

# 1 Thinking about maps

*Rob Kitchin*<sup>1</sup>

NIRSA and Department of Geography, National  
University of Ireland, Maynooth, Ireland

*Chris Perkins and Martin Dodge*

School of Environment and Development,  
University of Manchester

## Introduction

A map is, in its primary conception, a conventionalized picture of the Earth's pattern as seen from above.

(Raisz 1938)

Every map is someone's way of getting you to look at the world his or her way.

(Lucy Fellowes, Smithsonian curator, quoted in Henrikson 1994)

Given the long history of map-making and its scientific and scholarly traditions one might expect the study of cartography and mapping theory to be relatively moribund pursuits with long established and static ways of thinking about and creating maps. This, however, could not be further from the truth. As historians of cartography have amply demonstrated, cartographic theory and praxis has varied enormously across time and space, and especially in recent years. As conceptions and philosophies of space and scientific endeavour have shifted so has how people come to know and map the world.

Philosophical thought concerning the nature of maps is of importance because it dictates how we think about, produce and use maps; it shapes our assumptions about how we can know and measure the world, how maps work, their techniques, aesthetics, ethics, ideology, what they tell us about the world, the work they do in the world, and our capacity as humans to engage in mapping. Mapping is epistemological but also deeply ontological – it is both a way of thinking about the world, offering a framework for knowledge, and a set of assertions about the world itself. This philosophical distinction between the nature of the knowledge claims that mapping is able to make, and the status of the practice and artefact itself, is intellectually fundamental to any thinking about mapping.

In this opening chapter we explore the philosophical terrain of contemporary cartography, setting out some of the reasons as to why there are a diverse constellation of map theories vying for attention and charting some significant ways in which maps have been recently theorized. It is certainly the case

that maps are enjoying something of a renaissance in terms of their popularity, particularly given the various new means of production and distribution. New mapping technologies have gained the attention of industry, government and to some extent the general public keen to capitalize on the growing power, richness and flexibility of maps as organizational tools, modes of analysis and, above all, compelling visual images with rhetorical power. It is also the case that maps have become the centre of attention for a diverse range of scholars from across the humanities and social sciences interested in maps in-and-of-themselves and how maps can ontologically and epistemologically inform other visual and representational modes of knowing and praxis. From a scientific perspective, a growing number of researchers in computer science and engineering are considering aspects of automation of design, algorithmic efficiency, visualization technology and human interaction in map production and consumption.

These initiatives have ensured that mapping theory over the past twenty years has enjoyed a productive period of philosophical and practical development and reflection. Rather than be exhaustive, our aim is to demonstrate the vitality of present thinking and practice, drawing widely from the literature and signposting relevant contributions among the essays that follow. We start the chapter by first considering the dimensions across which philosophical differences are constituted. We then detail how maps have been theorized from within a representational approach, followed by an examination of the ontological and epistemological challenges of post-representational conceptions of mapping.

### **Dimensions across which map theory is constituted**

A useful way of starting to understand how and why map theory varies is to explore some of the dimensions across which philosophical debate is made. Table 1.1 illustrates some important binary distinctions that strongly influence views on the epistemological and ontological status of mapping: judging a philosophy against these distinctions provides an often unspoken set of rules for knowing the world, or in our case, for arguing about the status of mapping. These distinctions are clearly related to each other. An emphasis upon the map as representation, for example, is also often strongly associated with the quest for general explanation, with a progressive search for order, with Cartesian distinctions between the map and the territory it claims to represent, with rationality, and indeed with the very act of setting up dualistic categories. By exploring how these dimensions work we can begin to rethink mapping and explain the complex variety of approaches described later in this book.

The mind–body distinction is often a fundamental influence on how people think about the world. If the mind is conceptualized as separate from the body then instrumental reason becomes possible: the map can be separated from the messy and subjective contingencies that flow from an embodied

Table 1.1 Rules for knowing the world: binary opposites around which ideas coalesce

Mind	Body	Structure	Agency
Empirical	Theoretical	Process	Form
Absolute	Relative	Production	Consumption
Nomothetic	Ideographic	Representation	Practice
Ideological	Material	Functional	Symbolic
Subjective	Objective	Immutable	Fluid
Essence	Immanence	Text	Context
Static	Becoming	Map	Territory

view of mapping. As such, science and reason become possible and a god-like view from nowhere can represent the world in an objective fashion, like a uniform topographic survey. On the other hand assuming a unity of mind and body and emphasising the idea of embodied knowing focuses attention on different, more hybrid and subjective qualities of mapping, rendering problematic distinctions between the observer and observed.

The question of whether geographic knowledge is unique or whether the world might be subject to more general theorizing also has fundamental implications for mapping. An ideographic emphasis on uniqueness has frequently pervaded theorizing about mapping in the history of cartography: if each map was different, and described a unique place, searching for general principles that might govern design, or explain use would be doomed to fail. Instead, mapping becomes the ultimate expression of descriptive endeavour, an empirical technique for documenting difference. Artistic approaches to mapping that privilege the subjective may be strongly compatible with this kind of interpretation. On the other hand a more nomothetic approach, which emphasizes laws and denies idiosyncratic difference risks reifying artificially theorized models or generalizations while at the same time offering the possibility of scientific universalization. Many of the approaches described in the chapters by Goodchild and Gartner in this volume subscribe to this quest for order. Debate continues around the nature of map generalization and whether mapping is holistic or fragmentary, stochastic or regular, invariant or contingent, natural or cultural, objective or subjective, functional or symbolic, and so on. It is clear, however, that since the Second World War a number of different scientific orthodoxies have pervaded the world of Western academic cartographic research which almost all trade on the notion of searching for a common, universal approach. Yet, paradoxically, everyday ideas of geography and mapping as ideographic and empirical survive.

As we examine in detail later in the chapter, the idea of viewing maps as texts, discourses or practices emerged in the late 1980s, in stark opposition to the more practical and technologically driven search for generalization. These new theoretical ways of understanding mapping often emphasized the discursive power of the medium, stressing deconstruction, and the social and

cultural work that cartography achieves. Here, the power of mapping becomes a more important consideration than the empirical search for verifiable generalization and the chapters by Crampton; Harris and Hazen; and Prosen in this volume considers some of these alternative approaches.

Structural explanations of the significance of mapping have also strongly influenced understandings of maps. Insights drawn might stem from class relations, from cultural practice, from psychoanalysis, or linguistics: for example semiotic approaches to mapping have been a powerful and influential way of approaching the medium and its messages for academic researchers. There is an ongoing debate in relation to mapping over how the agency of an individual might be reconciled with this kind of approach, given that structural approaches often posit fundamental and inevitable forces underpinning all maps. There is also a continuing debate over the philosophical basis of the structural critique. For example, is it grounded in a materialist view of the world, or in a more ideological reading of the human condition.

The distinction between forces producing the world and the forces consuming it also has a strong resonance in philosophical debates around mapping. The cultural turn in academic geography encouraged a growing emphasis on the contexts in which maps operate, encouraging a shift away from theorizing about production and towards philosophies of mapping grounded in consumption. Here, the map reader becomes as important as the mapmaker. Technological change that reduced the significance of barriers to accessing data, and the democratization of cartographic practice have also encouraged this changed emphasis. Associated with this shift has been the increasingly nuanced drift towards poststructuralist ways of knowing the world, which distrust all-encompassing knowledge claims. Instead of a belief in absolute space, or a socially constructed world, an alternative way of understanding mapping has emphasized relativity and contingency in a universe where notions of reality come to be replaced by simulation and in which the play of images replaces visual work, or in which speed of change itself gains agency.

## **Representational cartography**

### ***Maps as truth***

It is usually accepted that cartography as a scientific endeavour and industry seeks to represent as faithfully as possible the spatial arrangements of phenomena on the surface of the earth. The science of cartography aims to accurately capture relevant features and their spatial relations and to represent a scaled abstraction of that through the medium of a map. Maps seek to be truth documents; they represent the world as it really is with a known degree of precision. Cartography as an academic and scientific pursuit then largely consists of theorizing how best to represent and communicate that truth (through new devices, e.g. choropleth maps, contour lines; through the

use of colour; through ways that match how people think, e.g. drawing on cognitive science).

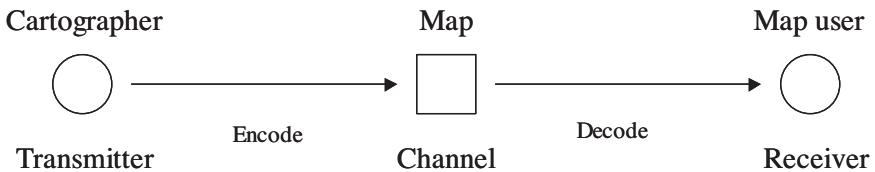
This quest for producing truth documents has been the preoccupation for Western cartographers since the late Middle Ages, and especially with the need for accurate maps with respect to navigation, fighting wars and regulating property ownership. It was only in the 1950s however, that the first sustained attempts began to emerge in the US to reposition and remould academic cartography as an entirely scientific pursuit. Up until then the history of cartography was a story of progress. Over time maps had become more and more precise, cartographic knowledge improved, and implicitly it was assumed that everything could be known and mapped within a Cartesian framework. The artefact and individual innovation were what mattered. Space, following Kant, became conceived as a container with an explicit geometry that was filled with people and things, and cartography sought to represent that geometry. Scientific principles of collecting and mapping data emerged, but cartography was often seen as much of an art as a science, the product of the individual skill and eye of the cartographer. Mapping science was practical and applied and numerous small advances built a discipline.

In the latter part of the twentieth century, US scholar Arthur Robinson and his collaborators sought to re-cast cartography, focusing in particular on systematically detailing map design principles with the map user in mind. His aim was to create a science of cartography that would produce what he termed “map effectiveness” – that is, maps that capture and portray relevant information in a way that the map reader can analyse and interpret (cf. Robinson and Petchenik 1976). Robinson suggested that an instrumental approach to mapping grounded in experimental psychology might be the best way for cartography to gain intellectual respectability and develop a rigorously derived and empirically tested body of generalizations appropriate for growing the new subject scientifically. Robinson adopted a view of the mind as an information-processing device. Drawing upon Claude Shannon’s work in information theory, complexity of meaning was simplified into an approach focusing on input, transfer and output of information about the world. Social context was deemed to be irrelevant; the world existed independent of the observer and maps sought only to map the world. The cartographer was separate from the user and optimal maps could be produced to meet different needs.

The aims of the cartographer were normative – to reduce error in the representation and to increase map effectiveness through good design. Research thus sought to improve map designs by carefully controlled scientific experimentation that focused on issues such as how to represent location, direction and distance; how to select information; how best to symbolize these data; how to combine these symbols together; and what kind of map to publish. Framed by an empiricist ideology, the research agenda of cartography then was to reduce signal distortion in the communication of data to users. Art and beauty had no place in this functional cartographic universe.

Out of this context in the late 1960s and 1970s emerged an increasingly sophisticated series of attempts to develop and position cartographic communication models as the dominant theoretical framework to direct academic research. Communication models encouraged researchers to look beyond a functional analysis of map design, exploring filters that might hinder the encoding and decoding of spatial information (Figure 1.1). For researchers such as Grant Head (1984) or Hansgeorg Schlichtmann (1979) the map artefact became the focus of study, with an emphasis on the semiotic power of the map as opposed to its functional capacity; while Christopher Board (1981) showed how the map could be conceived as a conceptual, as well as a functional, model of the world. As models of cartographic communication multiplied so attention also increasingly focused on the map reader, with cognitive research seeking to understand how maps worked, in the sense of how readers interpreted and employed the knowledge maps sought to convey. Drawing on behavioural geography, it was assumed that map reading depended in large part upon cognitive structures and processes and research sought to understand how people came to know the world around them and how they made choices and decisions based on that knowledge. This approach is exemplified in the work of Reginald Golledge (1999), Robert Lloyd (2005) and Cynthia Brewer (cf. Brewer *et al.* 1997). Here the map user is conceived as an apolitical recipient of knowledge and the cartographer as a technician striving to deliver spatially precise, value-free representations that were the product of carefully controlled laboratory-based experiments that gradually and incrementally improved cartographic knowledge and praxis. Most research investigated the filters in the centre of this system concerned with the cartographers' design practice, and the initial stages of readers extracting information from the map (such work continues, e.g. Fabrikant *et al.* 2008). Little work addressed either what should be mapped or how mapping was employed socially because this was beyond the philosophical remit for valid research.

Other strands of scientific research into mapping emphasized the technologies that might be employed. Waldo Tobler's (1976) analytical cartography emerged in the early 1970s, offering a purely mathematical way of knowing the world, and laying the foundations for the emergence of



*Figure 1.1* The basic map communication model, conceptualizing cartography in terms of stages in the transmission of spatial data from cartographer to reader via the map. Source: redrawn from Keates 1996: 114.

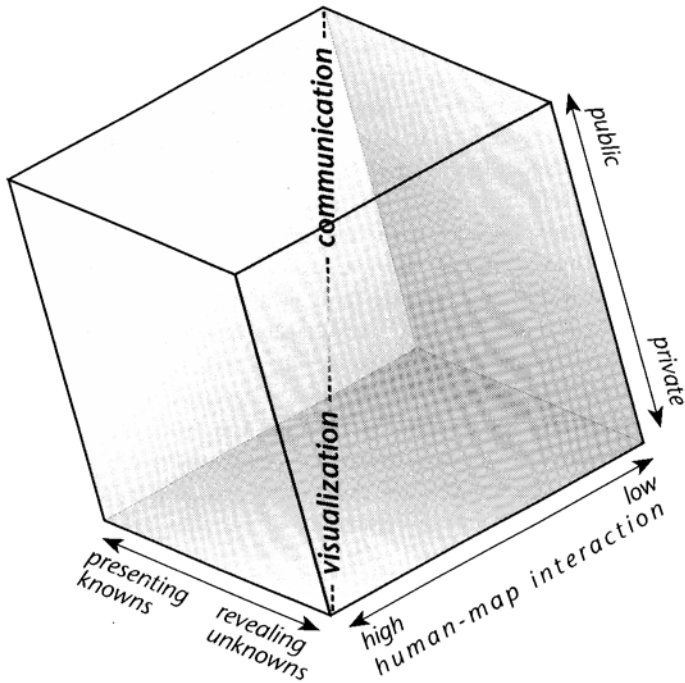
geographic information science. This analytical approach sought progress through the application of mathematical models and the subsequent application of technology so as to create new conceptual bases for mapping the world. Over time, conceptual and technically-driven developments in computer graphics, computation and user interfaces have begun to fundamentally transmute the role of the map from a finished product to a situation where the map is displayed within a visual toolbox to be used interactively for exploratory data analysis (typically with the interlinking of multiple representations such as statistical charts, three-dimensional plots, tables and so on). This changing conceptualization of the map is at the heart of the emerging field of geovisualization, which in the last decade or so has been one of the leading areas of applied cartographic research (cf. Dodge *et al.* 2008; Dykes *et al.* 2005). Although distinctly positivist epistemologies underlie most of the geovisualization research, some have tried to open up the scope of visualization in more politically progressive directions, for example Craine and Aitken's chapter in this volume that considers the emotional energy latent in cinematic qualities of maps, and Kwan's (2007) work in fusing geospatial technologies with feminist theory to map affect and emotional geographies.

In other contexts different theoretical positions were adopted. For example, the French disciplinary tradition was much less influenced by Robinsonian functionalism and empirical research. Semiotic approaches were much more influential in this context, and may be traced back to the influential theories of Jacques Bertin. In 1967 Bertin derived from first principles a set of visual variables that might be manipulated by designers concerned with the effective design of mapping and other visualizations.

By the mid 1980s the cartographic communication model as an organizing framework for academic research was beginning to wane. Technological changes rendered problematic a single authoritative view of the world at a time when data were becoming much more readily available, and when technologies for the manipulation and dissemination of mapping were also being significantly changed. Users could become mappers and many possible mappings could be made. Digital mapping technologies separated display from printing and removed the constraint of fixed specifications. GIS increasingly supplanted many technical aspects of cartographic compilation and production. Digital position, elevation and attribute data could be captured from remotely sensed sources, and easily stored and manipulated in a digital form. Imagery could be generated to provide frequent updates of changing contexts. Maps could become animated. From the late 1990s the Internet has allowed maps to be evermore widely shared and disseminated at low cost. Mapping needed to be understood as much more of a process than was possible in communication models.

In the face of these profound challenges a second dominant approach to mapping research had replaced cartographic communication by the mid 1990s

as the scientific orthodoxy. The linear inevitability of communication was supplanted by a multifaceted and multilayered merging of cognitive and semiotic approaches, centred on representational theory, and strongly influenced by the work of Alan MacEachren (1995). Articulating ideas grounded in Peircean semiotics, this approach recognized the need for a much less literal and functional positioning of maps. The iconic diagrammatic description of this approach is the notion of ‘cartography cubed’ (Figure 1.2). The dimensions of interactivity, the kind of knowledge, and the social nature of the process show the three key ways in which scientific understanding has been repositioned. Mapping can now be investigated as collaborative, the social context beyond map reading per se can be charted, and the process of knowing explored. And mapping is one of many kinds of visualization. However, mapping is still about revealing truth through a scientific approach reliant upon Western ways of seeing and upon technologies of vision; it still depends upon scientific experimentation and a representational view of the world.



*Figure 1.2* MacEachren’s conceptual device, the “cartography cube” employs the three different axes to encapsulate the distinctive characteristics of contemporary map use. Source: MacEachren 1994: 6.



### ***Maps as social constructions***

The view that cartography produces maps of truth in an objective, neutral, scientific fashion has been challenged by a number of scholars. In the late 1980s, the work of Brian Harley began to question how mapping operated as a powerful discourse, challenging the scientific orthodoxy of cartographic research. He proposed a new research agenda concerned with the roles maps play in different societies, arguing that maps often reinforce the status quo or the interests of the powerful, and that we should investigate the historical and social context in which mapping has been employed. In this view cartography was not necessarily what cartographers said it was. Instead, Harley argued that we could only understand the history of cartography if we interrogate the forces at play around mapping.

Harley (1989) drew on the ideas of Michel Foucault among others to argue that the process of mapping was not a neutral, objective pursuit but rather was one laden with power. He contended that the process of mapping consists of creating, rather than simply revealing, knowledge. In the process of creation many subjective decisions are made about what to include, how the map will look and what the map is seeking to communicate. As such, Harley noted, maps are imbued with the values and judgements of the individuals who construct them and they are undeniably a reflection of the culture in which those individuals live. Maps are typically the products of privileged and formalized knowledges and they also tend to produce certain kinds of knowledge about the world. And in this sense, maps are the products of power and they produce power. In contrast to the scientific view that positions maps in essentialist terms, Harley cast maps as social constructions; as expressions of power/knowledge. Others, such as Denis Wood (1992) and John Pickles (2004), have extensively demonstrated this power/knowledge revealing the ideology inherent in maps (or their “second text”) and how maps “lie” (or at least provide selective stories while denying their selectivity) due to the choices and decisions that have to be made during their creation, and through how they are read by users.

This social constructivist critique sometimes also articulated structural explanations for mapping, which sought understanding beneath the apparent surface of observable evidence. For example, David Harvey’s (1989) Marxist analysis of the role of mapping in time–space compression examined the role of global images in the expansion of European colonial powers, and situated these as reflections of a changing mode of production. Drawing on linguistic structural thought Denis Wood (1992) employed Barthean semiotics to persuasively argue that the power of maps lay in the interests they represented. Mapping in this view always has a political purpose, and this “interest” often leads to people being pushed “off the map”. Wood argued that mapping works through a shared cultural reading of a number of different codes in every map, which may be analysed in a semiotic process to reveal the power behind the map. These interests all too often led to subjugation,

oppression, control and inequality. Through economic relations, legal evidence, governance or social practice the power of maps continues to be used to control. It has been argued that many of the social roles played by cartographic knowledge stem from the modernist project, and that mapping mentality is integral to the modernist enterprise itself (Cosgrove and Martins 2000). By examining different categories across which power might be articulated contextual studies can reveal how maps reflect but also constitute different kinds of political relation. Colonialism, property ownership, national identity, race, military power, bureaucracy and gender have all been theorized as playing key roles in mapping relations (see Anderson 1991; Haraway 1992; Pickles 2004).

For example, local knowledge has been translated into tools to serve the needs of the colonizer, with new territories scripted as blank spaces, empty and available for the civilizing Western explorer to claim, name, subjugate and colonize (Edney 1997). Projection and design have been used to naturalize the political process of imperial control and sell imperial values to citizens at home. The continuing progress of colonial adventures is mapped out nowadays in our news broadcasts, and on the Internet, but the imperial rhetoric of control, governance, management of territory and creation of new imperial landscapes remains the same (cf. Gregory 2004). The colonial project relies on the map, and in turn the map relies on colonial aspirations.

The work by Harley, Wood, Harvey and others set the groundwork for work since the 1990s that has been labelled critical cartography (see Crampton and Krygier 2005) and with respect to wider geospatial technologies, critical GIS (see Schuurman 1999; O'Sullivan 2006). Critical cartography is avowedly political in its analysis of mapping praxis seeking to deconstruct the work of spatial representations in the world and the science that produces them. It is, however, decidedly not against maps, but rather seeks to appreciate the diverse ways in which maps are produced and used by different individuals and groups. From such a perspective there is no one "right way" to produce maps, but their makers need to be sensitive to politics and context of their making and use. For some theorists this means moving beyond thinking of maps as representations to try to conceive of a post-representational cartography.

## **Post-representational cartography**

### *From ontic knowledge to ontology*

Despite the obvious advances of the various social constructivist approaches in rethinking maps, more recent work has sought to further refine cartographic thought and to construct post-representational theories of mapping. Here, scholars are concerned that the critique developed by Harley and others did not go far enough in rethinking the ontological bases for cartography, which for them has too long been straitjacketed by representational thinking. As

Denis Wood (1993) and Jeremy Crampton (2003) outline, Harley's application of Foucault to cartography is limited. Harley's observations, although opening a new view onto cartography, stopped short of following Foucault's line of inquiry to its logical conclusion. Instead, Crampton (2003: 7) argues that Harley's writings 'remained mired in the modernist conception of maps as documents charged with "confessing" the truth of the landscape'. In other words, Harley believed that the truth of the landscape could still be revealed if one took account of the ideology inherent in the representation. The problem was not the map per se, but 'the bad things people *did* with maps' (Wood 1993: 50, original emphasis); the map conveys an inherent truth as the map remains ideologically neutral, with ideology bound to the subject of the map and not the map itself. Harley's strategy was then to identify the politics of representation in order to circumnavigate them (to reveal the truth lurking underneath), not fully appreciating, as with Foucault's observations, that there is no escaping the entangling of power/knowledge.

Crampton's solution to the limitations of Harley's social constructivist thinking is to extend the use of Foucault and to draw on the ideas of Heidegger and other critical cartographers such as Edney (1993). In short, Crampton (2003: 7) outlines a 'non-confessional understanding of spatial representation' wherein maps instead of 'being interpreted as objects at a distance from the world, regarding that world from nowhere, that they be understood as being in the world, as open to the disclosure of things'. Such a shift, Crampton argues, necessitates a move from understanding cartography as a set of ontic knowledges to examining its ontological terms. Ontic knowledge consists of the examination of how a topic should proceed from within its own framework where the ontological assumptions about how the world can be known and measured are implicitly secure and beyond doubt (Crampton 2003). In other words, there is a core foundational knowledge – a taken for granted ontology – that unquestioningly underpins ontic knowledge.

With respect to cartography this foundational ontology is that the world can be objectively and truthfully mapped using scientific techniques that capture and display spatial information. Cartography in these terms is purely technical and develops by asking self-referential, procedural questions of itself that aim to refine and improve how maps are designed and communicate (Crampton gives the examples of what colour scheme to use, the effects of scale, how maps are used historically and politically). In these terms a book like Robinson *et al.* (1995) is a technical manual that does not question the ontological assumptions of the form of mapping advocated, rather it is a 'how to do "proper" cartography' book that in itself perpetuates the security of cartography's ontic knowledge. In this sense, Harley's questioning of maps is also ontical (e.g. see Harley 1992), as his project sought to highlight the ideology inherent in maps (and thus expose the truth hidden underneath) rather than to question the project of mapping per se; 'it provided an epistemological avenue into the map, but still left open the question of the ontology of the map' (Crampton 2003: 90). In contrast, Crampton details

that examining cartography ontologically consists of questioning the project of cartography itself.

Such a view leads to Crampton, following Edney (1993), to argue for the development of a non-progressivist history of cartography; the development of a historical ontology that rather than being teleological (wherein a monolithic view of the history of cartographic practices is adopted that sees cartography on a single path leading to more and more complete, accurate and truthful maps) is contingent and relational (wherein mapping – and truth – is seen as contingent on the social, cultural and technical relations at particular times and places). Maps from this perspective are historical products operating within ‘a certain horizon of possibilities’ (Crampton 2003: 51). (See also his chapter in this volume that discusses the ways different forms of mapping inframe racial identities with important ramifications for how humanity is made visible.) It thus follows that maps created in the present are products of the here-and-now, no better than maps of previous generations, but rather different to them. Defining a map is dependent on when and where the map was created, as what constitutes a map has changed over time. For Crampton (2003: 51) this means that a politics of mapping should move beyond a ‘critique of existing maps’ to consist of ‘a more sweeping project of examining and breaking through the boundaries on how maps are, and our projects and practices with them’; it is about exploring the ‘being of maps’; how maps are conceptually framed in order to make sense of the world. Several other cartographic theorists have been following similar lines of enquiry to Crampton in seeking to transfer map theory from ontic knowledge to ontology and it is to them that we now turn.

### *Maps as inscriptions*

John Pickles (2004) has sought to extend cartographic theory beyond ontic status by conceiving of maps as inscriptions as opposed to representations or constructions. His work focuses on ‘the work that maps do, how they act to shape our understanding of the world, and how they code that world’ (p. 12). As such his aim is to chart the ‘practices, institutions and discourses’ of maps and their social roles within historical, social and political contexts using a poststructural framework that understands maps as complex, multivocal and contested, and which rejects the notion of some ‘truth’ that can be uncovered by exposing ideological intent. Pickles’ detailed argument unpicks the science of representation, calling for a post-representational cartography that understands maps not as mirrors of nature, but as producers of nature. To paraphrase Heisenberg (1959, cited in Pickles 2004), Pickles argues that cartography does not simply describe and explain the world; it is part of the interplay between the world and ourselves; it describes the world as exposed to our method of questioning.

For Pickles, maps work neither denotatively (shaped by the cartographic representation, labelling, embedded with other material such as explanatory

text, etc.) or connotatively (what the mapper brings to the representation in terms of skills, knowledges, etc.) but as a fusion of the two. Pickles thus proposes a hermeneutic approach that interprets maps as unstable and complex texts, texts that are not authored or read in simple ways. Rather than a determinate reading of the power of maps that seeks to uncover in a literal sense the authorial and ideological intent of a map (who made the map and for what purpose), Pickles expresses caution in fixing responsibility in such a manner, recognizing the multiple, institutional and contextual nature of mapping. Similarly, the power of maps is diffuse, reliant on actors embedded in contexts to mobilize their *potential* effects: ‘All texts are . . . embedded within chains of signification: meaning is dialogic, polyphonic and multivocal – open to, and demanding of us, a process of ceaseless contextualization and recontextualization’ (Pickles 2004: 174).

Alongside a hermeneutic analysis of maps, Pickles proposes that a post-representational cartography consists of the writing of denaturalized histories of cartography and the production of de-ontologized cartography. Denaturalized histories reveal the historicizing and contextualizing conditions that have shaped cartographic practices to ‘explore the ways in which particular machines, disciplines, styles of reasoning, conceptual systems, bodies of knowledge, social actors of different scales . . . and so forth, have been aligned at particular times and particular places’ (Pickering 1995, quoted in Pickles 2004: 70). In other words, they consist of genealogies of how cartography has been naturalized and institutionalized across space and time as particular forms of scientific practices and knowledge. A de-ontologized cartography is on the one hand about accepting counter-mappings as having equal ontological status as scientific cartographic (that there are many valid, cartographic ontologies), and on the other, deconstructing, reading differently, and reconfiguring scientific cartography (to examine alternative and new forms of mapping).

### *Maps as propositions*

Like Pickles, Crampton and others, Wood and Fels (2008) extend the notion of a map as social construction to argue that the map itself, its very make-up and construction – its self-presentation and design, its symbol set and categorisation, its attendant text and supporting discourse – is ideologically loaded to convey particular messages. A map does not simply represent the world; it produces the world. They argue that maps produce the world by making propositions that are placed in the space of the map. Maps achieve their work by exclaiming such propositions and Wood and Fels define this process as one of ‘posting’ information on map. Posting is the means by which an attribute is recognized as valid (e.g. some class of the natural world) and is spatialized. It is the means by which the *nature* of maps (is – category) and the nature of *maps* (there – sign) conjoin to create a unified spatial ontology (this is there). However, the map extends beyond spatial

ontology by enabling higher order propositions (this is there and *therefore it is also*; Wood and Fels 2008) to link things in places into a relational grid.

Wood and Fels argue that the power of this spatial propositional framework is affirmed through its call to authority – by being an objective reference object that is prescriptive not descriptive. So the map produces and reaffirms territory rather than just describing it. Authority is conveyed through what they term the paramap. A paramap is the combination of perimap and epimap. The perimap consists of the production surrounding a map: the quality of the paper, the professionalism of the design, the title, legend, scale, cartouches, its presentation and so on. The epimap consists of the discourse circulating a map designed to shape its reception: advertisements, letters to reviewers, endorsements, lectures, articles, etc. Together, the perimap and epimap work to position the map in a certain way and to lend it the authority to do work in the world.

Because maps are prescriptive systems of propositions, Wood and Fels contend that map creation should not solely be about presenting information through attractive spatial representations as advocated by the majority of cartographic textbooks (which borrow heavily from graphic design traditions). Instead they suggest map design should be about the ‘construction of meaning as a basis for action’ (p. xx). They propose turning to cognitive linguistics to rethink map design as a form of ‘cognitive cartographics’. Cognitive linguistics examines the ways in which words activate neural assemblages and open up ‘thinking spaces’ in the mind within which meaning is constructed by linking present information with past knowledge. They contend that maps perform like words, by firing-up thinking spaces. Employing cognitive cartographics, they suggest, will create a non-representational approach to map design focused on the construction of meaning rather than graphic design and the nature of signs. It will also enable cartographic theory to move beyond the compartmentalized thinking that has divided map making from map use by providing a more holistic framework. In other words, both map design and map reading can be understood through a cognitive cartographics framework. These ideas are developed in Krygier and Wood’s chapter in this volume.

### ***Maps as immutable mobiles and actants***

In his book, *Science in Action*, Bruno Latour (1987) used the example of cartography to explore how the cultures and mechanisms involved in production of Western scientific knowledge gained their power and authority to make truth claims about the world that in turn are employed to do work in the world. He cogently argued that the assemblage of cartographic theory, mapping technologies (e.g. quadrants, sextants, log books, marine clocks, rulers, etc.), and disciplinary regimes of trade and service (e.g. sea captains all taught the same principles and practices of surveying, recording and bringing back spatial data) worked together to enable information from distant

places to be accumulated in a cyclical and systematic fashion and for maps to enable appropriate action at a distance (maps informed their readers as to local conditions and guided their safe navigation).

As the scientific basis of map making and map use became conventionalized, Latour argues that maps increasingly took on the status of immutable mobiles. That is the mechanisms used to generate cartographic information and the form maps took (in terms of scale, legend, symbols, projection, etc.) became familiar and standardized through protocols so that the map became a stable, combinable and transferable form of knowledge that is portable across space and time. As such, a map produced in South America by Argentinean cartographers is decipherable to someone from another country because it shares common principles that render it legible. Moreover, spatial data transported from South America in the form of latitude and longitude can be used to update charts of the area or be combined with other information, despite the fact that the cartographer is unlikely to have ever visited the area they are mapping.

Mapping then is seemingly transformed into a “universal” scientific practice and maps become mobile and immutable artefacts through which the world can be known and a vehicle through which spatial knowledge can be transported into new contexts. What is mapped, how it is mapped, and the power of maps is the result of Western science’s ability to set the parameters and to dominate the debate about legitimate forms of knowledge. As Latour notes, however, cartographic theory and praxis is seemingly immutable in nature because it disciplines its practitioners and silences other local mapping knowledges. And yet, immutable Western cartographic practice is itself similarly the product of localized practices that are deemed appropriate within a limited circle of practitioners and mapping agencies, who exercise powerful claims to scientific objectivity and truth. The immutability of maps is then at one level a powerful illusion, but one that readily does work in the world.

Latour contends that the immutability, combinability and mobility of maps allowed exploration, trade and ultimately colonialism to develop by allowing control to be exerted from afar and knowledges about new territories to be effectively transported globally. Maps became a vital part in the cycle of knowledge accumulation that allowed explorers to ‘bring the lands back with them’ and to successfully send others in their footsteps (Latour 1987: 220, original emphasis). Latour thus argues that the European cartographers of the Renaissance produced centres of calculation (key sites of cartographic practice) that came to dominate the world. In so doing, maps he suggests do not simply represent space at a particular time, but produce new spaces–times. Maps open up new possibilities – such as international trade and territorial conquest – and thus create new geographies and histories.

To understand maps then, Latour suggests that it is necessary to unpick the cultures, technologies and mechanics of how a particular form of mapping came to gain immutability and mobility to reveal its contingencies and relationalities. Following on from his work, the development of Actor-Network

Theory (ANT) in science studies has provided a framework for considering how maps work in concert with other actants and actors to transform the world. ANT involves the tracing out of the context and instruments of mapping – its assemblage – not just cartographic praxis. For example, understanding the road system, Latour argues, cannot be fully realized by looking at infrastructure and vehicles alone, it also needs to consider civil engineering, plans of roads, standards for signage, garages, mechanics, drivers, political lobbying, funding, spare parts and so on.

Maps do not have meaning or action on their own; they are part of assemblage of people, discursive processes and material things. They are deployed in an actor-network of practices rather than existing as de-corporalized, a priori, non-ideological knowledge objects. ANT then seeks to provide a broader and richer understanding of the creation of maps through particular actor-networks (e.g. a national mapping agency) and the use of maps as actants within various actor-networks (e.g. land conservation) by considering the diverse, day-to-day practices of, and the interactions and the circulation of ideas and power between, various actors (people, texts, objects, money) (Perkins 2006). In so doing, ANT identifies the nature of “boundary objects” (objects such as technical standards that enable the sharing of information across networks), “centres of calculation” (locations such as mapping agencies where observations are accumulated, synthesized and analysed), “inscription devices” (technical artefacts that record and translate information such as tables of coordinates or satellite imagery), “obligatory points of passage” (a site in a network that exerts control and influence such as government department), “programs of action” (the resources required for an actor to perform certain roles) and “trials by strength” (how competing visions and processes within the network compete for superiority) (cf. Martin 2000). From this perspective, the stories of mapping always need to be considered as historically contingent actor-networks; as timed, placed, cultured and negotiated; a web of interacting possibilities in which the world is complex and nothing is inevitable. The focus shifts from what the map represents to how it is produced and how it produces work in the world (Perkins 2006).

### ***From ontology to ontogenesis: maps as practices***

In recent years, there has been a move towards considering cartography from a relational perspective, treating maps not as unified representations but as constellations of ongoing processes. Here it is recognized that maps are produced and used through multiple sets of practices. Spatial data are surveyed, processed, cleaned; geometric shapes are drafted, revised, updated, copied, digitized and scanned; information is selected for inclusion, generalized and symbolized. A map is then worked upon by the world and does work in the world. It might be folded or rolled, converted to another file format, embedded in other media; it might be packaged, marketed, sold, bought, used, stored, collected, re-used, thrown away or recycled; it might be read in different



ways in different contexts; it might be employed to plan a journey, make money, play a game (see Perkins in this volume) or teach moral values. Map making and map use is understood as processual in nature, being both embodied and dynamic.

Mapping can then be conceptualized as a suite of cultural practices involving action and affects. This kind of approach reflects a philosophical shift towards performance and mobility and away from essence and material stability. This rethinking of cartography is supported by historical and contemporary work. Researchers concerned with historical contexts increasingly stress the interplay between place, times, actions and ideas. Mapping in different cultures reflects multiple traditions including: an internal or cognitive set of behaviours involving thinking about space; a material culture in which mapping is recorded as an artefact or object; and a performance tradition where space may be enacted through gesture, ritual, song, speech dance or poetry (Woodward and Lewis 1998). In any cultural context there will be a different blend of these elements. Interpreting mapping then means considering the context in which mapping takes place; the way it is invoked as part of diverse practices to do work in the world. Instead of focusing on artefacts, aesthetics, human agency, or the politics of mapping, research focuses on how maps are constituted in and through diverse, discursive and material processes.

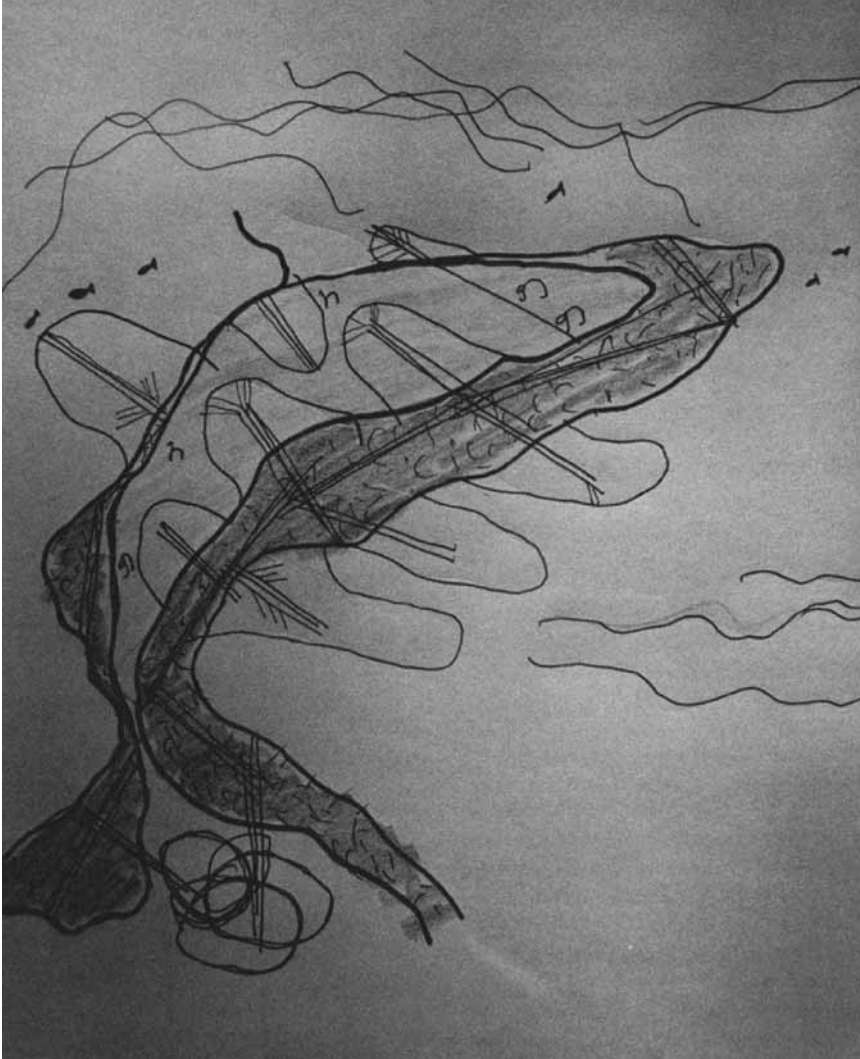
Arguments presently emerging in the literature extend both the notion of maps as processes and the ontological thought underpinning cartography by problematizing the ontological security enjoyed by maps. The idea that a map represents spatial truth might have been challenged and rethought in a number of different ways, but a map is nonetheless understood as a coherent, stable product – a map; a map has an undeniable essence that can be interrogated and from which one can derive understanding. Moreover, the maps and mapping practices maintain and reinforce dualities with respect to their conceptualization – production–consumption, author–reader, design–use, representation–practice, map–space. This position has been rejected by those adopting performative and ontogenetic understandings of mapping. Maps rather are understood as always in a state of becoming; as always mapping; as simultaneously being produced *and* consumed, authored *and* read, designed *and* used, serving as a representation *and* practice; as mutually constituting map/space in a dyadic relationship.

James Corner (1999) argues that cartographic theory has been hampered by a preoccupation to view maps in terms of what they represent and mean rather than what they do. Drawing on poststructural theory, he problematizes the conception of maps as representations that are separate and proceeding from territory. Following Baudrillard, Corner argues that a territory does not precede a map, but that space becomes territory through bounding practices that include mapping. Moreover, given that places are planned and built on the basis of maps, so that space is itself a representation of the map, the ‘differentiation between the real and the representation is no longer

meaningful' (p. 222). Maps and territories are co-constructed. Space is constituted through mapping practices, among many others, so that maps are not a reflection of the world, but a re-creation of it; mapping activates territory.

Corner develops an understanding of maps as unfolding potential; as conduits of possibilities; as the sites of imagination and action in the world. The 'function of maps is not to depict but to enable'; 'mappings do not represent geographies of ideas; rather they effect actualization' (p. 225, original emphasis). Mapping involves *processes* of 'gathering, working, reworking, assembling, relating, sifting, . . . speculating and so on . . . [that] allow certain sets of possibility to become actual' (p. 228, our emphasis). In this sense, maps remake 'territory over and over again, each time with new and diverse consequences' (p. 213). Corner explains that maps engender such re-territorializations because they are doubly projective: they both capture elements from the world and also project back a variety of effects through their use. As such, the agency of maps lies not in 'their reproduction or imposition, but in uncovering realities previously unseen or unimagined' (p. 213). He thus suggests that cartographic research and practice needs to focus on mapping actions and mapping effects and not solely on the construction of maps per se. He charts four practices of mapping – drift, layering, game-space and rhizome – to illustrate how the processes of mapping and the on-going construction of space entwine. To take one of these, Corner (1999: 244) argues that the map acts as a rhizome because it is infinitely open with many diverse entry points and exits that enable 'a plurality of readings, uses and effects', opening up milieus to new possibilities of action. So a "standard" topographic map sheet from the Ordnance Survey for example has 'multiple entryways, diverse uses and applications, infinite routes and networks, and potentially endless surfaces of engagement' (p. 246) that when enacted brings the world into being in new ways.

Tim Ingold (2000) also develops an approach to mapping grounded in cultural practice. He makes a distinction between mapping, map-making and map-use and argues that map-use (navigation) is to navigate by means of a map, plotting a course between one location to another in space. Mapping, in terms of wayfinding practices however, consists of moving from one place to another in a region. He argues that maps that chart peoples' experiences of movement – such as sketch maps, indigenous maps – are expressions of mapping. For him, because these mappings refer to the itineraries of their inhabitants they do not detail locations in space but histories of movement that constitute place. Such movements consist of passages through vistas, rather than an abstracted Cartesian landscape and therefore encode mobility as opposed to location (see Figure 1.3). As such, the resulting mappings are 'not so much representations of space as condensed histories' (Ingold 2000: 220) and therefore un-maplike. They are un-maplike because the knowledge they portray is bound to the place where they are made, unlike Western cartographic practice, which seeks to be non-indexical – that is a view from nowhere. However, as Turnbull (1989) and others have noted,



*Figure 1.3* A paper rendering of indigenous hunting “map” created by an Andamanese person for an anthropology researcher. Source: Pandya 1990: 790.

the non-indexical nature of maps is an illusion – they are always a view from somewhere bound within the practices and knowledges of their makers.

Western cartography, according to Ingold (2000: 203), thus ‘transforms everywhere-as-region, the world as experienced by a mobile inhabitant, into everywhere-as-space, the imaginary “bird’s-eye view” of a transcendent consciousness’ (see also Proppen’s chapter this volume who discusses the

nature of disembodied views of the whole earth). In so doing, people and their experiences are obliterated from the map and the structure of the world is fixed without regard to the movements and actions of its inhabitants – ‘the world it describes is not a world in the making, but one ready-made for life to occupy’ (p. 235); ‘in the cartographic world . . . all is still and silent’ (p. 242). Maps as reminders of paths and expressions of experience, as they were conceived in the European Middle Ages, morphed into supposed representations of space through the application of scientific principles. The issue is, however, that people live in the everywhere-as-region and know as they go – they are constantly mapping as they move through places employing a form of process cartography – so there is a disconnect between Western notions of a map, and the everyday ways in which people come to know and be in the world. This leads to a paradox – the more a map ‘aims to furnish a precise and comprehensive representation of reality, the less true to life this representation appears’ (p. 242). For Ingold, we need to simultaneously understand and value the process cartography of mapping and critique and reform representational modes of cartography.

Del Casino and Hanna (2005) draw on poststructural theory, and in particular the ideas of Deleuze and Guattari and Judith Butler, to argue that maps are in a constant state of becoming; that they are “mobile subjects” whose meaning emerges through socio-spatial practices of use that mutate with context and is contested and intertextual. For them the map is not fixed at the moment of initial construction, but is in constant modification where each encounter with the map produces new meanings and engagements with the world. Del Casino and Hanna (2005: 36) state that ‘[m]aps are both representations and practices . . . simultaneously. Neither is fully inscribed with meaning as representations nor fully acted out as practices.’ In so doing, they argue that maps are not ‘simply visual objects ripe for deconstruction. . . . Maps . . . are tactile, olfactory, sensed objects/subjects mediated by the multiplicity of knowledges we bring to and take from them through our everyday interactions and representational and discursive practices’ (p. 37).

Maps and spaces co-produce each other through spatial practices to create what they term “map spaces”, wherein it is impossible to disentangle fully how the map does work in the world from how the world shapes how the map is performed – they are co-constitutive. Del Casino and Hanna (2005) illustrate their arguments by an examination of how visitors produce the historic town of Fredericksburg in Virginia, by deploying tourist maps, along with other texts and narratives (such as a guided tour), which together shape how people interact with the space and the town. They show that the real is read back into the map, making it more legible. Tourists are both consumers and producers of the map; authors and readers. Meaning emerges through action and action is shaped by meaning in a complex, recursive and intertextual performativity. The tourist map of Fredericksburg then is never complete, but is always mobile; always being produced by tourists and producing Fredericksburg.

In a similar vein, Kitchin and Dodge (2007) have argued that map theory needs to shift in perspective from seeking to understand the nature of maps (how maps are) to examining the practices of mapping (how maps become). Maps they argue are not ontologically secure representations but rather a set of unfolding practices. They state:

[m]aps are of-the-moment, brought into being through practices (embodied, social, technical), *always* re-made every time they are engaged with; mapping is a process of constant re-territorialization. As such, maps are transitory and fleeting, being contingent, relational and context-dependent. *Maps are practices* – they are always *mappings*; spatial practices enacted to solve relational problems (e.g. how best to create a spatial representation, how to understand a spatial distribution, how to get between A and B, and so on).

(Kitchin and Dodge 2007: 5, original emphasis)

From this perspective, they contended that Figure 1.4 is not unquestioningly a map; it is rather a set of points, lines and colours that is brought into being as a map through mapping practices (an inscription in a constant state of re-inscription). As such, the map is (re)made *every time* mapping practices, such as recognizing, interpreting, translating and communicating, are applied to the pattern of ink. These mapping practices give the map the semblance of an immutable mobile and ontological security because they are learned and constantly reaffirmed. As Pickles explains:

[m]aps work by naturalizing themselves by reproducing a particular sign system and at the same time treating that sign system as natural and given. But, map knowledge is never naïvely given. It has to be learned and the mapping codes and skills have to be culturally reproduced.

(2004: 60–1)

Maps do not then emerge in the same way for all individuals. Rather they emerge in contexts and through a mix of creative, reflexive, playful, tactile and habitual practices; affected by the knowledge, experience and skill of the individual to perform mappings and apply them in the world. This applies as much for map making as for map reading. As such, the map does not represent the world or make the world, it is a co-constitutive production between inscription, individual and world; a production that is constantly in motion, always seeking to appear ontologically secure. Conceiving of maps in this way reveals that they are never fully formed but emerge in process and are mutable (they are re-made as opposed to mis-made, mis-used or mis-read).

In terms of cartographic research, this conceptualization of maps necessitates an epistemology that concentrates on how maps emerge – how maps are made through the practices of the cartographer situated within particular contexts and how maps re-make the world through mutually constituted

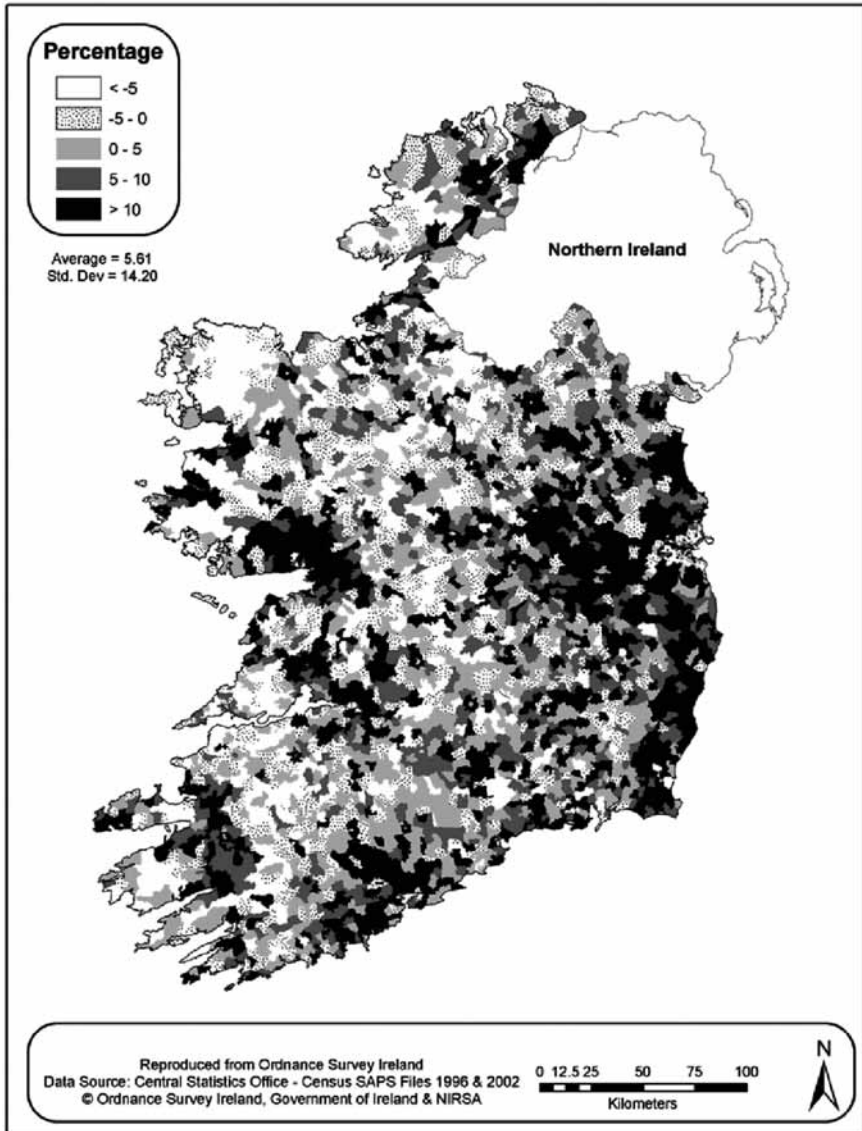


Figure 1.4 Is this image a map? Population change in Ireland, 1996–2002. Source: R. Kitchin.

practices that unite map and space. As Brown and Laurier (2005: 19, original emphasis) note, this requires a radical shift in approach from ‘*imagined scenarios, controlled experiments or retrospective accounts*’ to examine how maps emerge as solutions to relational problems; to make sense of the

‘unfolding action’ of mapping. Their approach is the production of detailed ethnographies of how maps become; map making and use is observed in specific, local contexts to understand the ways in which they are constructed and embedded within cultures of practices and affect. In their study they examined how maps are used in the context of navigating while driving between locations through video-based ethnography. Their work highlighted how a map, journey and social interaction within the car emerged through each other in contingent and relational ways within the context of the trip.

## Conclusion

Mapping, its theory, praxis and technologies, is a rapidly changing and exciting field of study. Intellect, capital, culture and innovation are reshaping how maps are made, used and thought about. In this book we are particularly concerned with exploring the diverse constellation of contemporary mapping theories. As we have so far demonstrated, the theories of mapping consist of a set of winding and contested journeys through philosophical and practical terrains. These journeys are far from over and the philosophical underpinnings of maps remain a fertile ground in which to explore issues of space, representation and praxis. The chapters that follow provide detailed examinations into contemporary cartographic theory. They highlight that there are many rich ways of rethinking maps both ontologically and epistemologically. It is certainly not clear if any of these different modes of thought will emerge to become paradigmatic and it may be the case that we are entering a period characterized by theoretical diversity and exchange. For us, such a period will continue to be highly productive in terms of thinking through the nature and role of maps, their production and use, and the work that they do in the world. There is much rethinking yet to be done!

## Note

- 1 Parts of this chapter draw upon material from Kitchin and Dodge (2007), Kitchin (2008) and Perkins (2009a and 2009b).

## References

- Anderson, B. (1991) *Imagined Communities: Reflections on the Origin and Spread of Nationalism*, London: Verso.
- Bertin, J. (1967) *Sémiologie Graphique*, Paris: Gauthier-Villars.
- Board, C. (1981) ‘Cartographic communication’, *Cartographica*, 18(2): 42–78.
- Brewer, C.A., MacEachren, A.M., Pickle, L.W. and Herrmann, D. (1997) ‘Mapping mortality: Evaluating color schemes for choropleth maps’, *Annals of the Association of American Geographers*, 87(3): 411–38.
- Brown, B. and Laurier, E. (2005) ‘Maps and journeys: an ethno-methodological investigation’, *Cartographica*, 40(3): 17–33.
- Corner, J. (1999) ‘The agency of mapping: speculation, critique and invention’, in D. Cosgrove (ed.) *Mappings*, London: Reaktion Books.

- Cosgrove, D. and Martins, L.L. (2000) 'Millennial geographics', *Annals of the Association of American Geographers*, 90(1): 97–113.
- Crampton, J. (2003) *The Political Mapping of Cyberspace*, Edinburgh: Edinburgh University Press.
- Crampton, J. and Krygier, J. (2005) 'An introduction to critical cartography', *ACME: An International E-Journal for Critical Geographies*, 4(1): 11–33.
- Del Casino, V.J. and Hanna, S.P. (2005) 'Beyond the "binaries": A methodological intervention for interrogating maps as representational practices', *ACME: An International E-Journal for Critical Geographies*, 4(1): 34–56.
- Dodge, M., McDerby, M. and Turner, M. (2008) *Geographic Visualization: Concepts, Tools and Applications*, Chichester, England: John Wiley and Sons.
- Dykes, J., MacEachren, A.M. and Kraak, M.-J. (2005) *Exploring Geovisualization*, London: Elsevier.
- Edney, M.H. (1993) 'Cartography without "progress": Reinterpreting the nature and historical development of map-making', *Cartographica*, 30(2/3): 54–68.
- Edney, M.H. (1997) *Mapping an Empire: The Geographical Construction of British India*, Chicago, IL: University of Chicago Press.
- Fabrikant, S.I., Rebich-Hespanha, S., Andrienko, N., Andrienko, G. and Montello, D.R. (2008) 'Novel method to measure inference affordance in static small-multiple map displays representing dynamic processes', *The Cartographic Journal*, 45(3): 201–15.
- Golledge, R.G. (1999) *Wayfinding Behavior: Cognitive Mapping and Other Spatial Processes*, Baltimore, MD: Johns Hopkins University Press.
- Gregory, D. (2004) *The Colonial Present: Afghanistan, Palestine, Iraq*, London: Blackwell.
- Haraway, D. (1992) *Simians, Cyborgs, and Women: The Reinvention of Nature*, New York: Routledge.
- Harley, J.B. (1989) 'Deconstructing the map', *Cartographica*, 26(2): 1–20.
- Harley, J.B. (1992) 'Rereading the maps of Columbian encounters', *Annals of the Association of American Geographers*, 82(3): 522–36.
- Harvey, D. (1989) *The Condition of Postmodernity*, London: Blackwell.
- Head, C.G. (1984) 'The map as natural language: a paradigm for understanding', *Cartographica*, 31(1): 1–32.
- Henrikson, A.K. (1994) 'The power and politics of maps', in G.J. Demko and W.B. Wood (eds) *Reordering the World: Geopolitical Perspectives on the Twenty-First Century*, Boulder, CO: Westview Press.
- Ingold, T. (2000) *The Perception of the Environment: Essays in Livelihood, Dwelling and Skill*, London: Routledge.
- Keates, J.S. (1996) *Understand Maps*, Harlow, England: Addison Wesley.
- Kitchin, R. (2008) 'The practices of mapping', *Cartographica*, 43(3): 211–15.
- Kitchin, R. and Dodge, M. (2007) 'Rethinking maps', *Progress in Human Geography*, 31(3): 331–44.
- Kwan, M.-P. (2007) 'Affecting geospatial technologies: Toward a feminist politics of emotion', *The Professional Geographer*, 59(1): 22–34.
- Latour, B. (1987) *Science in Action*, Cambridge, MA: Harvard University Press.
- Lloyd, R. (2005) 'Assessment of simulated cognitive maps: The influence of prior knowledge from cartographic maps', *Cartography and Geographic Information Science*, 32: 161–79.



- MacEachren, A.M. (1994) 'Visualization in modern cartography: setting the agenda', in A.M. MacEachren and D.R.F. Taylor (eds) *Visualization in Modern Cartography*, Oxford: Pergamon.
- MacEachren, A.M. (1995) *How Maps Work: Representation, Visualization and Design*, New York: Guilford Press.
- Martin, E. (2000) 'Actor-networks and implementation: Examples from conservation GIS in Ecuador', *International Journal of Geographical Information Science*, 14(8): 715–38.
- O'Sullivan, D. (2006) 'Geographic information science: Critical GIS', *Progress in Human Geography*, 30(6): 783–91.
- Pandya, V. (1990) 'Movement and space: Andamanese cartography', *American Ethnologist*, 17(4): 775–97.
- Perkins, C. (2006) 'Mapping golf: A contextual study', *The Cartographic Journal*, 43(3): 208–23.
- Perkins, C. (2009a) 'Performative and embodied mapping', in R. Kitchin and N. Thrift (eds) *International Encyclopedia of Human Geography*, Oxford: Elsevier.
- Perkins, C. (2009b) 'Philosophy and mapping', in R. Kitchin and N. Thrift (eds) *International Encyclopedia of Human Geography*, Oxford: Elsevier.
- Pickles, J. (2004) *A History of Spaces: Cartographic Reason, Mapping and the Geo-Coded World*, London: Routledge.
- Raisz, E. (1938) *General Cartography*, New York: McGraw-Hill.
- Robinson, A.H. and Petchenik, B.B. (1976) *The Nature of Maps*, Chicago, IL: University of Chicago Press.
- Robinson, A.H., Morrison, J.L., Muehrcke, P.C., Kimmerling, A.J. and Guptil, S.C. (1995) *Elements of Cartography*, 6th edn, New York: Wiley.
- Schlichtmann, H. (1979) 'Codes in map communication', *The Canadian Cartographer*, 16(1): 81–97.
- Schuurman, N. (1999) 'Critical GIS: Theorizing an emerging discipline', *Cartographica*, 36(4): 5–21.
- Tobler, W.R. (1976) 'Analytical cartography', *American Cartographer*, 3(1): 21–31.
- Turnbull, D. (1989) *Maps are Territories: Science is an Atlas*, Chicago, IL: University of Chicago Press.
- Wood, D. (1992) *The Power of Maps*, New York: Guilford Press.
- Wood, D. (1993) 'The fine line between mapping and map-making', *Cartographica*, 30(4): 50–60.
- Wood, D. and Fels, J. (2008) *The Natures of Maps: Cartographic Constructions of the Natural World*, Chicago, IL: University of Chicago Press.
- Woodward, D. and Lewis, G.M. (1998) *The History of Cartography*. Vol. 2. Book 3. *Cartography in the Traditional African, American, Arctic, Australian, and Pacific Societies*, Chicago, IL: University of Chicago Press.