Continuous connectivity, handheld computers, and mobile spatial knowledge

Matthew W. Wilson
Graduate School of Design, Harvard University
Department of Geography, University of Kentucky

Wilson, Matthew W. Forthcoming. Continuous connectivity, handheld computers, and mobile spatial knowledge. *Environment & Planning D: Society & Space*.

Abstract:
As geospatial information seemingly moves from users' personal computers to 'the cloud', the use of the phrase 'geographic technologies' has increasingly indicated things beyond desktop GIS. With these shifts in the distribution of geospatial data and practices, and the rise of the geoweb as a site of inquiry, new concepts are needed to better understand the conditions of geographic technologies. In this paper, I conceptualize one such element of interactivity: connection. Here, I argue that a logic of continuous connectivity underlies the development of digital spatial media and influences the contemporary production of spatial knowledge. For those lives lived that are presumed to be 'always-connected', interactions are figured by these connections to digital media. Many of these digital devices (especially mobile ones) become functional only through a series of connections to data and communication networks. For instance, mobile phones are in continuous communication regardless of direct use, 'listening' to cellular towers and analyzing proximity to deliver the best possible connection. From these system-level codes that maintain device connectivity to software-level codes that push and pull data to and from 'the cloud', being always-connected is part of a cultural milieu that has diverse implications not only for attention but also for the development of collective, spatial knowledge. Here, I situate the emergence of continuous connectivity in the marketing of handheld computers in the late-1990s, to historicize the importance of connection for understanding geospatial practices.

Key Words: mobile devices; code; technology; advertisements; spatial knowledge

Continuous connectivity, handheld computers, and mobile spatial knowledge

> *Fall COMDEX 93 revealed the essential weakness of the hottest new product category of 1993: the personal digital assistant (PDA). The problem is that no one really knows yet how PDAs will actually be used. (Computer Technology Review, 1993, as cited in Allen, 1998: p. 3)*

Mobile technologies have an infectious quality, in that they are devices that, despite their relatively recent prominence, many feel they cannot exist without. Increasingly these devices are built to be held and worn, and represent multi-billion dollar industries in entertainment, communication, education, personal management, and of course serve security functions. As these technologies occupy the imaginary of popular culture and the reality of Silicon Valley bottom lines, they further entrench notions of desire and mimicry – in their effortless portability, flawless facades, and seamless interoperability. Not only do these devices perform the functions of their design, they perform us, our design: how we want to be represented and read. The development of one such device in the 1990s, the "hottest new product category" termed the personal digital assistant (PDA), marks a moment in computing that conditions our current digital culture and, as I suggest, conditions the forces that assemble self and society.

Handheld computing objects enable the construction of *our-self-our-world*, an inseparability well-illustrated by the controversy surrounding 'homeless hotspots' at the 2012 South by Southwest conference. Here, a NYC-based marketing firm enrolled individuals living on the streets of Austin, Texas to sell access to a wireless station hanging around their necks. From the perspective of the firm, this presented a win-win situation. Conference goers could feed their seemingly insatiable desire for mobile connectivity, while the homeless of Austin could sell a product that was highly desirable. Indeed the consumer-oriented consciousness that surrounds mobile devices has again reached a fever pitch. In what follows, I examine the present histories of handheld computing, suggesting that any serious, critical engagement of the knowledge produced through the use of these technologies needs to consider the conditions of their development, marketing, and use (indeed, even their disposal). Along these lines, I suggest that critical mapping scholarship has under-theorized the role of

technological futurism and fetish, central to the map 2.0 or geoweb movement. More specifically, how might we situate the emergence of continuous connectivity as a cultural milieu, and what are the implications for how we study geoweb practices?

I explore these present histories to analyze how their emergent discourses permeate the current use of mobile technologies, in three parts. In the first section, *Technological discourses*, I review computing histories which pre-figure and intersect the emergence of a 'continuous connectivity' discourse. In the section *Situating handheld computing,* I introduce the discourse of 'continuous connectivity', setting it off from the centralized computing of the US postwar period and from the personal computing movement of the 1980s. I then trace this discourse in the history and marketing strategies of Palm Computing in the late 1990s, in a final section: *Computing for your hand.* As the GISciences begin to unpack the social implications of the geoweb, I argue for further consideration of the ways in which mobile spatial knowledge is entangled in consumer technology development.

1.0 Technological discourses

Computing developments have long been critiqued as inextricably bound up in the military-industrial complex (Edwards, 1996; Haraway, 1997). This critique has been extended to technologies like geographic information systems (GIS) and global positioning systems (McHaffie, 1997; Roberts and Schein, 1995; Smith, 1992). Generally, these literatures suggest that in order to fully understand the societal implications for computing technologies, the histories of their development must include their multiple co-implications, funding paths, and articulated problem-areas. These multiple positionings have bearing on their current implementations. In this section, I briefly review the discourses that shape the history of the computer as important for situating the development of handheld devices. By reading the histories of handhelds within the broader histories of computing, connections and contingencies emerge in the material-discursive relationships of their capital flows, imaginations, and logics of development.

A critical history of computing eventually settles in on Silicon Valley, California, where venture capitalism has persisted since the post-WWII period alongside the expanding role of the university in advancing state objectives and a growing need for high-technology occupations (Edwards, 1996). General purpose computing brought about the development of new machines – analog and digital computers, to extend (not replace) human 'computers' -- rooms of individuals doing the work of calculations (Grier, 2005). While popular histories of the computer recognize its origins as a product of military finance (for instance, see the website of the Computer History Museum, computerhistory.org), the connections between the military and the development of computing systems run deeper. Edwards complicates these origin stories, by demonstrating that computers emerged from a collaborative effort of military agencies, civilian researchers, and war-time contexts. For instance, the problem of ballistics during World War II, of calculating the trajectories of artilleries in mass, required the collaborative efforts of professors at MIT and Princeton, of 'computers' or hundreds of people using desk calculators, as well as Vannevar Bush's efforts to create an administrative system to more closely link government to science. This form of materialist, critical inquiry into technoscientific production, demonstrated by Edwards and perhaps most well-known in the work of Donna Haraway[1], not only investigates how the development of computers is situated in the military-industrial complex, but it also places computing development within the larger governmental and university apparatuses – to tease out the discourses that make such endeavors possible.

The development of computing technology and the bolstering of Cold War ideologies were co-constitutive, reinforcing movements (Barnes, 2008; McHaffie, 2000). Edwards (1996) identifies two discourses in play here: *closed-world* and *cyborg* discourses. Closed-world discourse -- of modeling

[1] Haraway (1991, 1997) similarly complicates narratives about technological development by situating the moments of reliance and contingency, for example, in concepts of health and animal-testing. The developments of technoscience are not external to society. Instead, technology and society are co-constitutive constructions – fictions that necessarily make the real.

and simulating the world as a closed system with systematized communication -- and cyborg discourse -- of the integration of humans into these systems and the experiences of connection and even intimacy afforded by such integrations -- are the discourses that I suggest situate a later emergence of the handheld computer. His thorough diagramming of these discourses (of each having techniques, technologies, practices, experiences, fictions, fantasies, ideologies, language and metaphors) reinforces the collusions between these discourses in computing development (1996: p. 15, 21), and provides a method of unpacking the complexities of technoscientific production.

In addition to interrogating the constitutive histories of computing development, scholars of software studies carefully explicate the accrual of software in everyday life. Here, even the relationship between hardware and software is problematized. Generally-speaking, the need for computers to transmit and receive information lead to a systematization of computing hardware. This is what Kittler (1995) terms the "implosion of hardware" and is followed by an "explosion of software" (p. 2). Kittler argues that the distinction between software and hardware is constructed, that 'hardware' is necessarily software, and vice versa:

> *Not only no program, but no underlying microprocessor system could ever start without the rather incredible autobooting faculty of some elementary functions that, for safety's sake, are burned into silicon and thus form part of the hardware. (1995: p. 3)*

That software retains this independence from hardware in society is, for Kittler, a strange fiction. The claims of copyright and commercial property bolster this constructed distinction. Furthermore, automated programming, or the transformation of coding schemes into reusable code, enabled the creation of higher-level programming languages, and as Chun (2004) writes, enabled "one to forget the machine" (p. 30). This process of forgetting occurs through an abstraction, where the action of coding is experienced as a machinic practice, where the machine as a matrix of voltage transistors disappears into the box, where the microprocessor is just any other interchangeable, exchangeable component of the material objects of computing. Coding languages draw us away from the machine.

However, as computing becomes part of bodily performance, new relationships are forged

around software. This major break in computing development occurs in the late 1980s of Silicon Valley, where computing development began to move beyond the 'personal computer' and towards handheld and ubiquitous computing (Galloway, 2004). Galloway writes of developers at Xerox who were interested in this new form, "in 'invisible' computers that would allow [users] to focus on life beyond computational devices" (p. 385). Hardware and software further collapse in this scheme. The body is raised to the level of hardware – of the 'mechanics' that underlie the practice of computing – as that which makes mobile.

Computing-you-carry is about mobility and movement. It's about bringing the power of the computer with you, of allowing your mobile self to connect beyond the self, to leave a trace or remnant, to remain connected. As de Souza e Silva (2006) writes, the phenomena of mobile computing constitutes 'hybrid spaces' – spaces that are both physical and virtual. These spaces enable new forms of interaction with computing, including location-based services (Wilson, 2012), digiplaces (Zook and Graham, 2007), code/space (Kitchin and Dodge, 2011), and the geoweb, more broadly (Crampton, 2009; Elwood, 2010). Geographers have productively intervened in this discussion of the hybrid spaces constituted by mobile computing by exploring the spatialities that emerge from such technological development.

Indeed, digital technology begets new spaces of interaction (Crang et al., 2007; Dodge and Kitchin, 2005a, b; Graham, 2005; Thrift and French, 2002). Dodge and Kitchin (2005a) draw on the concepts of technicity and transduction (Mackenzie, 2002) to discuss the embeddedness of software in everyday life. Technicity refers to the effect of code, of its fundamental importance to "make things happen *in conjunction* with people" (Dodge and Kitchin, 2005a: p. 169, emphasis original). Transduction through code is about the reformulation of a domain (in this case, space) through the reiterations of coding effects. Graham (2005: p. 562) argues that certain applications of code serve to contribute to inequality, by separating "privileged and marginalized groups" in what he terms "software-sorted geographies". Furthermore, these spaces of interaction are not only produced

through actual coding practices, but also through technological fantasies (Crang and Graham, 2007). Through the fantastic images of new technologies and the coding practices of actually-existing techni-cities, spaces are produced in which organizations and individuals imagine new applications of possibility in the everyday.

The proliferation of spatial media over the last decade can be situated within research on the role of geospatial technologies in society, although this research rarely examines the imaginations and discourses that motivate spatial technology development (Leszczynski and Wilson, 2013; Wilson and Graham, 2013). And while the discourse of citizen empowerment figures much of research on community uses of geospatial technologies (Aberley, 1993; Corbett and Keller, 2005; Elwood, 2002; Ghose, 2001; Harris and Weiner, 1998; Leitner et al., 2000; Ramasubramanian, 1999), little research has examined how this discourse emerges from within the histories of geospatial computing development.

For instance, the growing interest by geographers to study the impacts of governmental 'neoliberalization' provided a stage in which to discuss the increasing use of geographic information systems (GIS) by non- or extra-statal organizations (Craig and Elwood, 1998; Elwood, 2004; Elwood and Leitner, 2003; Ghose, 2001). And while these '*x*-GIS' literatures (public participation GIS, participatory GIS, community GIS, qualitative GIS, etc.) do well to describe the multiplicity of contexts (Elwood and Ghose, 2004) and challenges (Elwood and Leitner, 2003) that face organizations that adopt spatial technologies, the technological assemblage itself is often absent from the discussion. This area of research -- the social history of GIS -- was part of the original NCGIA agenda and an area that O'Sullivan (2006) argues has been largely left untouched.

The writing of a social history of GIS now necessitates a broadened scope, as the ubiquity of digital media increasingly conditions geospatial technology development and use. Inquiry into the technoscientific discourses that shape the geospatial requires, I argue, a more complex understanding of the embrace of technology – the logics that constitute the technology and the desires that mediate

its use. The mobile formation of spatial knowledge (whether considered neogeographic, volunteered geographic information or simply part of an expanding geoweb) rests precisely upon these logics and desires, and requires methods of inquiry that is practiced largely outside of the traditional GISciences. In the following section, I begin a tracing of the emergence of a discourse of *continuous connectivity*, examining this discourse as it stretches out from a particular technoscientific object: the PalmPilot. I suggest that continuous connectivity, understood through this lens, has significant implications for the practice of mobile spatial knowledge and, more generally, the advancing edge of digital culture.

2.0 Situating handheld computing

> *What does the future hold for the calculator? In the midst of more powerful computers that are being built smaller and smaller, the calculator may change somewhat. Many users feel that laptops and calculators may find some middle ground. Indeed, the line between computers and calculators may be blurring already. … Sometime in the future, computers may evolve into calculators or calculators may turn into computers. (Kim, 1990: p. 62)*

The vision of a calculator-sized computer existed in the imaginations of hardware designers well into the late 1980s (Butter and Pogue, 2002; Kim, 1990). As in the above quote, miniaturization -- the "smaller and smaller" and yet "more powerful" prospect of computing -- conditions the development of handhelds. Popular discourses of computing development highlight an evolutionary imagination, that compelling use cases drive the production of new computing devices. Indeed, that our computers have become more like calculators is far from beyond our imagination. Computing is now touted as ubiquitous and pervasive, sending and receiving messages in an intricate web of hardware-as-accessory. However, as part of that process of becoming ubiquitous, there were great energies put into the size of the computer (and sacrifices in power or functionality were overcome, or re-prioritized). This concentration on the down-sizing of computing eventually enabled new form-factors and new applications for computers, and thereby, new interactions and new forms of connectivity. I argue that this distinct break in computing-development discourse emerges as device

construction shifts into the aesthetic and the affective.

The handheld computing device becomes a new generation of a specific technology, marked not specifically by closed world discourses of Cold War America, as it is not exclusively motivated by calculated inputs and outputs to produce predicted outcomes (Edwards, 1996), but by a postmodern notion of connectivity – of being 'jacked in' – a cyberspace mantra drawn out of cyborg discourse. However, while the technological outputs of this mobile computing era are entirely undetermined (or constructed so), the fantasies surrounding their development and implementation are not. Sam Kinsley (2010), for example, suggests that ubiquitous computing technologies, specifically those designed in Silicon Valley, are guided by anticipatory logics – of technologies that anticipate the states of other objects of the collective web. These visionary futures move beyond computing that you hold in your hand, or store in your pocket. Not only is it computing that you wear, but it is a system of interconnected interfaces and a milieu of *interfacing* as a cultural paradigm (Johnson, 1997).

And unlike its technological kin of the post-WWII era, handheld computing did not emerge from within a problem-to-be-solved, a science-to-be-practiced (and a nation-to-be-'saved'), but as an idea born by Silicon Valley venture capitalism and competitive entrepreneurialism, that even portable, pen-based computers could be made for consumers (Butter and Pogue, 2002: p. 8). In situating computing development, to tell the story of the handheld, I therefore add a third discourse – a discourse of *continuous connectivity* – to the discourses of the closed world and of the cyborg.

Continuous connectivity frames a different problematic in computing development. While computing development of the Cold War era was concerned with creating mathematics and machinations to construct closed systems for controlled simulation and to develop systems for effective information transmission, a discourse of continuous connectivity emerges out of the desires for new affective relationships with increasingly personalized computing. Drawing on Edwards's (1996) diagramming of computing development discourses, Table 1 below depicts the techniques, technologies, practices, experiences, fantasies, languages, and metaphors of continuous

connectivity discourse.

Table 1. The discourse of continuous connectivity, as adapted from Edwards (1996).

	Discourse of continuous connectivity
Techniques	Synchronization protocols and ergonomic, hand-based user-interface design
Technologies	Personal digital assistants, pen-based computing, handheld devices, connection cradles, Bluetooth and wireless synchronization
Practices	Practices of mobile computer usage, always-connected devices, cloud-based computing
Experiences	Experiences of bringing computing with you, your computer desktop in your pocket, accessing the server farm from your hand
Fantasies	Visions of ubiquitous computing and wearable computing, of the fantasies of the smallest, most powerful, personal computer
Languages	The language of connectivity and transferability, of devices that are globally distinct
Metaphors	"The whole world in your hand", "See the future in your hand", "Where do you want to go today?"

The *techniques* of continuous connectivity involve synchronization protocols, which allow for the mobility of workstation-based databases and documentation, and for design requirements for handheld user interfaces. These techniques were realized and supported through *technologies* like the 'craddle' for the PalmPilot and its requisite HotSync software. Pen-based interactions required software to recognize a new form of handwriting called "Graffiti" by Palm. Together these techniques and technologies are *experienced* as *practices* of mobile computer usage – of bringing the computer in your pocket – and lead to the *fantasies* of wearable, ubiquitous computing. The *languages* that permeate this discourse are the languages of connectivity and transferability, as well as the (global) positioning language of the device that is distinct in its 'signature'. "You've got the whole world in your hand", as the chorus goes and handheld enthusiasts suggest (Peraino, 1999), is the flip side of the world *knowing* your hand, no longer indistinguishable in the noise of digital culture. These *metaphors* tie together world and hand, where the hand unlocks vision towards new futures and new spaces ('see the future…' as response to 'where do you want to go today?').

The previous computing discourses articulated by Edwards (1996) are not revoked, but are reformulated. Continuous connectivity draws upon the efforts of the closed-world, to further build systems of communication that participate in a reconfiguration of time and space across the globe. Furthermore, the discourse of the cyborg is inextricably linked to continuous connectivity. The fantasies of particular human-technological interactions become realized in the handheld, creating new practices that motivate an affectual connection between self and device and other (Dourish and Bell, 2007; Turkle, 1999, 2007). It is this manifestation of a discourse of continuous connectivity that the following section takes up, to further situate the kind of excitement that handheld technologies evoke in the late-1990s, and further still, today. For as scholars of the geoweb rush to understand the new geographies of user-generated geospatial data, I argue it is these moments of the late-1990s where technologies of mobility emerge in a fantastic display of unencumbered imagination and bravado.

3.0 Computing for your hand

Practices of storytelling about technological achievements permeate our daily encounters with technology. In order to understand *why* or *how* individuals make use of mobile technologies, I suggest that there must be an analysis of the discursive regimes that condition the possibility of that technology's use. In what follows, I examine the storytelling that surrounds the personal digital assistant, or PDA, by drawing on "the inside story", the reporting, and advertisements of Palm Computing (acquired in 2010 by Hewlett-Packard), the corporation largely responsible for major strides in handheld computing development. The PDA, and specifically the PalmPilot, is arguably the first major consumer digital device that is emblematic of a discourse of continuous connectivity[2].

[2] Other important technologies left unexamined here include general advances in cellular telephones, filofaxes, paper-based personal organizers, and portable media players like the Sony Walkman of the 1980s (thanks to an anonymous reviewer). Here, I take up the synchronization capabilities of the PalmPilot as a marked shift in the discourse of computing development. This synchronization idea (of taking aspects of your personal desktop computer with you) dominates handheld computing development, I suggest, until around 2011 when Apple enabled devices like the iPhone and iPad to be autonomous -- no longer an 'accessory' of a desktop or laptop computer (Golson, 2011).

For technophiles of the late-1990s, it is a touchstone and an object that inspired *Newsweek* to report on "The Cult of the Pilot" (Kaplan et al., 1997).

The handheld computer can be read through 'technological frames' (Allen, 2004: p. 176-177), which are developed by Bijker (1995) as a way of analyzing the formation of a socio-technical group around:

> *goals for a technology; key problems to be solved by a technology; problem solving strategies; requirements to be met by solutions; and an exemplary artifact – a physical role model for what the technology should be. (Allen 2004: p. 173)*

This schema for identifying and analyzing technological development, for Allen (2004), demonstrates key groupings around personal digital assistants. He identifies four technological frames: palmtops, pen-based computing, personal communicators, and connected organizers. These technological frames are moments of stabilization around a particular technological ideal or artifact, and become for Allen a conceptual framework for analyzing *how* this stabilization occurred in the development of PDAs. Here, I examine palmtop computing as a technological frame that demonstrates a specific notion of connectivity.

3.1 Palmtop computing

Piloting Palm, a book by Andrea Butter and David Pogue, documents the history of Palm Computing, narrating the tribulations and trepidations of those developers who were architecting a distinct computing form. The chapter titles themselves demonstrate the perception of the authors (one of which was an executive at Palm during its early years) that this corporation viewed their work as chartering new territories in computing development, including: *In the Valley of Dreams*, *The Zen of Palm*, *Crossing the Desert*, *The Fight for Independence*, *Sea Change*, and *Uncharted Waters*. This history narrates the evolving technological passions of Jeff Hawkins, the founder of Palm Computing credited with the major developments in handhelds: his earliest interests in the human brain, his early employment at GRiD computing, and his eventual success in the industry of handheld devices and the software

that makes them run.

Butter and Pogue (2002) trace Hawkins throughout the earliest years of Palm, including the years leading up to the creation of the company. Hawkins's work at GRiD Systems, a computer company in the San Francisco Bay area, extended his earlier studies on the human brain at University of California at Berkeley. Hawkins oversaw the development of the GRiDPad, which was released in 1989. This was a pen-based computer, and Hawkins wrote the software that recognized handwriting. By 1991, the GRiDPad was the only commercially 'available' pen-based computer (at $2,500 each), and nearly $100 million dollars had been poured into pen-based computing start-ups.

However, the GRiDPad was too big, too heavy (at 4.5 pounds), and too expensive for Hawkins vision of a mini computer that everyone could own. His thinking was somewhere under $1,000 per unit and small enough to conveniently fit it in your hand. His decision to break away from GRiD Systems, with rights to the handwriting recognition software, would mark the beginning of a company forged on the venture capitalism of Silicon Valley. Calculators formed the comparison in his vision for the ubiquity of handheld computing. Documented by Butter and Pogue, Hawkins wrote in his overview of the technology targeted at potential investors in 1991:

> *Palmtop computing devices will be as ubiquitous as calculators by the end of the decade… (Butter and Pogue 2002: p. 9)*

Butter and Pogue highlight Hawkins's vision of a consumer handheld computer. The calculator was the closest device to that consumer model. However, in addition to this excitement about 'consumer-available' computing, there was also anticipation about the form-factor of the device, and, more specifically, a vision that these devices should be held in one hand – something that simply was not possible with the GRiDPad. In February of 1992, Hawkins kicked off the development of a device called the Zoomer (after con*sumer*), with four companies present: Tandy, GeoWorks, Casio, and the newly-named Palm Computing.

The notion of pen-based computing was spreading; John Sculley, then CEO of Apple Computer, had just announced that something he termed a *personal digital assistant* would be a $3.5

trillion market. Hawkins and his small team at Palm believed that the Zoomer was the device for that market. However, a few months later in May of 1992, Apple announced with a glitzy PR campaign, the Newton – a device that could recognize handwriting, including cursive handwriting. In response, Casio, a partner of Palm, put impossible deadlines on the team, and required that the software for the Zoomer had to be burned permanently into the device's ROM, which made updated software releases impossible. Additionally, GeoWorks, the partner responsible for developing the operating system of the Zoomer, had never worked with 'electronic ink', or pen-based computing systems. Disaster seemed ever-present for Palm and for pen-based computing. By 1994, the Newton had proved a failure, and according to Butter and Pogue (2002), had poisoned the market for handheld computing. The Zoomer emerged without much fanfare, and Casio opted to stall development of the Zoomer II.

However, handheld devices would *train* their users to write in particular ways that the computer could understand. Recognizing this, Hawkins returned to software, and Palm Computing attempted to write code that could make other handheld devices like the Newton work better. Two pieces of software, according to Butter and Pogue, charted a new future for the company: PalmConnect and Graffiti. Graffiti signaled a change in handheld computing development. These devices needed their own shorthand – a sophisticated way of communicating with the handheld computer that was not about handwriting, and more about glyphs, or symbology. Instead of attempting to decipher various handwriting styles, Graffiti was a new alphabet.

PalmConnect changed the discourse about handheld development. It was no longer about providing consumers with mini-computers. Instead, it was about *accessorizing* the computers they already owned. PalmConnect allowed consumers with computers to bring data with them – to extend their computer's desktop. With this focus on software, Palm set to engineer a new handheld device, without the help of their partners at Casio. Butter and Pogue cite a confidential document that circulated amongst the engineers:

> *Palm envisions a product that is smaller than today's PDAs or even most of today's electronic organizers. The device target design would be shirt pocket-sized… Code name for the product is Touchdown. It is a direct extension, it could be even called an accessory, to your desktop PC… (Butter and Pogue 2002: p. 80-81)*

By 1995, Palm had realized the design vision of Hawkins. The device would retail for under $300 and had a more simplified user interface. By making a device that was "shirt pocket-sized" as an "accessory" to a desktop computer, the user could be both connected to their information and be mobile: continuous connectivity.

The discourse of *continuous connectivity* enrolls the body as an extension of the computing experience. As developers sought to fit computing technologies to the hand (to reach the form factor of a shirt-pocket-sized computer), software solutions were designed to make sense for the hand. The very name of the visionary company in the field of handheld computing, Palm Computing, was chosen to evoke the body – to be of the hand – and in doing so constituted a new way of thinking about computing. Bodily enhancement through handheld technologies meant new ways of producing local knowledges and new ways of interacting with these knowledges. The concept of the handheld as a computing accessory – an accessory of your body – lends a notion of connectivity to this discourse of mobility, that while you are 'over there', moving around, you are always also 'here', interfacing with your desktop computer. As an aspect of a discourse of mobility, connectivity linked up these moving bodily technologies to the computer, linking the pocket to the desktop. Mastering the design of these devices involved a mastering of bodily appendage. The result was a biopolitical computing. It was "the whole world in your hand", your "life in a box", as one *Wired* writer penned, on his relationship with his handheld computer (Peraino, 1999).

In the wake of the PalmPilot announcement in 1996 and its associated Palm software for synchronization and data entry, both the popular media and (to a lesser extent) the information and computational sciences documented how the opposition between connectivity and mobility collapses. Considered an infrastructural problem in computing, mobility was materially -- and, importantly, discursively -- reformulated. The discourse of continuous connectivity is one result of this

reformulation (others include, of course, the rush of speculative capital and the reorganization of the computing industry). Journalists reported that the PalmPilot "does not try to compete with a PC but complement it" (Orlowski, 1996, n.p.) and was an 'accessory' (Bliss, 1997; Davey, 1997; Ortiz, 1996; Smith, 1997; Sweeney, 1997). This impacted the perceived function and utility of the device: that a well-designed palmtop like the PalmPilot was one "that moves information back and forth from the desktop, not one that creates information" (Slatalla, 1997, n.p.). Microsoft palmtops took a different approach, and the press generally reported the distinction; the *New York Times* hammered on: "Stop trying to replace the personal computer and instead create a PC extension" (Slatalla, 1997, n.p.). This was felt as a sea-change in computing. Eric Benhamou, president of 3Com (then, the company that owned the PalmPilot), stated, "it gives you the feeling of being connected" (Newman, 1997, n.p.). Indeed, this was bigger than new form factors for computing hardware; it was about life lived as always-connected. At the close of 1997, the following excerpt from a report underlines the sentiments surrounding these devices:

> *Is that a Palm Pilot in your pocket?*
> *From digital phones that send e-mail and faxes to little electronic organizers that allow you to write notes to yourself in airports, you'll be equipped with a device that makes you feel in control of your life, even if you aren't. Now, for most things, you'll be able to leave that laptop at home. (Wilson, 1997, n.p.)*

In just over a year, palmtop computing industries (with PalmPilot unarguably occupying center stage) shifted computing squarely into the affective, to "feel in control of your life" (above).

While computer and information scientists also examined emerging handheld computing devices (understandably with greater delays than popular media), the topics of study were more about the infrastructural demands created by the eager expansion of this consumer electronic sector. Scholars discussed disconnection realities, security and privacy risks, power consumption, (Ahson and Mahgoub, 1998) and limited radio frequency bandwidth (Chlamtac and Redi, 1998; Hartwig et al., 2000) amid a growing interest in wireless networking (Woo et al., 1998; Zimmerman, 1999). They documented the need for more and better sensors to capture a device's context such as location and movement (Schmidt et al., 1999; Van Laerhoven and Cakmakci, 2000), while examining the various

cognitive implications for handheld device interfaces (Tseng et al., 1998). The uncertainty of the industry (Allen, 1998) despite the proliferation of consumer predictions (Allen, 1999) likely aggravated these more technical issues as well as those of interoperability and an increasingly unwieldy set of mobile standards (Press, 1999).

New devices and software, like the marvels of Apple's Siri product (software on a mobile device that interacts through voice-commands) reported now, often capture our attention in ways that appear completely ahistorical. However, the storytelling that surrounded Palm Computing should cause some pause, to recognize that bright and shiny objects that demand 'new' forms of interaction are predicated on previous successes and failures in technological development. In this sense, Palm Computing "locks in" (to draw on Lanier, 2011) a specific notion of mobile connectivity by the late-1990s: society *should* place value on the ability to move about with unprecedented access to exteriorized knowledge. In the next section, I share one aspect of this moment of technological futurism and fetish, snapping photos of *Wired* magazine advertisements that define the contours of these developments, specifically as they are invested in the body.

3.2 Marketing the hand

The advertisements of handheld devices in the late-1990s illustrate this discourse of continuous connectivity, particularly as it invokes the body. The issues of *Wired* during this time period, from 1997 through 1999, depict the computing industry's reinvention of mobile consumer electronics (see Figures 1 through 6), reflecting a reconfiguration of the affectual dimensions of computing development: how the devices feel, look, move, and enable. They constitute new textures of human-computer-human interaction, and mark a terrain of competition among mobile technology developers. Indeed, as I flip the pages of these advertisements, I am reminded of the ill-defined frontier of technology development, of the costly innovations which failed, and the naive understandings of users (and user diversity). As is commonly heard among popular technology

commentators, many of these devices were simply 'ahead of their time', and yet the time-spaces that they produced is astonishing.

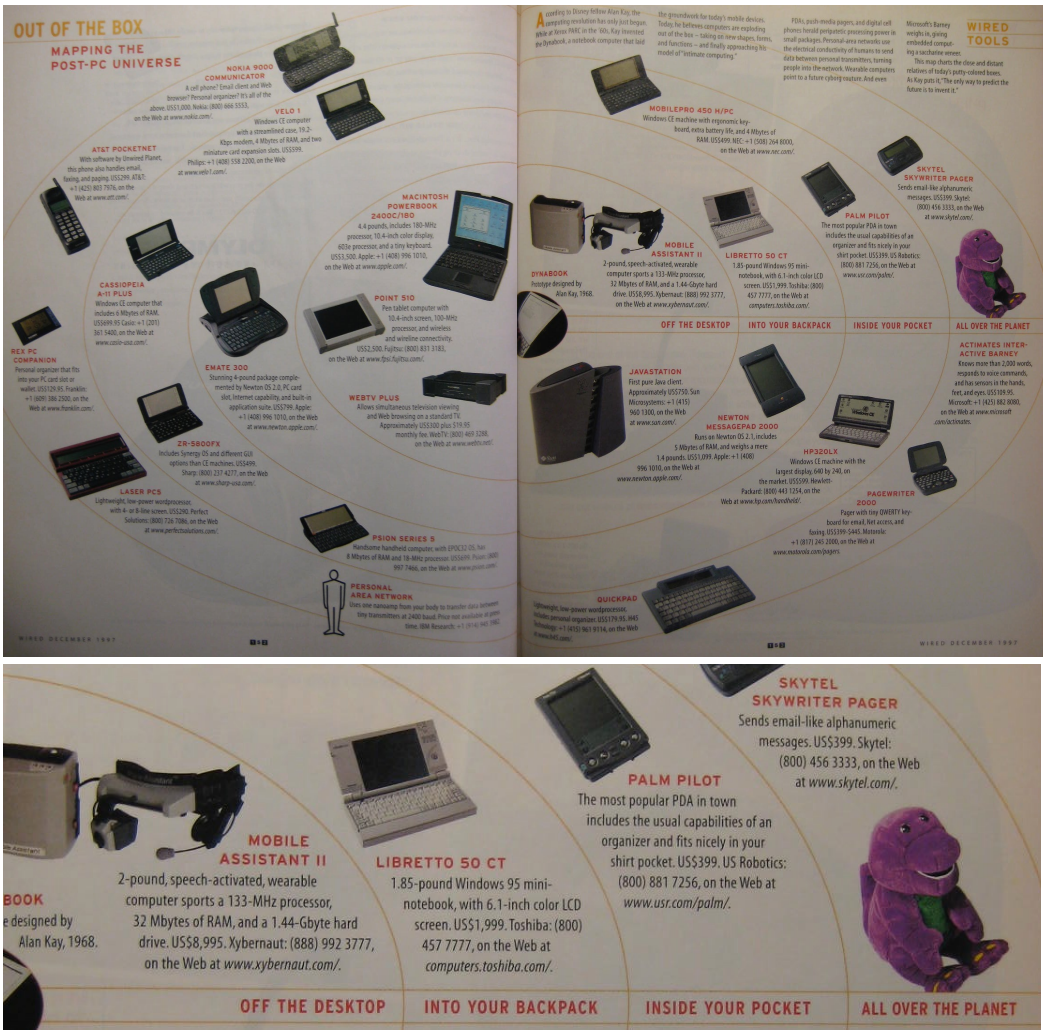

Figure 1. In a special feature of Wired in December of 1997, the 'post-pc' universe is mapped in a concentric rings. Moving out from the center the feature depicts the 'mobility' of technology at that time, from the desktop, to the backpack, to the pocket, to "all over the planet". The PalmPilot (inset) is conspicuous as the only pocket-based computer that doesn't operate as a clam-shell.

In 1997, *Wired* announced the 'post-pc' era (see Figure 1). The Pilot (as it was originally called, before a pen company's cease-and-desist order) had only been a product for about 18 months. The pages of *Wired* document a range of products that provide a backdrop for this era. 56 Kilobytes per second modems were just being introduced by US Robotics. AirWalk sneakers and Furbies were trending. Microsoft had introduced the 'Natural' Keyboard, an ergonomic input device. Apple had

just announced their 'Think Different' campaign, with Steve Jobs back in command. Sony introduced the Digital Versatile Disc, or DVD, followed shortly by the Playstation. Y2K was on the horizon. Norelco developed the first electric razor that dispensed lotion. The Pentium III was being hyped. Desktop computers were clocking in at just over 300Mhz and Star Wars fans were getting glimpses of the digitally-mastered Episode 1: The Phantom Menace.

Computing and consumer electronics were being marketed as reflections of the self: the *personal* computer. Advertisements epitomize the unrolling of continuous connectivity for palmtop computing; here, I highlight five aspects: (1) the importance of perceived use, (2) the traveling of tasks, (3) the creation of mobile knowledge, (4) the personalization of the product, (5) and bodily invocation and extension.

First, many handheld devices had real usability problems, particularly the Windows CE devices which were found to require too many steps to complete simple tasks (Butter and Pogue 2002). Indeed, the imaginations for the use of these devices extend a fantastic notion of interaction that was largely not realizable. The advertisement for the Newton MessagePad 2000 (Figure 2) confronts the tension between mobility and usage, touting "the only handheld computer you can actually use". The perceived use of these handheld devices, produced by marketing materials, was that the user could practice their *usual* work while on the device, with "crisp backlighting", better management of power consumption, screen size that allows you to "read the entire width of a fax", "record and take notes simultaneously", with a "real detachable keyboard (not a tiny, finger-cramping version)" (Figure 2). Perceived use is produced through these advertisements as competitors attempt to define the terms of effective and productive, continuous connectivity.

Figure 2. Apple announces the Newton MessagePad 2000, "the only handheld computer you can actually use", in this advertisement from Wired in May of 1997.

Second, the corporate struggle over the perceived use of handheld devices often targeted the ability for certain tasks to travel. As I discussed earlier, the PalmPilot (Figure 3) was considered

particularly successful by the popular media in this regard. In order for tasks to travel, Palm created synchronization software for the maintenance of connection to a centralized computer (i.e. the desktop computer). 3Com's slogan for the PalmPilot in this advertisement -- "The connected organizer" -- reiterates a continuous connectivity discourse for the purpose of illustrating a higher degree of travel. In contrast to the Newton advertisement with a keyboard resting upon an empty workspace, the Pilot advertisement captures the frenzy of everyday life in the street of a global city. "8 a.m. Bob's number in Milan. You got it." The rhythm of encounter in a world of commerce is expressed in the moving design of the text that mirrors the traffic jam in the photo. Instead of reproducing the stationary work of a desktop computer, PalmPilot elevates those tasks that demand continuous connectivity: "Whatever's important to you -- appointments, contacts, e-mail, expense tracking -- the pocket-sized PalmPilot™ connected organizer makes it easy to stay on top of things."

Third, the discourse of continuous connectivity necessitates knowledge made mobile. Portable data storage systems for consumers were just barely crossing the gigabyte threshold. For instance, the digital camera created by Sony (announced in late 1997, see Figure 4), used 3.5-inch floppy disks for storage, emphasizing the speed and ease of capturing mobile data. Relatedly, the advertisements for the Newton (Figure 2) and the PalmPilot (Figure 3) highlight the importance of capturing information and accessing information *in situ* as the expression of a mobile computing elite. As handheld digital devices further develop, this capacity for mobile knowledge becomes the axis around which later innovations in hardware and software turn, more specifically impacting the work of participatory mapping and volunteered geographic information, and forming the foundation of the geoweb. These consumer affectations within a discourse of continuous connectivity are entangled in current digital culture.

Figure 3. This 1997 magazine advertisement for the PalmPilot imagines the technology that allows the user to access their information anywhere, whenever: confidently, "You got it.".

Figure 4. Sony announces the Digital Mavica, a digital camera that uses the 3.5" floppy disk for storage, in this Wired advertisement in September of 1997.

Fourth, mobile technologies were advertised as devices that produced the self, putting into tension the concept of a 'personal computer' (or PC) which generally indicated desktop computing. Palmtops mark a shift in the computing industry as devices like the PalmPilot are marketed as ever more personal -- a personal digital assistant. Of course, PCs could not be carried on a person. However, Figure 5 depicts an attempt to maintain this notion of the personal in personal computing, demonstrating a conditioning of consumer electronics: the personal sells. Here, a personal computer advertised by Compaq seems to dominate the entire desk. By current standards for computing footprints, it is hard not to feel overwhelmed by this image. However, Compaq attempts to showcase the personal aspect of this machine, by having your cup of coffee, favorite desk lamp, natural lighting, and a houseplant -- items nearly pushed off the desk.

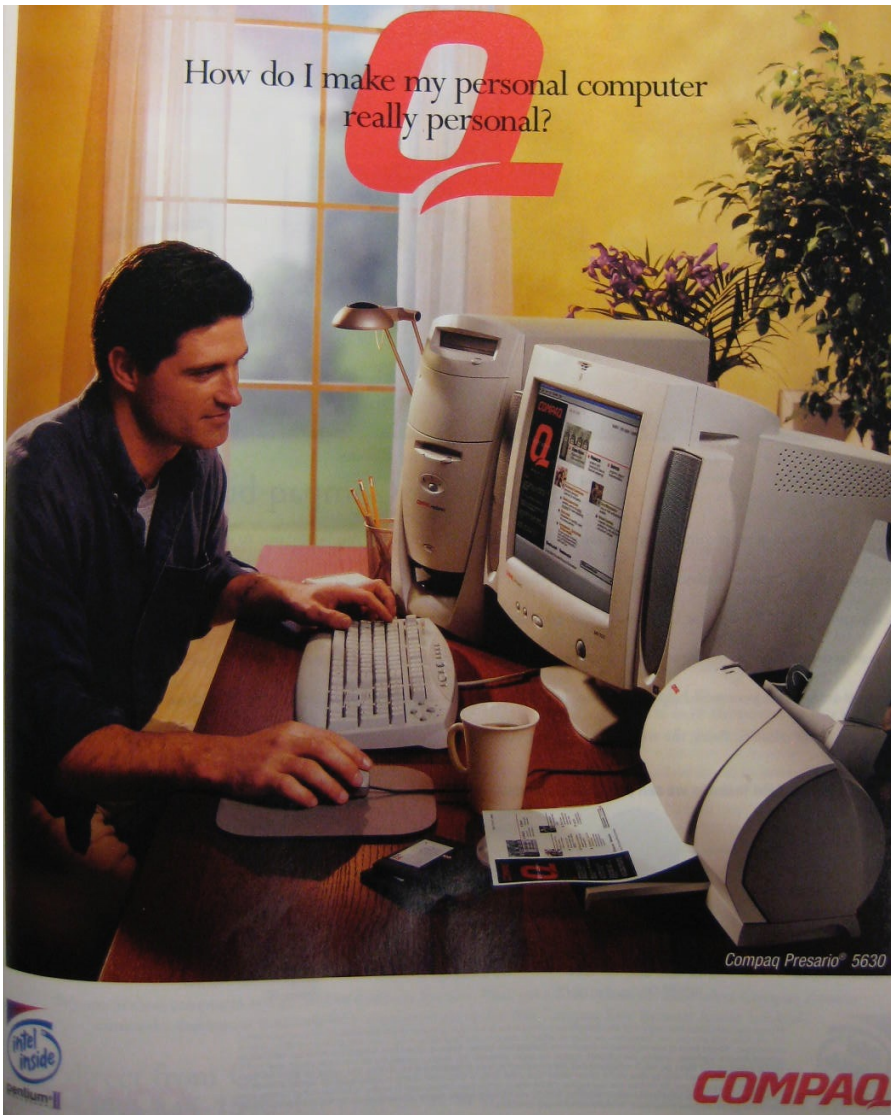

Figure 5. In this Wired advertisement in November of 1998, the concept of 'personalized' computing is instructive. For Compaq, the image of computing at home, with the cup of coffee, house plants, and natural-lighting situation softens the computer and its assorted peripherals.

Fifth, the imagery of the hand becomes iterative, reappearing in other handheld advertisements by Palm, Microsoft, and later, Handspring. Handheld technologies were being marketed as bodily technologies, as technologies that act as an extension of the body. In a move that garnered much public attention, 3Com's ad campaign for the Palm V, "Simply Palm", epitomizes this invocation of the body. In Figure 6, we see the flip sides of a page in *Wired* in 1999. On one side, the picture of a faceless, nude female body holding the handheld device emphasizes the simplicity of the technology, paralleling the minimalist and simplistic form of the presented nude, white female body.

On the reverse of the magazine page, the placement of the Palm V covers her rear. This presentation of the female form uses the slippery slope of soft-core imagery to entice a market of (male, heterosexual) handheld enthusiasts[3]. The subtleties of the 1999 advertisement are productive of the drumbeat of continuous connectivity, while a quite different setting than the advertisement of 1997 (Figure 3). The earlier advertisement placed the user in the frenetic environment of the global city street with the device in hand providing an essential toolset for a business elite ("Bob's number in Milan. You got it."); however, in Figure 6 the user's everyday life (scheduling meetings, classes, therapy, "dinner w/Mark", making shopping lists to purchase "leg warmers" and reading the news) is presented through technological mediation of her body. "Simply Palm" indicates this everydayness, as effortless as breathing.

The discourse of continuous connectivity is an embodied one, as it sutures technology to bodied form. In order for bodies to be mobile, technologies must be mobile, and in order to move, handheld technologies need a body – a hand to hold them. The product's footprint and the device's marketing both mimic the design of the user interface. A connectivity that was once stationary is now mobile. Mobility and connectivity, traditionally opposed, come together in the handheld device. The marketing of these devices emphasize this discourse of continuous connectivity as that which conditions their perceived use and the range of tasks that are supported, determines the types of mobile knowledge that are accessed and created, and produces the self through personalization and invocation of the body. As such, handheld computing enables the data-rich environment that dominates current discussions of technology, where individuals serve as conduits for the production and consumption of mobile spatial knowledge.

[3] Following this advertisement, a series of parodies emerged titled "Simply Porn", created by Jason Kottke, who was attempting to critique the advertising campaign as blatantly using images to sell devices (Quistgaard, 1999).

Figure 6. Palm Computing, then owned by 3Com, announces their "Simply Palm" ad campaign with this advertisement in Wired (April of 1999). These two advertisements are on the reverse of each other, giving the illusion of complete visibility of the female body.

4.0 Conclusions

> *"I'm Clarence, a 4G Hotspot." (Wortham, 2012, n.p.)*

Being continuously connected through handheld devices encounters certain limits. A vast literature narrates these limits as largely (infra)structural, and documents a digital divide to illustrate the material geographies of technological capacity (Graham, 2011). These limits are also technocultural. Being disconnected has taken on new value, just as being continuously connected is the object of existential angst. BBH Labs, the agency that turned Clarence and 12 other volunteers into a 'homeless hotspot' in Austin, Texas, decided to discontinue their efforts to build out this sociotechnical solution to the dual problems of unrealized labor value and of connectivity deserts.

While being continuously connected through a 'homeless hotspot' was considered by many users a step too far in computing, other spaces of persistent disconnectivity such as airplane passenger cabins may soon be spaces where users can reconnect during take-off and landing (Bilton, 2013).

This prevalent discourse of continuous connectivity is not simply a social commentary on media proliferation (although, see Gleick, 2011; Lanier, 2010). Instead, I have argued here that continuous connectivity was constituted by the computing industry to condition new styles of interaction. And its current expression takes on many forms: in advertisements for consumer electronics, in pedagogical studies of cognitive development, in popular media on the changing cultures of interaction, in the political ecologies of device construction and disposal, etc. Indeed, there are many implications, deeply material and discursive, for the rise of continuous connectivity through handheld computing.

By insisting on these multiple discursive-materialities which permeate the use of mobile technologies, I intend to disrupt more popular narrations of information technology use that lean toward the 'new' and tend toward the ahistorical, by examining the development stories and marketing conditions of handheld computing. Continuous connectivity draws in the narratives of the history of computing, the embodiment of the technology, and its fantastic imaginations of use. This discourse creates a space where work around mobile spatial knowledge happens. Of course, this is not the only discourse that conditions and operates through mobile device development and use. Other discourses and more-than-visual forces bear on our current relationships with handheld technologies (c.f. Ash, 2010; Paterson, 2006).

But as the GISciences rush to interrogate and extend the possibilities for spatial analysis and representation that come with the proliferation of handheld devices (manifested in research areas like volunteered geographic information, neogeography, and the geoweb), what is needed is a deeper tracing of their conditions. The frameworks that support mobile knowledge are bolstered by a pervasive digital culture wherein metadata (or informational context) determines the range of

affective possibilities: 'I am here, not there; my knowledge is likewise.' This is to say that mobile knowledge is geographically sorted, and further that the affective capacity for mobile knowledge is already conditioned by consumer electronics (their innovations, marketing, and attempts to shift the field of interaction, prevalence in certain communities, by specific populations, etc.). Therefore, I suggest a renewed commitment to the GIS & Society agenda to centrally place inquiry into the conditions of technological development, as these impact a society increasingly hungry for compelling geospatial data. Mobile knowledge is predicated on a hyper-mediated everyday life -- where continuous connectivity structures interactions, from research and development to the production and marketing of handheld devices, from the congealment of venture capital to the presumed normalcy of life always connected.

References

Aberley D, 1993 *Boundaries of home: Mapping for local empowerment* (New Society Publishers, Gabriola Island, B.C.)

Ahson S A, Mahgoub I, 1998, "Research issues in mobile computing" *Performance, Computing and Communications 1998 IEEE* 209-215

Allen J P, 1998, "Who Shapes the Future? Problem Framings and the Development of Handheld Computers" *Computers and Society* 3-8

Allen J P, 1999, "Handheld Computing Predictions: What Went Wrong?", in *Handheld and Ubiquitous Computing*, Springer pp 117-123

Allen J P, 2004, "Redefining the network: enrollment strategies in the PDA industry" *Information Technology & People* **17** 171-185

Ash J, 2010, "Architectures of affect: anticipating and manipulating the event in processes of videogame design and testing" *Environment and Planning D: Society and Space* **28** 653-671

Barnes T J, 2008, "Geography's underworld: The military-industrial complex, mathematical modelling and the quantitative revolution" *Geoforum* **39** 3-16

Bijker W E, 1995 *Of bicycles, bakelites, and bulbs : toward a theory of sociotechnical change* (MIT Press, Cambridge, Mass.)

Bilton N, 2013, "Disruptions: F.A.A. May Loosen Curbs on Fliers' Use of Electronics" *The New York Times*, 24 March

Bliss J, 1997, "Resellers Wary: Smaller units may find niche, but problems remain -- Giving a hand to handhelds" *Computer Reseller News*, 30 June

Butter A, Pogue D, 2002 *Piloting Palm : the inside story of Palm, Handspring, and the birth of the billion-dollar handheld industry* (John Wiley & Sons, New York)

Chlamtac I, Redi J, 1998, "Mobile Computing: Challenges and Potential", in *Encyclopedia of Computer Science* (International Thomson Publishing)

Chun W H K, 2004, "On software, or the persisence of visual knowledge" *Grey Room* **18** 26-51

Corbett J M, Keller C P, 2005, "An Analytical Framework to Examine Empowerment Associated with Participatory Geographic Information Systems (PGIS)" *Cartographica* **40** 91-102

Craig W J, Elwood S A, 1998, "How and Why Community Groups Use Maps and Geographic Information" *Cartography and Geographic Information Systems* **25** 95

Crampton J W, 2009, "Cartography: maps 2.0" *Progress in Human Geography* **33** 91-100

Crang M, Crosbie T, Graham S, 2007, "Technology, time-space, and the remediation of neighborhood life" *Environment and Planning A* **39** 2405-2422

Crang M, Graham S, 2007, "Sentient Cities: Ambient intelligence and the politics of urban space" *Information, Communication & Society* **10** 789-817

Davey T, 1997, "Faster, Smarter, Smaller" *Information Week*, 3 November, pages 125-126

de Souza e Silva A, 2006, "From Cyber to Hybrid: Mobile Technologies as Interfaces of Hybrid Spaces" *Space & Culture* **9** 261-278

Dodge M, Kitchin R, 2005a, "Code and the Transduction of Space" *Annals of the Association of American Geographers* **95** 162-180

Dodge M, Kitchin R, 2005b, "Codes of life: identification codes and the machine-readable world" *Environment and Planning D: Society and Space* **23** 851-881

Dourish P, Bell G, 2007, "The infrastructure of experience and the experience of infrastructure: meaning and structure in everyday encounters with space" *Environment and Planning B: Planning and Design* **34** 414-430

Edwards P N, 1996 *The closed world : computers and the politics of discourse in Cold War America* (MIT Press, Cambridge, Mass.)

Elwood S A, 2002, "GIS use in community planning: a multidimensional analysis of empowerment" *Environment and Planning A* **34** 905-922

Elwood S A, 2004, "Partnerships and participation: Reconfiguring urban governance in different state contexts" *Urban Geography* **25** 755-770

Elwood S A, 2010, "Geographic information science: emerging research on the societal implications of the geospatial web" *Progress in Human Geography* **34** 349-357

Elwood S A, Ghose R, 2004, "PPGIS in Community Development Planning: Framing the Organizational Context" *Cartographica* **38** 19-33

Elwood S A, Leitner H, 2003, "GIS and spatial knowledge production for neighborhood revitalizaiton: negotiating state priorities and neighborhood values" *Journal of Urban Affairs* **25** 139

Galloway A, 2004, "Intimations of everyday life: ubiquitous computing and the city" *Cultural Studies* **18** 384-408

Ghose R, 2001, "Use of Information Technology for Community Empowerment: Transforming Geographic Information Systems into Community Information Systems" *Transactions in GIS* **5** 141-163

Gleick J, 2011 *The information : a history, a theory, a flood* (Vintage Books, New York)

Graham M, 2011, "Time machines and virtual portals: the spatialities of the digital divide" *Progress in Development Studies* **11** 211-227

Graham S, 2005, "Software-sorted geographies" *Progress in Human Geography* **29** 562-580

Grier D A, 2005 *When computers were human* (Princeton University Press, Princeton)

Haraway D J, 1997 *Modest_Witness@Second_Millennium. FemaleMan©_Meets_OncoMouse™: feminism and technoscience* (Routledge, New York)

Harris T M, Weiner D, 1998, "Empowerment, Marginalization, and "Community-integrated" GIS" *Cartography and Geographic Information Systems* **25** 67

Hartwig S, Lück M, Aaltonen J, Serafat R, Theimer W, 2000, "Mobile Multimedia: Challenges and Opportunities" *Transactions on Consumer Electronics, IEEE* 1167-1178

Johnson S, 1997 *Interface culture : how new technology transforms the way we create and communicate* (HarperEdge, [San Francisco])

Kaplan D A, Hafner K, Croal N g, Gajilan A T, 1997, "The Cult of the Pilot" *Newsweek*, 21 July, page 47

Kim I, 1990, "Handheld Calculators: Functions at the Fingertips" *Mechanical Engineering* **112** 56-62

Kinsley S, 2010, "Representing 'things to come': feeling the visions of future technologies" *Environment and Planning A* **42** 2771-2790

Kitchin R, Dodge M, 2011 *Code/space : software and everyday life* (MIT Press, Cambridge, Mass.)

Kittler F, 1995, "There is No Software" *CTheory* **a032**

Lanier J, 2010 *You are not a gadget : a manifesto* (Alfred A. Knopf, New York)

Lanier J, 2011 *You are not a gadget : a manifesto* (Vintage Books, New York)

Leitner H, Elwood S A, Sheppard E, McMaster S, McMaster R B, 2000, "Modes of GIS Provision and their Appropriateness for Neighborhood Organizations: Examples from Minneapolis and St. Paul Minnesota" *URISA Journal* **12** 43-56

Leszczynski A, Wilson M W, 2013, "Theorizing the geoweb" *GeoJournal*

Mackenzie A, 2002 *Transductions : bodies and machines at speed* (Continuum, London ; New York)

McHaffie P H, 1997, "Decoding the globe: globalism, advertising, and corporate practice" *Environment and Planning D: Society and Space* **15** 73-86

McHaffie P H, 2000, "Surfaces: tacit knowledge, formal language, and metaphor at the Harvard Lab for Computer Graphics and Spatial Analysis" *International Journal of Geographical Information Science* **14** 755-773

Newman M, 1997, "As PCs shrink, the hype grows; Computers of the future will be portable, powerful" *Pittsburg Post-Gazette*, 19 November, pages E-1

O'Sullivan D, 2006, "Geographical information science: critical GIS" *Progress in Human Geography* **30** 783-791

Orlowski A, 1996, "Pilot is a digital delight" *Mail on Sunday*, 15 September, page 35

Ortiz C, 1996, "Microsoft Launches Windows 'Lite' For Smaller Computing Devices" *Associated Press*, 18 November

Paterson M, 2006, "Feel the presence: technologies of touch and distance" *Environment and Planning D: Society and Space* **24** 691-708

Peraino V, 1999, "The Whole World in Your Hand" *Wired*, April

Press L, 1999, "The Post-PC Era" *Communications of the ACM* **42** 21-24

Ramasubramanian L, 1999, "Nurturing community empowerment: Participatory decision making and community based problem solving using GIS", in *Geographic Information Research: Trans-Atlantic Perspectives* Eds M Craglia, H Onsrud (Taylor & Francis, London) pp 87-102

Roberts S, Schein R H, 1995, "Earth Shattering: Global Imagery and GIS", in *Ground Truth: The Social Implications of Geographic Information Systems* Ed J Pickles (Guilford, New York) pp 171-195

Schmidt A, Beigl M, Gellersen H-W, 1999, "There is more to context than location" *Computers & Graphics* **23** 893-901

Slatalla M, 1997, "Take a personal computer. Shrink it. Add a Windows operating system. Now what?" *The New York Times*, 16 June, page 6

Smith N, 1992, "History and philosophy of geography: real wars, theory wars" *Progress in Human Geography* **16** 257-271

Smith P, 1997, "Wealth of knowledge in palm of your hand" *The Scotsman*, October 1, page 13

Sweeney D, 1997, "Bringing Wireless Data Into Focus" *WirelessWorld*, April

Thrift N, French S, 2002, "The automatic production of space" *Transactions of the IBG* **27** 309-335

Tseng H-M, Tiplady B, Macleod H A, Wright P, 1998, "Computer anxiety: A comparison of pen-based personal digital assistants, conventional computer and paper assessment of mood and performance" *British Journal of Psychology* **89** 599-610

Turkle S, 1999, "Cyberspace and Identity" *Contemporary Sociology* **28** 643-648

Turkle S, 2007 *Evocative objects : things we think with* (MIT Press, Cambridge, Mass.)

Van Laerhoven K, Cakmakci O, 2000, "Waht shall we teach our pants?", in *The Fourth International Symposium on Wearable Computers, IEEE* pp 77-83

Wilson M W, 2012, "Location-based services, conspicuous mobility, and the location-aware future" *Geoforum* **43** 1266-1275

Wilson M W, Graham M, 2013, "Situating Neogeography" *Environment and Planning A* **45** 3-9

Wilson P, 1997, "1998: What's In The Cards: Dealing yourself into 1998 may mean using a wireless modem, censoring software, a palm pilot, all on a new-style laptop that will look just like everyone else's because its a clone." *The Vancouver Sun*, 31 December, page D10

Woo T Y C, Sabnani K K, Miller S C, 1998, "Providing Internet services to mobile phones: A case study with email", in *The Ninth IEEE International Symposium on Personal, Indoor and Mobile Radio Communications* pp 99-105

Wortham J, 2012, "Use of Homeless as Internet Hot Spots Backfires on Marketer" *The New York Times*, 12 March

Zimmerman T G, 1999, "Wireless networked digital devices: A new paradigm for computing and communication" *IBG Systems Journal* **38** 566-574

Zook M A, Graham M, 2007, "The creative reconstruction of the Internet: Google and the privatization of cyberspace and DigiPlace" *Geoforum* **38** 1322-1343