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Clues. Anomalies. Understandings.
Writing Images
Beyond the Map
The Idea and Image
Critical Interfaces
Making Culture
Prototyping the Past
Book Art

critical making

DESIGN and the DIGITAL HUMANITIES

Jessica Barness
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guest editors

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DESIGN and the DIGITAL HUMANITIES

GUEST EDITORS' INTRODUCTION

4–11 Critical Making at the Edges
Jessica Barness, Amy Papaelias

THEORY AND SPECULATIONS

12–33 Meta!Meta!Meta! *A Speculative Design Brief for the Digital Humanities*
Anne Burdick

34–61 Clues. Anomalies. Understanding. *Detecting underlying assumptions and expected practices in the Digital Humanities through the AIME project*
Donato Ricci, Robin de Mourat, Christophe Leclercq, Bruno Latour

62–77 Writing Images and the Cinematic Humanities
Holly Willis

78–99 Beyond the Map: *Unpacking Critical Cartography in the Digital Humanities*
Tania Allen, Sara Queen

FORMS AND OBJECTS

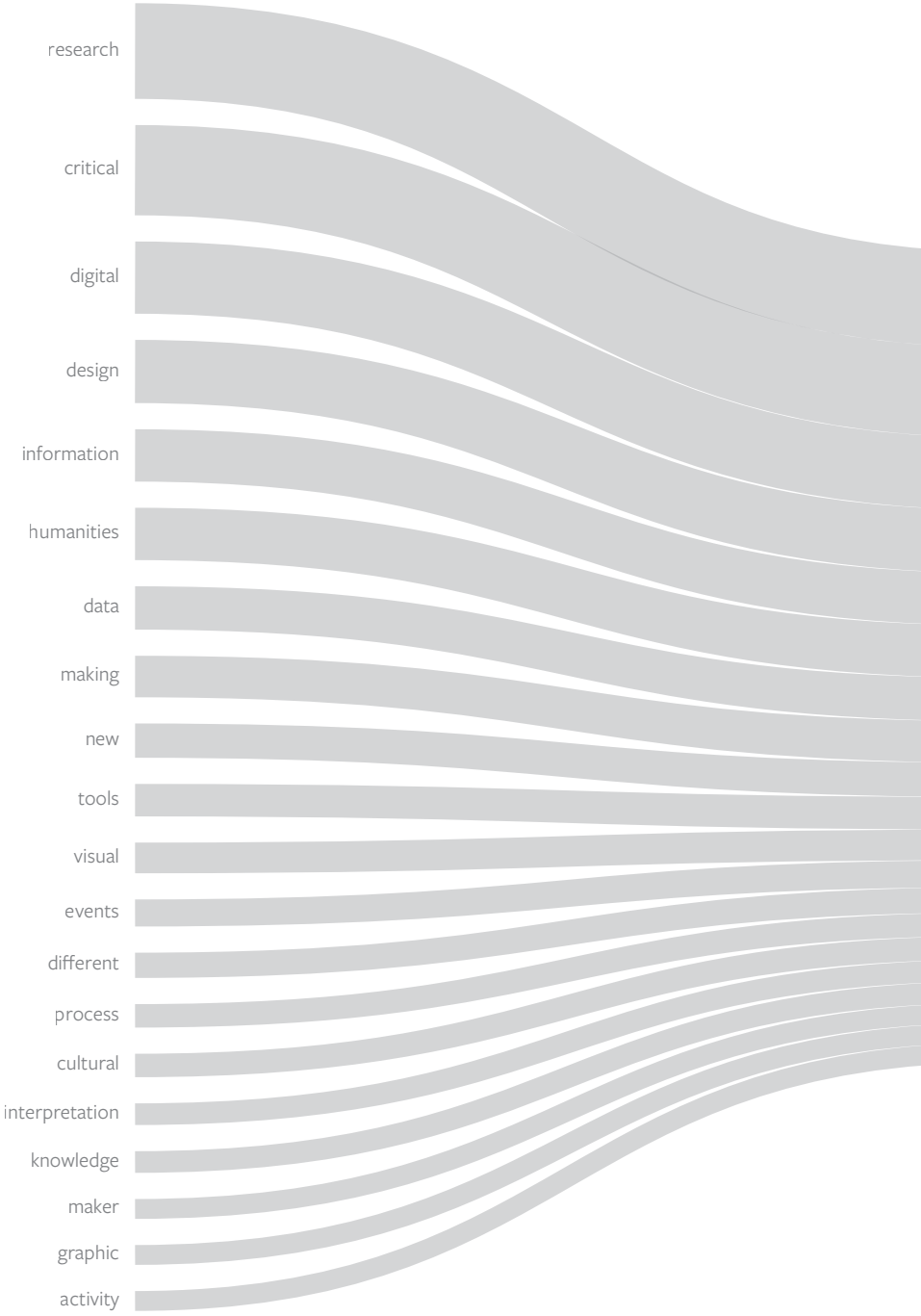
100–119 The Idea and Image of Historical Time:
Interactions between Design and Digital Humanities
Stephen Boyd Davis, Florian Kräutli

120–139 Critical Interfaces and Digital Making
Steve Anderson

140–155 Making Culture: *Locating the Digital Humanities in India*
Padmini Ray Murray, Chris Hand

156–177 Prototyping the Past
Jentery Sayers

178–203 *visual book review + essay*
Book Art: a Critical Remix of *The Electric Information Age Book*
Steven McCarthy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Beyond the Map:
Unpacking Critical Cartography in the Digital Humanities

Tania Allen
Sara Queen

Abstract
The importance of visualization as a formative and evaluative tool in the digital humanities begs for a deeper examination of the methods and literacy that accompany the making process. Current design and humanistic pedagogy and best-practice are heavily focused on understanding context — of place, culture, situation, or artifact. The iterative construction of visualizations which diversely examine these contexts of interpretation can illuminate both what is and what might be. Building on landscape and mapping theory which argues the map does more than reflect reality, it actively shapes our understanding of the physical, political and social world, this paper suggests the development of a theoretical perspective that goes beyond the examination of the artifact (i.e. the map) to include the critical evaluation of the activity of map making (i.e. the conditions that inform the activity of mapping and visualization and how to go about it) and its impact on the propositional nature of exploratory research (i.e. how the activity of mapping affects the decisions that researchers make about where, how and to what extent to intervene).

Keywords: cartographic tools, critical cartography, critical making, design research, design thinking, theoretical perspective on mapping

Introduction

We begin with the three-part assumption that theoretical perspectives and methods evident in design research are relevant to current discourse in the digital humanities (1) because of their parallel origins intersecting science and art, (2) because the activity of visualization through mapping is fundamental to generative research due to the overlapping nature of theory and practice, (3) and because mapping as a critical and reflective activity is essential to the interpretive nature of both fields. These assumptions are supported by the exponential growth of mapping as a research tool in design and humanities-based education and practice over the past 30 years: from concept maps and their capacity to assist in understanding complexity (Novak and Gowan, 1984) to critical cartography and its contribution to understanding landscape as a cultural and social phenomenon (Corner, 1999a), to geographic information systems (GIS) as a tool for providing a bird's eye view to environments and their demographics, and to the most recent data visualizations and their ability to highlight previously invisible relationships from vast amounts of data (Lima, 2013). As Denis Cosgrove attests, "The map is perhaps the most sophisticated form yet devised for recording, generating and transmitting knowledge" (1999, p. 12).

We base our definition of critical cartography on Jeremy Crampton and John Krygier's explanation as "new mapping practices and theoretical critique" (2006, p. 11). Our definition acknowledges the emergences of critical cartography in the 1990s — led by James Corner, JB Harley, Denis Cosgrove, and others — but expands this critique beyond the artifact to the methods and bias that culminate in its production. We further define critical cartography as an active practice — engaged by the cartographer during the generative, analytical, synthetic, and formative phases of research and inquiry. Because of what we see as similarities of process, we expand the usage of cartography to include new modes of data visualization in addition to traditional geo-spatial forms. There are a plethora of existing projects in the digital humanities that use cartographic strategies to investigate, navigate, and compare data and digital archives. In this paper, we are primarily concerned with how the digital humanities might leverage these methods to also confront the bias of the process and results. To explore the potential for expanded functions of mapping in the digital humanities, we have outlined a number of theoretical projects or issues a digital humanist might pursue. Many of these examples are based on existing projects; however, rather than critique those projects, each with their own motivations and accomplishments, we are using similar digital data sets or content to explore the potential of critical cartography to further shape the environments, tools, and methods native to the humanities.

Well illustrated by Stephen Ramsay's (2011b) proclamation that the growth of the digital humanities inherently "involves moving from reading and critiquing to building and making" (para. 4), we argue that the iterative and generative methods explored through critical cartography offer valuable insight to help explore and define the future of the digital humanities. However, this argument is not without tension. Johanna Drucker (2011) addresses the conflicts that arise when utilizing data

visualization tools that are taken directly — and without conceptual modification — from the scientific paradigm from which they originate. Drucker argues that this most profoundly affects the interpretation of meaning at the core of humanistic research when it collides with (or is subsumed by) the rational and scientific framework on which most data visualization and mapping relies. Drucker suggests a significant paradigm shift that begins by redefining data (what is given) as capta (what is taken). We extend Drucker's propositions by offering a theoretical perspective on mapping that balances the benefits of visualization strategies as cognitive tools to render a quantitative absolute with the ability of maps to explore truth as subjective, constructed, and incomplete.

As a cognitive tool, the benefits of mapping are well documented. In *Design for Information*, Isabella Meirelles builds on the historical and contemporary research of Donald Norman, Jacques Bertin, and others in arguing that "[v]isualizations of information can be considered cognitive artifacts, in that they can complement and strengthen mental abilities" (2014, p. 12). By making the tacit explicit, mapping provides a critical tool in the construction of knowledge (Novak and Gowin, 1984). Through the use of observation and pattern-finding, mapping has been utilized as a tool for inductive or deductive reasoning. However, because of its potential to "make sense of chaos" (Kolko, 2010, 15) by abstracting, manipulating, isolating, and visualizing, mapping also utilizes design thinking processes such as abductive reasoning and the "logic of conjecture" in its creation (Cross, 1990; Martin, 2009). Abductive reasoning is particularly powerful in the creation of hypothesis (or proposals) based on inherently incomplete information. As the scope of the digital humanities moves into uncharted territory, thinking that is both interpretive *and* propositional is pivotal to develop a vision of what *might be*. Theories of design thinking also provide parallels with the cognitive tools of mapping which move iteratively between processes of **analysis** (dissection), **synthesis** (assemblage), and finally **formation and action** (generation) (Bloom, 1956; Cross, 1990; Dubberly, Evenson & Robinson, 2008). Within each of these processes, **evaluation** of the activity and artifact provokes greater insight into the research findings.

These strategies for design thinking align with important behaviors in critical cartography through an active and reciprocal process of generation and selection. By encouraging a fluctuation of scales, behaviors of critical cartography also provoke pattern-seeking that is less recognizable in non-visual forms. The very activity of mapping the members of a literary group like the Black Mountain Poets (Figure 1) illuminates connections previously unrecognized. If the map maker also engages in an iterative process that includes isolating, comparing, assuming, and judging, they might further reveal additional patterns. These patterns might highlight (1) commonalities of origins, circumstances, and experiences that drove a similar trajectory and philosophy within the group; (2) how philosophies "born" from the group travelled and evolved over space and time; (3) and how individual influences grew and matured both inside and outside of the immediate group.

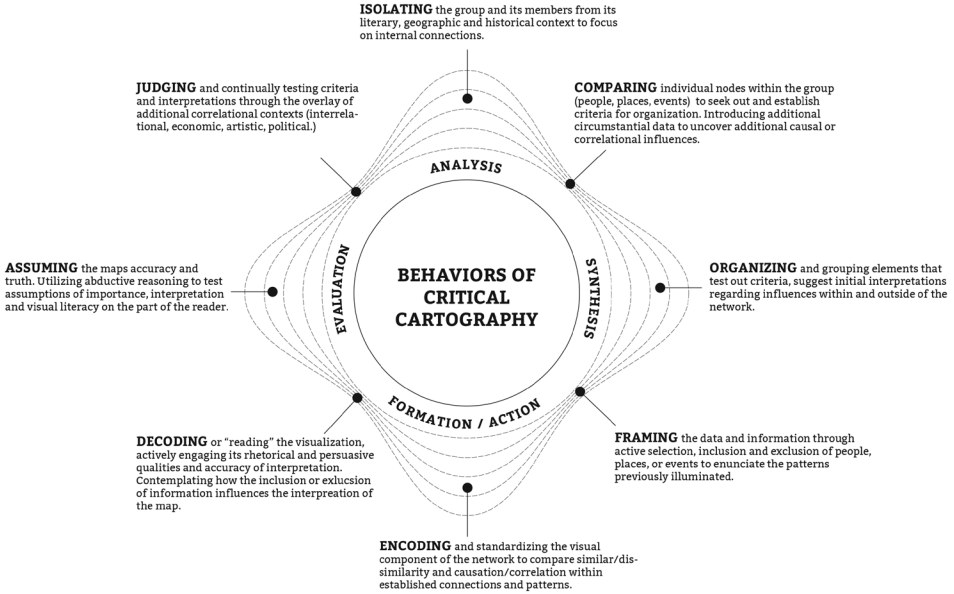

Figure 1.
At its foundation, mapping complements the design thinking process by encouraging adaptive and integrative thinking through fluctuating scales of observation and evaluation.

If the argument for mapping within design and humanistic research is based on its contribution to making more informed decisions and constructing interfaces or interventions within the subject matter, then deliberation on the activity of mapping is equally necessary. The critical literature extracted from geography and cartography has focused primarily on the cultural, political, and social impacts of the map that result from the bias, power, and values embedded within it but less so on an evaluation and methodology for the activity of mapping to address this imbalance. Cartographer Jeremy Crampton recognizes this lack of discourse coming from geography and GIS when he argues, "If you open any of today's prominent textbooks on cultural, social or political geography it is more than likely that you will find no discussion of mapping..." (Crampton, 2010, p. 1). As in design research, incorporating mapping within digital humanities necessitates a literacy of mapping that exposes the persuasive quality of the map (Harley, 2002) and applies the critique of the artifact to evaluate the non-neutral process of its construction. Like other generative practices, critical cartography must include a component of "reflection in action" (Schon, 1984) that reads the map as a social and cultural construct and engages in a critical dialogue that ventures beyond the object.

Mapping in the Digital Age

The relevance of mapping as a critical and generative design research tool is of particular importance within the digital humanities at its current point of development. Matthew Gold, editor of *Debates in the Digital Humanities*, has described this current context as "...a significant moment of growth and opportunity for the field" but warns

"at stake in the rise of the digital humanities is not only the viability of new research methods (such as algorithmic approaches to large humanities data sets) or new pedagogical activities (such as the incorporation of geospatial data into classroom projects) but also key elements of the larger academic ecosystem that supports such work" (p. ix). As suggested through Gold's statement, mapping has much to contribute to the digital humanities by providing important tools to organize, synthesize, and interpret the vast amounts of primary and secondary source information that is increasingly accessible within the digital humanities. An example that we increasingly see is visualization of library collections. Through sorting and categorizing, these maps help aggregate topics so viewers can see the totality of library holdings. Pushing this further, maps can also reach outside of the library's collection to include events, non-traditional media, photo collections, and much more. In this way, the map becomes a tool for situating library collections in contemporary events and dialogs. As the digital humanities move into a sphere that is participatory, co-creative, networked, and increasingly focused on making, the consideration of the user experience becomes pre-dominant. Academics, students, and professionals must find new modes to understand a multiplicity of scales which measure the diverse contexts and platforms that their work occupies. These needs provide real and complex challenges that mapping has the ability to engage — challenges that necessitate a fluctuation in scale, orientation, and media to gain insight into how best to confront them.

In today's networked world, access to both data and technologies provides an important context for developing a critical literacy of mapping and cartographic tools. The unique ability of mapping to make the complex accessible and knowable is appealing to a wide array of disciplines outside of geography, and consequently we see an increasing interest in these tools in different contexts. These conditions suggest an opportunity to develop a theoretical perspective focused on critical engagement in the mapping process. This development first requires establishing a middle ground between the positivist perspective of mapping as truth-seeking and an interpretivist paradigm that sees the map solely as construct. This starts by looking specifically at the dimension added to research and practice through the **cartographic tools** mapping utilizes. Successful integration of **critical making** into the mapping and research process necessitates reframing the emphasis of mapping from product to process. And finally, the assumptions and judgments visualized and developed through mapping require a focused **critical analysis** to encourage debate, questioning, and awareness of how mapping affects findings.

Cartographic Tools

Tools borrowed from geography are critical assets to advance mapping beyond the analysis of isolated project components and into the synthesis of both process and outcomes for generative research — research that is beyond a verbal activity in both design and the digital humanities. The map is a widely accepted way for researchers to understand complex issues through cartographic strategies for orienting a phe-

nomena within its larger context, uncovering the dimensions appropriate to examine its extents and impact, highlighting organizational patterns and relationships otherwise invisible, and translating observations into visual models that help identify novel intervention opportunities. The effective use of these cartographic features requires both an understanding of how they contribute to the creative activity of mapping as well as critical reflection on how they manipulate the findings.

Of the a priori features borrowed from cartography, including scale, organization, orientation,and framing (Figure 2), "scale is fundamental" (Cosgrove, 1999, p. 9). **Scale** describes relative or absolute size in terms of spatial dimensions, temporal units, or thematic attributes. Scale also has three types: cartographic, analytic, and phenomenal. Cartographic scale, with which we are most familiar, refers to the depicted size of a feature on a map relative to its actual dimensions. Analytic scale refers to the size of the unit at which a problem is studied. Phenomenal scale refers to the size in which the object or process exists, regardless of how it is represented in the map (Smelser and Baltes, 2001). Within design research, each of these types of scale are interrelated; the cartographic scale of the visualization and the analytic scale of the research question should consider the phenomenal scale of its subject to properly capture the extents of the issue at hand. The same subject matter examined at different scales can reveal different, sometimes contradictory, patterns. Often design research requires an isolation of scales — from a component scale out to a system scale — to study the relevant aspects of complex scenarios. "Scale selection and manipulation is thus a powerfully imaginative and generative act which at once records and sets in train chains of meaning and association in an active process of knowing" (Cosgrove, 1999, p. 9). Critical cartographers must remain cognizant of how scale skews the map's reading through the extents of what is observed and proposed.

Contributing to the map's scale are the dimensions that quantify space, time and theme through absolute or relative increments. In geographic maps, space is generally the primary measure defined in absolutes such as feet, meters, or miles. In a timeline, the scale of the map can be measured by absolute temporal units (minutes, hours, days, years, etc.) or relatively by proportional spacing events along an axis. Often maps have more than one scale overlaid to illuminate patterns between dissimilar attributes. Iteratively testing the effects of different measures across diverse scales encourages insight toward the non-neutral imprint these attributes have on the analytic, synthetic, formative, and evaluative processes of research.

Critical cartography in humanistic research can challenge traditional dimensions of scale to accommodate variable measures of experience and perception. For example, when mapping the 1963 March on Washington, the map maker must decide on the extents of the geographic measures of the map (i.e. showing the origin points of bused protesters from across the country, including only the marchers who walked from the surrounding east coast region, or limiting the frame of the map to the National Mall and Lincoln Memorial site). Additionally, considerations on the temporal dimension of the map might include events precipitating the march (i.e. showing significant events beginning with slavery during the colonial era, key events

in the civil rights movements, important events in Dr. Martin Luther King, Jr's life, or the organization of the march itself) as well as the causal relationships for events that followed (i.e. national civil rights legislation, global civil rights events, or contemporary challenges to equality). Each of these scalar decisions define the extents of the map in space and time, in turn limiting what is understood as important factors to the overall interpretation of the event. For instance, shifting the scalar attributes of personal accounts to create a sortable, mutable, and layered visualization might illuminate shared experiences versus individual testimonies. By challenging how to visualize different experiences of space and time simultaneously, the goal of the research shifts from the discovery of a singular history to an interpretation of multiple histories.

Another essential aspect of maps is that they **organize and prioritize** vast amounts of information through visualizing an overarching system of relationships. Proximity, hierarchy, categorization, isolation, and overlay are the primary ways by which traditional maps compare diverse sets of information to uncover patterns and connections that might otherwise be overlooked. This synthetic view of a scenario moves beyond "a mirror of nature" to "redescribe the world… in terms of relations of power and of cultural practices, preferences, and priorities" (Harley, 2002, p. 35). As Manual Lima (2011) argues in his book *Visual Complexity,* "any system can be depicted and interpreted in multiple ways, and a specific map delivers only one of many possible views… In some cases, the maps of these hidden structures are the only visual reference we have, constituting its own alternative territory" (p. 80).

In the digital humanities, the power of maps to visually organize, compile and relate different sources and media into a synthetic whole is particularly powerful. The plethora of primary accounts and secondary reports of 9/11 (i.e. maps of the different flight paths, timelines of the events, news reports, graphic novels, text messages, and personal photos) offer a unique perspective of what took place on that date. As distinct sources — each mediated by its hosting platform's format and rhetoric framework — these reports provide piecemeal vision of the unfolding events from singular viewpoints. But once assembled onto a level plane, the disparate accounts are connected through visualizing an order of events in space that illuminates simultaneity of actions and people in addition to connecting historical precedents leading up to those events. Through this engagement, the pieces become part of a larger, collective narrative that provides the digital humanist with evidence to construct new insights previously unconsidered.

Within the process of organizing and translating data into a graphic format, editing occurs whereby "mapping differentiates itself from the territory precisely through acts of selection… all maps are thematic: selecting and highlighting specific phenomena, consciously removing others… such choices and the presences and absences they create are profoundly significant both in the making and meaning of maps" (Cosgrove, 1999, p. 11). Therefore as map makers and map users, "we must search for what it de-emphasizes; not so much what the map shows, as what it omits" (Harley, 2002, p. 45). Like scale, the organizational structure of the map biases the user's judgments of the information displayed. Through the extraction of more and less important

components of a system, mapping encourages the emphasis of certain elements over others. Imposing this hierarchy facilitates the ability to test various orientations and speculate more fluidly on the relationship between intervention and impact but also actively influences the researcher's belief in the findings. This is especially relevant within the digital humanities as the discipline expands beyond leveraging digital tools to sort and organize vast amounts of archival metadata towards building tools that contribute new knowledge and generative methods to the domain (Ramsay, 2011a).

Through mapping, the activity of inclusion and exclusion forces a confrontation with the values and assumptions that drive who or what is rendered and why. A simple Google search on any research topic will return a variety of results, ranging from the highest academic expert to the casual observer and blogger. In translating these results into a cartographic form, assessments are made regarding criteria for sorting, grouping, and framing that in turn determine which sources are included or excluded. The cartographic form illuminates the established criteria for who and what are legitimate contributors, authors, or forms of media. By exposing the choices made in alignment with that criteria, the map maker is forced to reflect on the judgements of credibility and validity that determine why certain voices are included while others are excluded, reinforcing the need for active, iterative, and conscious editing processes.

Supporting the organization and modeling of a scenario, maps **orient** the viewer and maker within an abstract construction by conveying the location of one's self, or a component, in relationship to other elements. Orientation allows for wayfinding by providing a point of origin for the viewer to enter and navigate within the map as well as to project a new understanding over the real territory it describes. Orientation is a product of hierarchy and centrality which privileges what is at the center of the image as well as its relationship with other elements in the map. Orientation provides a critical vantage point that must be studied in relationship to the effect it has on the map's purpose and persuasion. A basic application of orientation within the digital humanities field is a cartographic bibliography which connects the influence of cited authors. Depending on the criteria for shared connections (academic training, age, collaboration, theoretical perspectives, research methods, etc.), different authors appear more or less influential, and different connections to other authors become visible. Each change in criteria shifts the visual display and meaning of the map through changing the origin point, the relative importance of each author, and their evident connections to one another.

Framing, like scale and organization, is a process where the map-maker (and later viewer) intentionally defines the territory and agenda of the map. Framing sets the physical boundary of the map, restricting the extents of the subject described, but it can also conceptually position the map through the inclusion and exclusion of certain information. Through such elements as the language, iconography, and symbolism chosen for denotation, cultural framing filters the perceptions, interpretations, and understandings of the subject in ways consistent with shared cultural beliefs and experiences. Framing not only affects how we filter a given scenario in the creation of the map but also affects how we interpret meaning as a user. As Christian Jacob

(1999) describes, "any map is an interface — pragmatic, cognitive, metaphysical — between its users and the world that surrounds them... As an optical, as well as an intellectual prosthesis, maps allow human senses and the human mind to achieve a new level of reality... more accessible to study that the reality itself" (p. 25). Framing is linked to perspective as a literal and figurative vantage point that includes socio-political, economic, and cultural worldviews and experiences. Commonly, geographic maps view their subject from a distant or removed aerial perspective and orient the territory facing north up. These culturally agreed upon semiological keys, which we often take for granted, are rules that allow us to understand abstract constructions of the world and project those insights back on the real world. Other than the bird's eye view from an airplane or high overlook, aerial perspective is not our typical experience of a landscape and configures a description of territory in terms other than those we experience daily. Through this abstraction, cartographers highlight attributes of the territory that are unperceivable from the human perspective and de-emphasizes or omits sets of information that interfere with their agenda.

Cartographic framing in the digital humanities situates a place, event, text, or cultural artifact in its larger context. If the goal of a project is to "reconstruct" a historical piece of destroyed architecture through written accounts of patrons and users, design drawings, and photographs, there are multiple strategies for framing the display of that data. At one end of the spectrum might be a rendered simulation of the space which assembles (and edits) the diverse perspectives in order to construct a unified virtual world where the sources of information and their nuanced contradictions are no longer unidentifiable or accessible by the user (Drucker, 2012). At the other end of the spectrum, the resulting cartographic construction might be an interactive floor plan overlaid with historic photos and written accounts which acknowledges the different sources and their bias, thereby illuminating different motivations for the design, construction, use of the space, and its varied cultural significance. These two scenarios utilize the same data set, but through choices in the visual and conceptual framing, they provide very different user interfaces to experience the subject of the map.

The primary cartographic assets of scale, organization, orientation, and framing are deployed through a wide range of tactics (Figure 2), and each contributes to the map's larger role as an analytic, synthetic, and formative research tool. As a powerful **analytic** tool, the map breaks complex issues or systems into smaller pieces to allow the researcher to extract and study a single component or relationship in depth. Design and humanistic research often begins by collecting data and observing phenomena from a variety of sources before assembling those diverse information sets into tangible and comparable ideas. Generally this process proceeds or is simultaneous to the problem definition and therefore highly informs the question seeking phase of a research project. As a **synthetic** research tool, mapping allows researchers to take the diverse observations and data they have gathered surrounding a question and its contextual relationships to render new insights and relationships previously unseen. The patterns that the map uncovers provide a clear entry point for the researcher

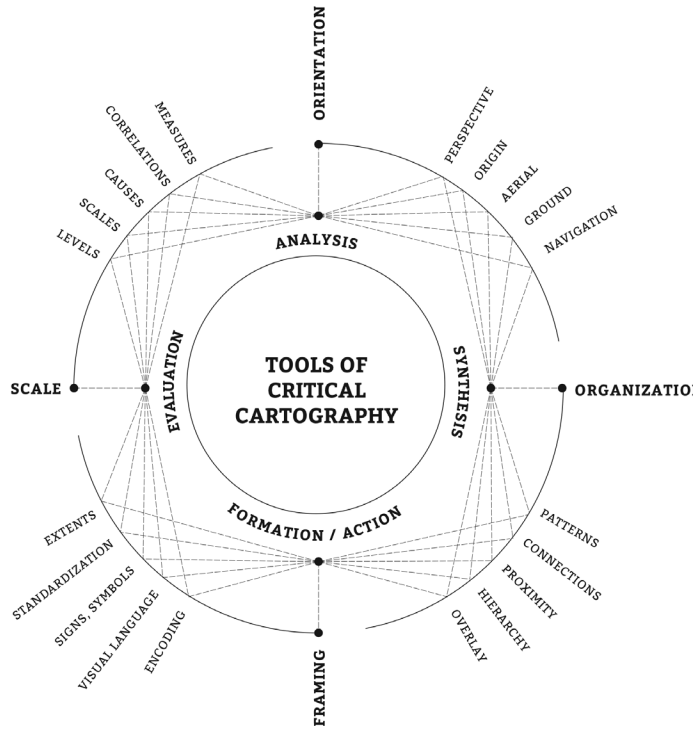

Figure 2.
The addition of cartographic tools into the digital humanities provides increased opportunities for humanistic interpretation through the primary functions of orientation, framing, organization and scale.

to make critical judgments that support or deconstruct preconceived ideas as well as incite new alternatives previously unconsidered to seed future opportunities. The landscape architect and theorist James Corner argues that "the function of mapping is less to mirror reality than to engender the re-shaping of the worlds in which people live" (Corner, 1999a, p. 213). As a **formative** research tool, the power of mapping has two main assets. Primarily, by providing a bird's eye view of a system with its complexity of nodes and connections, mapping encourages a critical consideration of the impact of discrete research interventions on alternate parts of the system. Secondarily, mapping in the formative stage of the generative process encourages iterative speculation through the use of overlay to test a variety of constraints and opportunities for the intervention itself.

A Theoretical Perspective for Critical Cartography

In each of these three functions (analysis, synthesis, and formation), mapping encourages an iterative and non-linear process, similar to that in design. Shifts in scale and perspective actively contribute to the bridge between analysis, synthesis, formation, and action by forcing a constant re-orientation and re-configuration (Figure 3). This fluctuation in perspective encourages debate around new ideas and insights through lateral thinking (DeBono, 1970). Additionally the mapping process exposes the over-

arching systems of relationships through the visual connections that it creates, while simultaneously allowing for a depth of investigation by isolating and highlighting particular intersections supporting focused deliberation. Here the map's role in mediating the existing environment inaugurates opportunities for later intervention and positions the designer and digital humanist's approach towards action. Building on Stephen Ramsay's (2011b) position that a defining component to the digital humanities is the process of building and making, we recognize digital humanities projects as interventions because they force a confrontation with assumptions, challenge knowledge bases, and have the potential to transform disciplinary landscapes through the construction of new research methods, digital tools, and user interfaces. In advancing Geoffrey Rockwell's acknowledgement of the importance of "thing knowledge — the tacit knowledge of fabrication and its cultures" (Rockwell, 2011, para. 5), much can be applied from the design process towards methods of generative and exploratory research.

The translation of the non-visual to the visual through **encoding** (in the creation of the map, converting and abstracting information into a graphic language) and **decoding** (through the dissection of the graphic image, evaluating alignment with or building meaning around its concept) performs important functions by encouraging a consistent evaluation of form, content, and communication that is essential to research, the construction of knowledge, and the identification of opportunities for alternative futures. Translation and abstraction facilitate encoding and decoding as the map maker moves back and forth between concrete observations and conceptual ideas or models. Here "abstraction is the key word in the process that leads from the empirical vision to the mental schematization" (Jacob, 1999, p. 40) whereby visual language is standardized and seemingly irrelevant differentiators are removed to allow the researcher to more easily see relevant patterns and phenomena. Aided by computational power of digital tools, the iterative and divergent testing of approaches to encoding, modeled on design processes, can transform how visualizations are utilized in the digital humanities. This critical approach to the rhetorical nature of encoding / decoding processes that construct the map's meaning must consider the rules and visual vocabulary by which information is coded. The rules of most graphic vocabulary was developed in the sciences and preferences quantitative research (Drucker, 2012). Therefore, like any designer who must iteratively test material translations to best serve an intended function, the digital humanist must actively interrogate the tools that input and manipulate data as well as the visual language that displays it.

In order to fully engage the strength of mapping in translating, clarifying, and constructing knowledge, researchers must also consider how maps (and the codes or softwares that construct them) distort the truth (and even lie) by employing their position as a reflection of reality (Harley, 1989) that persuades and manipulates. Within this critical view the map maker knowingly or unknowingly inserts bias into the map which persuades its viewer (and maker) of a certain, inherent truth. Much of the critical literature on and surrounding mapping has focused predominantly on the artifact (i.e. the map itself) as a symbol of values, biases, and assumptions on the part of

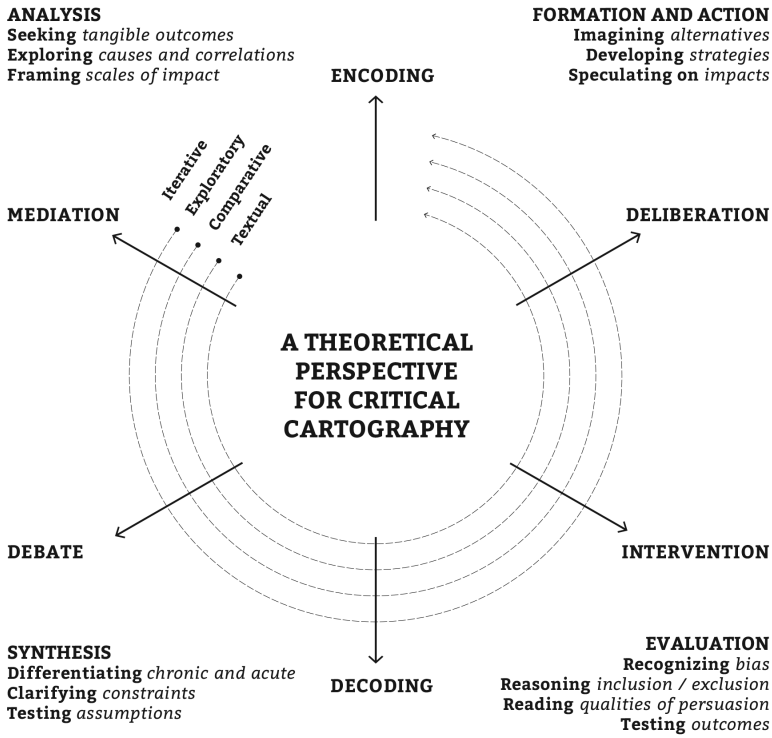

Figure 3. Using cartographic tools for encoding/decoding, debate/deliberation and mediation/intervention in the digital humanities includes a focus on the iterative, exploratory, comparative and textual components of map making to support critical analysis and design thinking that move the map away from an artifact of proof and towards one of critical understanding and insight.

the mapmaker. JB Harley (1989) has argued that the map is a "social construct" and a product of the "rules of society" and the "rules of measurement" (p. 6) — rules that might seem fixed but are actually in continuous negotiation. As the activity and process of mapping is utilized more frequently to aid us in deciphering the vast amounts of data at hand, so the literacy surrounding the methods employed to create them must be utilized. Movement towards this maturity starts with a focused critical reflection on the methods employed and questions asked during the map-making process.

Critical Making

Essential to the intentional use of cartographic tools in design research and the digital humanities is an active consciousness of the persuasive qualities of translation and abstraction as well as the exploratory potential of mapping to define numerous possible measures of an issue. To aid in the critical making process, we have identified four fundamental characteristics to the development of a theoretical perspective for mapping in design research: map making should should include aspects that are iterative (vs. linear), exploratory (vs. proving), comparative (vs. singular), and textual (vs. aesthetic). Here we argue that these distinctions are important for developing mapping as a methodology rather than a passive tactic.

Like design, map making is enhanced greatly when seen as an iterative process whereby the map is not just a finished product, but an ongoing generative and reflective process for advancing critical and creative thinking (Dubberly, 2010). Because an essential component to mapping processes is interpreting and encoding observations from diverse perspectives, iteratively testing appropriate orientations, scales, and translations for those observations facilitates the working back and forth between concrete observations and the abstract concepts they illuminate. These map-supported processes are also integral to iterative problem seeking and idea generation. As Donald Schon (1984) proposed, design is a "reflective dialog" between the designer and situation more so than a linear problem solving process, and the map is a powerful device to lend insight to that reflective dialog by providing the measures necessary to assess a proposal's usefulness and impact. In addition to facilitating investigation on a design problem or issue at hand, critical cartography can also serve as an internally reflective tool for designers and researchers as they consider their process and consciously reflect on their assumptions and bias throughout. Returning to the cartographic bibliography exemplified earlier, each change in criteria provides an opportunity for the map maker to reflect on the decisions made and knowledge built as a result of its construction. It also provides an opportunity to introduce new data and content, such as non-academic authors, to see how those perspectives integrate into academic dialogs or to explore public awareness and relevance.

Map making should also be exploratory and used as a tool for designers and scholars to think "aloud." Design research requires integrative thinking which combines analytic thinking process with the ability to work through sometimes contradictory information (Martin, 2007). Maps require a similar conceptual leap, as cartographers must often work with incomplete information and tolerate uncertainty as they construct relationships previously unseen. This requires the cartographer to ask deeper, more focused questions and often return to gathering additional data or to step back and visualize the given information from an alternative orientation or scale to explore the various potentials. Here the intention is not to resolve the observations into a single truth in order to elicit a specific design approach or conclusion but instead explore "what if" for a number of possible truths. As a cognitive tool, map making supports open-ended exploration of the complexities of design problems and research questions by complementing and even strengthening our mental abilities through increasing our working memory, facilitating our ability to search or navigate large information sets, supporting perceptual inference and discovery, and providing testable models of actual and theoretical worlds (Meirelles, 2013, p. 12). Mapping's greatest benefit comes when seen less as a tool to prove a point and more to illuminate, uncover, and provoke insights and new connections. This can only be done when the goal of the activity is the process rather than the product. The interactive nature of digital tools provide a strong environment in which to re-frame the map in this way. For example, a project that uses crowd-sourcing to map literary influences on rap songs over 20 years is inherently dynamic in the way that meaning is constructed in real-time. As more information is introduced and mapped onto the

system, the patterns of influence similarly shift. This same approach could also be explored within a contained data set by changing criteria to highlight different types of literary influences — when and where literary influences were most prevalent, whether or not similar influences appear in other musical genres, or if a reciprocal effect occurred where lyrics from rap songs found their way into popular literature. In critical cartography, these maps then become exploratory research tools, helping the digital humanist visualize a larger landscape in order to carve out a smaller territory to investigate more deeply.

Related to its iterative and exploratory attributes, as a comparative process, mapping also works best when used to encourage parity — combining various data sets to highlight alternative relationships and ultimately stimulate systems thinking. Comparative processes support iterative experimentation by testing how components relate to form a synthetic interpretation of the issue at hand. They also help predict how an intervention in one discrete area might affect the system as a whole. Naturally, designers and researchers approach a research question with pre-conceived assumptions as to how components relate to one another. Therefore, it is important that the mapping process be understood as a tool for uncovering juxtapositional relationships and how new information and interventions might affect those connections.

The final element contributing to this theoretical perspective for mapping in design research and the digital humanities is that map making involves a literacy focused on the effectiveness and impact of its agreed upon (or obvious) meaning as well as its contested (or nuanced) connotations. Fundamental to this aspect is the idea that "maps are text in the same senses that other nonverbal sign systems — paintings, prints, theater, films, television, music — are text" (Harley, 2002, p. 36). Cosgrove (1999), along with JB Harley (2002) and other geographers, points out that the visual systems which maps use to connect represented space with "ideas of the real" are historically and culturally determined and that "within the frame of one map there may be several texts — an intertextuality" (Harley, 2002, p. 38). As Johanna Drucker's statements cited earlier in the paper underscore, the digital humanities focus on interpretation means that the process of translation and encoding becomes infinitely more complex and inter-relational (2011, 2012). The potential complexity in the authorship and reading of the map's content begs that the map maker be not only aware of, but in command of, how abstraction and translation processes inform the map's rhetorical nature. This includes an understanding and consciousness of Harley's "systems of meaning" (2002) borrowed from art history which identify physical, psychological, and rhetorical interpretations that are dictated by an agreement as to what signs, symbols, and language mean within the map's construction. The strength of the map as encoded text is that it highlights aspects and opportunities invisible without the abstraction, translation, and isolation of the complex design problem or research question. Critical reflection and dialogue on these cultural constructs — both as assets to clarify meaning as well as obstacles to interpretation — promotes a better understanding of the connection between process and outcomes.

Critical Analysis

Equally important to critical insight on map making is the reflective analysis of the procedure and its influence on the map artifact. "Representing multidimensional information structures in a two dimensional visual display is not trivial" (Meirelles, 2013, p. 9). The rhetorical nature of the map and the influence that the tools and conventions of mapping have on the message should be critically questioned in the decoding or use of the artifact. Harley points out that "the fascination of maps as humanly centered documents is found not merely in the extent to which they are objective or accurate. It also lies in their inherent ambivalence and in our ability to tease out new meanings, hidden agendas and contrasting worldviews from between the lines on the image" (Harley, 2002, p. 36).

Critical analysis requires map makers to be aware of how the perspective of the map and its translation of information conditions the viewer's (or their own) understanding of the information displayed. The iterative and exploratory nature of map making, which requires cartographers to test many different alternatives to visualize and translate observations, plays an equally important role when interacting with and decoding the map. Critical cartographers must actively consider diverse lenses and alternative interpretations to challenge the assumptions and bias they bring to their research. The graphic language of "maps as unique systems of signs whose codes may be at once iconic, linguistic, numerical and temporal" (Harley, 2002, p. 79) requires us to question how we make meaning from the signs and whether that meaning is singular or multiple, implicit or explicit. This involves exposing what informs or influences our interpretation, including cultural and experience-based knowledge that preface certain understandings of visual images, as well as recognizing what is included versus excluded. In mapping the March on Washington, the interpretation of the map is directly influenced by the people, events, and narratives that are included as well as the visual representation they take. The inclusion of information such as who didn't participate (and why) or simultaneous and reactionary demonstrations changes the conversation from one of celebration to one of contention — an important alternative interpretation. Attention must also be paid to the orientation, scale, and extents of the map as it influences the scope and definition of the project. Critical consideration of alternative measures, impacts, and patterns should be developed as a way to reflect on the judgements formed from the display of the map. If the temporal timeline in the March on Washington map ended with the introduction of civil rights legislation, the map showcases an interpretation of current America as being "post-civil rights" — inferring that issues inherent in the Civil Rights Movement are no longer in existence. If, however, the timeline continues into the current day and includes current events surrounding the #blacklivesmatter movement, the interpretation is expanded to include civil rights as an ongoing and relevant issue. This critical eye should also be applied to the instruments, code, or software that aid in the construct of the map, acknowledging where and how the tool distorts or preferences certain information or organizational structures. Visualizing the March on Washington as a

series of bar charts or as a dynamic timeline with sliders that allow the reader to see where participants in the march are living and working today changes how the viewer understands the context of the event and those involved. In critical cartography, the map becomes a visual tool for analyzing the construction and deconstruction of knowledge and interpretation.

Critical Impact

One of the most overlooked aspects of mapping as design research is the impact that mapping has in determining the approach and goals of a research proposal. This agency which the map lends to the design process is equally influential in the digital humanities whereby the visualization of and navigation through a large data set inherently positions the researcher and user of the research as active participants in the making of meaning. The power of the map's mediation, as a non-neutral synthesis of a research problem, inherently influences and transforms the generative process and demands the responsibility of the map maker in shaping it. "The graphic is no longer only the 'representation' of a final simplification, it is a point of departure for the discovery of these simplifications and the means for their justification" (Bertin, 2010, p. 4). The ability to abstractly organize a scenario is extremely useful to designers or researchers who are searching for acute issues within larger chronic problems. In this role, the theoretical model of the research problem constructed through the map has the potential to highlight opportunities for intervention and even suggest the assessment outcomes which might be used for measuring its impact on the overarching chronic problem. In this way map making dissects very complex, seemingly unsolvable problems into potential opportunities to effect change through a graphic language which emphasizes (or highlights) existing gaps within the greater context. Therefore the map has the potential to serve as a generator precisely because it offers a conjecture or starting point for reconsidering a place or situation of knowledge. Here mapping is a "collective enabling enterprise" that "reveals and realizes hidden potential" (Corner, 1999a, p. 213).

The potential for impact on the final design or research proposal begins very early in the map making process; the selection of scale and orientation contributes to how the scope of the problem is defined from the outset and often aligns with or drives the goals of a later proposal. As Denis Cosgrove articulated, "Another form of mapping is the creative probing, the tactical reworking, the imaginative projection of a surface. Here, mapping becomes the two-dimensional 'staging' of actuality or desire. 'Perspective' has a temporal as well as spatial meaning — looking forward, the sense of prospect. Thus the map excites imagination and graphs desire, its projection is the foundation for and stimulus to projects" (Cosgrove, 1999, p. 15).

A few designers, including James Corner, Alan Berger, Anuradha Mathur, and Dilip Da Cunha, take this impact of the map one step further to claim that critical cartography can be the design intervention in and of itself. Through their seminal research publications and exhibitions of maps, they incite alternative beliefs about a

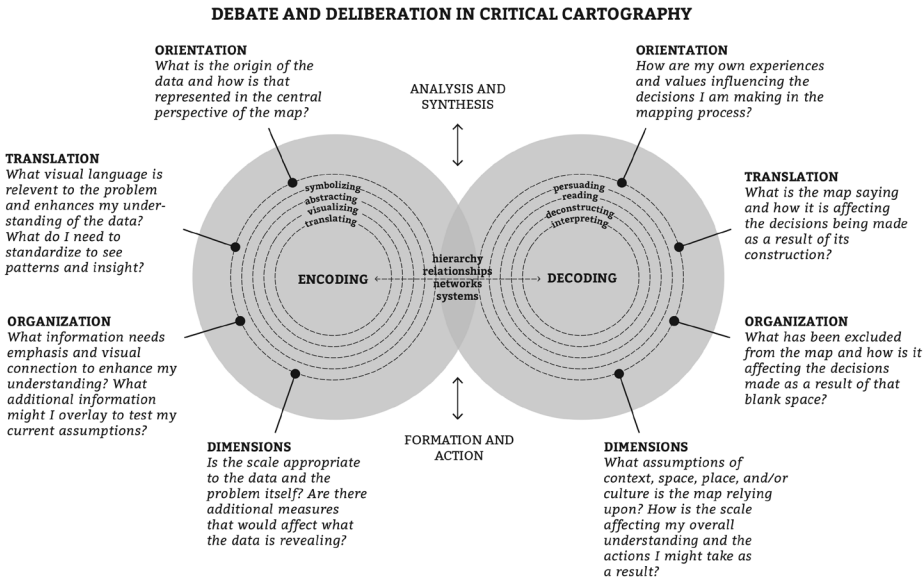

Figure 4. Central to critical cartography is provoking debate and deliberation throughout the encoding and decoding process. These questions acknowledge the major attributes that mapping provides for design research, while challenging the assumptions it can illuminate.

landscape's geographic, cultural, and economic measures influencing both the public's interpretations of its histories and possible futures. Their work as design-cartographers transforms the landscape, not by physically altering it, but by influencing one's perception and future use of it.

Conclusion

The growing popularity of mapping in the digital humanities and design research begs for a greater literacy of the non-neutral processes of map making as preparation for deeper reflection on its use. As a cognitive and reflective process, mapping has the ability to support design thinking through experiential learning and development because it incorporates concrete experience (feeling), reflective observation (reviewing), abstract conceptualization (thinking/generalizing) and active experimentation (doing/testing) (Kolb, 1984). In facilitating experiential learning, mapping moves in a non-linear sequence between observing and gathering information, encoding information through graphic systems of abstraction to make the invisible visible, translating the abstract relationships through decoding to identify novel opportunities for intervention, and extracting judgments of the work produced based on measures determined through the initial framing of the question. Here mapping is an act of making precisely because it supports "the ability to imagine that-which-does-not-yet-exist, to make it appear in concrete form as a new, purposeful addition to the real world" (Nelson and Stolterman, 2014, p. 12).

With the integration of mapping into research and generative processes, designers and digital humanists need to be intentional in developing tactics for the rigorous

use of cartography. To achieve this goal, evaluating and outlining a theoretical perspective for mapping as a part of the generative research process needs to include explicitly critical and reflective components. Debate and dialogue in the activities of making, evaluating, and utilizing the outcomes inherent in critical cartographies starts with specific questions regarding the purpose of the map and the bias of the data upon which we are relying: *What purpose does the map serve in the context of this project and its potential impact? How is the process of gathering and recording the information influencing its visual translation? How is our process of making influencing what we are learning and the proposals we generate as a result?*

Strategies for synthesizing and communicating design research need to include critical questions regarding how the researcher might bias the findings: *What assumptions do we bring to how we abstract and translate the gathered information? What are the culturally determined rules of measurement and graphic conventions being used or broken? What is included versus excluded? What hierarchical, causal, or correlational relationships are implied? What is the agenda of the map?*

Lastly we must be critical of how the mediation of the map affects formation and action, including the definition of project goals and outcomes: *How has the map identified new opportunities for intervention? What are the opportunities for measurable impact? What are the goals of the project and how do we assess those through measurable outcomes?*

Through the asking of explicit and targeting questions, we can move mapping beyond an organizational and visual strategy towards an actively critical and reflective tool that helps designers and researchers conceive large systems, individual components, and discrete moments for intervention.

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Tania and Sara lead the faculty lead initiative *Co/lab* at North Carolina State University which facilitates cross-disciplinary design research through mapping methodologies and visualization strategies with the goal of facilitating deeper, more diverse understandings of physical place, cultural space and social territory through innovative courses and projects that map urban territory, history and social relationships. Through Co/lab they have developed a number of public participatory mapping projects on such topics as public transportation, memory and placemaking. Tania received a Bachelor in History from Washington University, a Certificate in Visual Communication from the School of the Art Institute of Chicago, and a Master of Graphic Design from NC State University. Sara received a Bachelor of Environmental Design in Architecture from NC State University and a Masters in Architecture from the Graduate School of Design at Harvard University.

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