The matter of 'virtual' geographies

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Abstract

Geographers have long wrestled with the spatial characteristics of digital mediation. In this regard 'the virtual' as somehow other and immaterial has proven a persistent trope. The aim of here is to argue for a greater attention to the material conditions of the digital. This article revisits the articulation of 'virtual' geographies and reviews recent discussion of digitally mediated activity. To materially address 'the virtual', the fundamental relationship between humans and technology is investigated as 'technics', using recent work in the geographies and philosophy of technology. Observations are made about how this may inform broader understandings of spatiality and culture.

I Introduction

There is a mode of writing about electronic telecommunications technologies which is now becoming ubiquitous. According to this body of literature, what we are seeing is nothing less than a new dimension coming into existence (Thrift, 1996: 1465).

[A] consideration of the nature, composition, political economy, and spatialities of software—an unpacking of its aetiology—is important in order to more fully understand how the world, and its practices, ideas, rules, measurements, locations, equations, images, and so on, are captured and worked on by software, and how such software does work in the world in diverse ways by instructing various technologies and people how to act (Kitchin, 2011: 950).

With the advent of the world wide web, in the early 1990s, geographers offered interesting insights into the potential and the reality of what was variously described as 'cyberspace', the 'information superhighway' and the 'virtual'—for example: Batty (1994; 1997), Bingham (1996; 1999; 2001), Graham (1998a; 2004; 2005), Dodge (2001;

Dodge and Kitchin, 2000), Kitchin (1998b; 1998a; 2011; Kitchin and Dodge, 2011) and Hillis (1998; 1999). The popular evocation of an alternate and immaterial realm—for example, a 'cyberspace', 'infobahn', 'matrix' or 'virtual reality'—has proven persistent in some quarters. It is not uncommon to hear an opposition set up between 'the virtual' and 'the real', or 'the physical', referring to interactions with and through Information and Communications Technologies (ICTs). As Thrift (1996) suggests, above, this opposition apparently calls into being a new dimension of spatial experience. However, as Paterson (2006: 692) observes, conjuring the virtual as an immaterial realm has somewhat faded in popular parlance, coinciding with an increasing mobility of digital media, such that allusions to a 'cyberspace' feel somewhat dated. Yet 'virtual geographies' are still investigated (for example Batty, 2012; Barnard-Wills and Ashenden, 2012; Chan, 2008; Graham et al., 2009) and so this arguably leaves the problematic conceptualisation of the materiality of 'virtual' geographies under-discussed. Thus, and as Kitchin (2011), above, asserts in relation to software, it is necessary to unpack the aetiologies of those spatial formations. We therefore need to move beyond the frictionless immateriality of 'virtual geographies' towards a greater attention to the material conditions of contemporary digitally-inflected spatial formations. The aim of this article is therefore to argue for materially grounded geographical studies of the digital; to cite examples of this in practice, to offer theoretical resources to support such analyses; and to signal possible future directions of research.

The conceptualisation of the 'virtual' in 'virtual geographies' has been largely addressed as an issue of spatiality, when explicitly addressed by geographers. This 'virtual' is considered as (socio-) technically produced space, information and (screen-based) representations, that form the 'new dimension' problematized by Thrift (1996: 1465). 'Virtual geographies' have often been represented as somehow foreign or extra-spatial, with significant mediation through language and a reliance upon metaphors (critically addressed by Adams, 1998; Hillis, 1999). Such means of description have a

basis in distinctly Cartesian and Euclidian ontologies of space. There is an assumption of a separation between the physical, often referred to as 'real', world and the abstract or mental, 'virtual', world; and those worlds are frequently considered in terms of normative three-dimensional extensions.

As Shields (2003) discusses, in some detail, the 'virtual' implied in 'virtual geographies' is only loosely related to the philosophical conceptualisations of the virtual. Several geographers expand upon Gilles Deleuze's (1988; 2004; 2005; 2006) theorization of the virtual (after Bergson) as the immanent potential of the world from which the present is actualised (for example: Dewsbury et al., 2002; Greenhough, 2010; Saldanha, 2006; Thrift, 2000). In contradistinction to this ontological conceptualisation of excessive potential, the 'virtual' of 'virtual geographies' tends to mean simulation or a kind of digital liminality, akin to a space 'between' screen and body, data and machine (see: Shields, 2003: 45-80). Doel and Clarke (1999) contrast the Deleuzian virtual with the 'virtual illusion' of a frictionless 'cyberspace', which they describe as an 'impoverished understanding of space-time':

> The virtual illusion… amounts to the desire for an unlimited realisation of the possible, to its delimitation and exhaustion in the real (Doel and Clarke, 1999: 280).

To reconcile these alternative readings of virtuality it is, I argue, necessary to attend to the materialities in which potential becomes actualised and through which digital mediation is afforded.

The architectures, appliances and infrastructures of the governmental security systems (Barnard-Wills and Ashenden, 2012), video games (Graham et al., 2009) or city management systems (Batty, 2012) discussed as 'virtual geographies' are unquestionably material in character. This materiality is not a passive collection of stuff that is distinct from active organic life. Instead, all materiality, not only the organic, is 'variously turbulent, interrogative, and excessive, [it] is perpetually beyond itself'

(Anderson and Wylie, 2009: 332). As Wilson (2011a: 858) has argued, it is necessary to 'destabilise notions of the material defined against the immaterial'. Not only are the various constituents that make up 'virtual geographies' not abstract and immaterial but also the constituent matter can be understood to be 'vibrant' (following Bennett, 2010). It is important to see the agency of code and data, evoked as 'virtual' technologies, as inextricably tied to the appliances and infrastructures through which they are materially expressed. The matter of 'virtual geographies' is, then, animated and modulated, marking them as an ongoing concern for geographical study.

In order to consider how the materialities of 'virtual geographies' can be better addressed, this paper is organised in five sections. The next section (II) reviews the various ways in which contemporary work in geography addresses the role of computing and digital media in spatial experience. I discuss significant trends in the study of digital geographies and highlight their material bases. In the third section the qualities of what are thought of as digital or virtual are discussed in relation to the concept of 'technics' as a means of explicitly situating their materiality. In conclusion, I argue that, rather than reproducing apparently disembodied forms of spatial knowledge, to study digital technologies in terms of technicity offers a means of studying contemporary socio-technical situations that recognises the inherently material character of 'virtual' geographies.

II Contemporary digital geographies

Operating throughout a range of computational systems and devices, software saturates the urban landscape. From the plethora of internet-based services to access control of public transport and even the management of water and sewage, software and code, as Amin and Thrift (2002) note, is imbued in the everyday spaces of capitalist societies. Computation, code and software have been variously identified as important concerns for geographical enquiry. In this section I want to discuss the recent

geographical articulations of digitally mediated activity, for example as 'Code/space' (Kitchin and Dodge, 2011), 'DigiPlace' (Zook and Graham, 2007), 'automatic productions of space' (Thrift and French, 2002) and 'software-sorted geographies' (Graham, 2005). The purpose of this section is to discuss the ways in which geographers have addressed code, data, software and the virtual, drawing out three key themes: the automatic production of space, spaces of calculation and transduction. It is from these themes that I draw out both the strengths and absences in the expression of the materialities of 'virtual geographies'.

Following earlier work by Adams (1997; 2011), Graham (1998a; 2005), Hillis (1999) and Kitchin (1998b; 2011; Kitchin and Dodge, 2011) we can see how, and perhaps why, metaphors and neologisms are used to describe computer-mediated spatial experience and also how geographers have situated the agency of those terms. Earlier studies of computation and digital media attempted to formulate understandings of nascent or imagined technologies. Such engagements with 'virtual geographies' of 'cyberspace' were necessarily speculative; the technology was either fiction or only existed as prototypes and very expensive and therefore exclusive devices. Early studies were therefore concerned with understanding nascent or imagined technologies, exemplified by Pile's (1994) playful speculative commentary and Kneale's (1999; Kitchin and Kneale, 2001) explorations of 'cyberpunk' fiction. Nevertheless, it seems increasingly important to answer the charge of Zook et al. (2004) that

> 'there are few studies…that explicitly aim at "getting behind" these spatial metaphors, to begin describing how digital communication technologies actually do their "work" at the level of individual, everyday performances of space' (Zook et al., 2004: 158).

The expansion of digital technology ownership, from games consoles to smart phones, and the rise in embedded computation, in cars, public transport systems, and urban infrastructures, has created case studies of widespread everyday use. In this

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section I explore particular themes in recent work in human geography that can be understood to chart ongoing engagements with what has been characterised as 'virtual geographies'. This is not intended to be a typology of contemporary 'virtual geographies', because, by now, I hope it has become clear that this article treats that term as problematic. The aim is to identify common features of related work from which we can compose an understanding of the materiality of such geographies. The three interlinking themes that I identify are: the 'automatic production of space', 'spaces of calculation' and spatial 'transductions'.

1 Automatic production of space

[C]ode orchestrates a widening array of public, private and public-private spheres and mobility, logistics and service systems and spaces (Graham, 2005: 562).

In a 2002 paper, Thrift and French argue that 'more and more of the spaces of everyday life come loaded up with software... that are installing a new kind of automatically reproduced background' that they describe as the 'automatic production of space' (Thrift and French, 2002: 309). Thrift variously examines digital art (2004b), software (Thrift, 2011; Thrift and French, 2002) and 'intelligent' environments (2003; 2004c) in terms of the various constructive apparatuses that formulate our spatial experience with and through technologies. This is significantly augmented and extended by the work of Dodge and Kitchin, who have developed an agenda for studying what they call 'Code/space', the now widespread automatic production of space, with code having particular agency in that production. Kitchin and Dodge (2011) offer a wealth of examples of the forms and formulations of Code/spaces, as automatically produced spaces contingent on code, and 'coded spaces', that are imbued with software but do not depend upon it.

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The increasing agency of ICTs and their infrastructures has also been carefully studied by Graham (1998b; 2002; 2004), who has cautioned against the creeping automation of systems that orchestrate and propagate contemporary geographies of inequality (2005: 575) and the embedding of monitoring and surveillance technologies into the material fabric of urban landscape (1998b; Crang and Graham, 2007). Cities are accordingly a principal focus, with examinations of infrastructure for telecommunications networks, associated policy, the forms of socio-economic development thereby developed and the ongoing shifts in spatial experience of the city engendered by the growth in ICTs (Graham, 2004; 2005; Graham and Marvin, 2001; Graham and Thrift, 2007). In a related manner, governance as a technological concern has been addressed in terms of: 'technology zones' to encourage production (Barry, 2006), network infrastructures (Graham and Marvin, 2001) and civic participation (Craig et al., 2002). In particular, Barry's (2001) analysis of the government of and with technology covers a diverse range of concerns. Many of these case studies have calculative systems or logics at their heart, which rely on computation to mobilise their 'grammars of action'.

There are, of course, a range of other enquiries into automatic productions of space, including children's experience of mobile media (Jones et al., 2003; Pain et al., 2005), air travel (Adey, 2004; Budd and Adey, 2009) and car travel (Sheller and Urry, 2004; Thrift, 2004a). Outside of geography, there are popular articulations of 'pervasive' or 'ubiquitous' computing by writers such as McCullough (2004) and Greenfield (2006), and the growth of 'digital humanities' research offers further insights (in particular: Berry, 2011; 2012). Following a flourishing of studies of all things digital, exemplified in geography by books such as 'Virtual Geographies' (Crang et al., 1999) and 'Mapping Cyberspace' (Dodge and Kitchin, 2000), concerted studies of the evolution and increasing significance of the digital in our lives have waned. With some honourable exceptions, there are relatively few empirical examinations of contemporary digital

geographies[1], particularly those not tied to screens. Where geographers have addressed the intermediation of spatial experience through computation we have tended towards the study of intentional, apparently human-driven, activities, such as consumption (Ettlinger, 2008), travel (Budd and Adey, 2009), and mapping (Crampton, 2009). There are excellent critical and conceptual articulations of the issues that code and software can and may present for geographical studies (such as Graham, 2005; Kitchin and Dodge, 2011; Thrift and French, 2002). However, there remain few empirical studies of 'how digital communication technologies actually do their "work" at the level of individual, everyday performances of space' (Zook et al., 2004: 158). Some of the phenomena of the automatic production of space have been identified—the code/spaces of airports (Adey, 2004; Kitchin and Dodge, 2006), the conspicuous mobility of 'spatial media' (de Souza e Silva and Frith, 2010; Wilson, 2012) and the plethora of online and simulated environments—it remains necessary to continue to study both existing and emerging automatic productions of space, and the agency of code and software in particular.

Where code and software are involved in forms of spatial experience, a prime source of data is ourselves: our movements and our activities, which are fed back into algorithms that respond and anticipate. The ways our habits can be modelled, such that our actions can be anticipated are not new concerns but they do raise issues surrounding the manner and means by which we are the subjects of calculation, both for governance and for capital, and this is the subject of the next section.

2 Spaces of calculation

> By code, we mean to refer to a system of regulation, a regime, which is both structured and structuring… the primary function of code is normative (Thomas, 2005: 649).

The growth of networked ICTs has augmented the techniques and technologies of calculation and governance that are employed to control, regulate and secure spaces. Geographers have variously tackled such issues in terms of (for example): access, government, security and surveillance (Adey, 2009; Amoore, 2006; Andrejevic, 2003; Barnard-Wills and Ashenden, 2012; Graham, 2005). ICTs can accordingly be understood as a part of the ongoing development of political arithmetic, population statistics and political economy. This is not the direct, day-to-day, production of spatial experience through code and software but rather the growth of the agency of the digital in existing mechanisms of the governance of society and space. A key means of understanding such developments is through conceptualisations of calculation. Populations have been the subjects of calculation for the purposes of governance for some time (Barnes and Hannah, 2001; Elden, 2007). Statistics as a programmatic calculus provided a basis for the disciplinary regimes Foucault (1991: 80) highlights as 'calculated, reasoned prescriptions in terms of which institutions are meant to be reorganised, spaces arranged, behaviours regulated'. With automated calculation, through ongoing increases in computational power and digital storage capacity, the algorithm has become the preeminent system of calculation, constituting 'grammars of action' (Agre, 1994) that parse and describe the ways in which human action is sensed and stored (see Galloway, 2004; Galloway and Thacker, 2007).

The protocols by which code is compiled and executed and data is exchanged, are founded upon that calculative logic, which functions as a form of virtualisation. The virtualisation of spaces for the purposes of calculation and thus control are thus networked systems of control, in the mode of cybernetics. For Galloway (2004), contrary to early utopian appeals for an ungoverned 'cyberspace' (for example Barlow, 1996), internet protocols have logics of control at their heart. Of course, as with other forms of governance, digital protocols carry the risk of implicitly embedding forms of prejudice within automated systems, for example in facial recognition systems for CCTV

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(Gray, 2003). Equally, it is possible to see how automated commercial judgements, such as credit checking systems, could connect consumer marginalisation with customer personalisation (Agre, 2001). However, as Stephen Graham argues:

> Spaces which escape the reach of regressive software-sorting systems do and will remain. A politics of transgressing, resisting, and even dismantling such increasingly inequitable systems is possible. Software-sorting techniques also offer much potential for progressive and empowering policy innovations (Graham, 2005: 577).

The security and access of regulated places have also been studied as prevalent forms of the automatic production of space founded in a calculative reasoning. For example, both Budd and Adey (2009) and Dodge and Kitchin (2004) have identified the airport as the securitised code/space par excellence. Addressing and geocoding have long histories of rendering territory discreet and calculable (Rose-Redwood, 2006; 2012); algorithmic technologies are instrumental to the everyday 'war on terror' and its associated imaginative geographies, of 'failed states' or an 'axis of evil' (Amoore, 2006); and the body is rendered as a territory to be statistically modelled, where risks are assessed and given financial values (French and Kneale, 2009; 2012).

A discourse of spaces of calculation might be taken forward in a number of ways. While there have been a range of studies of the calculative practices of the state, ranging from the delineation of territory (Crampton, 2011) to logistics (Cowen, 2010) and on to surveillance (Graham and Wood, 2003), there have been fewer studies of calculative practices by non-state actors. A growth area for the study of how the agency of the calculation of space is shifting away from the state is scholarship in critical geographical information systems. For example, we might look to how participatory mapping affords different cartographies and modes of political engagement (Elwood, 2006; Wilson, 2011a) and the growth of 'citizen science' (Haklay, 2002; Sui et al., 2013) as a means to counter established hierarchies of knowledge. Geographers might also look to the

increasing number of digital systems inserted into everyday spaces that attempt to calculate our bodily dispositions for commercial gain, For example, the company QuiVidi have created a system 'automated audience measurement' system that purportedly can track the gaze of people near billboards using cameras to discern if and how long people look at adverts, and demographic distribution (age, gender, ethnicity and so on) of the 'audience' (see: http://www.quividi.com/). The 'Footpath' system created by the company Path Intelligence uses passive mobile phone signal detection to track movements through shopping centres in order to track consumer behaviour (see: http://www.pathintelligence.com/en/products/footpath/footpath-technology).

Geographers are well placed to contribute to critical examinations of the increasing use of calculative software systems that both enable and seek to control the production and performance of space and place. Code, computation and software can also function as modulators, in a collective reshaping of spatial experience and it is to that form of mediation that I turn next.

3 Transductions

> Transduction is… the making anew of a domain in reiterative and transformative individuations—it is the process by which things transfer from one state to another (Kitchin and Dodge, 2011: 72)

Embodied forms of mediated everyday life and various (specific) activities with and through technology have been the focus of geographical enquiry. Just as code and computation can produce spatial formations they can also modulate them, iterating and transforming those relations within a given domain. These processes can be understood as 'transductions', whereby 'a domain structures itself as a partial, always incomplete solution to a relational problem' (Mackenzie, 2003: 10; cited in Kitchin and Dodge, 2011: 72). In recent geographical enquiry there has been a range of work that attends to particular spatial formations we can understand as examples of transductive processes.

Explorations have been made of how technologies such the web (Bingham, 1999; 2001; Bingham et al., 2001), social media (Wilson, 2011b; 2012) and video games (Ash, 2009; 2010b; 2010a; 2012) play a role in the contemporary spatial understandings of everyday life. Equally, outside of geography there have been investigations into the role of restraining and surveillance technologies (Troshynski et al., 2008; Murakami Wood, 2008) and what 'wirelessness' means to our experience of everyday life (Mackenzie, 2009; 2010).

Social media have emerged as a site of concern for geographers interested in understanding everyday life, and in particular the environs of the city. Wilson (2011b; 2012) offers some useful observations about the technically mediated 'conspicuous mobility' that forms emergent cartographies of everyday life through location-based services such as 'Foursquare'. In addition to geographical study, social networking systems have featured as a central concern in discussions around how our capacity for attention is mediated (Crogan and Kinsley, 2012). The phenomenological relationship between body and screen in the act of playing video games has been identified by Ash (2009; 2010b; 2010a; 2012) and Graham et al. (2009) as a fruitful locus of geographical enquiry. Ash has variously investigated the affectual responses (2010a), spatial awareness (2009) and temporal sensibilities (2010b) that emerge from and are transduced by video gameplay.

To study the transductions of contemporary digitally-inflected geographies has become imperative for our broader geographical understanding of the world in which we live. This point is pertinently made by Kitchin and Dodge (2011) in the conclusion of their book 'Code/Space'. It is not only a snapshot of contemporary forms of transduction with and through computation, and a critical response to such observations, but also a rallying cry for further critical research, in the shape of the concluding manifesto for software studies. As Kitchin and Dodge (2011: 71-73) suggest, in the formation of code/spaces and the en-coding and transduction of parts of everyday life, we are

negotiating the ongoing reformulation of what it is to be human. There accordingly needs to be a much broader attempt to study the specific examples of the increasing transductive agency of the digital in everyday life by geographers.

4 Attending to matter

Accounts of contemporary digital geographies sometimes elide specific material conditions with generalised observations about forms of spatial experience. There is, of course, an issue of focus here: it is hard, and sometimes dull, to discuss cables, circuits and sensors. Nevertheless, such things are material expressions of a sociotechnical milieu, and as important constituents of infrastructure, following Star and Ruhleder (1996), are composed with code and software, bodies and language in the production of space. Of course, I am not suggesting that we should only describe those immediately obvious physical constituents of a system. Rather, following Kitchin and Dodge (2011), I am suggesting that we need to attend to how

> the material fabric and social relations of places are constantly created and
> recreated through spatial practices that vary their pacing, so some changes are
> more immediately noticeable than others (Kitchin and Dodge, 2011: 68).

The construction of the everyday urban landscape continues to be adapted to accommodate the variety of technical apparatuses used in the production of space.

The material consequences of automated calculative systems can be most obviously seen in systems that regulate physical access to particular places. 'Smart' card systems for access to buildings, public transport and payment systems have become regular parts of everyday life, as physical artefacts of 'software-sorted' geographies (Graham, 2005). Whereas with obvious access systems, requiring a 'key' (perhaps in the form of a card), their material aspects are immediately evident, because of their contingency within the system, there are other, less obvious, calculative systems in place, such as systems for addressing and town planning, food preparation and logistics and energy services distribution.

In this section I have identified three overlapping themes within contemporary digital geographies: the automatic production of space, spaces of calculation and transduction. The range of work reviewed illustrates both the diversity of computationally inflected spaces and the interest and importance placed in their study by geographers. Whereas earlier work addressing speculative, or imaginary, 'cyberspaces' evoked a separate, disembodied dimension of spatial experience, much of the research reviewed here demonstrates the imbricated nature of the constituents of a given sociotechnical milieu. Even so, in some accounts there remains a faint implication of a foreign automatism that 'replaces' human agency. This highlights the difficult understanding we have of the abstract yet fundamental relationship between 'the human' and 'the technical', frequently held as separate and yet intimately intertwined. This relationship haunts all accounts of technology use. The next section addresses this problematic in order to recuperate the material nature of 'the virtual'. We will thus explicitly deal with the conceptualisation of the relationship between humans and technology as 'technics'.

III Technicity

Central to the materially inflected investigations of digital geographies reviewed above is an often hidden or assumed understanding of the nature of our relations with and through technology. Computing technology, in particular, has prompted some problematic spatial understandings of how we relate to technology. Networked computing has been represented as somehow special or 'other', with a de-naturalising power, insofar as it apparently permits a form of disembodied or immaterial action, or brings into existence a new spatial realm, a 'cyberspace', following Thrift (1996: 1465). Much of that rhetoric of 'cyberspace' has been dropped, as demonstrated in section II, but the simple opposition between real and virtual continues to be raised. This is problematic because in opposing 'the virtual' and 'the real' we either oppose technically

mediated experience to other forms of experience, or we oppose our technical life to other, apparently 'natural', forms of existence. Either way, we risk re-asserting old, problematic binaries: human/technology and nature/society (see Bingham and Hinchliffe, 2008; Dixon, 2008; Murdoch, 2006: 1-4). The aim of this section is therefore to offer a means of addressing the human-technology relation as a constitutive grounding for the ways in which we understand the world without reducing it to a simple binary.

1 Technics and technicity

A useful way of thinking about what technology is and does in relation to 'the human' is the concept of 'technics', as the problematic and constitutive relation between what we call 'human' and 'technology', and accordingly 'technicity' as the (emergent) qualities of that relation as it is performed. Pioneering theorisations of *technē* (following Aristotle and Plato) as technics have been offered as: coterminous with our 'nature', by Marx; the ontological 'enframing' of (human) being, following Heidegger; or a 'part larger than the whole of which it is a part' in the origins of the human (Derrida, 1984: 148). More recently scholars such as Hayles (1999; 2012), De Landa (1991; 2011) and Stiegler (1998; 2009b; 2010c) have positioned the 'theory and praxis of technicity [as] one of the defining... conceptual tasks of our moment' (Bradley and Armand, 2006: 9). Technics both precedes and surpasses 'particular technical objects or social functions' (Mackenzie, 2001: 237). This is not to say that there is a settled consensus on the conceptualisation of technicity. As Bradley and Armand (2006) highlight, theorising technicity, as the qualities of the co-constitutive relation between 'human' and 'technology', is performative and thus based in praxis. To think more explicitly about the materiality of spatial formations convened with and through digital technology, 'technicity' offers a fertile conceptual basis for discussion. In this section I will review pertinent conceptualisations of technicity with a view to advancing a means of

addressing the material grounding of what are often seen as abstract or immaterial technologies.

Geographers have broached the concept of technicity by largely drawing on theoretical resources associated with phenomenological understandings of being (for example: Ash, 2012; Kitchin and Dodge, 2011; Bingham et al., 2001). In particular, this work has been influenced by the work of Adrian Mackenzie (notably 2002), who in turn is influenced by French philosophers of technology Gilbert Simondon and Bernard Stiegler. From this work, it is possible to identify, broadly, two ways to understand technicity: 'the unfolding or evolutive power of technology to make things happen' (Kitchin and Dodge, 2011: 42; pace Mackenzie, 2002); and the 'co-constitutive milieu of relations between the human and their technical supports' (Crogan and Kennedy, 2009: 109; pace Stiegler, 1998). I will expand on these in turn. First, following Kitchin and Dodge's use (drawing on the work of Mackenzie, 2002), we can understand technicity as the power technologies have, both on their own and in combination with the human body, to make things happen in the world. We can accordingly understand the automated agency of software and other technologies in the production of code/space as a form of technicity. Second, we can think of technicity as the ways in which humans and technology mutually co-constitute one another in an ongoing formulation of associative milieus. The reciprocal arrangement does not have the human at its centre but is a transduction, whereby the human and technical individuals concretise in relation. Technicity in this sense is not a capacity but a form of relation through which we come to understand our technical 'supports' and ourselves, and somewhat dissolves that distinction.

Further to the second definition, and following the philosopher Bernard Stiegler, we can also use technics as a key means of understanding what constitutes us as 'human'. Technics, in this way, can be situated in an 'aporia of origin' of the human, which is at the heart of Stiegler's theorisation of 'technogenesis'. The theory of

technogenesis offered by a range of anthropologists and philosophers is the idea that humans and technology co-evolved together, that you do not get one without the other. Humans are irreducibly distinct because of the reflexive transmission of complex cultures made possible by technics and the 'exteriorisation' of thought. Both Stiegler and Derrida argue that the mental interior is only recognised as such with the advent of the technical exterior: our conscious self-knowledge is only possible with the ability to exteriorise thought as a trace, commonly as language and gesture. Stiegler explains this aporia of origin as a paradox:

> 'The paradox is to have to speak of an exteriorisation without a preceding interior: the interior is constituted in exteriorisation' (Stiegler, 1998: 141).

Technics can be thought of as a technogenetic 'double-bind' between being both constitutive and a supplement of 'the human'. The interior and exterior, and with them the contemporary understanding of the experience of being human and what we understand to be technology, are mutually co-constituted and *continue to be so*. Stiegler argues (1998; 2009a) that the anthropological basis for this double-bind is situated in our capacity to exteriorise thought as traces, most powerfully as language and thus writing[2]. This should not be mistaken for technological determinism, however, because technics cannot 'determine' our situation without culture, as the transmission of memory[3].

The materialisation of thought, exterior to the mind and body, is 'tertiary retention', where (following Husserl, 1991) 'primary' and 'secondary' retentions are internal to the mind and body (see Stiegler, 2010a: 8-11). A mental reality, or 'technical mentality' (pace Simondon, 2009), can thereby be 'projected onto a support that is neither cerebral nor psychical but rather technical' (Stiegler, 2012), which Stiegler (2009b: 7-9) calls the process of 'mnemotechnics'. Stiegler (1998: 59) suggests these forms of 'retention' precede us and yet they are a part of us, there are forms of retention that were created long before the birth of an individual and yet that person can access

them as a form of 'cultural memory' (see: Stiegler, 1998: Part 1). Furthermore, and as Ash (2012: 189-192) explains, technics as the (co-originary) relation between human and technology is also the means by which human time consciousness, as the negotiation of the 'now', is 'actively and continuously shaped' (192).

This 'technogenetic' theorisation of technics significantly relates to and perhaps, in some cases, challenges a growing body of work in geographies of the 'posthuman' (Buller, 2013; Castree and Nash, 2006; Coyle, 2006; Panelli, 2010). Technics as a 'co-originary' relation between what we understand to be human and the supports we use, from flint axes to the world wide web, describes what Stiegler calls a 'default' of origin: There are no essential, or *a priori*, human qualities in this argument but 'the human' is distinct. What distinguishes humans, beyond morphological difference, is our complex form of time consciousness, the ability to anticipate forms of future and to transmit memory across generations. Stiegler provocatively asks if the human invents the technical or could it be the other way around? To answer his own question Stiegler argues that they are, instead, co-constitutive. To paraphrase Stiegler (1998), the tool invents the human, or the human invents herself by inventing the tool, through techno-logical exteriorisation. This exteriorisation, as previously stated, is in fact the co-constitution of the interior and exterior, which, according to Stiegler, produces the illusion of a succession from interior to exterior. We do not have access to the 'original' moment of the invention of the human/technical, instead, through our technical prostheses, we have the ongoing 'already there' record of exteriorised memory, transmitted across generations:

> The already-there is the pre-given horizon of time, as the past that is mine that I have nevertheless not lived... This means that there is no already-there, and therefore no relation to time, without artificial memory supports' (Stiegler, 1998: 159).

Indeed, if we break down the meaning of the word *pros-thesis* we see it literally means 'to set in front' (see Stiegler, 1998) and so in our day-to-day use of our technical supports we are always already 'setting ourselves in front of ourselves', remembering what it is to be human, in an everyday fashion, and continuing to perform the aporia of our origin.

We can see, then, that, to theorise technicity, we must also understand what we consider to be human to have no essential grounding. This is the 'double-bind' Stiegler's innovative philosophy presents to us, the negotiation of the 'now' is a process of tranduction. Following Stiegler's theorisation of technogenesis, the account of the human here is not one of miraculous separation from nature, or from technology, but of imbrication and becoming with a wealth of other entities. This is not a deterministic relation precisely because, following Kitchin and Dodge:

'transduction… is then never fixed, shifting with place, time and context (social, political and economic relations and situations)' (Kitchin and Dodge, 2011: 75).

If critical posthuman geography 'attends to the ways in which ideas of the human, nature and culture continue to work even in accounts which suggest their implosion' (Castree and Nash, 2006: 502), this theorisation of technics, and technogenesis more broadly, offers a useful and critical phenomenological grounding for posthuman geographies, particularly of the digital. Indeed, this resonates with the account of technogenesis that is firmly established in other disciplinary contexts (see in particular Hansen, 2006a; Hayles, 2012; Stiegler, 1998; 2009b; 2010c). Given this understanding of technics, the 'digital' is the latest significant step in the processes of the descretisation of knowledge and memory exterior to the body, as the philosopher Bernard Stiegler forcefully shows (2010b; 2011b; 2012), and code is precisely its ontogenetic vanguard. To advance these critical analyses of the technicities of a given state of affairs, a particular transductive process, it is necessary to find a way of thinking about contingent and relational ensembles of human and non-human bodies, organic and

inorganic matter, with particular characteristics and durations. The next section returns to the theorisation of 'transduction' as a means of critically articulating technicity in a given spatial formation.

2 Transduction

A useful way of understanding the comingling of 'human' and 'non-human' articulated by technics is the process of transduction, which is already being used to a limited extend by geographers such as Kitchin and Dodge (2011) but is both founded in and significantly advanced by the work of philosophers of technology Gilbert Simondon and Bernard Stiegler. Simondon introduces the concept of transduction as a means of describing actions that not only propagate a particular state of affairs but also modulate the domains in which they take place (see Combes, 2013: 6-9). It is the ontogenetic character of technical being:

> 'By transduction, we mean a physical, biological, mental, or social operation, through which an activity propagates from point to point within a domain, while grounding this propagation in the structuration of the domain' (Simondon, 1964: 30; translated in Combes, 2013: 6).

Transductive processes constitute milieus of association between various entities, which Stiegler argues, following Simondon (1958), is 'the coupling of the human *qua* social being to matter *qua* geographical system' (Stiegler, 1998: 59). In the vein of the various understandings of 'assemblage' recently taken up in the social sciences (see Anderson et al., 2012; Marcus and Saka, 2006; Ong and Collier, 2005), transduction is a way of thinking about contingent and relational ensembles of human and non-human bodies, organic and inorganic matter, with particular characteristics and particular durations. Accordingly, our understanding of and relations with and through the world are not wholly settled but are experienced as 'metastable'.

Transduction produces what Simondon (1992) calls a 'metastability', which Stiegler describes as

a process that is in movement to the extent that it is: on the one hand partially stable and able to maintain its form… and yet, on the other hand, partially unstable, insofar as this form never ceases to become other than what it is (Stiegler, 2011a: 38).

Metastability describes the iterative and transformational nature of transduction (see: Stiegler, 2009a: 76-79). For example, we come understand the nature of our being and subjectivity through our performance of and in the world, in everyday activities such as text messaging, as relations are formed between constituent actors in that activity. An activity is experienced as metastable, remaining a tendency towards a particular state of affairs because bodies, devices, environments, infrastructures and others shift and change, thus changing or instituting a new tendency. Each entity in the assemblage formed through transduction is both distinct and bound into broader systems: no individual entity is an 'absolute; by itself alone, it is an incomplete reality… and yet it is not illusory either… [it is] associated with a milieu' (Combes, 2013: 21) that is metastable, within a consistency of relations, yet always with the potential to become something else. Thus a process of transduction, in the context of the digital geographies discussed here, constitutes both a physical and cultural milieu that is 'creative of new reality and values—but it can also be imagined as engendering in the same movement unknown forms of divergence' (Stiegler, 1998: 60).

Considering the transduction that takes place in the sending of a text message, we see that, rather than being an 'immaterial' process, there is a significant network of matter and energy upon which this 'virtual' activity is predicated. A device, usually a phone, is used to input the message. The physical functions of that device are contingent upon a wealth of highly processed materials, often with complicated origins[4], enmeshed into complex chemical arrangements and interdependent components. For example, a capacitative touch screen, made from glass and electrically conductive materials, uses the body's electrical capacitance to sense the point of touch (Greenstein, 1997: 1318).

This is often processed via one of many Application-Specific Integrated Circuit chips in the device, feeding data to other components that process software, which in turn changes the electrical charge within different areas of the screen (pixels) to display images. To 'send' the software engages the modem of the device to communicate with the network, translating data into modulated pulses in particular frequencies of the electromagnetic spectrum. The phone network infrastructure itself is constructed of many transceivers on towers, providing wireless communications capacity, that are also connected to the physical network infrastructure, which is composed of copper and fibre optic cables, exchange points and network switches, through which binary data are transported over significant distances at the speed of light. Protocols encoded into devices and software control the communication of particular kinds of data. For text messaging, the Short Message Service (SMS) protocol is used by the various actors in the network to route and interpret a message. A centralised SMS Centre, a specific type of server (both hardware and software), stores and forwards messages when the network completes the connection to the recipient device (see Hillebrand, 2010).

For a moment a body is composed with energetic and clearly material systems to record and convey meaning, however trivial, to an-other. Circuits of connection, energy transfer, cognition and meaning are composed between bodies, devices, infrastructure, data and others into a milieu that not only performs the action of sending a text message but changes the composition or states of the variously composed individuals involved. In this way, transduction is a way to understand how technicity emerges in particular spatial formations. Transduction is accordingly a means of understanding the ways in which we can be said to come to 'be', given a theory of technogenesis. These concepts allow us to recognise the various contingencies between different entities, both human and non-human, that are composed at different speeds, for particular durations of time and which reveal and even produce our own understanding of temporality. Understanding our intimate and co-developing relations with and through technology

through the concepts of technicity and transduction enables a means of accounting for the various constituents to be addressed without reductionism: either totally reducing a system to its parts, or reducing, and eliding, those parts as simply 'nature' or 'technology'.

<div align="center">*</div>

This section has sought to outline the inseparable connection between our understanding of the forms of digital systems—understood as abstract networks, data and code—and the material systems through which they are expressed. First, by discussing contemporary theoretical work, the concept of technicity is defined here as the qualities of the co-constitutive relation between the human and the technical. Technicity thus provides a means for anchoring the apparently immaterial forms of data, code and information to their material expressions in appliances and systems. Second, I suggest that technicity is actualised in particular spatial formations, through which particular relations of transduction are expressed. The conclusion of this article therefore examines how the concept of technicity addresses and enhances ways in which geographers can think about the materiality of digital technologies, and how this in turn may influence broader understandings of spatiality and culture.

IV Conclusions

The ways that geographers address digital technologies have diversified from the almost eschatological early discourse of virtual geographies, significantly influenced by Euclidian metaphors of 'virtual reality' in the 1990s. In this article I have reviewed a range of geographical engagements with compositions of bodies, code, data, infrastructures and languages that illustrate both the diversity of computationally inflected spatial formations and the interest and importance placed in their study by geographers. Whereas earlier work on 'virtual geographies' that addressed speculative, or imaginary, 'cyberspaces' evoked a separate, perhaps disembodied, dimension of

spatial experience, much of the contemporary research reviewed here demonstrates the very material nature of the constituents of an apparently 'virtual' milieu. Building from these contemporary digital geographies, I have discussed the concept of technicity—defined as the qualities of the co-constitutive relation between the human and the technical—as a means of addressing the material grounding of what are often seen as abstract or immaterial technologies. To conclude then, I want to offer a reading of 'technicity', as discussed above, as a means of addressing the materiality of 'virtual geographies' to suggest how this can inform how geographers address spatiality and culture and to signal potentially fruitful forms of geographical inquiry.

Technicity provides a means for epistemologically anchoring the apparently immaterial forms of data, code and information to their material expressions in appliances and systems. The various ways of thinking through technics—as the relationship between the (mental/psychic) interior and exterior, the ongoing negotiation of the temporality, and the materialities of thought—allows us to think in a different way from the stark binaries of human/technology and human/nature. Technicity, as a concept, thus facilitates a means of negotiating two principal, yet somewhat divergent, uses of the term 'virtual': its philosophical sense as immanent potentiality as well as the (abstract) traces of memory; and the rendering of the apparently abstract or immaterial aspects of digitally mediated experience.

First, technicity allows a means of situating those aspects of the traces of memory, as virtual, in material assemblages while retaining their abstract nature. Second, the latent potentiality held in the relation between the 'human' and 'technical' as technics can also be understood as a form of (techno-anthropological) 'virtual' (see: Fauré, 2012). Rethinking the virtual of 'virtual geographies' in terms of technicity highlights the material character of the spatial formations named as 'virtual geographies'. The agency and potentials of code and software, variously described in section II, thus foreground, through the relation of technicity, the material grounding of

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that potential. In this way we can understand code, data and software (previously considered to be immaterial) to have significant transductive potential to affect the world, functioning independently of the human, but that such potential is grounded in the material affordances of physically composed (complex) systems, made up of various kinds of infrastructure, silicon chips, magnetic storage devices and others. The characterisation of 'immaterial' geographies of digital technology is therefore rendered problematic. As Stiegler (2008) notes 'immaterial' is

> a facile word that is used even by people at the highest level, like André Gorz (2003), where it names what are in fact *evanescent* states of matter which remain, nonetheless, states of *matter* (Stiegler, 2008: 109 original emphasis, author's translation).

From a range of positions, including Bennett (2010), Coole and Frost (2010) and Stiegler (2008), then, we are compelled to seriously consider the vibrancy, or 'evanescence', of the complex material character of who and what we study. Rather than appeal to an amorphous alternate realm from which digital technologies draw their agency, and following the example of the work reviewed in section II, we can instead study the particular states of affairs in which agency and technicity are generated. Geography is, in this way, well placed to inform and enhance social scientific research concerning digital technologies, particularly in relation to the articulation of spatial experience and knowledge.

Beyond the rethinking of how we can study what have been called 'virtual geographies' in terms of their material grounding, this reading of technicity, through the work of Stiegler (1998; 2009b), can also, more broadly, enhance the ways in which geographers can think about spatiality and culture. First, and as already intimated, there is the issue of spatiality. Technicity, as the qualities of the co-constitutive relationship between humans and technology, importantly involves the materialisation of thought, through the exteriorisation of memory as traces such as writing. These processes of

exteriorisation intimately relate to the ongoing negotiation of spatial understanding, which is at once cultural and technical—as exteriorisation involves leaving traces of knowledge that can be inherited across generations. This is also an issue of abstraction, 'not least because the worlds we inhabit are unthinkable, unnavigable, and unliveable without abstractions in their manifold guises' (McCormack, 2012: 720). With the desire to articulate various forms of socio-technical relation comes various representational strategies—the most prevalent being metaphors or the appeal to separations of the human from technology and/or nature, the invocation of a new Cartesian dimension of spatial experience, or the implied separation of mind and body. Rather than reinforce binaries that abstract the human at the expense of biology, nature or technology, the concept of technicity offers a means of engaging with complicated entanglements of various organic and inorganic forms of life in a holistic form of abstraction, not least through the reading of the 'virtual' presented above.

Second, the reading of 'technics' presented here can inform understandings of 'culture' within geography. If we understand culture as the 'distinctive set[s] of processes – such as how meaning becomes shared, or the processes through which meaning becomes social and political' (Kirsch, 2013: 434) inflected by broader social themes, such as capitalism, race, class, gender and many others, then understanding that sharing becomes of prime concern. This sharing of meaning, through language, is importantly a technical issue, or rather, following the discussion above, it is an issue of technics. Culture can accordingly be thought of as metastable systems of retention, of exteriorised thought:

> 'A new born child arrives into a world in which tertiary retention [data, images, writing and so on] both precedes and awaits it, and which, precisely, constitutes the world *as* world' (Stiegler, 2010a: 9).

The ongoing creation of shared knowledge, and thus a shared memory and history, is in large part mediated by technology (with the notable exceptions of practices of oral

history and storytelling). The constitutive role of technics in our production and performance of culture has thus become a significant concern for the social sciences, and, given the materially spatial character of the exteriorisation of thought, it presents some productive lines of inquiry for geography.

At base, the theory of technogenesis presented here—in which there is no essential, transcendent category of the 'human' but rather an *ongoing* mutual constitution of the 'human' and the 'technical', or organic and inorganic being—allows us to set aside the need to resort to complex ontological arguments about origins, or imply a kind of anti-humanism. 'Humans', however we conceive of ourselves, and our geographies, remain important because we generally agree it is valuable to understand ourselves, but this is different from metaphysically setting ourselves apart. The conceptual toolkit of technicity and transduction enables nuanced accounts of our complex and increasingly significant uses of digital technology without invoking fixed or 'hard', and perhaps reductive, ontic categories, such as 'cyberspace'. This is not a means of continuing to fawn over a special domain of 'the digital', in the eschatological manner of the late 20th century, but rather to conduct work that attends to the manifold ways in which technical activities convene assemblages of bodies, objects, feelings, language, values and so on and fold them in and out of spatial practices.

Given the review of recent 'digital' or 'virtual' geographies and conceptual resources presented in this article, I want to briefly sketch two suggestions for how we might we take forward a renewed interest in the material bases of what are rapidly evolving digital geographies. First, with the growth in access to and ownership of digital technologies we are called to further investigate the forms of spatial experience that come about in the transductions of emerging technologies. Geographers are well equipped, theoretically and empirically, to discard the notion of immaterial 'cyberspaces' and to conduct more nuanced and careful studies of contemporary digital geographies. Yet, there remains a somewhat urgent need for serious and sustained

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critical, social scientific, engagement and study of the work of what have been considered 'immaterial': code, data, software, and so on, and their work in the world. A range of cross-disciplinary work reveals many aspects of digital phenomena but there remains a surprising tendency to see digital systems in narrow or artefactual senses, instead of as complex phenomena that variously contribute to 'heterological singularities and specificities of [many] different materialities' (Anderson and Wylie, 2009: 319). We must therefore continue to ask: how are the material fabric and spatial practices of particular digital geographies (continually) created and modulated (that is: *transduced*), and how do they vary in complexity, depth, pacing and reach?

Second, geographers have largely retained a distance from the material specificities of the production processes of digital technologies, preferring to describe and critique 'finished' technologies and their practices. While there have been a range of economic analyses of the creation and performance of institutions, regional centres and markets of production (for example Storper, 1997; Wang and Lee, 2010; Yang et al., 2009) there have been comparatively few studies of the material practices of technology production. For example, we can readily see how to chart the varied and many material interconnections (pace Cook et al., 2004) of a complex entity such as a smart phone. However, what would it mean to investigate the specific capacities and agencies of material entities themselves? We might, for example, look to examples such as Bennett's (2010) material-political reading of the capacities of metal in order to address matters such as the transductive agency of apparently spontaneous short circuits in data centres created by 'Zinc whiskers' (see Brusse and Sampson, 2004). Furthermore, we might continue to ask what material(s) are 'wasted', discarded or excluded in the production and use of digital technologies and what are the transductive agencies of such 'wasting' processes (following Gregson and Crang, 2010; Moore, 2012).

Geographers should, perhaps more assertively, continue to contribute to and challenge broader debates concerning 'the digital economy', the 'digital humanities', the

'internet of things', 'software studies' and so on in order to inject more nuanced, ontogenetic—and in particular *technogenetic*, understandings of materiality and spatiality (pace Anderson and Wylie, 2009). I have argued, through a technogenetic understanding of the human and the technical as always already intertwined, that the matters of 'digital geographies' are continually animated and modulated. This marks 'digital geographies' as an ongoing and pressing concern for geographical study.

Acknowledgments

Notes

1. In light of the deficit of empirical studies of contemporary digital geographies, the recent announcement of Rob Kitchin's five-year project 'The Programmable City' to study 'how software and technology influences how we live, work and operate in cities', supported by the European Research Council, is very welcome—see: http://communications.nuim.ie/240113.shtml (accessed: 26/01/2013).

2. Stiegler explains the co-originarity of humans and technics through innovative readings of work by the anthropologists Bertrand Gilles and Andre Leroi-Gourhan and the philosophers Gilbert Simondon and Martin Heidegger (with the influence of Jacques Derrida) in his series *Technics and Time*. Technics has an anthropological basis insofar as technical capacities are, for Stiegler, the most distinctive part of our evolution. With the exteriorisation of thought, comes its spatialisation, as it is rendered material. Exteriorisation also involves an anticipation of its further use, and so an appreciation of the passage of time. The ongoing development of what we

understand to be the human is thus always already in relation to the technical, and what Stiegler calls 'organised inorganic matter'. Stiegler argues that it is the organisation of inorganic matter as supplements, particularly for memory, that differentiates the human:

> If molecular biology is correct in claiming that the sexual being is defined by the somatic memory of the *epigenetic* and the germinal memory of the *genetic*, which in principle do not communicate with each other… exteriorisation is a rupture in the history of life resulting in the appearance of a third—tertiary—memory I have called *epiphylogenetic* (Stiegler, 2009b: 4).

Patrick Crogan (2010) provides an excellent overview of Stiegler's philosophy and activism in a recent editorial.

3. Stiegler's thesis of *epiphylogenesis* runs counter to rigid forms of both technological determinism and cultural constructivism, as Mark Hansen argues:

> there simply is no such thing as technical determinism, not because technics don't determine our situation, but because they don't (and cannot) do so from a position that is outside of culture; likewise, there is no such thing as cultural constructivism – understood as a rigid, blanket privileging of ideology or cultural agency – not because culture doesn't construct ideology and experience, but because it doesn't (and cannot) do so without depending on technologies that are beyond the scope of its intentionality, of the very agency of cultural ideology (Hansen, 2006b: 299).

4. Although hidden within the carapace of devices, many components contain a range of materials including arsenic, benzene, copper, hydrochloric acid, gold, silicon, silver, tantalum, zinc, and various plastics. Tantalum powder, for example, is used in capacitors due to its efficiency in low volumes, and is prevalent in mobile phones. A significant proportion of this mineral comes from the Democratic Republic of Congo, where its mining and extraction has been imbricated in conflict (see Taffel, 2012).

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