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Introduction: mapping times

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Digital mapping, though generally conceived as a spatial activity, is just as strongly grounded in time. The digital era has disintegrated the representational fixity of maps, and instead given rise to maps that shift with each moment and movement. Scholars, adept at grappling with the spatial implications of digitality, continue to struggle to conceptualise and communicate the temporal consequences of maps. In this collection, we seek to take up Doreen Massey's (2005: 107) still critical concern: how do we cope with maps as mediators of the 'ongoing stories' in the world? Mapping has long wrestled with enrolling time into such narratives. This collection examines how this difficulty is impacted by the presence of digital mapping technologies that, arguably, have disrupted our understanding of time as much as they have provided coherence. The contributions in this book move beyond the descriptive to pay particular attention to what might be called the 'critical dynamics' of time.

We, and other authors in this book, suggest that the relation between digital mapping and its temporalities should be conceived as plural, dynamic and situated. Also, as digital mappings are approached in this book from an interdisciplinary angle – as medial, cartographic and technological practices – different scholarly perspectives reveal different understandings of temporalities. These twin concerns with dynamism, and plural responses to dynamism, are the central foci of this volume. The chapters in this book reflect this multiplicity of tempo-spatialities rather than spatio-temporalities.[1] Many of the chapters implicitly reflect on Merriman's (2011) challenge that notions of 'space-time' and 'time-space' have frequently rested on rather static conceptions. In proposing 'movement-space' as an alternative, however, Merriman remains inattentive

to the *ontological* proclivities of particular *digital* formations. Although he does not invoke digital mapping in his re-theorisation, and although few of our authors directly cite his work, the implications of his intervention are pertinent issues consistently and carefully addressed in this book, precisely because the digital reveals the contingency, mutability and dynamism of mapping practices.

Our authors have diverse scholarly backgrounds and use these to investigate different cultural mapping practices in terms of ephemeralities, 'time's arrow', (a)synchronicities, rhythms and velocities. Together, the chapters offer a broad spectrum of methodologies and conceptual frameworks to help us understand the rich texture of relations between digital mapping and temporalities. This book also proposes that digital maps bring new temporal affordances into play for users through their cartographic interfaces. It is through these embedded and interactive affordances that digital mapping transforms our notions of immediacy and futurity; allowing us to track our current and past locations as well as calling the future into being by advising on potential routes and ways forward.

Introducing the future?

The 21 October 2015 was *Back to the Future* Day – the destination date referenced in Robert Zemeckis' iconic 1980s films, punched into the DeLorean time machine as the characters travel 'back to the future'. The twenty-six year gap between the November 1989 release of the film, and the imaginary Hill Valley[2] has now disappeared into the conundrum of history. However, at the time, this imagined future was safely enough removed from the very different 'home ages' of the film, allowing entertaining paradoxical contrasts between the past (1885 and 1950s America), the present (1985) and the future. This vision of the (now passed) future in 2015 acts as a temporal map of sorts; a marker in the various possible timelines yet to manifest themselves.

The films speak to our collection of chapters, not only because of this mutability and its relation to the imagined temporalities and spatialities of Hill Valley, but also because of their status as cultural markers relating to North American small-town life in the post-war era from the vantage point of 1985, and to the ways we at once remember the past, but also re-appropriate it to change the future (Ní Fhlainn, 2010). It plays with central tropes associated with time: 'time's arrow' is subverted as Doc and Marty are transported back, and to the future, to change events; the episodic structure of the trilogy of films and their duration reminds us that time plays out, but is also commodified, as a cultural and embodied experience screening in a multiplex, evoking particular emotions.

In light of this volume, *Back to the Future* also draws attention to important aspects of mapping as a device to carry people back into the past, and forward into the future. The technologies deployed in the film, such as the hoverboard and the DeLorean time machine, carry protagonists into possible futures in the same way that mapping transports people who deploy it, bringing new events to life. This kind of technologically driven future is analogous to recent Marxist and accelerationist literature concerned with futurity, for example Mason (2015) and Srnicek and Williams (2015). The plot devices in the film playfully draw together the synchronic and asynchronic, the past, the present and the future, and show how rhythms of everyday mapping encounters have consequences; the tracks of Marty interact with other characters, but sometimes not at the same time. The contingent nature of time itself becomes the storyline and also does its work through a particular temporality. This temporality invites the viewer to question links between the real and the 'reel'. Other cultural forms evoke the film(s), as: spin-off series, computer games and websites through which fans relive their encounters with the original. Websites map the locations in Los Angeles where scenes were shot, highlighting the practical linking of the imagined and the real through a mashup;[3] a digital mapping form that serves as a way into understanding the placed temporalities of past, present and future, which supports so called 'set-jetting' practice (Joliveau, 2009).

By the 1980s, digital mapping had slowly begun to supplant the dominance of printed maps, albeit in ways that were much less ephemeral than contemporary applications: technologies were deployed on desktops to fix and freeze possible futures, a means to an instrumental end. Affordances remained static – paper maps were increasingly made by deploying digital technologies, with users discernible from producers, in space and time. Maps were mobile things that could be deployed in different places, but the people deploying them were separate from the display – acting *after* the event – prompted by, yet not inhabiting an ever-changing map.

2015 was also the ten-year anniversary of the launch of Google Maps; a seductive and intuitive interface, accessible from touch-screens over most of this period. This has allowed users to navigate and produce the world in novel ways, promising a pervasive and always-on control over space. The 'slippy map' seamlessly facilitated a dynamic interaction with the interface and, with the launch of the first iPhone in 2007, increasingly came to be deployed on smartphones; carrying the map user with them and bringing into being new mobile possibilities. Throughout that period, Google Maps rose to become the *de facto* mapping platform for millions around the world. Fighting off direct challenges from rival technology companies such as Yahoo, Microsoft and Apple (as well as from several regulators and government agencies), Google also contested interventions

from the likes of OpenStreetMap (OSM), and acquired an ever-growing number of technology start-ups from Waze to Skybox Imaging, to strengthen its position as the most powerful digital mapping platform. As part of its ever-mutating strategy, however, Google sprung a surprise in 2015: quietly choosing to release its previously $400 per year Google Earth Pro software for free. The extent of the differences between Google Earth Pro and the free version were somewhat minimal, with Pro users able to import, print, capture and measure more extensively than their 'basic' counterparts. Clearly, our expectations for what a digital mapping service can and should allow us to do, has dramatically changed. Where once it required a $400 annual subscription to import up to 2,500 addresses and overlay historical traffic data, it now only needs a download installer and a licence key.

While these differences are superficially ones of cost, access and availability – between $400 and nothing at all – they are also indicative of *temporal* shifts in data acquisition, download speed, bandwidth capacity and user experience, as computer processing power, memory and storage have dramatically improved. Arguably, then, we are moving into another distinctive phase of digital life, characterised by ever-more novel functions designed to cater to temporal desires: 'slidable' Google Street View images, 'dynamic' in-train maps and 'rapid response' crisis management tools. These digital mapping transformations are no longer merely possible, they are to be *expected*. Far from the science fiction of *Back to the Future*, they are mere technological facts. Some have tentatively called this emergent landscape the 'post-digital' (Andersen, Cox and Papadopolous, 2014; Berry and Dieter, 2015), not only to account for the truism that digital software, platforms, apps and services comprise 'the everyday', and are now 'everywhere' and 'every*ware*' (Greenfield, 2006), but that there is now little 'unique' about this digital imbrication. As Cramer (2014: no pagination) suggests:

> pragmatically, the term 'post-digital' can be used to describe either a contemporary *disenchantment* with digital information systems and media gadgets, or a period in which our *fascination* with these systems and gadgets has become *historical* just like the dot-com age ultimately became historical in the 2013 novels of Thomas Pynchon and Dave Eggers. (emphasis added)

While these kinds of proclamations are certainly far from the whole truth – digital divides continue to abound – they nonetheless point towards a consolidation of now ten-year old digital platforms, and the generation of an *even newer* 'new normal' (Bratich, 2006: 493). In this changing context, the types of digital mapping platforms noted above, and talked about in much more detail within

this volume, have brought to bear a whole plethora of new temporal phenomena that situate and populate, activate and agitate, and even enervate and incapacitate the contemporary world.

Together, these two cultural references, the imagined temporalities of *Back to the Future* and the mutable affordances enacted by the Google mapping platform, signal an important need for re-engaging with temporality – for at once going back to the future, but also for a slippy re-mapping of temporality. That is the project this volume addresses – but first what exactly might temporality entail in this context, and how has it been imagined?

Thinking the temporal

Barbara Adam (2008) highlights seven key aspects of time, which, together, encompass important ideas implicit throughout this volume. Only chapter 11 explicitly adopts Adam's typology but themes charted by authors in our collection pick up on many of her concerns. She focuses on time frame, temporality, timing, tempo, duration, sequence and modalities. *Time frame* concerns the scale of analysis: dividing time up into units of varying scales, such as a day or a geological era. *Temporality* is much more procedural, and invites a focus on mutable qualities that unfold in human experience. *Timing* concerns the particularity of time: it emphasises events and moments instead of processes. *Tempo* is about speed: how fast something happens. *Duration*, on the other hand, concerns how long something lasts, whereas *sequence* addresses order and priority of events. *Modalities* considers the past, present and future in which time plays out.

These different aspects have been extensively theorised over a long historical trajectory dating back to the ancient Greeks and in this chapter we offer a situated approach to complex ideas, grounded in the main interpretations from philosophers and theorists from geographical backgrounds.[4] Philosophers have been very aware of changing ways of understanding the physics of time, and the significance of *time frames* adopted for the measurement or classification of time as an external metric. From the paradoxes explored by Zeno, through Newtonian mechanics, to the relative challenges of Einsteinian thought and quantum physics, scientific approaches to time as something outside of human experience continue to be profitably explored. Arguably though, the most relevant philosophical debate has focused on *temporality* as 'lived' or 'experienced' time, contrary to time theorised by physicists (see Hoy, 2012). The ways in which people apprehend and experience the temporal is of central concern for our arguments about digital mapping. May and Thrift (2001) suggest that four different domains characterise this geographical apprehension of

the temporal: a focus on natural rhythms and cycles, on systems of social discipline, on devices and technologies, and on conceptualisations. Our authors' concerns with Adam's aspects of time play out in lived human contexts; where digital mapping technologies evoke, but also themselves contribute to, making temporalities in particular social contexts. These studies are frequently underpinned by phenomenological and existential conceptualisations of temporality, or by conceptions of temporality that are strongly influenced by material-semiotic understandings of technologies such as digital mapping. So it makes sense to explore how different foundational thinkers have approached time as a necessary prerequisite for the case evidence.

Concerns for the nature of time are one of the most important aspects of phenomenological thought. Phenomenological approaches to *temporality* regard time as emerging in our individual capacities for making sense of the world. The father of phenomenology, Edward Husserl, focused on exploring what he termed 'internal time consciousness' – suggesting that the temporal was a central and indivisible aspect of being human (Hoy, 2012). This idea of 'being' was developed in Heideggerian thought through hermeneutics. Heidegger makes an important distinction between different modes of temporality, which he characterises as 'ontic' and 'ontological'. Ontic knowledge relates to the properties of things, whereas ontological knowledge 'is the basis on which any such theory (of ontic knowledge) could be constructed, the a priori conditions' (Elden, 2001: 9).

Henri Bergson's work with its focus on *duration* has been strongly influential, across many different disciplines addressing time. Bergsonian ideas regard time as mobile and incomplete, experienced in varying subjective ways and emerging from inner human life. The relation of individual and social memories is also an important theme emergent from Bergson's conceptualisations of temporality, which can be brought to life in digital mapping. These ideas are imbued with vitalism – the notion that some kind of life force beyond science imbues existence (Greenhough, 2010). This emphasis on temporal vitality is reflected in the rise of what has been termed new Bergsonian thought (May and Thrift, 2001), and is crucial for thinkers such as Gilles Deleuze. Deleuzian ideas embody a rhizomatic flowing and folding of temporality. Smith (2013) highlights the ways in which Deleuze freed time, giving it a power to do work, through processes of anticipation, archiving and synthesis. This emphasis inevitably also focuses attention onto *timing* and the momentary event. The non-representational theory that emerged in the middle of the 1990s as a post-phenomenological response to inject life into the dead geographies of representation (Thrift and Dewsbury, 2000), also regards time as contingent, and has focused on practice and performance as immanent and embedded in actions (Lorimer, 2005; Anderson and Harrison, 2010). Anticipation, pre-emption

and pre-caution characterise much recent geographical scholarship in this vein (see for example Amoore, 2013).

In Marxist material readings of change, documenting time-space compression (*tempo*) has been read as an outcome of changing modes of production (see Harvey, 1989). Technologies have clearly been deployed to speed up processes and in so doing, facilitate new cycles of capitalist accumulation. In extreme accounts, such as those of Paul Virilio, space itself becomes irrelevant in the acceleration occasioned by technological advance and where tempo changes everything (May and Thrift, 2001).

The *sequence* of time and predictability has also generated significant debate. Derridean deconstructionism distinguishes between the inevitability of '*futur*' – the future that is foreseeable and programmed – as against the impossibility of predicting, which he terms '*l'avenir*' – that which might come. The contrast between an animated inevitable outcome and a stochastic, unknowable other presents significant challenges addressed in several of our subsequent chapters. Futurity, for Derrida, remains open yet structured by history, and we only access this through events that are yet to come about (Hodge, 2007). A concern for genealogy and historicised interrogation of subject positions also informs Foucauldian notions of temporality, in which future power relations are disciplined by present and rational regimes of governance and biopower (Hoy, 2012).

There has been a blurring of the organic and inorganic in many recent approaches to the *modalities* of time, evidenced particularly in work drawing on traditions of science and technology studies (May and Thrift, 2001). A focus on digital mapping inevitably draws on the materiality of maps as 'things': on screens, as code, and embedded in other objects that circulate with varying degrees of mutability, freezing time, but also animating other human action. Actor-network explorations of temporality foreground the relations between technologies and other actants with an ongoing capacity to change life. The role of time in this kind of material assemblage is emergent and contingent; instead of working as a kind of background, time works as situated and is made by everyday practices and relations (Sørensen, 2007). The early 2000s presented a plethora of opportunities to study the digital aspect of such assemblages, given the rise in ubiquity of advanced cartographic displays. Parallel (but often apart from) the discussion in the social sciences and the humanities, cartographers and Geographical Information Science specialists debated over the rising challenges of making time accessible and understandable to increasingly diverse categories of users. The changes in velocity and volume of data, coupled with advanced ways of visualising it, created ample opportunities for experimental approaches to mapping (Kraak, 2003).

Rhythm has also been approached from different positions. Parkes and Thrift (1979) were among the first geographers to explore the potential power of considering how timetables and natural rhythms structure space. An academic turn towards researching mobilities further encouraged a focus on the performance of different rhythmic patterns. Influential in this context, also from a Marxist perspective, has been the work of Henri Lefebvre (2004), emphasising what he termed rhythm-analytical approaches to everyday life. More cultural reflections on rhythm and space characterise Tim Edensor's (2012) work.

Imagined relations of space and time, as reflected in Bakhtin's notion of the chronotope, offer another powerful tool for categorising the ways space and time come together in particular mapped configurations. Mike Crang (2001) suggests that the chronotope might usefully be extended beyond its original focus on imagined worlds of the novel, to other forms, such as urban life. The relations of space and time can in this account be charted as a kind of flowing, spatialised temporality, and the chronotope might usefully help to organise understandings of mapping imaginary reconstructions of moments, rhythms, memories, flows and processes. So a richly varied philosophical diversity characterises the ways in which geographical theorists have imagined the temporal, and our authors in this collection also deploy different thinkers in their analysis of the relations of mapping and time.

Time for a temporal turn

In spite of this long-standing and complex philosophical interrogation of temporality, commentators have argued that at various times from the 1980s, space has become much more significant than time in academic discourse. In part, this is a reaction to grand meta-narratives of Marxist thought (Massey, 2005). Figure 1.1, for example, shows how the term 'spatial turn' has been deployed in the last twenty years in the corpus of books published in the English language, as archived by Google. It highlights a spectacular growth in concern for local and spatial understanding, opposing universal explanations pursuing historical and often structural ways of knowing the world. Earlier concern for space had been demonised as acritical and reificatory, and the widespread acceptance of more partial and local ways of approaching research only really advanced with the widespread adoption of social constructivist and post-structural thinkers such as Said, Foucault, Lefebvre and Derrida. The trend continues to be evidenced in the frequent citation of luminaries of postmodern ways of knowing the world, from Soja, to Dear and Gregory, at varying times in different disciplines across the humanities and social sciences (Warf and Arias, 2009). This continuing

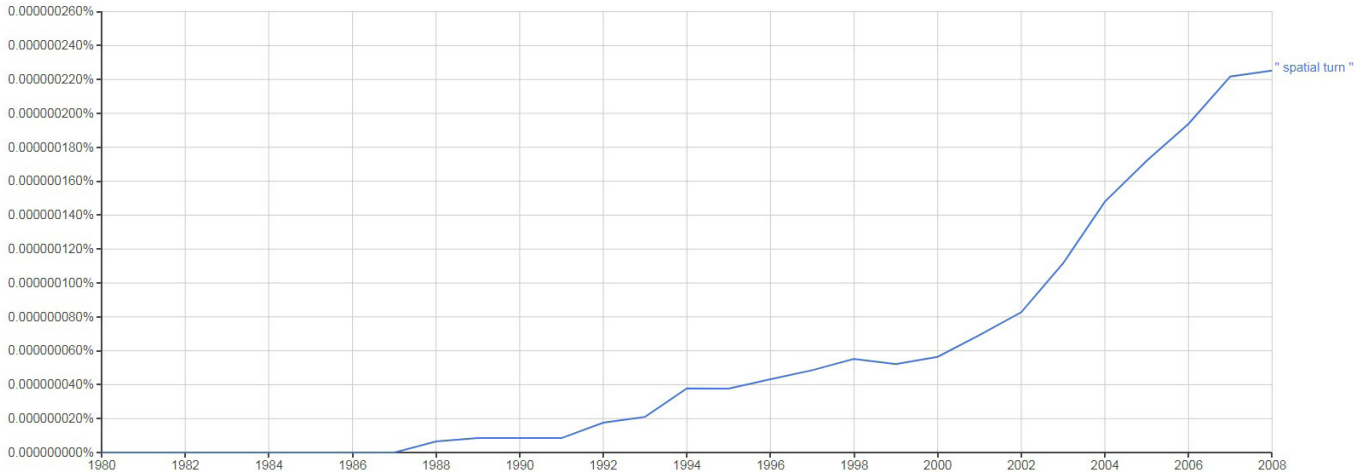

Figure 1.1 'Spatial Turn' over time (Google Books Ngram Viewer, http://books.google.com/ngrams).

spatial trajectory has implications for the ways in which temporality has been treated, or rather often elided, in academic work.

In particular, mapping has largely been regarded as a quintessentially *spatial* pursuit during the last thirty years of research and practice. Cognitive cartographic research focused upon *spatial* cognition (Perkins, Kitchin and Dodge, 2011). The history of cartography was safely separated from more mainstream social scientific research. Contemporary research focused on functional improvements in the ability to depict space and design interfaces to communicate knowledge about space. Geographical Information Science focused upon *spatial* analysis. From its inception, the internet was conflated with spatial metaphors such as 'cyberspace' and its topology charted (see for example Dodge and Kitchin, 2001; Graham, 2013). Contemporary digital communication networks facilitate this compression of time and space by 'flattening' the world.[5] Historians only began to deploy mapping technologies to investigate historical processes relatively late. This spatial fixation was critiqued from political and social positions, but interestingly temporality was only rarely explored by critical thinkers focusing on mapping. Further, radical rethinking of space-time and time-space from the position of animating the construct (see Merriman, 2011) underplays the implications of digital mapping for temporality: a point we return to in the conclusion to this chapter. For the moment though, it is safe to argue that few attempts have been made to resolve the paradoxes of this spatio-temporal dualism from the perspective of the *digital* aspect of digital maps. As previously noted, platforms like Google Maps have quickly entrenched themselves in the mundane conduct of users, building on 'social' and 'frictionless' qualities unique to contemporary mediascapes. Yet, when unpacking such objects of inquiry, the temporal is often under-theorised.

New media theorists of the late 1990s and early 2000s, by and large, considered digital modes of expression as extensions or re-mediations of televisual or filmic framings of space (Bolter and Grusin 2000; Manovich, 2001); as a communal space without boundaries for the expression of cultural identities (Baym, 1999; Jenkins, 2006); or as a virtual realm separate from, and/or in flux with, 'common' human biologies (Hayles, 2002). Already a decade ago, communication researcher Mark Nunes, picking up on the unique language of digital engagement used by academics and popular media alike, critically noted that:

> while the rhetoric may have cooled, reference to the Internet in spatial terms – as cyberspace or some other place – still occurs frequently on television and in print. This sense of space is also still mapped by the verbs of displacement – browsing, cruising, going – that have become common parlance for our human–computer interactions, along with our use of locatives and the spatial-geographic language of sites, addresses, and links that describe the material, conceptual, and experiential arrangements of

> the World Wide Web and other instances of networked communication. (Nunes, 2006: 2)

If the internet is firmly anchored in spatiality and its language, what hope did the 'geoweb' and closely related genealogy of digital cartography ever have in escaping similar framings?

Della Dora (2012) notes how the point of departure for contemporary digital mapping imaginations are embodied in US Vice-President Al Gore's famed 'Digital Earth' speech from 1998, in which he envisioned a joint mega-project of a singular virtual globe, maintained by multiple organisations and accessible to all. Such a creation would have been used for tasks as diverse as fighting crime, conducting diplomacy and preventing climate change. While lacking the sophistication of Gore's brainchild, modern digital maps are nonetheless engulfed in the same ethos of all encompassing 'truthful' territoriality. The likes of Google Maps, packaged with such services as 'My Places' or 'Street View', promise a convenient convergence of localities onto our multiple screens. At the same time, contemporary computational regimes foreground time and its management through the appropriate interfaces of digital media. From personalised phone assistants – like Apple's Siri or Google Now – to the influx of 'productivity' software that aims to help users maximise efficiency in regard to their own time management, guiding and affecting user temporalities has become the 'go-to' way for connecting people to their surrounding environment. To complete our understanding of digital cartography, we must examine it as part of a digital landscape that enacts temporal practices *along with* spatial ones.

The aim of this book is to highlight these practices, as now is the time for a temporal turn across a multitude of disciplines that address digital cartography. With mapping applications approaching their post-digital disenchantment (Cramer, 2014), and no longer viewed as the domain of highly specialised professionals, we see multiple avenues available for exploring such a turn.

First, one can argue that digital – as opposed to paper – mapping interfaces enact a different type of engagement with temporalities. Unlike the envisioned compressed real-time space of flows presented by the iconic world maps divided into time zones, the modern map is intimate and personal. The map at your fingertips is more likely to register your personal histories of travel, shopping or socialisation than it is to tell stories of shared and structured timelines across divides (Hind and Lammes, 2015). It moves as you move, animating time in ways that were impossible in the pre-digital age. Incorporation of asynchronous technologies with growing coverage removes the need (or desire) for a flattening of spaces; allowing such practices as geolocative games, where users incorporate revisiting the same places over time as part of their travel or leisure

routines. Wearable technologies, such as smart watches and health-trackers, furthermore maintain personal time zones by allowing users to track their own movements through time and space; to gauge and evaluate them. At the same time, they allow others to monitor personal time, even outside the clock-punching of the school or workplace, reflecting self-governmentality present in societies of control (Deleuze, 1992). Third, the digital allows new analytical depths of existing maps, for example through new re-imaginings, different visualisation techniques, renderings and the like. Such is the example of Minard's famous map of the Napoleonic Russian campaign, re-examined through digital technologies (Kraak, 2014).

These new forms of temporalities are incorporated into activities that go beyond the map *per se*, such as the precise quantification of subjective experiences of wayfinding, presented by GPS SatNav devices, or the almost-gameful 'swiping' experience of casual romance on Tinder, for the off chance of locating suitable partners in the condensed time-space bubble the app affords. New temporalities of working are called into play by the operation of the interfaces of apps such as Uber, or Deliveroo, and are enacted in the precarity and anxiety of the new 'gig' economy (Friedman, 2014). These new forms of temporalities are also embedded in the spell of 'real-time big data', in the rhetoric of the 'smart city' and in the dreams of control that are called into play (see de Lange, this volume).

Digital mappings are also central to an ongoing and increasing interest in 'map art', charted by several of our authors in this collection. By focusing upon new ways of imagining the temporal, that frequently work in opposition to the notion that mapping is useful or instrumental, these artistic re-mappings evoke diverse possible futures, instead of working to anticipate or close down possibilities.

Additionally, temporal considerations are required in order to *map the digital* rather than only *digitally map*. In an ever-changing landscape of companies, practices, technologies and users, the misleadingly simple term of 'mapping' something requires a way to document both *what* a thing is, and *where* it resides, but also *when* and for *how long*. The Livehoods project (Cranshaw *et al.*, 2012; Mobile Commerce Lab, 2015), where temporary maps of modular neighbourhoods in large cities are created based on characteristics of their residents' media use, is one example for such an approach.

New forms of 'liveness' are being called into effect by the technological assemblage around social media (Van Es, 2016). But, despite an intensifying narrative around 'real-time' digital capabilities, little attempt has been made to unpack such claims to technological immediacy. Also, despite routinely hyperbolic promises of 'live' data streams, 'background' updates and 'reflexive' systems, most digital users are faced with intermittent or incomplete

data streams, intrusive or unwarranted updates and largely unresponsive or generally clunky systems. Each of these promises to generate a rather contrasting vision of technological use. Take, for example, Google's launch of its Maps incarnation in 2014. Unlike two years previously, when Apple's equivalent resulted in a catalogue of geospatial errors – from mislabelled locations to melting photo imagery – Google suffered a different problem. Users began to complain it was slower at executing vital tasks – like loading map data and calculating route options – than the previous version. In response, Google offered a number of solutions: either users try its 'Lite mode' designed for less powerful machines, or upgrade their browser and the various plugins required to optimise in-built functions such as Street View. Although technical solutions of a kind, neither resolved a more resolute conceptual issue: that real-time technological functionality is still just a wild – if not wholly impossible – dream. The instant experiences that are promised to huge fanfares at seasonal product launches, promoted in global advertising material, and regurgitated wholesale by (usually) unwitting brand ambassadors, rarely constitute the reality.

While digital mapping platforms, applications and browsers are valued for their spatial processing capabilities, it is their temporal features that are felt most acutely – especially when they fail. It is failure that so often constitutes the contemporary digital mapping experience. Yet, like the real-time narrative, it has rarely been attended to. The emergence of new temporalities – borne out of the design of various mapping platforms – has led to a suite of novel 'failure spaces' and 'failure types'. Moreover, a plethora of work-arounds, patches, temporary fixes and wholesale reboots have been developed to combat such issues.

Emergent themes

The chapters in this book show that digital mapping needs to be viewed from an interdisciplinary angle, so as to best grasp what it means in terms of temporality. We have already established that temporality has been explored from many different academic perspectives. Furthermore, multiple positions, methodologies and assumptions are needed to do justice to the nature of digital mappings; being at once creative practices, media, cartographies and technologies. The rich interdisciplinary background of the authors allows these different positions to be developed. We need new ways of knowing and discovering, so as to capture a more nuanced and sensitive view of digital mapping as a phenomenological, cultural and political practice that goes beyond the technical, descriptive and cartographic analysis that predominates in digital mapping research. Through these different ways of knowing, more can be revealed about temporality and its

relations to the unfolding worlds of digital mapping. This volume then acts as a kind of temporal wayfinder, showing how temporality matters in contemporary discussions and practices relating to digital mapping and geolocative media, but also flagging some of the ways this might become increasingly important in the future.

We have chosen to divide this book into three parts that are not so much ordered by type of case, or disciplinary anchoring of authors, but are rather grouped so that each part highlights an important quality of temporality in relation to mapping.[6] All contributions move beyond the descriptive to pay particular attention to what we call the 'critical dynamics' of time. In each case contributions focus on, or cross-cut between, digital maps, digital mapping or digital locative media.

Ephemerality/mobility

Contributions in the first part, 'Ephemerality/mobility', consider the fleeting, dissipating and transient aspects of digital mapping and temporality. Whether the process involves making maps or traversing them, these temporal notions of digital mapping are experienced through interweaving narratives of the past and present that cannot always be easily captured. Movement, fluidity and dynamism characterise these different contributions, and they weave together inspiration from Deleuzian, non-representational or Foucauldian thought, with grounded and often performative attention to situated everyday experiences of temporality. The unstable elements of Adam's (2008) typology are emphasised here: the tempo, rhythms, modalities and social practices of temporalities, through which mapping is performed. Each chapter in this part deals with the ephemeral and mobile aspects of the relationship between temporality and digital mapping from a different angle, throughout all the phases of the mapping process, from inception to deployment and user manipulations of the map. By beginning this volume with this particular focus, we encounter digital mapping and temporality at its most personal and situated – whether it be the impending arrival of a GPS unit, the relationship between whispering scents and memory, the personal cartographies of communication, or the disjointed and affective reaction to unexpected glitches.

In 'Nodes, ways and relations', Joe Gerlach spins together a number of intersecting temporalities, narrating the otherwise irretrievable process of producing an OSM map with a group of other volunteer mappers. As a self-described 'intervention', these narratives unfold, deconstruct and liquidise traditional spatial metaphors through a series of animated interjections – Gerlach offers an auto-ethnographic exploration of mapping focusing on the banality of logistics

and equipment, while reflecting on the ideological and discursive nature of digital cartography. Together, these threads playfully 'undo' traditional conceptualisations of how mapping and cartographic processes are undertaken and narrated. In so doing, the chapter highlights the contingent, banal and embodied aspects of the ways in which the mapping of time plays out.

The next chapter, a trialogue between graphic designer and 'smell mapper' Kate McLean, Chris Perkins and Sybille Lammes, explores ways in which transient olfactory phenomena may be mapped and how this changes our conception of maps. McLean's mapping practice focuses on the fleeting temporalities of smell mapping. She describes the menagerie of sensory urban traces as quixotic – moving and sweeping over the city, sometimes lingering and at other times, dissipating. Urban smellscapes are deeply temporal, with rhythmic and durative qualities that are often subjective and ambiguous. Accordingly, McLean's digital mapping work aims to capture the movement, transient memories and ephemerality of her subject. Much like Gerlach, McLean's work is an intervention into traditional cartography, which has historically been bounded by static, spatial markers rather than the evanescent sensorium of urbanity and mobility, but it also evokes the mapping processes of the artist, whose practice has itself changed through time.

In the final chapter of this part, Pablo Abend explores how asynchronous temporalities may be animated and enfolded through digital mapping. Here, the passing times and changing seasons are unintentionally melded together in Google Street View – a winter's day from one perspective, a midsummer's night from another – in an algorithmic accident that echoes the poly-temporality of Gerlach's philosophical intervention. Rather than spatialising how Google Street View may appear at different times, Abend begins by drawing on media archaeology (see Parikka, 2012) in order to historicise this fettered relationship between movement (down a street in Street View) and photographic and filmic media (in the form of geographic imagery). Yet Abend argues that the heterogeneity of temporality augers a heterogeneity of 'frames', or singular spatial representations in Google Street View. Through the ephemerality of the seasons the temporal process at work is revealed. Seasons are unique and fleeting, and yet, like the smellscape in McLean's work, the echoes left after their brief appearances can be uncovered.

Thus, 'Ephemerality/mobility' ends on a slightly different note from which it started. It begins by discussing the transience of digital mapping processes and ends with the way these processes are embedded in maps themselves. Furthermore, the embodied mobility in both Gerlach's and McLean's chapters on mapping processes becomes a different kind of mobility – a passage defined by the ephemeral temporalities of digital mapping.

Stitching memories

The chapters in this part of the book look at various visual practices that engage digital technologies to stitch moments together in a non-linear fashion, in particular, as a way of remembering and capturing time. In so doing, they draw attention to the potential of digital mapping to reveal temporal juxtapositions, and (a)synchronicities. These go against the ephemerality that is so prominent in digital mapping, which is addressed in the first part of the book, not by denying its existence or experience, but by turning attention to both 'creative' *and* 'everyday' practices that counter digital mappings' fleeting instantaneity. So they draw out the implications in particular of Adam's (2008) ideas of time frame, sequence and duration, while also attending to the practices through which an apparent fixity might be constructed.

The first chapter by Rachel Wells, on the work of Wolfgang Weileder, shows how his photographic and other site-specific visual work seeks to undo the transience highlighted in the previous part. It establishes this by visually capturing time and recombining it in images. In his *atlas-project*, he horizontally stacks strips of photographic material shot at exactly the same place, over a stretch of time, thus creating time maps. Wells analyses this slicing and joining of temporal images from a Benjaminian perspective, arguing that Weileder's re-ordering of the ephemeral frees photography of its presumed stillness and reproducibility. Weileder's oeuvre juxtaposes time and expresses a 'dissatisfaction with the time-space coordinates of photography' and a 'withering away of aura' (Wells, this volume).

In his chapter about locative art practices, Gavin MacDonald also talks about recombining mapping temporalities; challenging, or at least problematising, like Wells, the conception of images as fleeting moments. MacDonald argues that this tendency to conceive of digital maps as a-temporal is rooted in two different a-temporalities at work in geomedia: a cartographic suturing of time and space – also redolent of Weileder's *atlas-project* – and a-temporalities generated by the acceleration and immediacy of digital media. To respond to this atemporal tendency he, unlike Wells, brings in the artist at work, showing how Street View captured two locative artists *during* their practice; at once highlighting different moments and re-ordering time. He also draws attention to the temporality of the locative art movement itself, stressing that changing technologies and their everyday deployment have made this discourse obsolete, or as we state earlier 'the digital is the normal' now (Wells, this volume). This is an important observation as it also stresses that possible relations between mapping interfaces and their temporal affordances are themselves changeable and time-bound. As we write, digital mapping has already developed minor histories (Gerlach, 2015),

as MacDonald shows when he looks back at the heydays of the locative art movement.

While both previous authors show how cartographic art can be used to map temporalities and meld temporal experiences – in so doing offering opportunities to remember and reconfigure cartographic time – the final chapter in the part is anchored in more 'everyday' practices. In Matthew Hanchard's contribution, 'practice theory' is put to work in order to shine a light on lived, embodied mapping practices. Through an array of cases – interviews with hotel owners and customers, local authority staff and hiking society members – Hanchard weaves a series of rich cartographic stories, drawing attention to the effects that digital mapping has had on both work and leisure practices. He thus draws attention to their temporal impact – on attention, on security and trust, on efficiency and on memory – as well as the methodological possibilities of deploying practice theory to investigate these.

(In)formalising

In the final part of the book, each chapter focuses on how digital mapping *(in)formalises* time. This tension – between the formal and informal – works to delineate how far digital maps have been able to capture, structure and regulate the temporal. Some technological agendas have worked to secure against future instabilities by exercising an anticipatory logic, such as weather maps, disaster maps or military maps (Monmonier, 2010). Others have actively worked to open and extend such a possibility, proliferating and intensifying rather than controlling or eradicating the temporal. In particular situations, digital maps have been designed to set temporal coordinates and codify gestures and actions, for example the Livehoods project mentioned above, which re-maps neighbourhoods based on social media usage of residents. Yet there continues to be a retaliatory strand of ideas, through which digital mapping re-works coordinates, rendering them unreliable, 'fuzzy' or unknown altogether. The following chapters challenge the inexorable march of dominant tempo-spatial linguistics, narratives and discourses by consistently returning to digital mapping's (in)formalising tendencies. Hence they each emphasise different aspects of Adam's (2008) trope of temporality, highlighting the tensions between the institutional and the personal and between the regulated and the open.

In Thomas Sutherland's chapter – 'Mapping the space of flows' – the notion of the 'flow' and its cartographic materialisation as a 'flow map' is put under the spotlight. Taken as a 'natural and unproblematic way of describing the temporalities and mobilities of digital, networked capitalism' (Sutherland, this volume), the notion of the flow risks reifying capital's apparently inevitable

fluid advance. The flow map, in turn, becomes the carrier and modulator for this double threat, presenting the world as an unceasing whirlwind of goods, services, capital and labour. Yet, as Sutherland suggests, the flow map has a much longer history, with its roots traceable to itinerant documents such as the *Tabula Peutingeriana*.[7] Nineteenth-century trade and battle maps crafted to show the extent of colonial power, however, arguably represent the true 'birth' of the genre. Yet, these flow maps have not only persisted, but have proliferated. There is, it seems, a rather unhealthy obsession with rendering the world as full of flows. The ironic repercussion of maintaining this obsession, Sutherland argues, is a complete ignorance of the turbulent nature of global life, replete with stoppages, blockages and fractures. Scripting an *a priori* form to such 'flow-thinking' – and by extension, the flow map – risks generating a world in which flow is seen as both normal and ontologically apparent.

Yet as Cate Turk makes clear in her chapter – 'Maps as foams and the rheology of digital spatial media' – the world is far from ontologically apparent. Despite a shift in the cartographic exhibition of phenomena – from static 2D to dynamic 3D maps – this new-found dynamism is missing from many contemporary analyses. More attention needs to be paid to the different types of dynamic features found within digital maps: from slippy interfaces and automated location preference features, to 'live' data feeds and evolving software updates. But as well as conceptual concerns, the chapter also draws attention to the methodological implications of dealing with dynamism in digital maps, by asking whether 'freezing' phenomena is necessary in order to analyse them. In an attempt to avoid such an icy approach, Turk novelly applies Peter Sloterdijk's work on bubbles and foams (see for example, Sloterdijk, 1998; 1999; 2004) to the world of humanitarian crisis mapping, in order to better comprehend their contingent and temporally variable ontological qualities.

Tuur Driesser is equally concerned about the ontological implications of new digital mapping platforms. His contribution – 'Maps as objects' – addresses the ways in which a 'pathogen weather map' of New York City, called PathoMap, articulates the relationship between present and future visions of the city, by mapping its 'microbial population'. Driesser suggests that city officials provisionally become able to prepare for, mitigate against and recover from an array of national and anthropogenic disasters. Concomitant with broader narratives around anticipation, contingency and foreclosure of future action, the PathoMap marks the shift from a politics of risk, to a 'politics of the possible' (Amoore, 2013), in which future threats (such as pandemics) are secured against.

Michiel de Lange's chapter – 'From real-time city to asynchronicity' – is an equally ambitious and provocative explication of a new cartographic vision of

the city. In expanding on Bleecker and Nova's (2009) call for an 'asynchronous' urban narrative, de Lange challenges the notion of 'real-time' that writes serendipity and the 'everyday messiness' out of city life. Urban dashboards – used by state departments and local authorities – further this 'realist epistemology' (Kitchin, Lauriault and McArdle, 2015: 13; Mattern, 2015) in which access to urban phenomena is unproblematically assumed to be both possible and reliable. The 'asynchroni-city', as proposed by Bleecker and Nova and taken up by de Lange, is a speculative – but not altogether hopeless – attempt to re-direct the dominant, neoliberal narrative away from an 'efficiency-driven real-time model' that favours a calculable and known future, to ask whether we should argue for a 'slow mapping' of the city. In critiquing an array of 'smart' urban dashboards, de Lange emphasises how asynchronous design 'may contribute to a "social" alternative' of adaptive, mutable, cartographic platforms.

Foreclosing the future

Temporality offers an important framework for understanding digital mapping in all its diverse forms. Deploying a temporal lens delivers fresh perspectives for understanding and analysing mapping practices, which is indispensable for understanding the form and affordances brought together in digital mapping. It also draws attention to different knowledge claims about time, temporality, time-space and space-time.

At the start of this chapter we introduced Merriman's (2011) concerns with non-digital animation and his rejection of static notions of spatio-temporality and tempo-spatiality. By focusing on ephemeralities, stitching and (in)formalities, the chapters in this book highlight the transformational potential of a temporal turn that moves beyond Merriman's concerns, taking on board different situated examples of digital mapping practice. Building on his conceptual idea of movement, our authors show how aspects of mapping practice might be understood as material, but also more-than-representational, socio-cultural phenomena. By focusing on a rich diversity of cases, from OpenStreetMap, to PathoMap and urban dashboards, the links between Cartesian ontologies and multiple temporalities are foregrounded. We are still governed by temporalities that are grounded in ideology, and discourse (pace; Merriman, 2011), but our chapters also enrol particular situated and temporal contexts.

So, the chapters in this book all take up Merriman's call for a rethinking of temporalities and apply this to the worlds of digital mapping. Qualities of digital mapping begin to emerge in these stories, that would otherwise have remained under-theorised.

Notes

1 We regard spatio-temporalities as starting from space: tempo-spatialities in contrast start from a consideration of the temporal.
2 The fictional setting of the *Back to the Future* franchise.
3 See www.seeing-stars.com/Locations/BTTF-Map.shtml (accessed 21 November 2017).
4 Geographers have a particular fascination with mapping (see Dodge and Perkins, 2008), but also with temporality (see May and Thrift, 2001).
5 A term popularised by the *New York Times* columnist Thomas Friedman.
6 The editorial team arrived at this tripartite division after an extended coding session, discussing similarities and differences between chapters.
7 The *Tabula Peutingeriana* illustrates the road network of the fourth- or fifth-century Roman Empire.

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