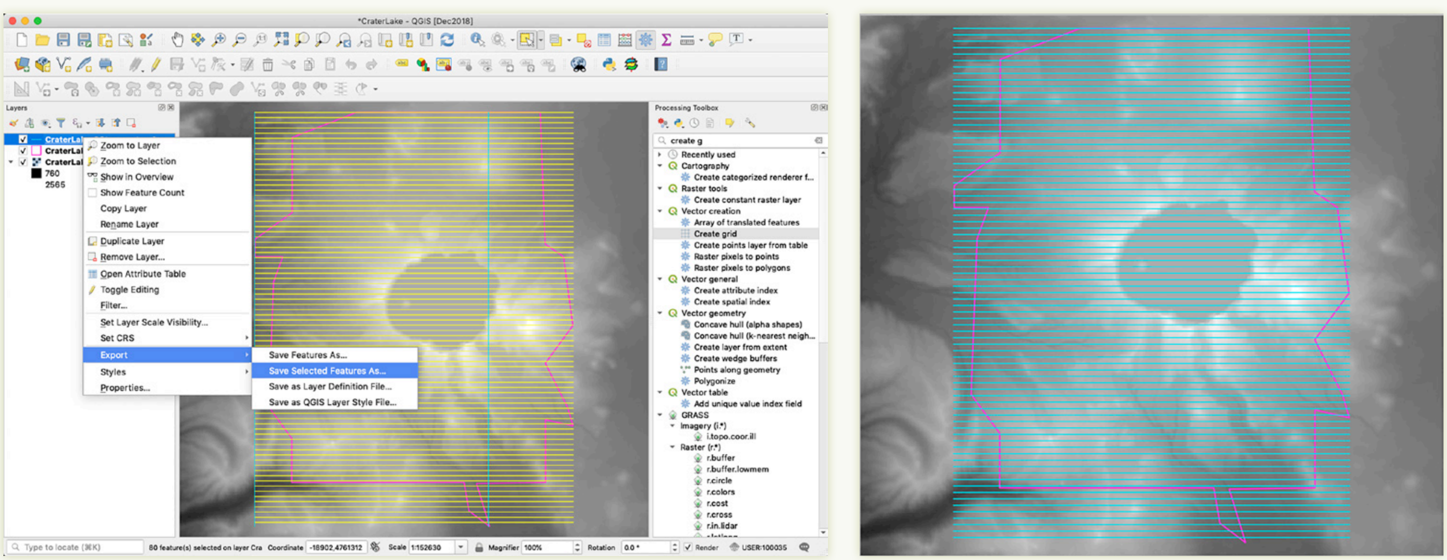

Figure 8. Save the horizontal (latitudinal) lines to a new layer.

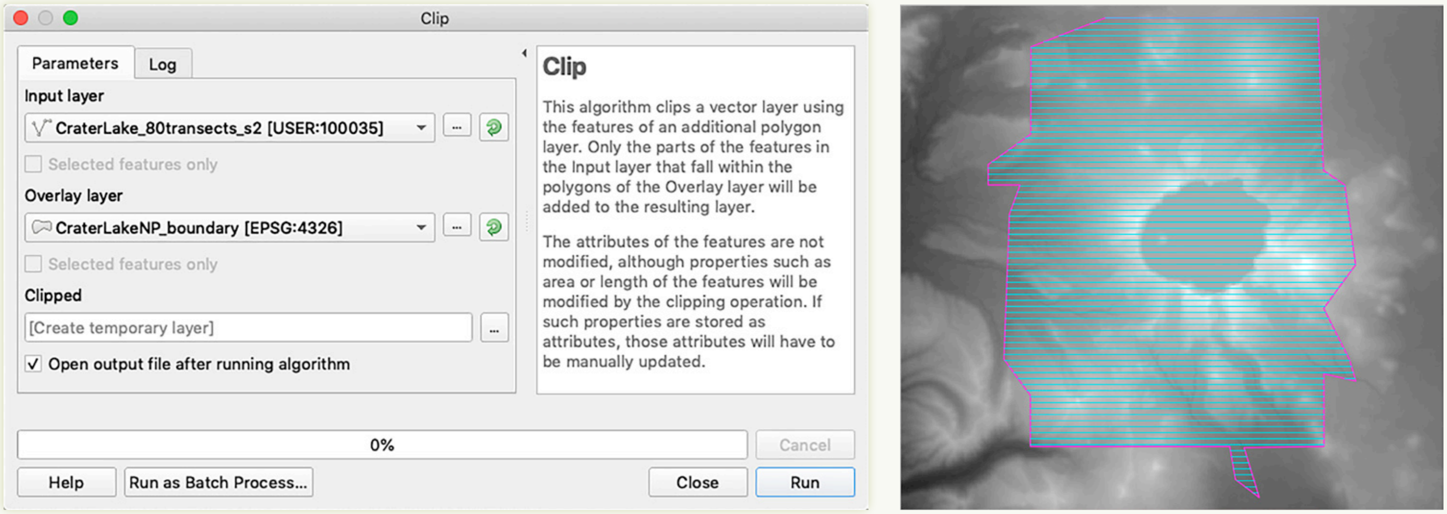

Figure 9. Clip the horizontal transect lines to the shape of the park boundary before converting them to points.

STEP 6: CONVERT LINES TO POINTS

In order to plot the transects in R you must first convert the lines to points, then sample coordinate and elevation values for each point. QGIS contains multiple line-to-point conversion tools; in this workflow I use the vector creation tool "Generate Points (Pixel Centroids) Along Line," which produces 24,654 points (Figure 10). For large areas such as the United States, I recommend the SAGA vector point tool "Convert Lines to Points," which allows you to increase the spacing of your sample points, and thus avoid generating thousands or even millions of unnecessary points.

STEP 7: ADD ELEVATION VALUES TO POINTS

This step requires the Point Sampling Tool plug-in (github.com/borysiasty/pointsamplingtool). Download the plug-in, then use it (**Plugin > Analyses > Point Sampling Tool**) to extract elevation values from the Crater Lake DEM at each sample point.

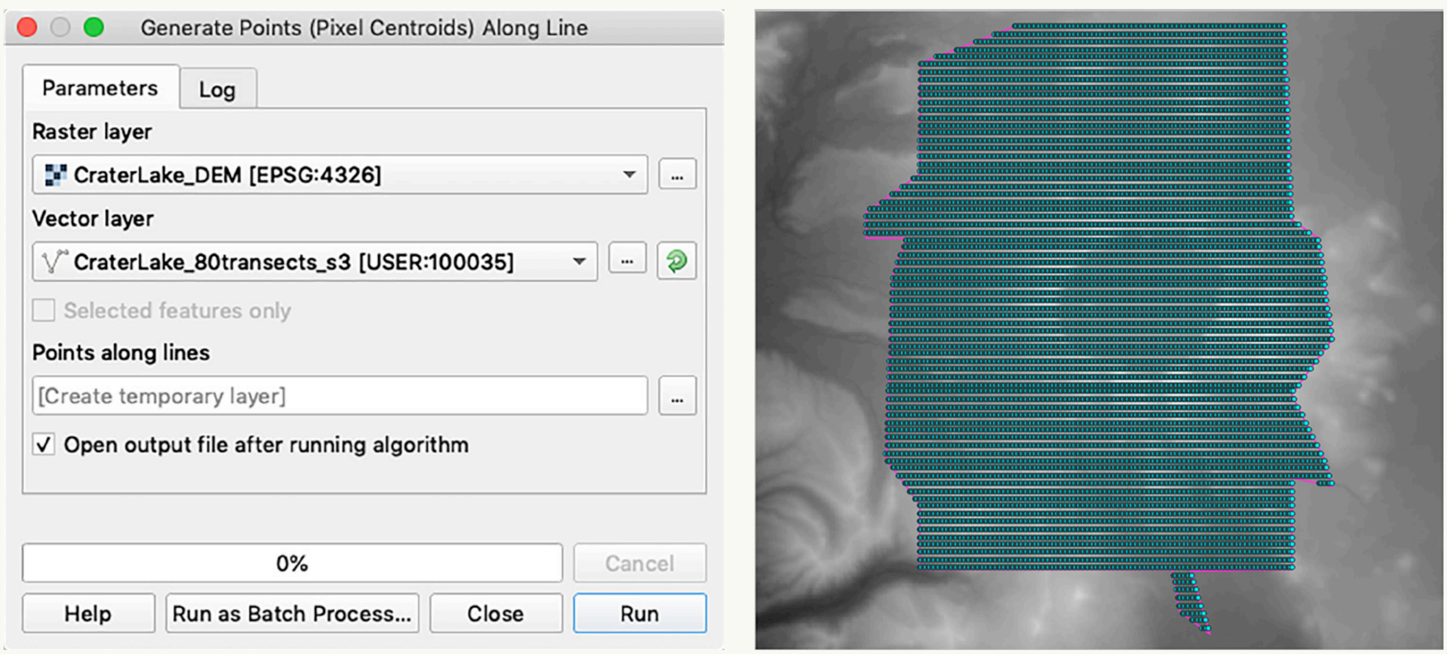

Figure 10. This specific tool generates one sample point per raster grid cell, which is often overkill and can produce an unnecessarily large file size. Proceed with caution.

STEP 8: ADD COORDINATE DATA TO POINTS

Open the Processing Toolbox (**Processing > Toolbox**) and select the SAGA GIS vector point tool "Add coordinates to points" to add a coordinate pair to each sample point. The resulting vector layer contains our transect data.

STEP 9: CONVERT VECTOR LAYER TO CSV

In the final step, convert the transect dataset to a comma-separated values (CSV) file (**Layer > Save As…**). This ends the QGIS stage of the workflow.

STAGE 2: R

These instructions were written using RStudio Desktop version 1.1.463 running R version 3.5.1. In this section I discuss each line of code from Example 1, below, which is also available in the R script file "CraterLakeTransectMap.R" in the Git repository for this project.

```
# load requisite packages
library(ggplot2)
library(ggridges)
library(mapproj)

# set your working directory
setwd("~/CraterLakeNP")

# Import the Crater Lake transect data
CraterLake_80transects &lt;- read.csv(file="CraterLake_80transects.csv",
   header=TRUE, sep=",")

# view data frame and change column headers
head(CraterLake_80transects)
names(CraterLake_80transects)[1] &lt;- "Elev"
names(CraterLake_80transects)[2] &lt;- "Lon"
names(CraterLake_80transects)[3] &lt;- "Lat"

# plot the transects with ggplot2 & ggridges
CraterLake_basic &lt;- ggplot(CraterLake_80transects,
  aes(x = Lon, y = Lat, group = Lat, height = Elev)) +
  geom_density_ridges(stat = "identity")

# Call the default plot variable
CraterLake_basic

# customize the appearance to mimic the Unknown Pleasures artwork
CraterLake_Joy &lt;- ggplot(CraterLake_80transects,
  aes(x = Lon, y = Lat, group = Lat, height = Elev)) +
  geom_density_ridges(stat = "identity", scale = 15,
  fill="black", color = "white") +

```

Example 1. *Full R script referenced in Stage 2, which is also available in the R script file "CraterLakeTransectMap.R" in the Git repository for this project.*

```
# set the upper and lower y-axis limits
ylim(42.77, 43.15) +

# add a title to the bottom of the plot frame
scale_x_continuous(name = "CRATER LAKE NATIONAL PARK") +

# use theme() to customize the background, axis labels, titles, etc.
theme(panel.grid.major = element_blank(),
   panel.grid.minor = element_blank(),
   panel.background = element_rect(fill = "black"),
   axis.line = element_blank(),
   axis.text.x=element_blank(),
   plot.background = element_rect(fill = "black"),
   axis.ticks.x=element_blank(),
   axis.title.y=element_blank(),
   axis.text.y=element_blank(),
   axis.ticks.y=element_blank(),
   axis.title.x = element_text(colour = 'white', size = 18)) +

# projects the transect data to a specified PCS
coord_map()

# Call the stylized plot variable
CraterLake_Joy

# Save the plot as a PNG or PDF
ggsave("CraterLake_Joy.png", dpi=300)
ggsave("CraterLake_Joy.pdf")

# Customized plot:
ggplot(CraterLake_transects,
  aes(x = Lon, y = Lat, group = Lat, height = Elev)) +
  geom_density_ridges(stat = "identity", scale = 15,
  fill="pink", color = "violetred4", size = 1, linetype = "12") +
  scale_x_continuous(name = "CRATER LAKE NATIONAL PARK") +
  ylim(42.77, 43.15) +
  theme(panel.grid.major = element_blank(),
     panel.grid.minor = element_blank(),
     panel.background = element_rect(fill = "pink"),
     axis.line = element_blank(),
     axis.text.x=element_blank(),
     plot.background = element_rect(fill = "pink"),
     axis.ticks.x=element_blank(),
     axis.title.y=element_blank(),
     axis.text.y=element_blank(),
     axis.ticks.y=element_blank(),
     axis.title.x = element_text(colour = 'violetred4', size = 18)) +
  coord_map()
```

***Example 1**, continued.*

```
# load requisite packages
library(ggplot2)
library(ggridges)
library(mapproj)
```

My method of plotting transect maps in R requires three packages: `ggplot2`, `ggridges`, and `mapproj`. `ggplot2` is a graphics and data visualization creation package based on *The Grammar of Graphics* (Wilkinson 2006). `ggridges` contains functions that plot data in the *Unknown Pleasures* style; this package is what inspired me to revisit transect mapping (and ultimately write this article), and is rightly the star of this workflow. The third package, `mapproj`, assigns a projected coordinate system to the plotted data.

```
# set your working directory
setwd("~/CraterLakeNP")

# Import the Crater Lake transect data
CraterLake_80transects <- read.csv(file=
  "CraterLake_80transects.csv",
  header=TRUE, sep=",")
```

Set the working directory to the folder containing the transect data, then import the Crater Lake transect data. The `read.csv` function imports data from a CSV file, reads it as a data frame, and assigns the data frame to a new R variable. In this example, we will also name the variable "CraterLake_80transects."

```
# view data frame and change column headers
head(CraterLake_80transects)
names(CraterLake_80transects)[1] <- "Elev"
names(CraterLake_80transects)[2] <- "Lon"
names(CraterLake_80transects)[3] <- "Lat"
```

Call the `head()` function to preview the first six rows of your transect data frame. Notice the data frame uses the same column headers as the CSV file: "srtm_12_04" for elevation values, "X" for longitude, and "Y" for latitude. I prefer to work with descriptive column headers, so I use the `names()` function to rename each header. These lines in the code above are completely optional and skipping them will not affect the operation of the plotting functions.

```
# plot the transects with ggplot2 & ggridges
CraterLake_basic <- ggplot(CraterLake_80transects,
  aes(x = Lon, y = Lat, group = Lat, height = Elev)) +
  geom_density_ridges(stat = "identity")
```

The lines above create a basic plot of the transect data. `CraterLake_basic <-` assigns the plot to its own R variable. Calling `ggplot()` initializes the plotting process. `aes()` refers to "aesthetic mappings" and defines how the variables in the data frame—Lon, Lat, Elev—will be mapped in the plot. Pass `aes()` arguments to assign longitude to the x-axis, latitude to the y-axis, and elevation to the height of each ridgeline. A fourth argument, `group = Lat`, instructs the plot to draw ridgelines by connecting points of equal latitude.

The `ggridges` function `geom_density_ridges()` is what draws the transects in a ridgeline plot. The argument `stat = "identity"` sets the height of the ridgelines to the elevation values in the data.

```
# Call the default plot variable
CraterLake_basic
```

Calling `CraterLake_basic` displays the plotted transect lines (Figure 11). Now, the default plot is not particularly attractive, so pass additional arguments to customize the plot's appearance.

```
# customize the appearance to mimic the Unknown
  Pleasures artwork
CraterLake_Joy <- ggplot(CraterLake_80transects,
  aes(x = Lon, y = Lat, group = Lat, height = Elev)) +
  geom_density_ridges(stat = "identity", scale = 15,
  fill="black", color = "white") +
```

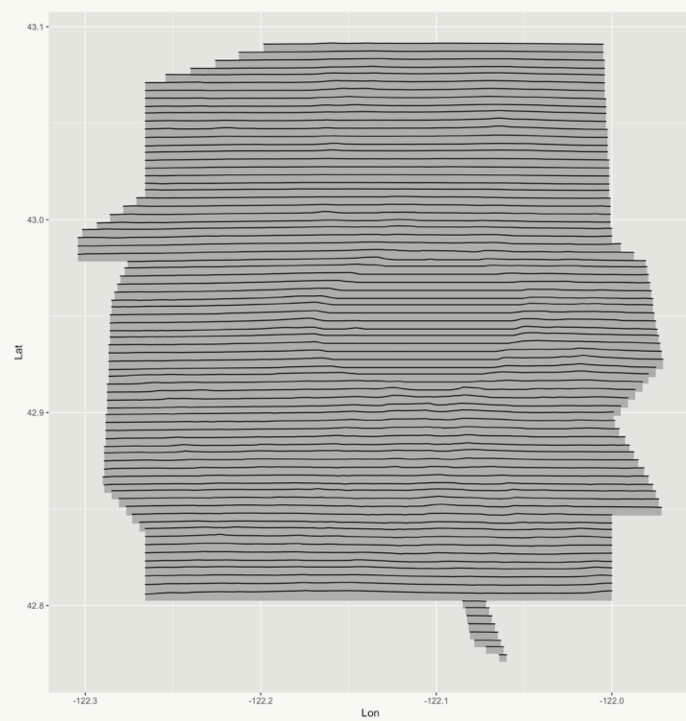

***Figure 11.** The default ridgeline plot of Crater Lake National Park.*

I have made four changes to the code seen in lines 19–22. First, I assigned the plot to a new R variable `CraterLake_Joy`. Second, I set the `scale` parameter, which controls the height of each ridgeline, to add vertical exaggeration to the transects and increase the amount of overlap. Lower scale values will minimize exaggeration and overlap, and may obscure the relative relief of the plotted transects; setting too high a scale value may result in over-exaggerated terrain and overlap. Third, I assigned two colors, white for the ridgelines and black for their fills. Fourth, I added a plus sign at the end (`+`) to indicate that subsequent lines contain additional plotting arguments.

```
33  # set the upper and lower y-axis limits
34  ylim(42.77, 43.15) +
```

`ylim()` sets the upper and lower latitudinal limits of the y-axis. This command is useful when mapping the same dataset to multiple scale factors because it ensures each plot uses the same y-axis interval. Be sure to assign latitudes that exceed the upper and lower boundaries of the mapped feature, otherwise the plot may cut off the transects or fail to plot them entirely.

```
36  # add a title to the bottom of the plot frame
37  scale_x_continuous(name = "CRATER LAKE NATIONAL PARK") +
```

This command adds a title underneath the x-axis.

```
39  # use theme() to customize the background, axis
      labels, axis titles, tick marks, etc.
40  theme(panel.grid.major = element_blank(),
41    panel.grid.minor = element_blank(),
42    panel.background = element_rect(fill = "black"),
43    axis.line = element_blank(),
44    axis.text.x=element_blank(),
45    plot.background = element_rect(fill = "black"),
46    axis.ticks.x=element_blank(),
47    axis.title.y=element_blank(),
48    axis.text.y=element_blank(),
49    axis.ticks.y=element_blank(),
50    axis.title.x = element_text(colour = 'white',
        size = 18)) +
```

Use `theme()` to customize the appearance of the plot. These lines remove all typical plot elements, such as grids, tick marks, axis labels, and adjust the background colors to match the ridgeline fill colors. I entered values to mimic the appearance of the *Unknown Pleasures* artwork—white lines and text on black background.

```
52  # projects the transect data to a specified PCS
53  coord_map()
```

The `coord_map()` function from the `mapproj` package defines a projection for the plotted data. Neither the CSV file nor the data frame contain any projection information, and as a result the plotted transects exhibit the sort of spatial distortion illustrated at the beginning of Stage One. By calling this function you can project the transect data to a specific projection, although I have found that leaving the field blank produces acceptable results for medium- and large-scale maps. Note that lines 28–53 of the R script will all execute at once.

```
55  # Call the stylized plot variable
56  CraterLake_Joy
```

Call `CraterLake_Joy` to view the *Unknown Pleasures*-styled transect map. As you can see, the results are pretty spot on (Figure 12)!

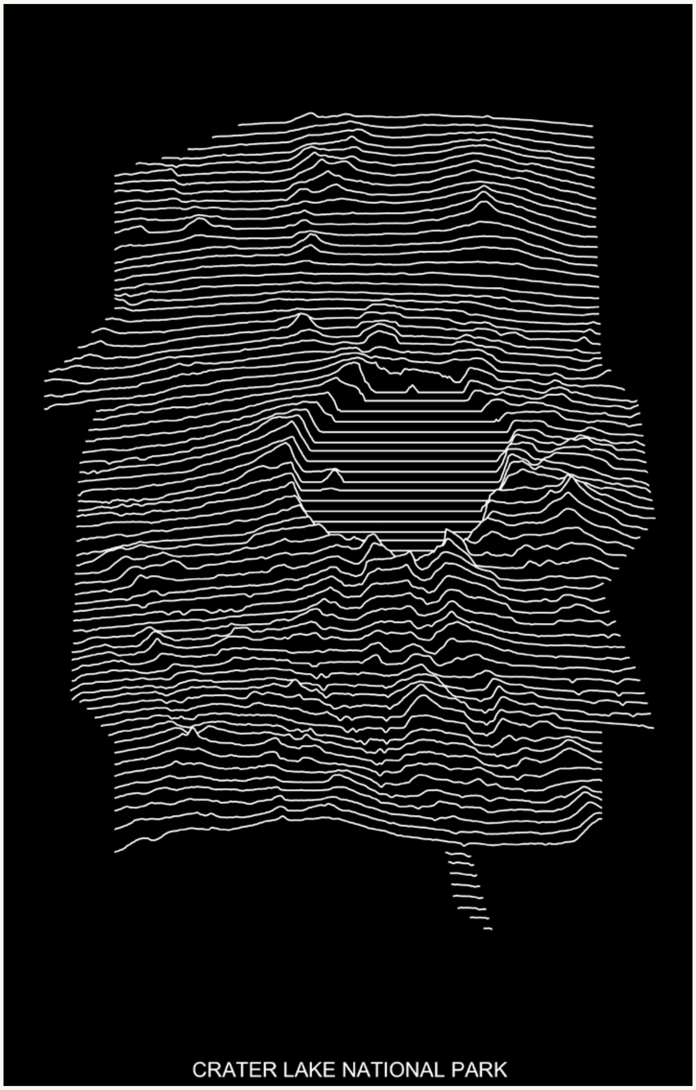

Figure 12. *Crater Lake National Park in the iconic style of Unknown Pleasures.*

```
# Save the plot as a PNG or PDF
ggsave("CraterLake_Joy.png", dpi=300)
ggsave("CraterLake_Joy.pdf")
```

As a final step, use `ggsave()` to save the plot in a format of your choice. In this example I exported both PNG and PDF formats to use in Stage Three of this tutorial. The exported maps will save to your working directory.

Concluding the R stage of this workflow are four practical and aesthetic suggestions. First, the graphic capabilities of `ggplot2` are extensive and I encourage readers to play around with their own stylizations beyond the *Unknown Pleasures* aesthetic. For instance, changing a few aesthetic arguments such as color, line weight, and line type can produce considerably different map styles (Figure 13).

Second, although the `coord_map()` argument can remain empty when mapping small areas, the default projection is inappropriate for large areas. The transect maps in Figure 14 illustrate this issue: A omits the `coord_map()` argument, B passes a blank argument, and C assigns an Azimuthal Equal Area projection. Clearly, C produces the most aesthetically pleasing representation of the continental United States.

Third, converting water elevation values to `NA` is an efficient way to remove those water features from the plot. For instance, Figure 15 displays Catalina Island before and after all sea level values were converted to `NA`. This method of "clipping" transects along a coastline is more effective than pairing elevation rasters and coastline vectors, which are often misaligned.

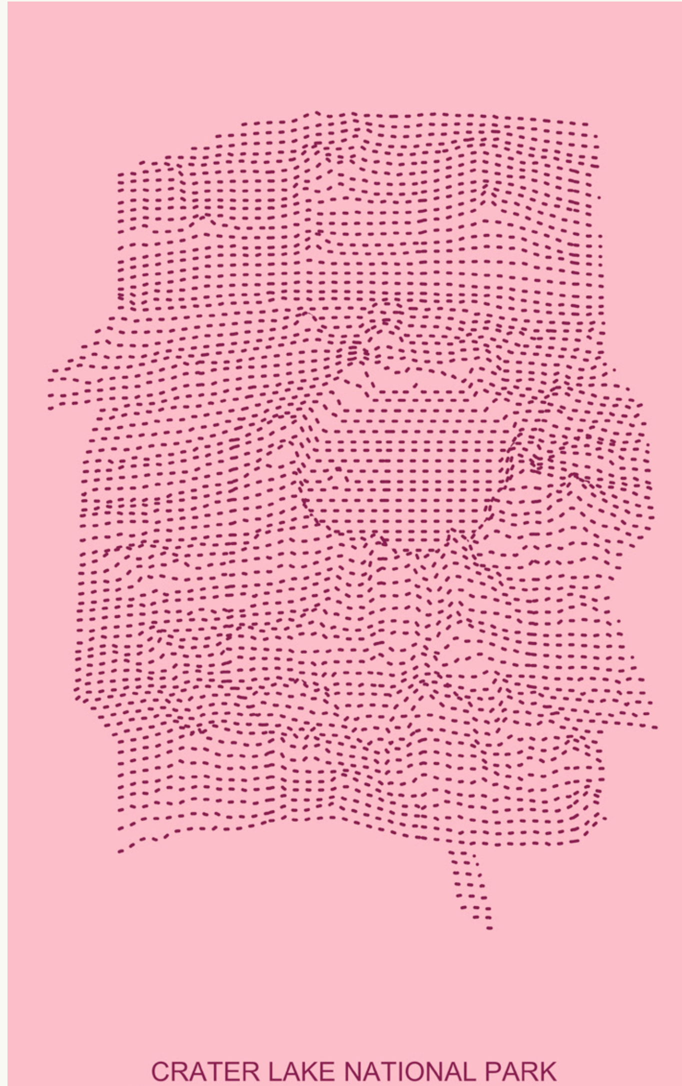

Figure 13. *A different aesthetic spin on the same data file.*

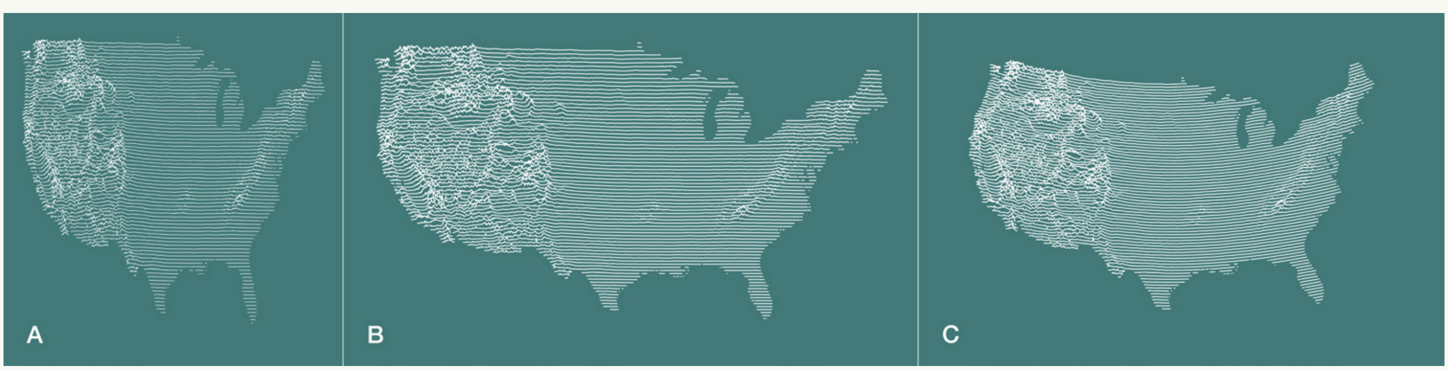

Figure 14. *A ridgeline plot of the continental United States. Omitting* `coord_map()` *entirely (A), passing a blank* `coord_map()` *(B), and passing* `coord_map("azequalarea", orientation = c(39.8283, -98.5795, 0))` *(C).*

Fourth and finally, look at the work of others! Many members of the cartography and R communities have developed their own transect map packages and workflows. As the GIS capabilities of R continue to expand, I expect to migrate the entirety of stage one into the R environment.

STAGE 3: ADOBE ILLUSTRATOR OR PHOTOSHOP

These instructions were written using Adobe Illustrator CC 2019 (version 23.0.1) and Photoshop CC 2018 (version 20.0.1). First, a disclaimer: this stage is not required to produce an attractive transect map. Feel free to stop here! The R packages `ggplot2` and `ggridges` (and many others) are capable of beautiful data visualization, and I create many of my transect maps in R with no external modifications. When I feel a bit more visual oomph is necessary, however, I turn to Adobe Illustrator or Photoshop to apply subtle modifications that I currently cannot perform in R. In this section I present the two most common "tricks" I use to enhance the final appearance of my transect maps: line gradients in Illustrator and background gradients in both Illustrator and Photoshop. In both cases I encourage the reader to explore and improve upon my examples. While the directions below are for Adobe products, other vector or raster graphics programs should be able to achieve similar results.

LINE GRADIENTS IN ADOBE ILLUSTRATOR

Apply a subtle gradient to transect lines to emphasize relative relief, create a faint impression of shaded relief, and add a touch of depth to the otherwise flat image (Figure 16). This technique requires the PDF created in R. Be aware the PDF, as exported, is composed of a single layer containing one text path and two clipping masks; the foreground clipping mask holds all of the individual transect line and fill pairs, and the background mask contains the panel and plot fills.

Open the PDF in Illustrator, then expand the layer and lock the bottom (background) clipping mask. Activate the Stroke (keyboard shortcut: **X**). Use the Direct Selection Tool (white selection arrow, keyboard shortcut: **A**) to select a single transect line, then select all other transect lines (**Select > Same > Stroke Color**); *do not* group the transect lines, otherwise you will ruin the overlapping pattern of lines and fills. Next, open the gradient tool

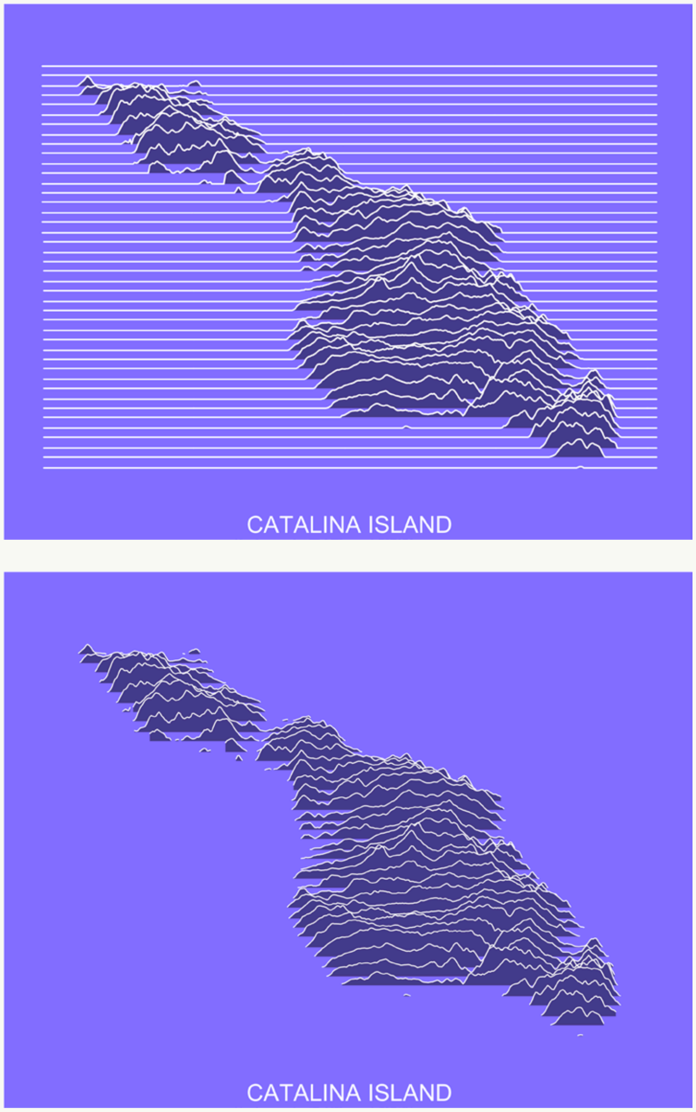

Figure 15. *Sea-level sample points removed with the line* `Catalina_NoWater$Elev[Catalina_NoWater$Elev <= 0] <- NA`

(**Window > Gradient**) and select the Linear Gradient option (this should be the default). Change the angle to -90º and set the Midpoint location to 75%. Click on the right color stop (the square at the end of the gradient slider) and assign the desired color. That's the whole procedure! It can take quite a bit of testing to find the appropriate gradient colors. Because I prefer a *subtle* gradient effect, I typically begin with a lighter tint of the fill color then make it progressively darker until I find the desired color. Assign too light a color and the gradient is not perceptible; assign too dark a color and the effect can be overwhelming. Note this does not produce a quantitatively consistent scale—that is, Illustrator does not assign a distinct color for each elevation value. Instead, the full gradient is stretched across the vertical range of each individual transect line.

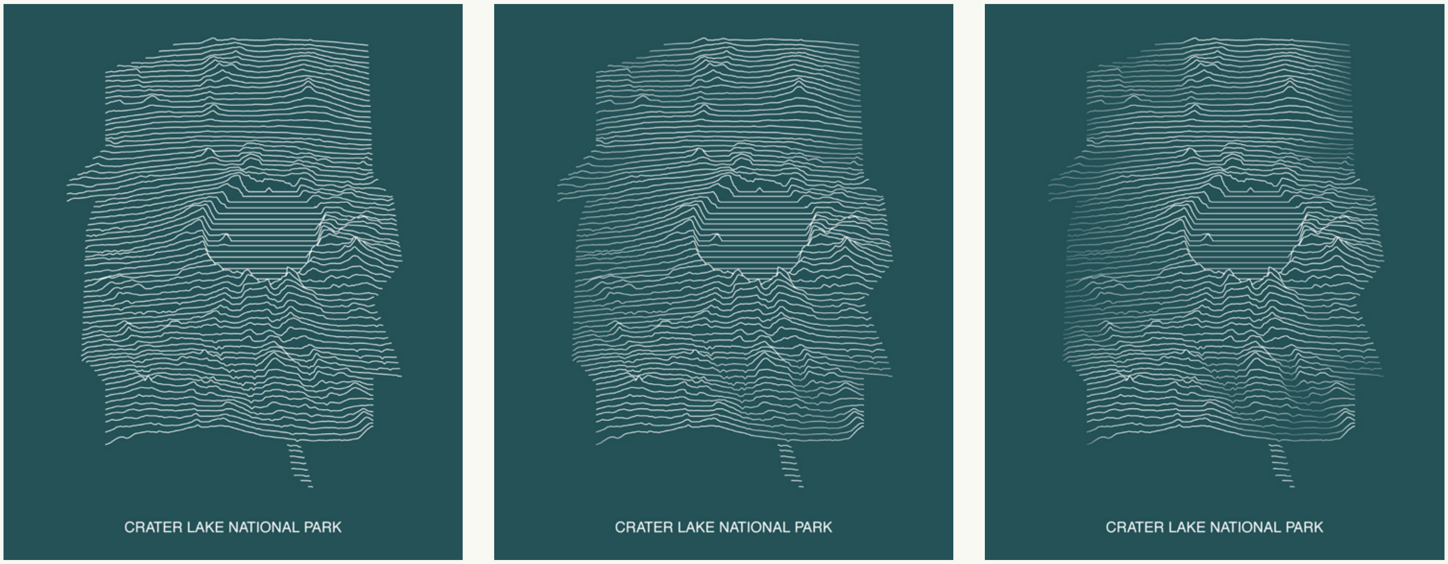

Figure 16. *Line gradients added in Illustrator: no gradient (left), subtle gradient (middle), and strong gradient (right).*

BACKGROUND GRADIENTS IN ADOBE ILLUSTRATOR OR PHOTOSHOP

Background gradients can give transect maps a nifty screen print effect (Figure 17). Unlike line gradients, you *can* apply a background gradient to a ridgeline plot in R. However, I am usually unsatisfied by the results and thus use either Illustrator or Photoshop to achieve the desired effect. The process, which is nearly identical in both software environments, utilizes the black-and-white Crater Lake transect map and the Screen blending mode. A layer's blending mode determines how its colors (the blend colors) interact with colors in the underlying layers (the base colors). The Screen blending mode combines blend colors and base colors to produce brighter colors, except for black, which is replaced entirely, and white, which is left intact. Screening works particularly well with the transect map, because the gradient replaces the black fill while leaving the white transects lines untouched.

In Photoshop, open the Crater Lake PNG (created in R) and add a new gradient fill layer on top (**Layer > New Fill Layer > Gradient).** Accept all defaults and click OK. In the Gradient Fill window click on the default gradient to open the Gradient Editor. Select the **Blue, Red, Yellow** preset. Click OK to close the Gradient Editor, then click OK to close the Gradient Fill window. Finally, change the gradient fill layer's blending mode to **Screen**.

In Illustrator, open the Crater Lake PDF and add a new layer on top. Create a rectangle (keyboard shortcut: **M**) with the same dimensions as the map. Change the rectangle blending mode to Screen (**Window > Transparency > Blending Mode > Screen**). Set the rectangle stroke color to **none**. Activate the rectangle fill color. Open the Gradient tool (**Window > Gradient**) and select the **Linear Gradient** option. Click on the right and left color stops (the circles squares at either end of the gradient slider) and assign the desired colors.

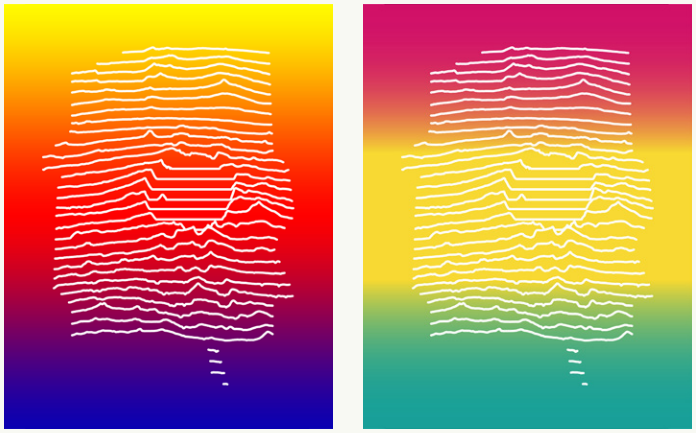

Figure 17. *Background gradients created in Photoshop (left) and Illustrator (right).*

MIMICRY, INSPIRATION, AND CREATION

There is a lot to be said for mimicry in mapmaking. I often find that I learn the most about cartographic forms and content through deliberate deconstruction and mimicry. This applies to everything from iconic works such as

Harry Beck's Tube map, to popular techniques like the illuminated (Tanaka) contour method, to singular data visualizations like the *Unknown Pleasures* album art. The challenge of this approach, as I have also found, is not limiting myself to simple mimicry or derivatives, but using them as sources of inspiration for my own creativity.

To this end, I encourage you to map your favorite locations in the *Unknown Pleasures* style. Go ahead, it's fun! But do not stop there—continue to explore the potential of this form, map unconventional data, develop your own workflow, and continue to improve your cartographic skills. There is no final design, and there is no correct number of transects. Does it matter if, regardless of how far you push the form, there will always be a shadow of a resemblance to the *Unknown Pleasures* album art? Perhaps, but who cares? Happy mapping!

RESOURCES

- ggplot2: **cran.r-project.org/web/packages/ggplot2**
- ggridges: **cran.r-project.org/web/packages/ggridges**
- mapproj: **cran.r-project.org/web/packages/mapproj**

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Fake Maps: How I Use Fantasy, Lies, and Misinformation to Understand Identity and Place

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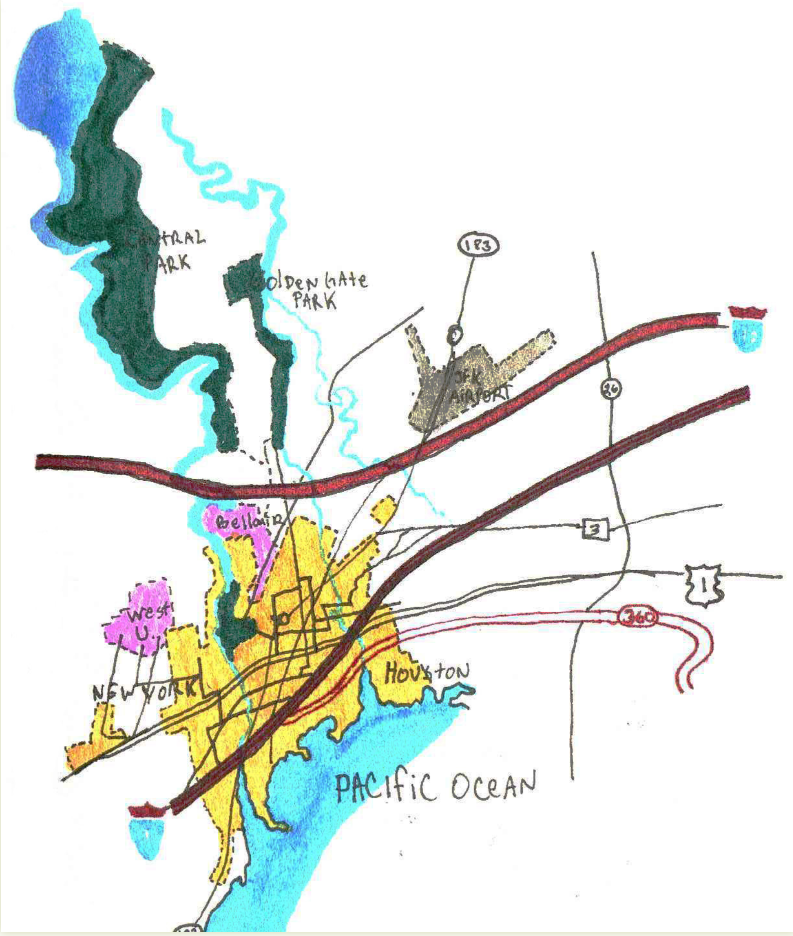
There were two maps that really influenced me as I was growing up in suburban Texas in the ’80s. The first was a map of Middle Earth found in J. R. R. Tolkien’s *The Hobbit* and the other was a map of the spice planet Arrakis from Frank Herbert’s *Dune*. Around fifth grade, I began to emulate those maps by creating my own based on imagined planets and civilizations. They were crude drawings, made with a #2 pencil on typing paper. And I made tons of them. I had a whole binder full of these drawings, with countries that had names like Sh’kr—which, in my head, was pronounced *sha-keer*. Maps, so often meant to represent reality, instead solidified worlds of fantasy and fiction.

Of course, I was not thinking critically about cartography in this way when I was in grade school, but those fantasy maps laid the foundation for me to explore mapping again in the late ’90s. By that time, I was going to art school in New York. It was such a contrast to growing up in Texas: the culture was different, the food was different (I never understood whole black beans in a burrito, coming from a place where refried beans were the norm), the ways people got around were different, and even the minorities were different. I was really out of my element, which I suppose is an important ingredient in an artist’s development. Sometime halfway through college, nostalgia hit me very badly. I missed home, and drove back and forth between Houston and New York in between each semester. Every time I did, I would miss home even more. The only thing that sort of helped with homesickness was to look at a map of my hometown. Then this coping mechanism spilled into my art practice one night, when I drew a small map in my journal of a fictional city with the words Houston and New York in it, along with a number of other places that were important to me. Just like the penciled maps I made in the fifth grade, I made more and more of them, but this time with a more developed aesthetic language. I played around with text and colors, and experimented with different media. It wasn’t long until I made the decision to start a long-term series based on this direction, which lasted for the next ten years: the America Series.



New York–Houston journal drawing, around 1995.

Hollywood. *Ink on paper, 80″ × 64″. 2005.*

THE AMERICA SERIES

In the Philippines, where I was born but never lived, people talk about "going to America." Not to the United States of America, but just America. America—the idea, the stereotype, and the cultural identity—this was the metaphorical place immigrants really wanted to move to. Not Sugar Land, Texas, the suburb of Houston where my family ended up. With the America Series, I sought to appropriate the visual language of maps without being bounded by geographical rules, leaving the content to be anything I wanted. Using the name "America" directed the intention of the series towards more of an identity rather than a location. This series became a map of America based on my own history, interaction, and memory of this country and the culture. There were some "American" traits I made sure to have just to keep the map reminiscent of the real world; for example I had to include a region similar to the Great Lakes, along with an East and a West Coast, some sort of Canada to the north and Mexico to the south, a Gulf region, some kind of island state analogous to Hawaii, and around 50 states. All of this created the signature look of the US, except that my America included five extra states for a total number of 55. This was an homage to the car, since the kind of map I originally appropriated was the road map and the national speed limit was 55—the double nickels. These five extra states were mostly there to add a more focused commentary on the culture and history of America. They are Hollywood (all the names in the state are fictional places in movies, books, and television), Monopoly (all the Fortune 500 headquarters are there; the capital of Monopoly is Bentonville, the HQ of Walmart), Disney (a company that definitely runs like a sovereign entity), Internet (the first version of the map was made in 2004 and the second in 2009; you can really see how much became outdated in those five years), and Territory (with the names of places that the US has occupied or colonized, including the Philippines). The last drawing in this series is the *America* key map. As I was drawing this final piece, nostalgia bubbled again, conjuring memories of the times I had worked on each individual state in the series: what I was thinking about then, or what I was listening to, or whom I had a crush on. So I chose a color scheme based on an old wooden map puzzle I had as a kid that had these same five colors.

America (Key Map of the States and their Capitals). *Ink on paper, 34" × 64". 2008.*

THE STRANGERHOOD SERIES

After the America series, I moved on to playing more with cartographic language and what it can do. My idea with the Strangerhood series was to use some of the conceptual strategies from the America series, but rather than look critically at the construction of my own identity, I wanted to see if I could look at the construction of a place's identity. The title Strangerhood is derived from sociologist Zygmunt Bauman (1991) and his allegorical use of the "stranger": an outside force that has both positive and negative effects on a society (and, in turn, a place). This was a role I was already familiar with since my childhood as a first-generation immigrant. This series took six neighborhoods in San Francisco that have been, or are being, gentrified: The Mission, Fisherman's Wharf, North Beach, The Castro, Chinatown, and Haight-Ashbury. I find that gentrification is part of a longer process that involves the appropriation of an identity or culture. To begin the series, I had to figure out how each neighborhood's identity and culture was demonstrated, exploited, and/or shared. I visited each one and looked for the visual languages that dressed them. For example, Fisherman's Wharf was originally a locale where Chinese and Italian immigrants sold their catches to a growing gold rush population, and it's become a popular tourist destination filled with what you would expect a tourist destination to have, things like souvenir shops and specialty foods. In each neighborhood I embodied the role of the stranger, taking pictures of all the patterns, color schemes, and texts found in the local businesses, architecture, murals, graffiti, etc. From these photos, I appropriated various patterns that made their way onto my map of Fisherman's Wharf. The origins of the patterns range from the San Francisco Carousel on Pier 39, to the Musée Mécanique (which is itself a transplanted identity from a totally different part of town), Ghirardelli Square, and the famous clam chowder bowls that are usually served in those red and white paper food

Fisherman's Wharf. *Ink on paper, 32" × 21". 2014.*

Chinatown. *Ink on paper, 32" × 21". 2014.*

baskets, often synonymous with a variety of tourist foods. There are hints of the Wharf's immigrant past, with some of the text marking the occasional Italian seafood restaurant. The text on these maps all comes from my photos—including perspective distortion—with only the color schemes changed. This appropriated text then takes on the role of cities on the map. So, with city names such as "Rain Forest," "Hard Rock," or "In-N-Out," it's an easy jump to assume that this "place" is geared toward the tourist, for whom homogeneous commercial establishments are the norm, rather than the more culturally specific immigrant neighborhood and identities.

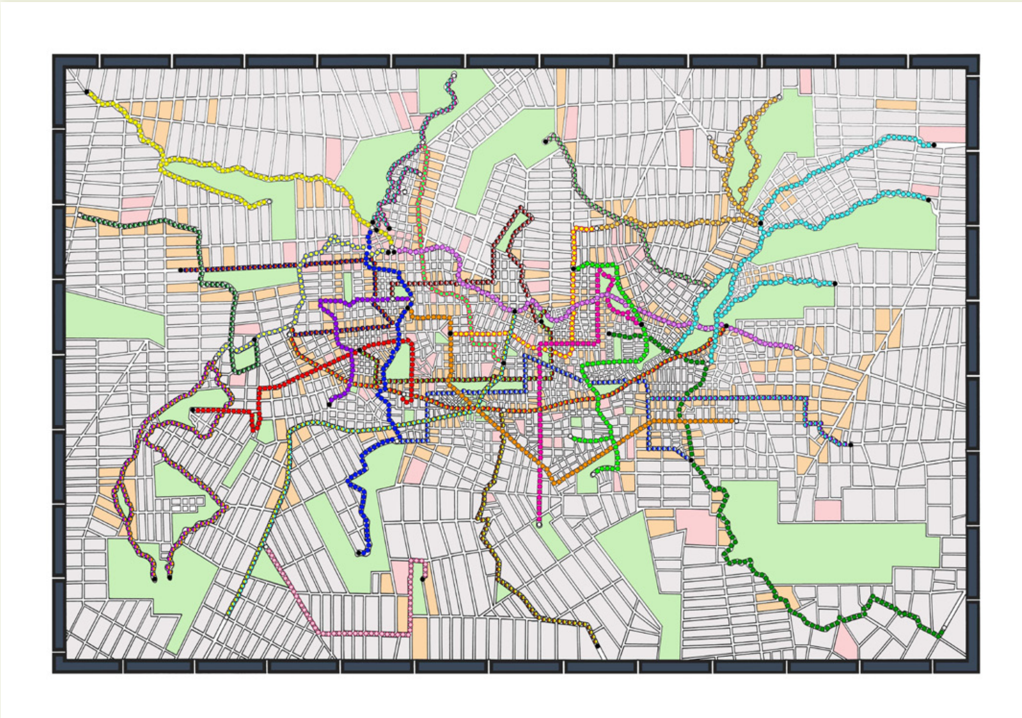
A permanent installation of the series is located at San Francisco International Airport, in Terminal 3.

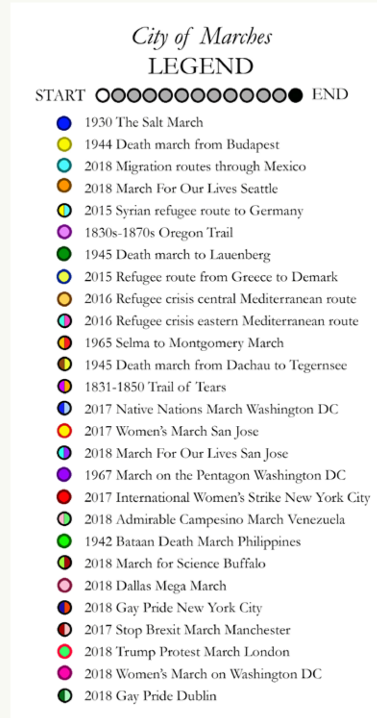
The Mission. *Ink on paper, 32″ × 21″. 2014.*

WHERE I AM NOW

My first official art piece that made use of maps was in 1996. Since then, I've tried to stretch the visual language of maps with different strategies and different content. Some series were purely abstract with no text, while others were heavy with recognizable references and strong social commentaries. One series attempted to compare the visual language of maps with other visual languages as a way to expose a universal structure, similar to Chomsky's (1965) idea of Universal Grammar for linguistics. And just like Universal Grammar, that series was inconclusive. I

The Strangerhood Series on display at San Francisco International Airport.





Left: City of Marches. *Dye-infused aluminum, 28″ × 40″. 2018. Right:* City of Marches *legend.*

felt that art shouldn't have conclusions, so I was OK with where it took me. But since Trump was elected, the world seems different, along with the American identity that I knew. I can't continue abstractly working with visual languages in a way that is divorced from what is going on in this country and the world. There isn't anything new with this administration that we haven't seen before: my parents knew and experienced the effects of Marcos and martial law in the Philippines a few years before I was born. But while my generation's response to the administration likewise isn't new—Boomers protested against the Vietnam War and embarked on myriad social and cultural movements—the sheer number of protesters and protests is. The scale is owed to the wholly unique organizing power of the current generation. So, when I was approached by the San Jose Museum of Art for a commissioned piece to be included in a show about walking in 2017, I started with researching protest marches. The result was a piece called "City of Marches," in which I took 27 marches, protests, parades, and famous trails out of their original context and superimposed all of them on top of each other within a fictional city grid. The urban planning of this "city" is molded by the marches and protests, a departure from the normative protest, where the route is molded by the shape of the city. The cultural impacts of these walks are forever commemorated by the street blocks that are shaped by them. I'm fascinated with my generation's response to what feels like an attack on our foundation as a people and culture. As more protests and marches occur in our daily lives, I'm hoping to be there to record them in a new map with a new city and a renewed sense of communal solidarity, only this time my work won't be all fiction.

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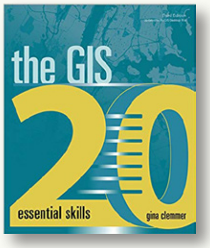
THE GIS 20: ESSENTIAL SKILLS, THIRD EDITION



By Gina Clemmer

Esri Press, 2017

182 pages, $49.99, softcover.

ISBN: 978-1-58948-512-9

Review by: Yanning Wei, Grand Valley State University

Based upon a student-friendly and project-centered writing strategy, *The GIS 20: Essential Skills* provides those new to GIS technology with a well-structured textbook to start their journey. The book has only 182 pages in total—which is very short compared with some other mainstream textbooks available in the market—but it covers a wide range of the topics with which every student of GIS must become familiar. In particular, the 20 chapters of this book address five essential aspects of modern GIS technology: software environment, input, output, data, and operations. By limiting her scope to only the most frequently used GIS concepts and operations, the author has constructed a convenient and practical handbook for students and other entry-level GIS practitioners. The key concepts are explained with as little technical jargon as possible, and there are screenshots and images illustrating almost every page.

The book begins with an introduction that briefly explains where and how to get the software platform needed for the exercises—ArcGIS Desktop—and provides tips about how to install it. The ArcGIS Desktop platform includes ArcMap, ArcCatalog, and other utilities, although *The GIS 20: Essential Skills* focuses on the use of ArcMap. Chapter 1 introduces concepts like the shapefile and demographic data, and also provides an introduction to the ArcMap interface. Chapter 2 deals primarily with basic operations in ArcMap, such as working with layers, changing map colors, and adding/editing map elements, in order to give students a taste both of using ArcMap and of mapmaking.

The third chapter introduces readers to the essentials of spatial reference systems, including map projections and coordinate systems, and their application in practice. The ability to handle spatially referenced data constitutes a primary difference between GIS software, like ArcGIS, and other vector and raster graphic programs that can be used to make maps as well. The role of some commonly used spatial reference systems like the State Plane Coordinate System (SPCS) and Universal Transverse Mercator (UTM) are demonstrated in the exercise. Chapters 4, 5, and 7 expose students to some basic data operations in ArcMap, through exercises employing data from the US Census Bureau. Methods for importing data from external sources and ways to clean raw data are included in these chapters. In particular, the *Join* operation—one of the most frequently used tools in relational database management—is introduced in detail. Other fundamentals of data manipulation, such as some of the functions available through the *Field Calculator* in ArcMap, are also briefly introduced. The explanation of how to use a spreadsheet like Excel to clean up raw data is of great usefulness, and the discussion of data cleaning serves to remind students that ArcMap operates on an advanced relational database management system.

The author guides readers through some basic GIS mapmaking in Chapter 6, covering concepts like data classification and color ramps useful for dealing with quantitative data, while the visualization of categorical data is explained in Chapter 9.

Chapter 8 introduces the concept and practice of geocoding through an exercise that exposes students to the power of spatial databases and the great potential of geospatial technologies in general. Students learn that the capability of translating non-spatial tabular data into spatial features is one of the unique and defining powers of GIS. Certain key concepts, like those behind ArcMap's *Address Locator* tool, are introduced to a level of detail sufficient for understanding. Chapter 10 also deals with physical addresses, albeit from a different perspective. This time, it is the coordinates collected by GPS that are used to pinpoint features on the surface of the earth. With the increasing use of mobile devices for data acquisition, the content of both of these chapters is essential to students and practitioners of GIS.

Chapter 11 is about editing in ArcMap—introducing students not only to the step-by-step editing of existing maps, but also to the creation of new datasets. Through this, students come to a practical understanding of how vector data models work and learn how they, themselves, can build spatial models to represent geographic features. With a clear understanding of vector data in mind, students are ready to learn about other spatial models, such as raster data, which is outlined later, in Chapter 17. Chapters 12, 13, and 16 turn again to some core ArcMap database table manipulation functions. Through detailed demonstrations of how to conduct *Select by Attributes*, *Select by Location*, and *Spatial Join* operations, these chapters teach students additional ways to work with GIS data, which are usually made up of both spatial and non-spatial components.

Chapter 14 shows students how to manipulate the geometries of spatial data using the *Buffer*, *Merge*, *Union*, *Append*, *Clip*, and *Dissolve* tools in ArcMap. This is followed by an introduction, in Chapter 15, of an advanced GIS data model: the geodatabase. Geodatabases come with many powerful data management functions and can handle complex spatial relations among spatial features that shapefiles cannot.

Chapter 17 deals with raster data and their relevant functions. Students learn not only the major differences between the vector and raster data models, but also the advantages of using raster data. In particular, georeferencing procedures are introduced in good detail.

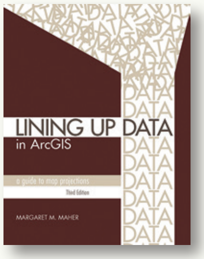
The last three chapters—18, 19, and 20—are all about what to do with GIS outputs. Students learn, for example, how to create and export reports in ArcMap and how to share their map products with other GIS professionals and users. There are also instructions on how to publish maps through ArcGIS Online, the increasingly popular online map platform hosted by Esri. This short book covers some essential GIS topics in a direct and basic manner. It can be used as a convenient entry-level study guide, or as a useful "cheat sheet," by anyone interested in learning GIS. The book is well designed and is easy to read, with no lengthy paragraphs, long sentences, or confusing jargon used anywhere in the book. Each chapter is made up of small sections that deal with particular key concepts in just a few steps, with all the key steps highlighted in black and bold. In comparison with the lengthy exercises found in some mainstream GIS textbooks, the well designed and focused mini-exercises—normally of just three to nine steps, start to finish—are of great value to students. In my opinion, the "smallness" of the exercises is the biggest strength of this book. This is because even students who are detail-oriented can be confused by wordy exercises, and that confusion can lead, as a result, to lost interest in learning GIS.

Even though the merits of this book are considerable, there are some noticeable shortcomings. For example, the book does not have a chapter that conceptually explains what GIS *is*. Nowhere is it really spelled out that while maps are just outputs, the core function of a GIS is actually about spatial data modeling and database management. While hands-on experience is definitely important to students, knowing that the framework of GIS covers much more than just mapmaking will encourage them to explore the great potential of GIS as a spatial science. I have seen many of my own students who perceive GIS as simply a computer-assisted map-drawing platform, and don't seem to be aware that there are a host of spatial reference systems and a powerful spatial database management system behind the software interface.

In addition, the book is not clear on the relationships among the essential spatial references system elements such as datums, map projections, and coordinate systems. It is worth pointing out that the importance of spatial reference systems to a functioning GIS can never be overestimated. The sheer proportion of hard drive space (nearly half) in an ArcGIS Desktop installation taken up by spatial reference system support files is just one indication of that fact. Without sufficient knowledge about these systems, it is hard for students to deal with the variety of real-world data that are commonly collected and managed through different reference systems by GIS professionals worldwide, let alone become capable of working independently and creatively. In fact, for students interested in GIS, a thorough conceptual understanding of the spatial dimensions of data—what spatial reference systems are and how they work in GIS—is necessary right from the beginning of their study.

In short, *The GIS 20: Essential Skills* is a good kick-starter for working with ArcGIS, even though it really only opens the door. Considering its modest size, scope, and ambition, it is, taken as a whole, a success.

LINING UP DATA IN ARCGIS: A GUIDE TO MAP PROJECTIONS, THIRD EDITION



By Margaret M. Maher

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ISBN: 978-1-58948-520-4

Review by: Fritz C. Kessler, The Pennsylvania State University

I previously had the privilege of reviewing the first edition of this practical "how to" book (Kessler 2012) and was pleasantly surprised to see that a third edition had been published. If you work with geospatial data in the ArcGIS environment, then you have probably encountered situations where your data didn't align. The culprit was undoubtedly one coordinate system not being in sync with another. Coordinate systems seem to strike fear into the hearts of many GIS users—a circumstance most likely due to the daunting mathematics that underpin them. This is unfortunate, as coordinate systems are an essential component of geospatial data, and working with them does not require an understanding of their sometimes-complicated mathematics. *Lining up Data in ArcGIS* avoids coordinate system math entirely, and instead focuses on the basic premise of understanding how to troubleshoot coordinate systems when things "go bad."

Eleven chapters are presented, with each focused on a different fundamental question that a GIS user may ask when working with a coordinate system—for example, "How can I tell what datum my data is on?" or, "How do I apply a vertical transformation?" According to Maher, these questions typify those "heard most often" among the nearly 16,000 customer queries she fielded in her 18 years working with the Esri Support Center (xiv).

Lining up Data in ArcGIS begins with a Table of Contents, Preface, and Introduction. The Preface explains that the third edition offers new content over and above the previous editions. The book is updated to reflect the release of ArcGIS Desktop 10.6, although the demonstrations are still valid as far back as version 10.1. A new chapter on vertical datums is included. Data sets used in the book are now provided for users to download and work with while reading through the chapters.

Chapter One briefly describes geographic, projected, and local coordinate systems, and how to identify them. This chapter also briefly touches on the project-on-the-fly process and common error messages. A helpful guide to identifying a coordinate system based on the numeric extents of the dataset is included. The guide suggests, for example, that a dataset based on latitude and longitude reports a maximum of two or three digits to the left of the decimal for the north-south and east-west extent, respectively. The chapter ends with a discussion of commonly used projected coordinate systems.

Chapter Two explains how to work with data defined in a geographic coordinate system (GCS). This chapter focuses on how to correct the offset between the North American Datum (NAD) of 1927 (NAD 1927 or NAD27) and NAD 1983 (or NAD83). One highlight from the instructions is an explanation of how to determine an appropriate geographic transformation option. For example, the chapter points out that there are many options for moving between the World Geodetic System of 1984 (WGS84) and NAD83—noting along the way that more than one NAD83 definition exists—and explains how one goes about making an appropriate selection. The chapter also discusses the importance of the High Accuracy Reference Network (HARN), as well as how to interpret the various errors and warnings associated with geographic transformation methods. The author makes the important point that datum transformations are two-way streets—the name given to the transformation is not an indication of its direction. A useful sidebar on the impact of GCSs and projected coordinate systems (PCS) on measurement types (planar, geodesic, loxodrome, and great elliptic) is provided.

Chapter Three provides an overview of two PCSs: the State Plane Coordinate System (SPCS) and Universal Transverse Mercator (UTM). The chapter begins with SPCS, SPCS zones, the maximum numerical values associated with the data extents, and common datums and units assigned to SPCS zones. An overview of the UTM PCS follows and focuses on the maximum numerical values associated with the data extents and common datums used with UTM zones. Helpful guidance on identifying an unknown PCS is provided. For example, when identifying a coordinate system for a United States–based dataset, one should consider that it may be a SPCS zone, UTM zone, or one of the unique county, state-wide, or continental coordinate systems in common or official use.

Chapter Four is one of three that focuses on integrating CAD data into the ArcGIS environment. Specifically, this chapter lays out step-by-step instructions on bringing AutoCAD (.DWG or .DXF) and Bentley (.DGN) file formats into an ArcMap session. Particular attention is paid to manipulating the projection, dealing with small measurement units associated with CAD files, and an explanation of the differences between the US and International Foot. The chapter closes with commentary on saving a custom projection file to disk, defining the projection using a custom projection file, and defining the projection for CAD data.

Chapter Five builds on material from Chapter Four, and discusses nine potential issues that ArcMap users may encounter when aligning CAD data once they have been brought into the ArcMap session. Each issue is presented separately, and the procedures on how to handle these potential issues are explained in detail. Some of these issues include non-standard units (e.g., tenths of a foot), CAD data that rest below sea level, the addition of a scale factor parameter to the projection file, and the need to apply a custom projection definition to the CAD file.

Chapter Six completes the process of importing CAD data into an ArcMap session. Surveyors often use a point of beginning (POB) to "fix" their survey to a real or assumed coordinate value and elevation. The CAD file may be rotated about this POB, and this can cause problems when bringing the CAD file into ArcMap. This chapter provides a step-by-step procedure on reconciling any rotation that had been performed in the native CAD environment. These step-by-step instructions are accompanied by many screen shots illustrating how the CAD files appear at each step of being brought into alignment in the ArcMap environment.

Chapter Seven covers the importance of datum transformations, and begins by explaining what a geographic transformation is and why it is important. The components of three-parameter and seven-parameter geographic transformations are compared. Common geographic transformation methods—including NADCON, NTv2, Molodensky-Badekas, longitude rotation, null, unit change, and Geographic 2D offset—are briefly described. An explanation of the process of creating and saving a custom geographic transformation concludes the chapter.

Chapter Eight looks at the way geographic transformations are applied, and focuses on what to do when a separate GCS defines each dataset. A detailed, step-by-step explanation shows how to apply a composite geographic transformation when moving between two disparate datums—NAD 1927 and NAD 1983 HARN—with a focus on the several intermediate transformations that are necessary in this process. The chapter concludes with a discussion of using the ArcToolbox Project tool to apply a geographic transformation.

Chapter Nine discusses vertical coordinate systems, and is new to this edition. It starts with an overview of vertical datums and how they differ from horizontal datums. The various components of a vertical datum—including ellipsoidal, geoid, and orthometric heights—are introduced, and then the process of applying a vertical datum transformation is discussed. This discussion includes a sample workflow where elevation data in text string format is downloaded from a National Geodetic Survey website and transformed into numeric data using the ArcToolbox Project tool. Readers are also cautioned in regard to the necessity of performing horizontal and vertical datum transformation separately. The chapter concludes with a reference to two useful online tools designed for working with United States vertical datums—VDATUM and VERTCON—created by the National Oceanic and Atmospheric Administration and the National Geodetic Survey, respectively.

Chapter Ten considers how one determines which map projection is appropriate for a given dataset. Beginning with a definition of GCSs, the author discusses the length of a degree and how GCS data are displayed in the ArcMap data frame. Attention turns next to PCSs, and the different elements of a PCS are individually described, including the properties of the various projection types—such as conformal, equal area, equidistant, and true direction—and the effects of these properties on linear units of measurement, including concepts such as "map units" and "grid north." The discussion of how to choose an appropriate projection for a GIS project is very helpful. Creating a custom projection is covered, with attention to the different map projection parameters that a user may need to modify (e.g., standard parallels). The concepts of false easting and false northing are also presented, and a brief overview of the Web Mercator projection rounds out the chapter.

Chapter Eleven is a collection of miscellaneous content that includes how to define a projection and its parameters, how to handle x,y data, and the shapes of buffers. The chapter begins by listing the components that are required for every GCS—name, units of measure, datum, spheroid, and prime meridian—and is followed by a list of possible components that a PCS could include. The author points out that, unlike a GCS, not every PCS has the same components. The advantages of using a PCS instead of only a GCS are detailed next, and the concept of a local coordinate system is explained. The process of adding x,y data to ArcMap, defining a coordinate system, and converting those data to a shapefile is explained and illustrated. The chapter finishes up with a detailed examination of how coordinate systems impact the shape of buffers in ArcMap.

Two appendices appear in the book. Appendix A lists eleven "Knowledge articles" from Esri's Support Center that focus on topics related to coordinate systems. Appendix B lists an additional fourteen online resources covering a range of coordinate system topics. A short bibliography of three additional readings and an index concludes the book.

Lining up Data in ArcGIS is intended to give GIS users a practical guide to solving many coordinate system issues, and, generally speaking, it succeeds in this. Since each chapter is framed around a "typical" coordinate system question, each chapter can stand on its own, and readers can pick and choose those that best suit their needs. For coordinate system novices, the framing questions are especially helpful in directing the reader to the relevant chapter. Reading this book will not provide the reader with any of the theory behind why data don't align, the mathematical underpinnings of coordinate systems, or research on coordinate systems, but there are other texts that provide this kind of knowledge. For example, Snyder's *Map Projections: A Working Manual* presents a mathematical basis of coordinate systems, while Canters's *Small-scale Map Projection Design* delves into research useful for designing new projections. In any event, if your aim is to learn about these advanced coordinate system topics, this isn't the book for you. The graphics included in the third edition of *Lining up Data in ArcGIS* reflect the Esri ArcMap interface design. However, as the Esri world transitions from ArcMap to ArcPro, I hope that when the fourth edition appears it will use screen shots and step-by-step instructions reflecting the newer software environment. Similarly, while data in vector format are, and will remain, prevalent, the next edition should include at least one chapter on coordinate systems and raster data.

Organizationally, it seems odd that the essential definitions of geographic and projected coordinate systems (GCSs and PCSs) and their components—concepts and terms that are used throughout the book—are to be found in the last chapter, rather than in the first. Readers could be directed to read through this chapter first to make sure they are equipped with this foundational knowledge before diving into other chapters. While this approach would reduce the amount of material repeated in multiple chapters, it would also render each chapter a little less self-contained and less able to stand alone. Done properly, however, it would be an advantage.

Finally, this book persists in propagating the incorrect idea that conformal projections preserve the shape of the data. Conformal projections in fact preserve angular relations—a property often associated with navigational map tasks such as charting rhumb lines or determining azimuths, bearings, and directions—and while this does mean that shape is preserved *locally*, this is not a *general* property and shapes of any size are still distorted.

The bottom line is that if you work with geospatial data in the ArcGIS environment and have problems with your data not aligning correctly, you should give *Lining up Data in ArcGIS* a careful read. You may just find answers to your coordinate system questions.

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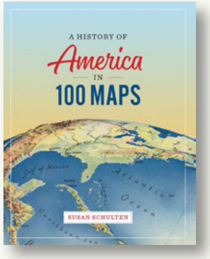
A HISTORY OF AMERICA IN 100 MAPS



By Susan Schulten

University of Chicago Press, 2018

256 pages, 120 color plates, $35, hardcover.

ISBN: 978-0-226-45861-8

Review by: Jörn Seemann, Ball State University

Richly illustrated coffee table books about maps have become quite popular in recent years. Anyone interested in cartography can learn about the history of the world map-by-map while sitting down with the *History of the World Map by Map* (Smithsonian Institution 2018), "go on a guided tour through the world's most incredible maps" aboard *All Over the Map*: *A Cartographic Odyssey* (Mason and Miller 2018, back cover), explore odd and unconventional maps for the "cartographically curious" through *The Curious Map Book* (Baynes-Williams 2015, back cover), or get insights into historic cartographic myths and blunders from *The Phantom Atlas: The Greatest Myths, Blunders and Lies on Maps* (Brooke-Hitching 2018), just to mention a few examples. All of these books aim to narrate history visually through cartography—inviting their audiences to read between the lines of a map in order "to tease out new meanings, hidden agendas, and contrasting world views" (Harley 1990, 4).

Among the myriad publications of this kind are atlases and map compilations that focus on what is loosely called America, but is in practice more narrowly interpreted as North America or even just the United States of America. *A History of America in 100 Maps* is one of the most recent of these works, conceptualizing US history through visual narratives. The author, Susan Schulten, is a historian at the University of Denver and a specialist on nineteenth- and twentieth-century United States history. Her particular interest in the history of maps has resulted in a considerable number of publications, including two very successful and highly readable books: one, *The Geographical Imagination in America* (2001), on the place of geographical imagination and of maps in popular culture, politics, and education; the other, *Mapping the Nation* (2012), on the interface between thematic mapmaking and national identity in nineteenth-century America.

The idea of telling American cartographic history is not new. Almost four decades ago, the renowned surgeon, writer, and map historian Simon Schwartz, and the map librarian Ralph Ehrenberg, published *The Mapping of America* (1980). The bulky, 363-page volume included more than 300 black-and-white and color plates and more than 200 illustrations to "present a detailed analytical history of the mapping of North America . . . [and] demonstrate that a map is often more than a visual record of boundaries" (Schwartz and Ehrenberg 1980, 9). More recently, *Mapping America: Exploring a Continent* presented more than 120 color maps tracing "the formation and development of the US over 500 years, from the time of the early European colonies through to the densely developed and influential country it is today" (Howells and McCorquodale 2010, 9).

So what's new about Schulten's book? At first glance, the author uses the same strategy as the earlier publications I have noted. She compartmentalizes the past by defining relatively distinct periods in US history, from "Contact and Discovery" (1490–1600) and "Early Settlement and the Northwest Passage" (1600–1700), to "Between War and Abundance" (1940–1962) and "An Unsettled Peace" (1962–2001). For each of the nine chapters, Schulten selects about a dozen maps that testify to moments or episodes that marked the country's history. The one hundred maps—covering a variety of topics, places, and contexts—were chosen from a number of prestigious libraries and map collections, with an emphasis on material from the British Library. Each map is accompanied by text that provides background information and contextualizes each specific historical moment. The full extent of each map is shown at reduced scale, but some have larger-scale detail views provided as well.

In her own words, Schulten intends to give "a visual tour of American history through maps, one that searches the main roads as well as the back-alleys of the past" (8), and the collection can indeed be divided into "main road" and "back-alley" elements. The "main road" examples are well known and familiar maps, whose historical significance makes their inclusion in any work on American cartographic history seem obligatory. Among these iconic maps is Waldseemüller's *Universalis Cosmographia* from 1507 (16–19). This is the map upon which the name "America" appeared for the first time, albeit only discreetly printed in the lower-left corner, in an area that today is part of Argentina. It is quite common for historians to describe this particular map as America's "birth certificate," or to describe its era as one in which the continent was "discovered"—despite its having been inhabited by several million people for a considerable period of time—but the use of these terms raises significant issues. While Schulten briefly discusses some of these problems in her Introduction, she misses several opportunities to engage them more deeply in the entries on individual maps.

Other "main road" examples include graphical statements of the exploration history of the American West: the map of the Lewis and Clark Expedition (114–115), and John Wesley Powell's map of the arid regions in the west (162–163). Powell's map proposed a system of land settlement based on watersheds and moisture regimes rather than the established grid system of square townships. A copy of the famous 1812 "gerry-mander" map of the Essex South District in Massachusetts (116–117) and a thematic map of the United States (174–175) indicating the circa-1914 status of women's suffrage—full, partial, or no—stand out as political statements in American history.

The "back-alley" maps are lesser known, forgotten, or ephemeral maps that, nevertheless, are important or fascinating pieces of US history. Examples are the young George Washington's hand-drawn map of the lands between Lake Erie and the Ohio River (circa 1754), showing French fortifications (84–85); a 1917 diagram of a typical line of battle during World War I with fire trenches, second lines, and no man's land (178–179); and Herb Ryman's 1953 bird's-eye view of Disneyland (226–227), used by Walt Disney to recruit potential sponsors for the amusement park project.

Schulten admits that it is impossible to tell a comprehensive cartographic history of America. Any attempt can only be "an eclectic and selective discussion of the many ways maps have been used in the past; to master and claim territory, defeat an enemy, advance a cause, investigate a problem, learn geography, advertise a destination, entertain an audience, or navigate terrain" (8). She is very careful with her selection of representative and illustrative examples, aiming not only to point out cultural differences and backgrounds, but cartographic diversity as well. On the one hand, the book includes maps that do not refer directly to the American territory, but that nonetheless had a strong impact on US history. For example, Schulten includes both a Portolan-style Dutch map of West Africa from around 1650 (50–51) and Malachy Postlethwayt's *A New and Correct Map of the Coast of Africa* (1757, 74–75). These maps pinpoint different African nations and those places on the coast that were ports of departure for the slave trade to the Americas, and serve as exquisite pictorial documents of the tragedy of slavery. On the other hand, the book also illustrates cartographic diversity in that it allows a comparison between mapmaking techniques in different countries and the way map standards and symbolization changed over decades and centuries. The reader can compare Miera y Pacheco's almost baroque-style 1778 map of the discovered and demarcated lands in the American Southwest—which juxtaposes an almost excessive physiographic relief imaging with a drawing of the Papal chariot pulled by lions (88–89)—with Herman Moll's far more sober 1720 rendering of the *North Parts of America Claimed by France*, where "parts unknown" are simply left blank (70–71).

Each map in *A History of America in 100 Maps* sparks curiosity and is worthy of detailed exploration, but I will restrict myself to a few extraordinary examples. Robarte Tindall's sketch of Chesapeake Bay (1608) is something of a cartographic ugly duckling—drawn with simple outlines and shapes in faded colors, but with a colorful ornamental frame. It contains only 21 place names (locations of indigenous villages), but emphasizes the meanders of the James and York Rivers in Virginia and provided the inaugural settlers of the Jamestown colony with a first notion of their environment (36–39). This map is an obscure cousin of John Smith's famous 1612 map of Virginia that highlighted the figure of the tribal chief Powhatan and the importance of indigenous informants for mapmaking. Smith discreetly indicated the limits of his geographical knowledge by a chain of Maltese cross symbols that surround Chesapeake Bay (40–41).

Another example of indigenous authorship is the transcribed copy of a deerskin map drawn by an unidentified indigenous leader for Francis Nicholson, who was governor of South Carolina between 1721 and 1725 (72–73). The original is long lost, but Nicholson had commissioned the fabrication of two copies, "most humbly Dedicated To His Royal Highness George Prince of Wales" (72). Initially, the drawing looks like a concept map or "a slightly confusing organizational chart" (72). However, a deeper reading reveals that the emphasis is not on *physical* distances, as it is in the case of Western maps, but on *networks* and *relationships* among and between Native American groups and European settlers. Thirteen irregular circular shapes in red represent different tribes and how they relate to each other and to "Charlestown," indicated as an angular grid of streets on the left side of the map.

Schulten also hints at gender and educational issues by including *A Map of the United States* (1818). This map was extracted from a copy of *Catharine M. Cook's Book of Penmanship At Mr. Dunham's School, Windsor, Vermont* found in the Osher Map Library, and is one of the few surviving examples of the geography exercises that were common at many schools for girls in the first half of the nineteenth century. Schulten writes that "[m]aps and geography were considered particularly appropriate material for girls, a 'useful' pathway to literacy and citizenship that also honed traditional feminine skills of 'accomplishment' such as painting or needlework" (118). Catharine Cook's schoolbook included drawings of the world and at least eight individual states, although Schulten reproduces only the map of the United States.

The book does not shy away from controversial issues such as racism. A sequence of three different maps exposes the segregation of ethnic groups in San Francisco, Chicago, and Philadelphia at the end of the nineteenth century. In San Francisco, the *Official Map of Chinatown* (1885), made in the style of a Sanborn fire insurance map by the Special Committee of the Board of Supervisors of the city, served as a political tool to demonize Chinese immigrants who, according to the map authors, were "'living scarcely one degree' above waterfront rats, in unimaginably crowded conditions" (164). The map color-codes buildings—highlighting such locations as Chinese gambling and prostitution houses and "opium resorts." From Chicago, *Nationality Map No.1* (1895), extracted from *Hull's House Maps and Papers*, reveals the ethnic configuration, segregation, and ghettoization of neighborhoods in that city. *The Seventh Ward of Philadelphia* map, by the scholar and civil rights activist W. E. B. Du Bois, not only points out racial segregation, but also the variations existing within predominantly African-American neighborhoods by identifying four classes of resident: the "middle classes and those above," the working people, the poor, and the "vicious and criminal" classes. These maps provide the context for two other maps: the *Metropolitan Cleveland Security Map* (1936)—a cartographic example of redlining (200–201)—and the *Afro American Travel Map* (198–199), part of a 1942 travel guide issued by the Afro Travel Bureau in Baltimore, "list[ing] places where weary motorists would not be refused service because of their race" (199).

The most compelling examples among the one hundred maps are two simple sketches (216–217) from the diary of 15-year-old Michal Kraus, a Czech Holocaust survivor. One of the drawings shows parts of lower Austria between Melk and Gunskirchen. The Mauthausen concentration camp, where between 100,000 and 300,000 people were murdered in the period from August 1938 to May 1945, has a prominent position on the map. Michal added two drawings of the camp with barracks, wooded areas, and watchtowers. The second sketch documents the tortuous return route to his hometown, Náchod, where he found out that his mother had been killed in the camps. Michal began to write his diary about the horrors of the Holocaust in 1951, about the time he permanently settled in the United States.

A minor issue with this book, for me, is the dichotomy of news vs. history. At what point does the past become history? Where does a history of the United States shade into current events? Although the last chapter ends with Laura Kurgan's 2001 map *Around Ground Zero* (256–257)—a pocket-sized foldout map of the site of the former World Trade Center that was created in remembrance of the 9/11 attacks—Schulten contemplates none of the more recent events and issues of the twenty-first century. Her Afterword addresses contemporary trends in cartography by giving the example of DeepMap, a software firm that provides mapping software for the autonomous vehicle industry, but she does not address other important challenges in cartography like deep mapping and the digital humanities, maps on a screen and in motion, and the constant frictions between mapmaking and GIS that have an impact on both history and the ways we conceive maps. Schulten might have usefully addressed the shift from paper to digital mapping, or the incredible speeds at which maps are often disseminated through social media, with pertinent map comparisons. In a recent article, for example, Anthony Robinson (2019) studied the Twitter-based distribution of a 2016 map of what voting patterns would have looked like had only women voted. The map went viral, provoking hundreds of replies and retweets, as well as the composition and dissemination of new variant maps derived from the original. This virtual map might have been juxtaposed with the 1883 "red-and-blue" map on popular vote by counties from *Scribner's Statistical Atlas* (156–157) Schulten had already included.

Despite its fantastic content, this volume is marred by the typography and the page layout. Although the unidentified sans-serif type is very pleasing, the 10-point (or smaller) font size used throughout is very hard to read and is a definite challenge for anyone's eyesight. As well, the text-image proportions on any given page can vary considerably. Where some pages are packed with text, others are left with large, awkward, empty spaces—not unlike the blank areas found on many maps from the Age of Exploration! Of course, there is no need to fill these gaps with sea monsters, but the space could definitely have been used to add more map details, cartouches, symbols, or curiosities. Another problem, common to many other books with large illustrations, is that the maps are not adjusted to the page size. Frequently, the images are printed over the inside margin and across the gutter so that map details are lost in the crease, and the maps appear chopped or truncated, thus considerably spoiling the visual experience. For her 2012 book, *Mapping the Nation*, Schulten offered zoomable, high-resolution copies of all maps on a companion website, *mappingthenation.com*. Readers of *A History of America in 100 Maps*, however, only have access to 15 map thumbnails on the publisher's promotion page, *america100maps.com*.

In summary, Schulten does exactly what she promises at the beginning of her book: provide a visual tour through American history, supported by maps. History, in this case, is not written with a capital H, but is instead conceived as a collection of individual stories, with each map having its own to tell. Reading *A History of America in 100 Maps* is certainly a nice way to learn about the United States of America's past and the fascinating parts mapmaking has played in that history.

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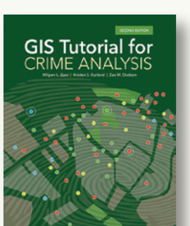
GIS TUTORIAL FOR CRIME ANALYSIS, SECOND EDITION



By Wilpen L. Gorr, Kristen S. Kurland, and Zan M. Dodson

Esri Press, 2018

348 pages, $84.99, soft cover.

ISBN: 978-1-58948-516-7

Review by: Janet Tennent, Montgomery College

GIS Tutorial for Crime Analysis is a workbook designed for use by police forces interested in leveraging the power of GIS in various aspects of their work. Through the use of such tools, police organizations can turn raw data into useful information products, mapping incident reports, crime statistics, and modeled prediction scenarios. Analysis of the locations where crimes have occurred, and where contributing conditions and phenomena intersect, can lead to more accurate predictions of developing or future crime patterns. This in turn can assist in planning for resource allocation—allowing police forces to move their officers from lower crime areas to places they may be more urgently needed. GIS can also be used as a community outreach tool for showing the public what their police forces are doing, and helping educate both neighborhood watch committees and individual citizens about what they can do to help protect themselves.

The book is geared toward the GIS beginner, but readers will still find having some GIS background very helpful. Most chapters feature two or three thematic scenarios followed by two or more Tutorials and a couple of Assignments each. The tutorials give step-by-step explanations for each of the scenarios covered, and also provide examples of the sort of results one should expect when performing, say, an attribute query. The assignments present similar tasks in a more "your turn now" manner, without the hand-holding. If the book were to be used as a classroom text, these assignments could easily become homework tasks to be handed in for grading. As with any other GIS book or tutorial, it is always best to complete all the steps in order.

The numerous maps and diagrams throughout the book are very helpful—especially for an individual without a GIS background—and can be used as a measuring stick that allows the reader to confirm that they are correctly completing and understanding the steps.

GIS Tutorial for Crime Analysis shows several ways that GIS can be applicable to police work. It introduces the basics of GIS to the neophyte, and is a great review for the GIS student going into the law enforcement field. I was taking my first course in GIS at the same time I was reviewing this book, and for the most part I had no problems or difficulties following it. I found each of the scenarios very interesting. I did find it a little disappointing, however, that in working through the Chapter 7 "Geocoding crime incident data" exercises, ArcMap would crash at various points—during both the Tutorial and Assignment segments. I retried the steps several times, and the same crashes would happen again and again. Some advanced GIS students in my school have since told me that they experience the same or similar problems with ArcMap in their coursework. It is not clear if this is a bug in the ArcMap program, or if the problem is in the tutorial, but either way, it disrupts the learning process.

Software problems aside, *GIS Tutorial for Crime Analysis, Second Edition* is a useful and usable resource for anyone interested in using GIS for crime analysis and police work. It explains the what and the why, and shows the how, of building a crime-analysis system, and it does so from the ground up for a reader with minimal pre-existing GIS skills.

A DIRECTORY OF CARTOGRAPHIC INVENTORS: CLEVER PEOPLE AWARDED A US PATENT FOR A MAP-RELATED DEVICE OR METHOD

By Mark Monmonier, Adrienne Lee Atterberry, Kayla Fermin, Gabrielle E. Marzolf, and Madeleine Hamlin

Bar Scale Press, 2018

163 pages, $7, softcover.

ISBN: 978-1-985690-22-6

Review by: Trudy Suchan

A Directory of Cartographic Inventors provides biographical information about the cartographic patentees featured in Mark Monmonier's recently published *Patents and Cartographic Inventions*: *A New Perspective for Map History* (**reviewed last year** in *Cartographic Perspectives* 90). The *Directory* is a resource that brings together and preserves much of the biographical research that underpinned, but did not make it into, *Patents and Cartographic Inventions*.

Where *Patents and Cartographic Inventions* is organized thematically around the inventions, *A Directory of Cartographic Inventors* is a straight-up reference book with 31 biographies in alphabetical order. All but two of the patentees featured in the *Directory*'s main section appear in *Patents and Cartographic Inventions*, as do all but three of the twenty-four additional inventors more briefly discussed at the back of the book.

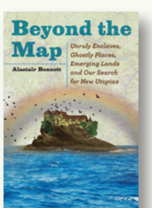
The *Directory* covers a roughly two-hundred-year period between 1789 and 1995, from the birth of Silas Cornell (whose globe was patented in 1845) to the death of F. Webster McBryde (who patented his McBryde map projection in 1977).

The inventors profiled made their livings many ways but a few groupings emerge. Among the patentees that fit our contemporary definition of geographer are Henry de Beaumont, founder of the Geographic Society of Geneva and holder of a patent for a world projection. F. Webster McBryde was on the geography faculty at Ohio State University, served as a senior geographer in military intelligence at the War Department during World War II, and founded the American Society for Geographical Research. Alphons van der Grinten's patented map projection gained fame once the National Geographic Society took it up, albeit after his death. The number of educators and engineers who filed cartographic patents is also notable. Ellen Eliza Fitz and Elizabeth Oram—who each patented globes and are the only two women profiled—were in the education field. The Joneses (who patented an in-car navigation system) and the Pollards (a map-quiz device)—two pairs of brothers—can be counted among the engineers. The book lists a number of patentees from the publishing and printing trades, and a great many that pursued multiple livelihoods. For example, John Plato (rural address finding) was a soldier, draftsman, lumber dealer, teacher, rancher, machinist, and a mapmaker for the US Government. Some, such as Edward Swett, were civic-minded, inventing a fire alarm system linked to a town or city street map. At least one inventor was rascally: Olin D. Gray (patentee of a globe containing a strip of pictures) ran an eponymous lithography firm and went afoul of the law by printing dodgy lottery tickets. Some sixty percent of those profiled held multiple patents, led by Jay Rhodes with over two hundred. Just shy of half of those listed in the *Directory* held additional patents unrelated to cartography; Max Bremsy, inventor of an in-car map system, also patented a cigar design.

The same template is applied across all of the biographies—birth date and place of origin, parents and siblings, schooling, means of livelihood and work locations, the patent(s), marriage and offspring, death date and place—and this structure makes clear the tantalizing gaps in any particular entry. Mark Monmonier's introduction catalogs the travails of searching for historical records and artifacts in today's online research domain. He and his team relied chiefly on census records and directories accessed through Ancestry Library Edition (**ancestry.com/cs/us/institution**).

In the course of doing the research for a book or dissertation, one tends to become an expert on all manner of detail that does not, for one reason or another, fit the flow of the final work. *A Directory of Cartographic Inventors*: *Clever People Awarded a US Patent for a Map-Related Device or Method* is a model for preserving this kind of information in a form available to the cartographic community. And, it would be neatly circular if the biographical information in the *Directory* eventually filtered back into genealogy networks such as Ancestry.com.

BEYOND THE MAP: UNRULY ENCLAVES, GHOSTLY PLACES, EMERGING LANDS, AND OUR SEARCH FOR NEW UTOPIAS



By Alastair Bonnett

University of Chicago Press, 2017

304 pages, $25, hardcover.

ISBN: 978-0-226-51384-3

Review by: Nat Case, INCase, LLC

Beyond the Map is a collection of thirty-nine essays about places, regions, and geographic features, all in some way disputed, abandoned, transient, or otherwise resistant to "mappedness," though, disappointingly, maps themselves are not really discussed in the book. The chapters are grouped into five broad themes: "Unruly Islands," "Enclaves and Uncertain Nations," "Utopian Places," "Ghostly Places," and "Hidden Places," each of which is (broadly) self-explanatory. At the ostensible heart of the book is the vision of a centrifugal "new era of geographic giddiness" and fragmentation—a scenario wherein the author sees the old sensible order of the world unraveling in the new millennium. This central idea, however, does not provide a strong guiding principle for the book. Instead it's pervaded with a kind of exoticism, the sort that also runs through much of online site *Atlas Obscura* (**atlasobscura.com**). It is an updated, more socially conscious, and in this case somewhat weary spin on, *Ripley's Believe It or Not*.

Bonnett covers some fascinating corners of the world—often through personal narratives. Many of the best locations are in his native Britain, but his narration gives a strong English tilt to even the non-British places. The submerged landscape of Doggerland—in what is now the North Sea—is well imagined, as are the ghostly remnants of Boys Town—a summer holiday camp for Welsh miners' children. The book's main interest lies in the episodes themselves, in the meat of description, rather than any analysis or framing. *Beyond the Map* is a highbrow entry in the genre that includes *Atlas Obscura*, *Ripley's*, and the hordes of other, more pedestrian productions one sees, with titles such as *Mysterious Atlanta*, *Lost Nauru*, *Haunted Cambridgeshire*, and so on (I made up all three of those). It's a fascinating and entertaining corner of geographic literature, but this example is spoiled by the author's attempt to dignify it with framing and theory.

What is missing is a convincing depth. Bonnett's own self-effacing personal reflections, even at their best, lack the poetic interest and evocation of better travel and place writers. He frequently refers to a spiraling apart of an old order, but does little to trace that spiraling, even in chapters on ISIL or the Ferghana Valley—a place where the roots of fragmentation are deep and rich. The Ferghana chapter is annoyingly superficial, as he hardly glances at the early Soviet history of the "-stans"—with their mix of Pan-Turkism, ethnic rivalry, and scheming alliances with Stalin's gangster-like organizers—and instead looks only one level deep. Bonnett writes of the effects of ill-defined Soviet border-making on a landscape facing climate change and human crowding, and then leaves it there.

Perhaps most telling is his chapter on underground Jerusalem—another place where controversies about history lie buried layer upon layer, underlying and feeding into intractable modern conflicts. Bonnett's best stab at evoking all this is to drift into an account of drinking and wandering about while attending a conference there some years ago. Maybe in other hands this anecdote might have revealed something profound or engaging, but here it neither illuminates the deep-rooted conflict nor makes interesting the writer's personal experience.

Any one of the five sections could, if expanded and fleshed out with some genuinely new and insightful comment, have itself made a deeper and more interesting book. In the end, though, *Beyond the Map* seems more a scattered travelogue or a patched-together collection of blog posts than a focused book. Most of the individual chapters aim at subjects of real interest and many reflect the honest point of view of a geographer who finds himself at a loss to explain or find meaning in his explorations. The problem is, this lack of meaning carries through into the whole itself, and left me with the sense that most of what I took away from the book was mere trivia.

OKLAHOMA WINTER BIRD ATLAS

By Dan L. Reinking

University of Oklahoma Press, 2017

52 pages, 367 maps, 255 color photos, 11 figures, 256 tables; $39.95 paperback, $65.00 hardcover.

ISBN: 978-0-8061-5897-6 (paperback);
978-0-8061-5898-3 (hardcover)

Review by: John Cloud, University of Maryland and National Museum of Natural History

The *Oklahoma Winter Bird Atlas* is based on many years of work—conducted from late 2003 through early 2008—by many bird observers, many (or most) associated with the George M. Sutton Avian Research Center in Bartlesville, Oklahoma. It was compiled and written by Dan L. Reinking, a biologist at the Center, who was also author of the 2004 *Oklahoma Breeding Bird Atlas* (Reinking 2004), or *OBBA*, based on research undertaken between 1997 and 2001. I think the earlier atlas might be the key to evaluating this companion volume and especially its cartography, which is singular in several senses.

As the author notes, most bird atlases focus on the birds' nesting seasons and places. After completion of the *OBBA* project, staff at the Avian Research Center decided to develop another project focused instead on birds that spend part or all of the winter in Oklahoma, whether they nested there or not. Because migratory birds pass through Oklahoma at all seasons, "winter" was defined for purposes of this project as December 1 to February 14. The focus was on live observation and counting of bird species by Center staff and volunteer observers during this specific period.

Oklahoma is situated in the center-south of the contiguous United States, and while it might seem small, perching like a bird on top of the much larger Texas, it is actually the twentieth-largest state by area. However challenged Oklahoma might be latitudinally, it makes up for it in its span of longitude. It stretches over an enormous gradient of land sloping down from the front range of the Rocky Mountains eastwards towards the Mississippi River. The land is generally warmer and wetter in the east, cooler and drier in the west. Oklahoma has thick woodlands in the east that thin to buffalo grasslands, then reduce to shrub thickets and grass steppes in the middle, and transition to rugged, juniper-filled canyons in the western Panhandle. I mention all this because there is exactly one basemap—showing the county boundaries of the state—for all 367 maps in the atlas. Each map consists of observational data placed upon the basemap, shown with small colored square or round dots, representing sightings (or the lack thereof) for 250 species of birds during the seventy-six day "winter."

Bird observations were gathered using three sampling patterns. The primary pattern consisted of 583 blocks of land, each about five kilometers on a side. A map shows the 577 so-called "atlas" blocks that were surveyed, and the six that were "incompleted" [*sic*] and not included (6; Figure 1). These blocks were randomly selected. However, anyone who knows birds or other animals knows that their distributions are almost never random—they frequent the places that are good for them. Random blocks of "land" will not, for example, sample the distributions of waterfowl. Therefore, a second set of "lake" surveys, centered on and around Oklahoma's abundant reservoirs were also included. Finally, special interest surveys and observations of "birds of opportunity" were solicited to round out the winter birds project data—as were the limited observations from the Audubon Society's traditional Christmas Bird Counts.

Atlas entries for the 250 bird species are organized by bird orders using the traditional sequence—waterfowl, for example, always come first, and so on—with each bird species getting a double-page spread. The left-hand page names the species and includes a good color photograph of a representative bird, along with basic habitat types preferred, general information about their distributions

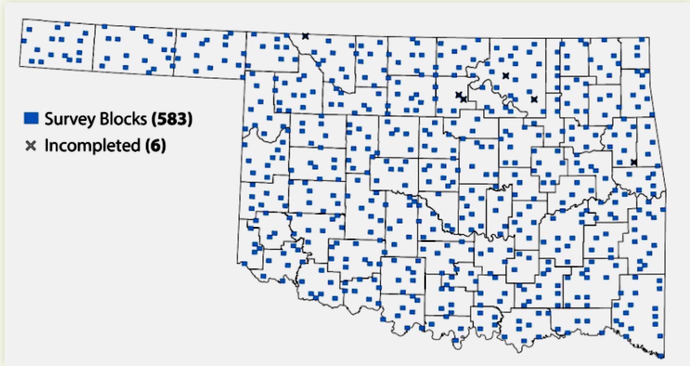


Figure 1. *Survey blocks in the atlas.*

in North America and in Oklahoma, and short descriptions of their behavior. The right-hand pages are where the cartography gets curious. The Oklahoma basemap is displayed 367 times. The first presentation, on the frontispiece, gives the names of the counties within their boundaries. All the other maps, if they display any data at all, present small squares showing the blocks where that species was observed, and small circles for observations from the lake surveys. In both cases, the squares and dots are color-coded in ranges of numbers of birds observed. An amazing 75 maps present neither dots nor squares—absence of data as data—and generally indicate the bird was observed in one of the special interest surveys. Below the maps there are specific journal references for that bird species, and then, generally, a lot of white space.

The species distribution maps, with their absence of information about landforms, landscape vegetation classes, or any depiction at all of the lakes or drainage, have an oddly abstract quality, somewhat like a Mondrian painting. Their starkness makes me think that perhaps the author assumed the reader would have access to the breeding bird atlas, which might supply what is missing from the winter atlas.

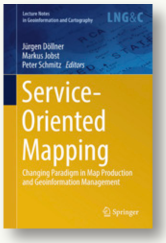
I'm not quite sure what the intended use of the *Oklahoma Winter Bird Atlas* might be. The atlas is a four-and-a-quarter-pound coffee table book, so it is clearly not optimized for use in the field. It is possibly most at home on a coffee table, to be looked through for ideas about where to go in Oklahoma to see birds in the middle of winter—or at least where they were seen in the winters of 2003 through 2008.

Out in the field, ornithology seems to be shifting profoundly to small digital systems, especially those designed and released by the legendary Cornell Laboratory of Ornithology. MERLIN assists in bird identifications (**allaboutbirds.org/guide/Merlin**), and eBird allows birds' locations, numbers, and dates to be uploaded to global databases instantly (**ebird.org**). eBird can even compile lists of birds "likely" to be found at a specified spot. Perhaps the *Winter Bird Atlas* can be reborn in a smartphone?

REFERENCE

Reinking, Dan L., ed. 2004. *Oklahoma Breeding Bird Atlas*. Norman, OK: University of Oklahoma Press.

SERVICE-ORIENTED MAPPING: CHANGING PARADIGM IN MAP PRODUCTION AND GEOINFORMATION MANAGEMENT



Edited by Jürgen Döllner, Markus Jobst, and Peter Schmitz

Springer, 2019

434 pages; $189 hardcover, $149 eBook.

ISBN: 978-3-319-72434-8

Review by: Amy Rock, Humboldt State University

The term "service-oriented mapping" refers here to mapping applications or map services, both Software-as-a-Service (SaaS) and Data-as-a-Service (DaaS), that in some way automate the delivery of map data to the intermediate or end user. In *Service-Oriented Mapping: Changing Paradigm in Map Production and Geoinformation Management*, the emphasis is largely on DaaS, and how to use it with desktop GIS products or free web-based interfaces. This book presents a generous collection of twenty service-oriented mapping examples from the international (predominantly European and African) community, and provides some insight into how national, multinational, and nongovernmental organizations are creating or leveraging these services to use or generate geographic data.

The chapters are organized into three parts: "Part I: Exploring a New Paradigm in Map Production," "Part II: Importance and Impact of the New Map Production Paradigm," and "Part III: Requirements of the New Map Production Paradigm." Part I leads off with a broad overview of issues related to the transition from paper to digital maps, emphasizing the evolution from long-lived artifacts presenting static, and eventually outdated, information, to more ephemeral electronic products involving interactive and potentially quickly updateable representations in keeping with the dynamic nature of many datasets. According to *Service-Oriented Mapping*, this new paradigm leverages the modern culture of "sharing and reuse" that requires us to think differently about modern map production. Other articles in this section discuss strategies for managing massive datasets and understanding their infrastructure needs, implementing custom applications, and developing automated processes to support on-demand mapping.

Part II, "Importance and Impact of the New Map Production Paradigm," provides a series of case studies and historical overviews of the transition to service-oriented mapping. While some of these articles are easily accessible to non-specialist audiences, others are highly technical, and include code samples and processes that are quite discipline-specific. Part III, "Requirements of the New Map Production Paradigm," is chiefly a discussion of the need for data and access standards to ensure interconnectivity and interoperability between various data systems and sources. It includes a study of how to define the needs of various user types to aid in developing standards—such as for metadata, storage formats, and accessibility—for archival entities.

It is clear the editors intended to present a range of service-oriented mapping applications, but the intended audience for their collection is less clear. The articles range in tone from a highly accessible white-paper style—useful to those planning for the use or provisioning of data or maps—to highly technical pieces clearly targeted at those who might be designing the delivery systems. Some entries focus on data processing and data mining, while others take data acquisition as an unproblematic given, and instead describe public-facing interfaces or resulting impacts on map production. Parts II and III are well curated, with all chapters relating strongly to the theme, but Part I is less organized. Some of the chapters in Part I are clearly related to the theme—an exploration of this "new paradigm"—but others are singular use cases detailing the development of particular map services, some more successful than others. For example, one case study provides considerable detail on the planning and implementation of a DaaS framework to serve the needs of agencies across Europe. The study discusses the engagement of key stakeholders, the collaborative design of service components, and the development timeline—which has been lengthy and is still ongoing. Another example outlines a map creation tool for Catalonia, in northeastern Spain, that was developed in a top-down manner, with no user input, and that was determined to be too complex to use once implemented. Yet a third case study describes the development of an automated process to add pie charts to any type of flow map, resulting in some pretty egregious violations of cartographic principles.

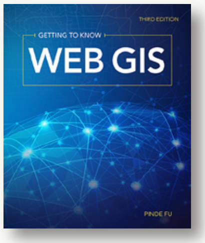
As a whole, *Service-Oriented Mapping* is plagued with minor editorial concerns, and a few chapters are both very poorly edited and tenuously placed in the literature. In particular, the opening chapter of Part II, "Developing a Statistical Geospatial Framework for the European Statistical System" (185–206), discusses how census point data were used to develop the framework, yet never mentions pertinent issues surrounding the protection of personally identifiable information. Other chapters refer extensively to European programs by their acronyms, often without explanation, which may leave the whole discussion confusing to non-European audiences.

The graphics in the print version of this book are uniformly poor—with most quite grainy and otherwise unreadable—something that is quite disturbing in a book of this price. Some graphics are slightly better than others due to their overall simplicity, and might have been perfectly fine had they been submitted in black and white, but most are completely illegible due to font size or complexity, exacerbated by the printing method. Curious to see what the colored mess purporting to be a section of a nineteenth-century geologic map of Austria (346) actually looked like, I combed the Internet for a digital image, and found a sample from the eBook version of *Service-Oriented Mapping*. The digital version reveals the map in full glory, but the print version looks like it was produced on a low-end inkjet printer on the draft setting. Issues of print quality aside, many of the graphics suffer from microscopic text and unclear organization, and even in the eBook they remain incomprehensible. Chapter 19, "Supply Chains and Decentralized Map Productions" (385–416), relies on a number of flow charts and diagrams to "explain" its points, but with no descriptive narrative in the text, and no legend to explain the abbreviations used in the diagrams, the reader is left quite perplexed. Even aside from this chapter, so many of the so-called mapping techniques presented throughout this book are so focused on expediency at the expense of sound cartographic principles that cartographers may likely find the book of dubious value

There are a few chapters in here which made the book worth reading—although not, in my opinion, enough to merit the cost. In particular, some of the case examples were quite good; making note of relevant sticking points in the process, or elements that required particular care. Chapter 3, "Establishing Common Ground Through INSPIRE: The Legally-Driven European Spatial Data Infrastructure" (63–84) provided a nice review of an existing framework. The chapter describes the project's goals, components and stakeholders, while noting that the development process has taken longer than anticipated—tenyears to date, and still not at full implementation—an important caution for agencies looking to undertake large-scale initiatives. Some of the discussions highlighted salient points about communication difficulties and standards disparities between agencies and between nations, and, similarly, some of the technical pieces described their methods with sufficient detail to make them entirely reproducible. Especially noteworthy is the contribution on and by the Spanish organization Vizzuality, creator of mapping applications for non-governmental organizations (NGOs). It provided three easy-to-digest case studies that include sufficient information to allow NGOs to understand the full benefit of making massive amounts of data available to, and manageable by, users ("Vizzuality: Designing Purposeful Maps to Achieve SDGs," 207–224). Also of note are Chapters 12, 15, and 16—all related to spatial data infrastructure. Chapter 12, "SDI Evolution and Map Production" (241–250) is on how such an infrastructure feeds map production, while the other two, "How Standards Help the Geospatial Industry Keep Pace with Advancing Technology" (303–324), and "Standards—Making Geographic Information Discoverable, Accessible and Usable for Modern Cartography" (325–344), are about the need for standards, and all three are both technical and accessible to a wide audience. This last chapter is available separately from the publisher, along with three other less useful chapters, priced at $29.95 each.

In general, however, *Service-Oriented Mapping: Changing Paradigm in Map Production and Geoinformation Management* is not sufficiently homogeneous to render it uniformly useful, and the issues with quality and consistency made it a difficult task to take in, or recommend, the entire book.

GETTING TO KNOW WEB GIS, THIRD EDITION



By Pinde Fu

Esri Press, 2018

486 pages; $94.99, paperback.

ISBN: 978-1-58948-521-1

Review by: Melo King, Smallmelo GIS, LLC

Back in 2012, I found the first edition of *Getting to Know Web GIS* quite valuable. It served as a resource for the Master's thesis I was then writing at the University of Redlands, which focused on building map-based web applications. It was also used as the text in the web GIS class I was taking at the time. Since then, I have continued to build GIS-based web applications and have witnessed firsthand the many changes in both web development and GIS during that time, so I was curious to see how *Getting to Know Web GIS* might have evolved, too.

The book's layout is generally similar to that of the first edition—it still has ten chapters, but only two appendices instead of three, and there has been some rearrangement of material. The text as a whole has kept up with the times and software versions, but the technology central to the material in Chapters Five and Six has changed significantly, resulting in major updates. Every chapter still has an introduction, a list of learning objectives (including a graphic showing how that chapter's topics fit into the big picture), a discussion of theory, a step-by-step tutorial, a Q&A section, an independent work assignment, and a list of resources. The tutorials are a huge component of the book, and take up many more pages than do the theoretical parts. This means that if you are only interested in the theory, *Getting to Know Web GIS* will end up being a much shorter read than you might at first have expected.

Chapter One introduces the reader to web GIS, and is similar across all editions. High-level terminology is explained, as are the advantages of web GIS applications over traditional desktop GIS. The chapter tutorial walks the reader through the process of building an Esri ArcGIS Online Story Map with photos, using out-of-the-box (OOTB) functionality. Showing the user how to build a web app straightaway in the first chapter is a great way to help allay the feelings of intimidation often associated with learning app development, and was a clever choice on the author's part. The reader walks away from the first chapter with a feeling of accomplishment—and they didn't even have to write any code.

The second Chapter, "Hosted feature layers and Esri Story Maps," is the only chapter that focuses on cartography and the map/app user experience—specifically, on "Smart Mapping" in ArcGIS Online (AGOL) and the Arcade application programming language now available across the ArcGIS ecosystem. "Smart Mapping" functionality offers web map users data-driven visualization styling suggestions for options like data class breaks and symbolization schemes. Arcade, on the other hand, is a JavaScript-like expression language for visualization and labeling. Its strength lies in its portability across the entire Esri ArcGIS platform and in its security—purportedly, an Arcade expression cannot be hacked, or injected with executable code outside of its intended context. This chapter also introduces web services—the way data residing on a server are delivered to a web map application. These service streams are ingested by the web map or app as data layers. The tools in Chapter Two could end up being valuable across a broad range of use cases, especially because, when building web map apps, the creator has to think about good *maps* and good *apps*—good *cartographic* and good *web* user experiences.

Chapter Three deals exclusively with the Web AppBuilder for ArcGIS—a WYSIWYG (What You See is What You Get) "drag and drop" tool for building map-based web applications within the Esri ecosystem. The Web AppBuilder automatically handles a great many of the tedious programming tasks—such as taking care of the styling variants required to accommodate the wide variety of hardware screen sizes, aspect ratios, and resolutions upon which a web app will be expected to work. Thus, the Web AppBuilder allows the web app builder to focus on the map content and app delivery method, instead of the nitty-gritty stuff. As someone who has been building web apps for a long time, this tool seems heaven-sent.

The fourth Chapter presents the reader with a range of uses for web GIS on mobile platforms—including Volunteered Geographic Information (VGI), Virtual Reality (VR), and Augmented Reality (AR)—along with the technologies Esri has developed to help their customers build for mobile platforms. There is a brief discussion on Esri's editable feature layers and their new "feature layer views"—which allow the service administrator to permit or deny different types of data access to users according to predefined "roles." The chapter then goes on to describe AppStudio. There are two different architectural approaches to building mobile apps: "native" (apps that run only on a particular mobile platform, such as Android, iOS, or Windows) and "hybrid" (cross-platform apps targeted to run on any of a variety of platforms). Esri's AppStudio allows the user to develop a single source of code that can be exported for multiple mobile platforms.

Chapter Five, "Tile layers, map image layers, and on-premises Web GIS," provides a discussion of the different data-layer type and server architecture options. Any web GIS app requires web-based GIS data, and to feed data to your app, you need a GIS server. *Getting to Know Web GIS* includes a very useful table comparing the relative capabilities of cloud (for example, ArcGIS Online) and on-premises enterprise (particularly, ArcGIS Enterprise) GIS server infrastructures. At this point in the chapter, I think that the reader could have been given a little more background information about the server/client relationship, but I also understand that the author is leaving the more complicated details until later in the book. Instead, he turns to a discussion of the different types of data layers—such as tile and map image layers—that can be accessed from a GIS web server for display in a web map. An especially useful table shows the conceptual relationships between the various proprietary Esri layer types and their corresponding open-source equivalents.

"Spatial temporal data and real-time GIS" is the title of Chapter Six, which hinges on both the four types of time found in GIS data—dynamic, discrete, stationary, and change—and on how GIS fits into the "Internet of Things." There is a big emphasis on Esri's GeoEvent Server, an ArcGIS Enterprise extension that ingests real-time data streams from sensors, and outputs a map data stream service that can be added as a layer in a web map. It is unfortunate that the discussion of licensing is saved for the chapter's Q&A section—it is only there that we learn that the GeoEvent Server requires not only a high-end ArcGIS Enterprise license, but an additional, and expensive, GeoEvent Server Extension license as well. Spendy!

Chapter Seven is focused on 3D GIS, and includes Indoor GIS as well as AR and VR—extending the earlier discussion in Chapter Four. The discussion of 3D data is particularly timely, given the growth in the use of drones to capture such information. In the Esri ecosystem, web *maps* are used for displaying two-dimensional data, while three-dimensional data are displayed in web *scenes*. The similarities and differences between a map and a scene, along with the different types of layers each can contain, is explained in useful detail.

Chapter Eight covers "Spatial analysis and geoprocessing." and is yet another topic thoroughly updated in this new edition. Geoprocessing—the ability to automate spatial analysis—is an important component of working with spatial data, and this chapter describes both the standard geoprocessing tools available in AGOL and how custom geoprocessing tools can be built in ArcMap or ArcGIS Pro and published to ArcGIS Enterprise as a geoprocessing service. Just like feature services can be consumed by a web map, geoprocessing services can be consumed by web applications, allowing users to perform analysis in the app. The chapter ends with a discussion of how geoprocessing services can be accessed by custom apps built with any of the various Esri Software Development Kits (SDKs) and Application Programming Interfaces (APIs). The majority of the Chapter Eight tutorials require an ArcGIS Enterprise license, which is slightly disappointing. It is also unfortunate that Esri doesn't allow custom geoprocessing services to be published by AGOL—that is to say, non-Enterprise-level license—customers.

Chapter Nine introduces a topic new in the third edition of *Getting to Know Web GIS*: image services and raster analysis on the web. The chapter starts with a refresher on what raster data are and how raster datasets can be organized into Arc mosaics and published as an image service through ArcGIS Enterprise. Image services provide an interface to the pixel values in the underlying raster data in a similar way that feature services provide an interface to vector data. The author describes the many powerful standard image services available to AGOL customers. He provides an example showing how an image service containing a raster dataset of sea surface temperature can be utilized to query and display the value of any given pixel. Another topic of note is the server-side on-the-fly processing that can be done with image services. An example of this includes the on-the-fly generation of aspect, slope, or hillshade rasters from an elevation image service. Custom image services can only be published by ArcGIS Enterprise customers with an additional Image Server license, and while AGOL customers can access Esri Living Atlas image services, ingesting and querying these commercial services consumes purchasable credits. This is another important financial detail that Mr. Fu glossed over or left out.

Chapter Ten is focused on building custom web apps with a map component. Web applications are dependent on an orchestration of database, back-end server, and front-end client components, and Fu takes the time to explain how this orchestration is effected. He does a really good job of providing basic building blocks, as well as touching on important topics for learning both how to program in any language and how to use the Esri ArcGIS for JavaScript API. Different front-end programming languages can be used to address different roles in web application development, and the author makes their different strengths clear. In describing the ArcGIS for JavaScript API, the author particularly discusses classes, methods, and properties, all of which are important programming concepts. There are informative discussions of both debugging and of Esri's Sandbox—both are valuable troubleshooting tools. The online Sandbox (**developers.arcgis.com/javascript/latest/sample-code/sandbox/index.html?sample=get-started-mapview**) is both a JavaScript map app testing environment and a great source for sample code.

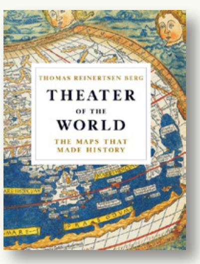
FINAL THOUGHTS

Getting to Know Web GIS, *Third Edition* covers enough detail on a wide range of web GIS topics to pique the interest and hold the attention of anyone wanting to make maps in an online environment.

I think that this is an ideal book for use in a GIS classroom where the curriculum is focused on Esri technology. With teaching aids—PowerPoint slides and sample data—available on the web, instructors are also given a leg up putting together content for any new web GIS class.

This book is also an appropriate resource for a GIS analyst in an Esri shop who has been asked to build GIS-based web apps, but has little or no previous background in web development. In my experience, there are many shops that find that they have to move quickly to meet new challenges in web and mobile mapping, and must do so without the luxury of additional hires. *Getting to Know Web GIS*, *Third Edition* should help any experienced mapping hand get a grasp on the new tools and environment.

THEATER OF THE WORLD: THE MAPS THAT MADE HISTORY



By Thomas Reinertsen Berg; translated from the Norwegian by Alison McCullough

Little, Brown and Company, 2018

367 pages, 55 color illustrations; $35.00, hardcover.

ISBN: 978-0-316-45076-8

Review by: Carolyn Hansen, Stony Brook University

In this work, Thomas Reinertsen Berg provides a broad survey of the history of mapmaking—from prehistoric images carved into the physical landscape to dynamic digital maps. As he explains in his introduction, the author emphasizes that maps hold importance as historical artifacts that tell a story about the lives of the people and societies who created them. He sees maps as not only representations of physical space, but also as depictions of cultural values and judgments made manifest by what is deemed worthy of inclusion. One of Berg's key ideas is that the history of maps is akin to the history of society, and that while maps serve a variety of practical purposes they also reflect the age in which they were created. Similarly, any reading of either history or maps will also reflect the age and environment in which that reading takes place. He also argues that, just like the maps themselves, his own analysis in *Theater of the World* is very much a product of his personal experiences and environment, and attributes his book's heavy focus on the mapping of the northern areas of the world—particularly on Norway and Scandinavia—to these factors.

The book is divided into ten chapters. The earlier chapters follow a rough chronological order, while the later ones are more thematically organized.

The first chapter, "The First Images of the World," deals with prehistoric maps, and begins with a map that was carved in stone sometime around the year 1000 BCE in Bedolina, Italy. The Bedolina Map is not geographically accurate in its depiction of houses, fields, animals, and people—nor was it widely considered a map until the 1930s. Berg uses the Bedolina Map to discuss the concept of mapping itself from a theoretical perspective. What is it, he asks, that ultimately makes a map different from other types of images? He acknowledges that scholars disagree on what constitutes a map, and argues that the Bedolina Map should be seen as a symbolic, rather than a physically accurate, representation of space, and thus a representation that fulfills a variety of societal needs. The author turns next to the religious aspects of prehistoric maps, and discusses what he refers to as "Maps of the Dead" (10) such as celestial maps and maps used for ritualistic purposes. One example cited is a ceremonial drum confiscated in the eighteenth century from the indigenous Sami people of Lapland, decorated with a map depicting the Sami worldview (14–15). In this chapter, Berg also explores significant early mapmaking artifacts from the Babylonians, Sumerians, and Egyptians—including a map of the Babylonian world that was inscribed by Babylonians on a clay tablet over 2,600 years ago, and that showed, among other things, the first indications of the cardinal directions of east, west, and north.

In "Like Frogs about a Pond," his second chapter, Berg focuses on Greek mapmaking—particularly that of Claudius Ptolemy, the astronomer and mathematician who, in about 150 CE, wrote the famous *Geographike Hyphegesis* (*Geographical Guidance*, or *Geography*). Berg argues that Ptolemy's work was the culmination of Greek geographical thought, drawing on the work of earlier scholars such as Herodotus, Aristotle, and Eratosthenes. Berg explores the theories of these philosophers and describes the importance of Ptolemy's *Geography*, and he writes that Ptolemy made groundbreaking contributions to the theory of map projections. Despite the fact that *Geography* did not contain any new geographic information, it was nonetheless a pioneering first attempt at a comprehensive work on geography, and it served as an authoritative source for mapmakers through the Middle Ages and into the Renaissance.

The "Holy Geography" chapter explores the shift from practical mapmaking, such as that seen in Roman city maps, to Christian mapmaking, the purpose of which was grounded in the Augustinian idea that humans should understand the Earth in order to better understand the Bible. Berg argues that as a result of the decline in travel and geographic expeditions during the Middle Ages, Christian maps did not have any new scientific information to share, but instead focused on God's dominion over Earth. To illustrate this point, Berg provides the example of the English *Hereford Mappa Mundi*, created sometime around the year 1300. Drawn on calfskin, the map is centered on Jerusalem and presents the world as a round land mass surrounded by otherworldly beings, representing the spiritual realm. Berg argues that the purpose of Christian maps was to transmit a Christian interpretation of history, of ethnology, and even of zoology. In this chapter, he also describes the rise of nautical charts in the Later Middle Ages as a practical counterpoint to Christian mapping. Where a Christian map informed its reader about the metaphysical world, the navigational chart dealt with getting from place to place. The *Carta Pisana*, for example—the world's oldest surviving nautical chart, dating from around 1275—locates as many as 927 named places, and covers an area that stretches from Lebanon in the east to Morocco and England in the west.

"The First Atlas" chapter comes next, and focuses on the European Renaissance rediscovery of Ptolemy. It describes how mapmakers both copied Ptolemy's maps and used his lists of geographic coordinates to create new maps. One example Berg cites is the *Cosmographiae Introductio*, published in 1507 by the German cartographer Martin Waldseemüller. Conceived as a new version of Ptolemy's *Geography*, Waldseemüller's work was the first to break with what was until then the established opinion that the recently discovered lands in the western Atlantic were a part of Asia—according to Waldseemüller, this land he called *America* was an island that represented a new, fourth, part of the Earth. Later in this chapter, Berg describes the 1347 Lucas Brandis map of the German city of Lübeck, contending that it was the first modern printed map because it was based on eyewitness accounts and evidence as opposed to relying on existing sources from the Classical and Biblical eras. He also details how Abraham Ortelius assembled the first atlas, *Theatrum Orbis Terrarum* (1570), by soliciting maps from his personal network of cartographers and redrawing them in a standardized manner. Berg argues that this atlas was the first attempt at a comprehensive, standardized view of the world and that it led to a rise in scientific and experience-based mapmaking.

In Chapters Five and Six, Berg explores the rising business of cartography through the movement of maps across Europe throughout the sixteenth and seventeenth centuries. During this period cartographers became business rivals, and the mapmaking trade came to focus increasingly on particular markets. Thus, maps created for traders sailing the Mediterranean or Baltic Seas, for example, came to be quite different from maps for the military, or civil administration maps. The author also describes the importance of triangulation surveys and their influence on national mapping in Europe. For example, the *Carte de France corrigée* (*Corrected Map of France*)—the first nation-wide mapping project employing triangulation methods—was published in 1682 by Jean Picard, and sparked considerable controversy in that France was shown to be about twenty percent smaller than had previously been believed. Berg also writes about the British Ordnance Survey and the pre-Napoleonic Franco-British triangulation efforts. The modern mapping of Norway—an undertaking that began in 1779—and the mapping of Denmark are both explored in Chapter Six.

Chapter Seven narrates the mapping of the Far North, the roots of which he traces back to the Viking narratives recorded in the Sagas. However, he notes that the systematic mapping of the polar regions did not begin until the seventeenth century, when Europeans began searching for the Northwest Passage and the Northern (or Northeast) Sea Route. He discusses the many English expeditions and discoveries, such as Henry Hudson's in 1610 and William Baffin's in 1615—of Hudson Bay and Baffin Island, respectively—as well as the numerous Russian expeditions to the Bering Strait, Sea of Okhotsk, and Chukchi Sea. The late nineteenth century Norwegian mapping expeditions lead by Harald Sverdrup get some particular attention. Sverdrup's belief that a number of Arctic islands—including Greenland, Jan Mayen, Svalbard, as well as Ellesmere, Axel Heiberg, and others to the west of Greenland—rightly belonged to Norway introduces Berg's discussion of the role of nationalism in exploration and mapping, and the use of land claims a means of acquiring and maintaining political power.

Chapter Eight describes the systematic development of maps based on aerial photographs, beginning with the work that French Captain Georges Bellenger carried out in 1914 and 1915. Berg writes that it was aerial photography that provided the most current and accurate maps for military purposes during World War I, and that the extensive airphoto-based project to map Norway in the early 1930s was largely inspired by the wartime example. By contrast, the author writes that no significant air-mapping breakthroughs were made in World War II, though the war did show the United States how far they were behind many other countries in this area. As soon as the war ended, the United States military began an intensive project to map Europe from the air before diplomatic and political considerations could prevent them from doing so.

The history of underwater mapping is the topic of Chapter Nine—and takes early nautical charting and the late-nineteenth-century Norwegian expeditions in the North Sea as starting points. Berg argues that a critical milestone in underwater mapping was the 1956 publication of Marie Tharp and Bruce Heezen's physiographic diagram of the floor of the Atlantic Ocean, which was drawn in a way to mimic the appearance of an aerial photograph. This was the first map of its kind, and, despite some geographical inaccuracies, it proved extremely popular with both geologists and the public. The map's popularity led to an increased interest in underwater mapping, and to new and improved technologies such as sonar and satellite-based sensors that allowed oceanographers to create ever more accurate images. Despite these breakthroughs, however, the process of underwater mapping remains tedious and difficult, and as a result, the mapping of the world's ocean floor remains incomplete.

The final chapter of *Theater of the World* explores maps in the Digital Age, arguing that the foundations for most of our current technology lie in scientific breakthroughs in fields like satellites and computing that were brought about by Cold War mapping activities. The author's discussion of the rise of various mapping technologies—such as GPS, GIS, online maps, and Google Earth—places each in a persuasive historical context. Beyond that, Berg argues that although maps created with these technologies may seem extremely different from early maps created by prehistoric peoples, *all* maps share the common purpose of presenting a worldview. Furthermore, because that worldview will eventually, and inevitably, change, Berg also contends that maps share the commonality of obsolescence—while any map may be the most current representation of the world at the time of its creation, over time every up-to-date map is transformed into a historical artifact.

Throughout his book, Berg provides sound analysis, reasoned arguments, and strong examples to support his assertions. The book is extremely well researched and clearly written. It is accessible to a general audience, and would be of interest to anyone who enjoys history or maps. While Berg acknowledges that no one can write a book covering all of the history of mapmaking, *Theater of the World* provides an excellent foundation in the general history of mapmaking in Europe, and the history of Norwegian mapmaking in particular.

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