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SENTIENT CITIES Ambient intelligence and the politics of urban space

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Mike Crang & Stephen Graham

SENTIENT CITIES
Ambient intelligence and the politics of urban space

Increasing amounts of information processing capacity are embedded in the environment around us. The informational landscape is both a repository of data and also increasingly communicates and processes information. No longer confined to desk tops, computers have become both mobile and also disassembled. Many everyday objects now embed computer processing power, while others are activated by passing sensors, transponders and processors. The distributed processing in the world around us is often claimed to be a pervasive or ubiquitous computing environment: a world of ambient intelligence, happening around us on the periphery of our awareness, where our environment is not a passive backdrop but an active agent in organizing daily lives. The spaces around us are now being continually forged and reforged in informational and communicative processes. It is a world where we not only think of cities but cities think of us, where the environment reflexively monitors our behaviour. This paper suggests that we need to unpack the embedded politics of this process. It outlines the three key emerging dynamics in terms of environments that learn and possess anticipation and memory, the efficacy of technological mythologies and the politics of visibility. To examine the assumptions and implications behind this the paper explores three contrasting forms of 'sentient' urban environments. The first addresses market-led visions of customized consumer worlds. The second explores military plans for profiling and targeting. Finally, the third looks at artistic endeavours to re-enchant and contest the urban informational landscape of urban sentience. Each, we suggest, shows a powerful dynamic of the environment tracking, predicting and recalling usage.

Keywords Ubiquitous computing; ambient intelligence; embedded politics; consumers; military targeting; urban art; tracking; geotagging

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Introduction

The 1990s have been characterized as the decade of the virtual (Manovich 2006). Information and communication studies were preoccupied with notions of a dematerialization and refiguration of identity. A great deal of both utopian and dystopian writing focused upon the alleged transcendence or loss of physicality and its replacement with new spaces and fora online (Graham 2004). It has become a well-established critique to point out that, far from forming an even and seamless electronic realm, there is a structure and geography to informational worlds. Thus, much writing has pointed to the persistence of divides in infrastructure and capacity, indeed the concentration of capacities and capitalization on location in new technology clusters and developments both in terms of connectivity (see for example Zook 2002) and social milieu that if anything become more vital for media knowledge workers (see for example Pratt 2002). Confining informational space to some 'global space of flows' that is 'out there', as Castells' (1996) influential work does, also has stark limits, in part because it implies an equation of the human with the near and local, the slow and the small (Thrift 2004a, p. 54). This seems problematic when these transnational flows are actually deeply embedded in ways that mean that many 'urban residents begin to experience the 'local' as a type of microenvironment with global span' (Sassen 2006, p. 23). The relationship and effect on place of accelerated mobile information is thus dialectical.

This paper attempts to outline some of the possibilities which open up when the city becomes a haze of software as much as a constellation of bricks and mortar (Amin & Thrift 2002). It asks what happens to places and people in networked environments where small informational devices and data are brought together – repeatedly, in real-time, and automatically, through systems that sink into the urban background? Instead of a story of the substitution of electronic media for physical encounter, then, we want to build an account of the permeation of the daily environment with communication technologies in 'a space in which the public is reconfigured by a multitude of media and communication networks interwoven into the social and political functions of space to form a "hybrid space"' (Kluitenberg 2006, p. 8).

In this paper we particularly want to explore some of the political implications of the embedding of computing into the background environments of cities. We also want to pay attention to the wider imaginaries that surround this process. Our focus is on pervasive or ubiquitous computing ('ubicomp'). Building on previous work that looks at the informational overcoding of environments, usually via geodemographic data, in complex and recursive fashions (see for example Burrows & Ellison 2004; Burrows & Gane 2006; Parker *et al.* this issue), we suggest that the interaction of data and processing

produces new patterns of identification and stratification in place. The identification and locating of people becomes a key issue. Far from the identity play celebrated for online environments, hybrid spaces enable visibility.

De Certeau described consumer society as being 'characterized by a cancerous growth of vision, measuring everything by its ability to show or be shown ... a sort of epic of the eye and the impulse to read' (1984, p. xxi). He identified the transformation of the uncertainties of history into readable spaces (1984, p. 36) through the placing of people and the creation of a localizable object. De Certeau saw social control and knowledge operating, like geodemographic information, by immobilizing society into a transparent text (1984, p. 94). His nightmare city was one of perfect knowledge and transparency where terror is no longer about the shadows but 'an implacable light that produces this urban text without obscurities, which is created by a technocratic power everywhere and which puts the city-dweller under control (under the control of what? No one knows)' (1984, p. 103). De Certeau's response was a celebration of opacity provided by social practices like walking. For him, consumers move in a system 'too vast to be able to fix them in one place, but too constraining for them to ever be able to escape from it' so instead the city is 'the scene of Brownian movements of invisible and innumerable tactics' (1984, pp. 40–41). People's lives escape the dictates of official knowledge where inverting the schema of the Panopticon 'haunted places are the only habitable places' (1984, p. 108). These realms create gaps and lacunae in the gaze of knowledge.

The discussion that follows suggests that these openings founded on the fluidity and transience of practices, the opacities of mobility and the hidden geographies of memory are now being rendered visible. The politics of visibility, then, emerges both in making the technologies visible to us and in how we are made visible to them. These technologies allow spaces to both remember and anticipate our lives. We examine how both the practices of consumption and the haunting memories that make places habitable might be rendered visible. In this, though, we play upon both the production of transparency and also its mythology – what de Certeau would call the erotics of knowledge or fantasies of vision.

In what follows we explore three key contemporary domains within which the reconfiguration of cities and their politics are being actively imagined and enacted through the imagination and deployment of ubiquitous computing (or 'ubicomp'). This is going on, we suggest, through the production and dissemination of technological fantasies, the more practical processes of technological development, and the actual deployment of, and contestation over, operational ubicomp systems. These three vignettes address: commercial fantasies of 'friction-free' urban consumption; military and security industry attempts to mobilize ubiquitous computing for the 'war on terror'; and attempts by artists to interrupt fantasies of perfect urban control through

artistic use of new ubicomp technologies to try and re-enchant urban space and urban life. In order to understand the effects it is necessary first to clarify the conceptual and analytical challenges raised by the shift to urban worlds which are continually ordered, animated and brought into being by interlinked computerised systems, which blend seamlessly into the urban background.

Promises and dreams of ubiquitous computing

Urban ubiquitous computing systems entwine people, place and software in complex ways. Software and algorithms code people, places and their data in interrelated systems that are then used to profile and drive decision-making systems. This raises a key question: What happens when the processing and not just the data is embedded in the everyday environment?

The rising concern with the embedding of software in the environment marks a notable shift from much critical writing of the 1990s that focused upon the screen sometimes as a space in its own right, but more often as a barrier or impediment to encountering the world (Friedberg 1993; Graham 2005). Instead, debate has moved 'toward embedding information technology into the ambient social complexities of the physical world' (McCullough 2004, p. ix). In a world of ubiquitous computing, lingering assumptions about processing being conducted in offices and in discrete artefacts called computers obscure rapidly developing processes. Already, less than a quarter of 'chips produced by Intel are destined for desk-top computers' (McCullough 2004, p. 5) and for many young Japanese the permanent networked capacity of DoCoMo *ketai* (i-mode standard cell phones) is their first, and most common, way of being 'online' (de Souza e Silva 2006, p. 263).

To clarify some of the dimensions that concern us here, it is useful to outline a typology of the multiple ways in which urban environments might become animated through ubiquitous computing systems hidden in the background of the city. We would point to three distinct but related approaches here.

Augmenting space

A first approach points out that the built environment has been saturated with information for centuries – from signage to adverts. The overlaying of new electronic media, however, produces a less stable topography that is both uneven and in ceaseless flux (Kluitenberg 2006, p. 8). The oft-heralded version of this is 'augmented reality' which attempts to 'overlay physical objects with virtual objects in real-time and allows people to experience the virtual as if it were real' (Galloway 2004, p. 390) and has generally aimed to allow the user to 'see the "real" world with overlaid graphical data' (de Souza e Silva 2006, p. 264).

The significant shift with 'augmented space' is overlaying physical space with *dynamically* changing information, multimedia in form and localized for each user where the data form an always connected, pervasive environment rather than necessarily appearing in our field of vision (Manovich 2006, p. 220). The novelty is the real-time alteration of the data, the convergence of different forms of access and its personalization. The screen is mobilized and goes travelling, becoming embedded in our environment rather than separating us from it. The term augmentation reflects media adding to our experiential world not taking it over (p. 225) and speaks a language of enhancement and new capacities, alongside a sensible recognition of incremental rather than epochal changes.

Enacting space

The vision of augmented spaces tends to produce a sense of superimposed but reactive environments – the emphasis is on the users' activity. So for a different, second, emphasis we might turn to Dana Cuff's depiction of enacted spaces composing 'Cyburgs', which are 'spatially embodied computing, or an environment saturated with computing capability. It is the imminent stage of digital media that places computation in all things around us, from our own skin and bodies (biotechnology and nanotech medication), to our clothing, to our cars, our streets, our homes, and our wildernesses' (Cuff 2003, p. 44).

In enacted space, the computer moves to inhabit the most ordinary of things to produce an 'enacted environment' which is more than an enhancement of our capacities, it relocates agency into the world:

> Our own agency is enhanced by the cyburg, for we can know and act in more powerful ways. Complementing our empowerment is the newly enacted environment. Not only do the walls have ears, but networks of eyes, brains, and data banks to use for purposeful action. Although we are reluctant to attribute agency to objects in our surroundings, it is a stance that won't survive long.
>
> (Cuff 2003, p. 44)

Transducting space

This all suggests that we need to think through the technological agency of ubiquitous computing more carefully. And here our third strand of approaches may help. Leaning on the work of Simonden and others it focuses on capacities such as technicity (the productive power of technology to make things happen) and transduction (the constant making anew of a domain in reiterative and transformative practices) (Dodge & Kitchin 2005, p. 162). This moves perhaps to a

more functional and instrumental understanding of technologies – or rather to see that they are most often used for these ends. This study focuses upon the 'coding' of people, places and objects – that is processes of identification and then the layering and cross-referring of these identifications through software algorithms. These studies focus upon how codes offer modes of address – both locating and hailing people and things. Thrift goes so far as to suggest this, building on many existing technologies, forms a 'technological unconscious' through 'the bending of bodies-with-environments to a specific set of addresses without the benefit of any cognitive inputs, a prepersonal substrate of guaranteed correlations, assured encounters, and therefore unconsidered anticipations' (Thrift 2004b, p. 177).

In terms of how this enables action, Dodge and Kitchin (2004, p. 198) distinguish 'coded space', where information is inscribed digitally that enhances the functioning of a particular environment, and 'code/space', where information and space are so fused that the space cannot function without the information and there is no uncoded, manual alternative. In part the enhanced 'technicity' these environments offer comes down to coded objects being networked through more codes and these enabling coded processes to organize new forms of action (transduction) (Dodge & Kitchin 2005). Coding is about making places happen – not in specific or discrete moments but continually. This means seeing that 'spaces depend upon the gradual construction of complex ethologies of bodies and objects, which are repositories of the 'correct' positionings and juxtapositionings that allow things to arrive and become known ... the modest but constant hum of connection and interconnection that they make possible' (Thrift 2004b, p. 175). This is an ontogenetic understanding of space which sees it as continually being brought into existence through everyday transductive practices (Dodge & Kitchin 2005, p. 162). Technologies are everyday events which involve spatialization, temporalization and embodiment simultaneously (Galloway 2004, pp. 404–405).

With these perspectives established we can now turn to our three explorations of key areas of urban ubiquitous computing: fantasies of 'friction free' urban consumption; dreams of securitized urban omniscience surrounding the 'war on terror'; and the efforts of artists to imagine very different dynamics of urban ubiquitous computing.

Fantasies of friction-free consumption

Locating consumers

The fantasy of active and learning spaces has long been touted in terms of the possibility for a customized consumer paradise where goods can be found on

demand – or, even better, before we realized we needed them. A variety of technologies build up profiles of preferences 'memorizing' our actions in places. Past patterns of purchase no longer need to be manually 'bookmarked' but form self-generated 'favourites' lists of goods regularly purchased (for instance in online supermarkets) and from thence it is but a short step to the lists of 'suggestions' compiled from those preferences (as in Amazon or many e-tailers). If online stores can remember their visitors, the possibilities of tags and coding mean 'real' stores and locations might also do so. In that sense spaces begin to have both a memory and anticipation of uses. Thus a shop might recognize a customer and produce a customized list of favourite or usual services or alert a specific member of staff. It is in effect 'projecting the interactive model of cyberspace back into physical space. The metaphor of cyberspace has, in other words, come full circle' (Andrejevic 2003, p. 134). First, spatial databases allow the selection of services based on location or proximity criteria. Second, mobile media offer the possibility of centring such searches on the current location of the user. Geolocation technologies offer the possibility of devices automatically knowing where they are (receiving locative data) or saying where they are (transmitting it) or both. Location starts to organize the interaction.

Searching tailored to location has been hailed as the 'killer app' for mobile network devices enabling a 'data-driven mass customization based on continuous, real-time monitoring of consumers' (Andrejevic 2003, p. 133). Except it has been hailed so often that it might make one wary of why it has not yet caught on (Sweeting 2005). There are technical issues in learning and responding to the preferences of consumers – just imagine the awful moment of Microsoft's office assistant ('Hi! You appear to be writing a letter...') loosed upon the planet ('Hi! You appear to be near our shop...') (McCullough 2004, p. 15). Equally, while mobile phones may carve the city up into 'cellspace' (Manovich 2006), these vary in size and signal triangulation is complex allowing only rough approximations for location, and, while satellite positioning systems are becoming common, they are by no means universal in either reception or embedding in devices. More crucially, the commercial logics of who would provide spatially referenced data on providers, who would provide it about users, who would make devices produce these data and who would work out the middleware to translate all these codings and who would profit from this have so far stymied many attempts. The technology exists, though it is not seamless, but the business model or operation is less solid.

The promises though are large and better than just finding a shoe shop when and where you need one. We might look at the possibilities for traffic organization and car pooling schemes. While organizations such as Zipcar have a distributed pool of cars, where you can look up a car by type, location and period available and rent it, trip sharing is yet more difficult

to organize. So far larger scale initiatives have often been thwarted by the lack of trust among large groups of unacquainted users and the complexities of coordinating large numbers of movements between different starting and end points at different times via different routes, with varying traffic conditions, subject to changes of demand at short notice. So most commercial providers work by either restricting the routes and set-down and pick-up points (the 'bus solution') or demanding advanced planning. However geolocation technology and geosensors offer the possibility of changing this. Rather than a vast central database, an augmented informational landscape would continually provide data on the location and direction of vehicles that could be picked up and sorted by those with receivers wishing to travel. Distributed sensors and computing would make it a collaborative task through ad hoc automated peer-to-peer communication (Winter & Nittel 2006). It offers the prospect of something like an electronic thumb for the twenty-first century. Of course, this in some ways offers a mythic technical fix since it does not build trust in other users in and of itself. Registering users and allowing drivers to decide what sort of people they will pick up might entail another coding and sorting of people.

Tracking objects through the world

These locative technologies are also crucial in the production of bricks'n'clicks assemblages of electronic and material provision in an augmented retail landscape. Corporations rely on connecting demands through to supply chains and, as supply chains lengthen and increase in complexity, the smooth flow of goods in response to demand has become a key issue for global capital. In this climate we can see the rise of technologies such as the Radio Frequency Identification (RFID) chip. The various types of this device can be attached to just about anything and used to record or code its identity. More expensive variants allow these data to be modified to record the handling and processing of an object, and while the majority are 'passive' devices and wait until a reader comes within a few metres, some others are powered and actively broadcast information. For large corporations and logistical companies 'RFID is a dream come true; a dream of controllability, transparency and efficiency as regards the worldwide tracing of goods' (Kluitenbrouwer 2006, p. 51).

If we take the RFID chips that allow recording, these create objects with memories, or indeed become SPIMES that are wholly trackable through their lives (Beer 2007), networked 'blogjects' that may be connected up and called forth to compose a 'life log' (Dodge & Kitchin 2007). Bleecker's (2006) notion of the 'blogject' is an artefact that develops data through tracing its use or movement. In this he takes forward the notion of the 'Internet of Things' from 'a nascent conceptual framework for understanding how

physical objects, once networked and imbued with informatic capabilities, will occupy space and occupy themselves in a world in which things were once quite passive' to one that sees things as fully agentive players (Bleecker 2006, pp. 1–2). Blogjects move from being artefacts coded with data, through those periodically connected to wider systems by users (such as in-vehicle maintenance logs), those that communicate themselves among a limited system without user intervention (such as in car computerized control systems) and finally to rhizomic blogjects (such as a Blackberry) that can only function in a network as they use and store data off site.

Such devices mean pervasive environments may produce seamless data trails across a number of devices. We have a combination of

> technologies [that] constitute 'history-enriched' digital objects that can produce autobiographical traces some of which objects are supplemented with profiling programmes that adapt them to personal preferences (eg, automatic interface customisation, predictive texting on mobile phones, etc) and thus learn or build in anticipation as well as memory. These automated forms of datalogging and personalization are being complemented by technologies for the conscious self-creation and public sharing of these personal materials, for example, through blogging and webcams.
>
> (Dodge & Kitchin 2007, p. 434)

They build skeletal memories of our practices and lives. There are then clearly issues of who accesses and controls this assemblage of data. Indeed, the issue would seem to be not one of blanket privacy but control over interchange of information where people want the benefits of tailored products but to do this by selecting which information is given to and received from whom (Kluitenbrouwer 2006).

Illustrations of how they work might be the trial Developed Area Information service in the Roppongi Hills complex in Tokyo, where with '*Mite Toru Click*' billboards are enabled via RFID chips to be clicked upon by a DoCoMo mobile phone to log the product, outlets and receive information. It boasts the '*Buratto Catch*' system where users are emailed information about areas they enter, tailored in light of their past preference. More widely '*uh Town*' pedestals in front of stores enable shoppers to log the location for future reference – a development from the QR system in Japan where camera phones read barcodes. A project echoing this in the West is the Windows Mobile application AURA launched in December 2006. The acronym stands for Advanced User Resource Annotation and it aims to 'connect shoppers on the go to a world of information about products' (MS press release). It depends upon objects being 'coded', in this case with a bar code. With an AURA-enabled device, you use a digital camera to snap the

bar code on a product, which it will relate to the database held by Microsoft and will return links and search results about the item to the handheld device. Initially this could be as simple as an on-the-go product price comparison service but Microsoft hopes everyday users will eventually augment the information AURA delivers by posting reviews and other details about things they buy or own. Microsoft's in-house anthropologist Marc Smith suggests AURA offers 'a little taste of what the future will be like when you can walk up to any device and interrogate it and annotate it' (Smith 2006).

Conversely, in this world objects you cannot code become mute and people invisible. Already a scheme named ThingLink (Kluitenbrouwer 2006, pp. 55–56) aims to help handicraft producers to give any object a digital reference on an online database to make them visible to Google and other e-commerce portals. In other words, things which are not coded start to become literally dumb. And among those uncoded things may well be people. 'From the perspective of these emergent forms of ambient intelligence, unwired humans will come across as singularly unintelligent, non-conversant and incomprehensible' (Andrejevic 2005, p. 103). Indeed, the overall logic of this 'm-commerce' might be said to be about delegated agency and moving agency away from people – creating not heightened frenetic communication but new forms of passivity (Andrejevic 2005, p. 101). Distributed processors will increasingly recall our lives, the traces of our movement and use that to anticipate what we might later do. However, this seems in some ways like a mythic world that has been heralded before and where previous attempts have had very low uptake – something Microsoft argues was because of inadequate technology when people were not regularly carrying portable devices with the processing power, wireless connectivity and cameras to make such a service feasible and easy. In both these senses, the desire to track people and the mythology of a complete vision, we want to suggest there are striking parallels with recent plans and developments in the militarization of urban space.

A 'New Manhattan Project'? Ambient intelligence and the 'war on terror'

> The time has come to change the perception that the high-tech US war machine fights at a disadvantage in urban areas.
>
> (Houlgate 2004)

A second key theme in discussions about the reconfiguration of urban spaces through ubiquitous computing centres on imperatives of securitization. In particular, the imagination, development and deployment of myriads of new sensing and surveillance systems in city spaces are at the heart of

efforts within the so-called 'war on terror' to both securitize Western or 'homeland' cities and to counter insurgencies within war-zone cities in the colonized frontiers of the global South. In both domains, the key dynamic centres on attempts at rendering complex urban flows and structures permanently transparent to tracking and surveillance systems. In military jargon, cities and the complex infrastructure grids within and between them are now deemed to be the central 'battlespaces' in which terrorists and insurgents are largely indistinguishable from the wider urban background and thus cannot be easily identified, tracked, or targeted.

'Identity dominance' in 'asymmetric warfare'

The key to this new type of conflict, which profoundly embeds the new 'battlespaces' in urban civilian life, is to mobilize ambient intelligence. Embedded in cities and urban infrastructures, to provide the 'battlespace awareness' necessary to identify, track and target lurking insurgents, terrorists and other 'targets', and so provide Western forces with what John Woodward, of RAND's Intelligence Policy Centre, calls 'Identity dominance' (McCue 2005).

Thus, military, defence and surveillance industries are offering ambient technologies such as RFID tags, algorithmic video cameras, data mining and biometrics as means to unveil the logistical, transactional and geographical movements of the human and non-human 'targets' of the war on terror. Prototype pervasive processors called 'Smart dust' were released in 2001, they were powered by solar energy and able to communicate about the environment they found themselves in, from San Francisco to Berkeley even if, at 7 mm in length, they were not (yet) wind blown as intended (McCullough 2004, p. 73). This is being done in a context where the complexity, density, dynamism and scale of urban centres are widely deemed by US defence analysts to undermine the high-technology advantages of Western state militaries. The new military focus is on informal, non-state terrorists and insurgents who blend into the background of the cities, city networks, and urban infrastructure systems they both choose as the bases for their actions, and exploit in their targeting operations.

An excellent example of the ways in which ambient intelligence technologies are being portrayed as central mechanisms through which to wage the 'war on terror' comes from a major report published by the Pentagon's Defense Science Board (DSB) in December 2004. One of many attempting to draw early military lessons from the urban insurgency in Iraq, this report was startling for one reason. It deliberately called for what it termed a 'New Manhattan Project', invoking the code-name famously used in the 1940s to describe the massive programme which developed the first atom bombs used to devastate Hiroshima and Nagasaki in May 1945

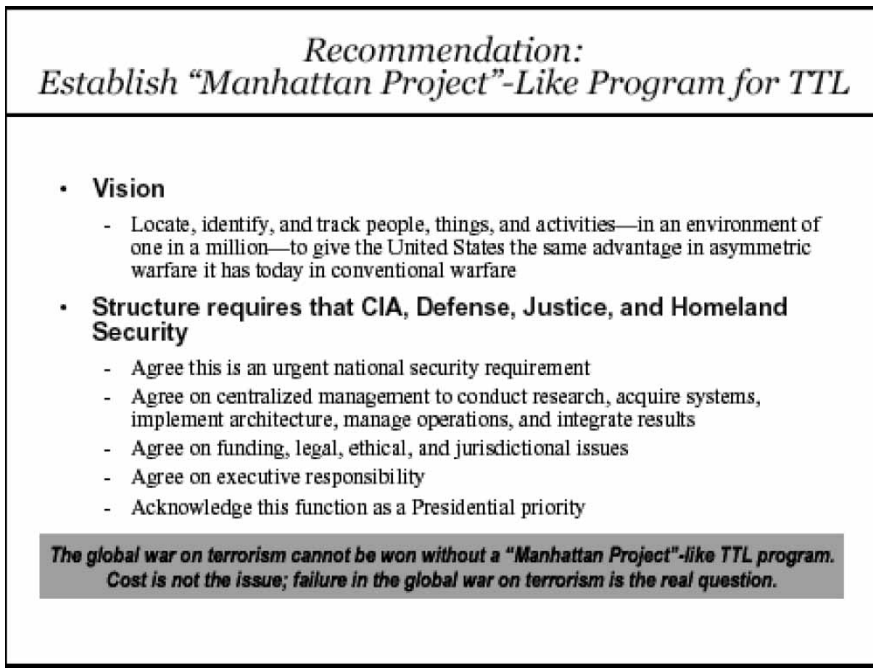

FIGURE 1 The US Defense Science Board's call for a New Manhattan Project based on Ambient Intelligence for 'Tracking, Targeting and Locating' (TTL) (DSB 2004, p. 189).

(Figure 1). It urged a similar concentration of military resources on what the Board saw as the key strategic priority for the twenty-first century: the technological unveiling of cities and urban life. Specifically, it saw possibilities to exploit ubiquitous computing technologies in developing a massive, integrated system of surveillance, spanning the world, and tailored specifically to penetrating the increasing complexity of urban life. Such a system, it argued, would once again render the US military's targets trackable, locatable – and destroyable. The purpose of the New 'Manhattan project', then, was seen to be to 'locate, identify, and track, people, things and activities – in an environment of one in a million – to give the United States the same advantages in asymmetric warfare [as] it has today in conventional warfare' (DSB 2004, p. 163). Strategically, the ideas of the report have been cemented as one of eight principle development areas into the New Pentagon strategy for a 'Long War issued in 2005'.

The United States' hegemonic capabilities for surveillance over the earth from the distant, vertical domains of air and space were deemed by the DSB to have 'poor capability for finding, identifying and tracking' what it calls 'unconventional war targets' (DSB 2004, p. 153) such as 'individuals and insurgent or terrorists groups that operate by blending in with the larger

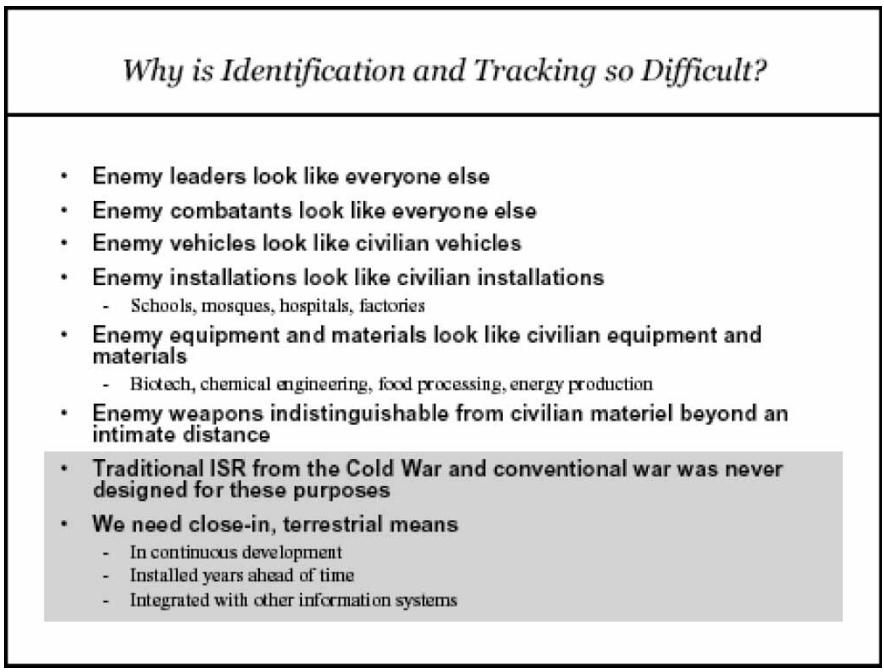

FIGURE 2 The Defense Science Board's diagnosis of the way in which US 'targets' in the 'war on terror' blend seamlessly into wider, civilian life in cities (DSB 2004, p. 180).

society' (Figure 2). Crucially, intimate and persistent military surveillance systems were needed which penetrated the details of everyday urban life. As the report put it, little less than a comprehensive rescaling of military imaginations of surveillance was needed and 'more intimate, terrestrial, 21st century ISR [Intelligence, surveillance and reconnaissance] were required' (DSB 2004, p. 2). The gaze of hegemonic military power, the report argued, thus needed to colonize not just the planetary scales of surveillance; it also needed to penetrate the fine-grained and local geographies of urban and infrastructural 'battlespaces'. Such a transformation was imagined to be profoundly temporal as well as geographical. 'The surveillance of people, things and activities required to populate the databases needed for identification, location and tracking', the authors write, 'will require a persistence beyond that typical of many of today's' military and security surveillance systems. These new surveillance systems, profoundly local and global at the same time, will, in other words, need to be 'always on'. This will allow them, through 'evidence-correlating and backtracking algorithms' (DSB 2004, p. 159) to call upon memories, via databases recording the history of movements and associations of things, activities and people, and anticipate,

so that threatening and 'abnormal' behaviours and emergences can be detected and dealt with before the point of terrorist or insurgent attack.

The new 'Close-in, terrestrial means' of surveillance, intelligence and targeting centre on the 'data mining' and tracking techniques familiar from the commercial aspirations. To achieve this, biometric sensors will need to verify and code people's identities, as they flow through national or other borders, through finger/palm prints; iris scans; DNA; face recognition; voice recognition; even odour and gait recognition (Figure 3). (The DSB report favours combinations of iris and fingerprint scans, combined with face recognition, as 'offering a reasonably effective compromise among speed, accuracy, ease of implementation and cost' (DSB 2004, p. 159)). A wide range of technologies deploying algorithmic calculation, tracking and data mining are being deployed to reconfigure passport systems, borders, even public transport transactions, based on the biometric tracking of identities. All of these centre on combinations of data mining, risk-profiling, attempts at pre-empting risk, and identifying purported 'targets

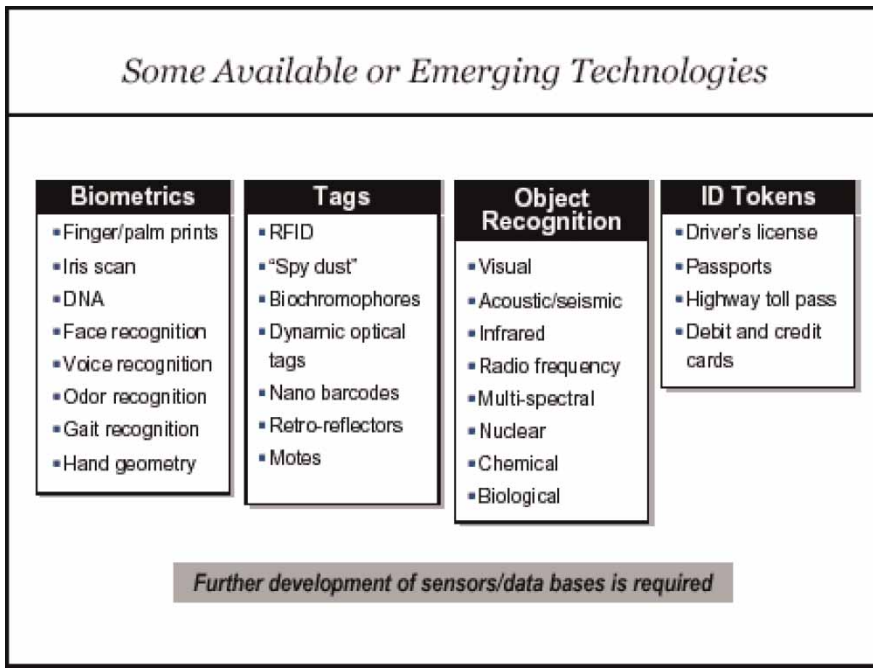

FIGURE 3 The US Defense Science Board's 2004 Assessment of the possible ubiquitous computing, ambient, biometric and surveillance technologies which might be exploited for new 'Tracking, Targeting and Locating' system geared to the global 'War on terror' (DSB 2004, p. 184).

of interest' through what Louise Amoore has called 'war-like architectures of self/other' (Amoore 2007, p. 1). They will also connect objects and itineraries into blogjects, storing data on who comes into contact with what and when. On the ground, biometric means of bordering, population control and incarceration have been widely employed in Iraq, notably in the city of Fallujah (where all remaining residents have been given ID cards embedding both fingerprints and retina scans which must be used to pass through fences and checkpoints encircling the town). Meanwhile, new projects titled 'Transparent Urban Structures' and the 'Visibuilding' programme have been funded which seek to build sensors that automatically penetrate the built fabric of cities.

'Combat zones that see': the politics of anticipatory seeing

A particularly interesting project embracing the ideas of the DSB report is the tellingly titled 'Combat Zones That See' (CTS) project set up by the US Defense Advanced Research Projects Agency (DARPA). Launched at the start of the Iraq insurgency in 2003, CTS 'explores concepts, develops algorithms, and delivers systems for utilising large numbers (1000s) of algorithmic video cameras to provide the close-in sensing demanded for military operations in urban terrain' (DARPA 2003, p. 4). Through installing computerized CCTV across whole occupied cities, the project organisers envisage that, when deployed, CTS will sustain 'motion-pattern analysis across whole city scales', linked to the tracking of massive populations of individualized cars and people through intelligent computer algorithms linked to the recognition of number plates and scanned in human facial photos to provide 'close-in, continuous, always-on support for military operations in urban terrain' (DARPA 2003, p. 6).

The work of the DSB is just one example of a vast complex of research and development driven by the apparent inability of Western militaries and police security agencies to actually identify, track and locate their 'targets' within a globalizing and urbanizing 'battlespace' where any simple separation of the home city from the hostile one breaks down. Crucial to these emerging surveillance systems is a radically new politics of anticipatory seeing. For the overarching feature of the new, militarized, surveillance push, whether its 'targets' are located in Manhattan and Baghdad, London and Fallujah, is an attempt to build systems of technological vision in which computer code itself is, along with databases of real or imaged 'targets', delegated with the agency of tracking and identifying 'abnormal' 'targets' from the background 'normality' of a homeland or war-zone city. Crucial here is the adaptation of the commercial practices of 'data mining' or 'predictive analytics' where algorithms are developed to look for patterns in the swathes of captured data, identify or profile behaviours or characteristics deemed to be 'unusual' or 'abnormal', and search for 'target' people, transactions or flows deemed to have such characteristics (see McCue 2005; Pruett 2005).

Jordan Crandall suggests that 'tracking is integral' to emerging modes of governance and military power based on 'anticipatory seeing' (1999). The key question now, he suggests, is 'how targets are identified and distinguished from non-targets' within 'decision making and killing' (1999). Identifying such targets becomes the role of statistical algorithms which sift the mass and flux of registered and sensed data searching for (what Mark Seltzer has termed) 'statistical persons'. Most important here is that all potential 'targets' must be incorporated into databases in the first place. Indeed, the existence of a signature in a database increasingly defines citizenship in this new age: 'frequently . . . there is no person who exists outside of the database' (Crandall 1999).

To Crandall, this widespread integration of computerized tracking with databases of 'targets' represents little but 'a gradual colonization of the now, a now always slightly ahead of itself' (Crandall 1999). This shift represents a process of profound militarization because the social identification of people within civilian law enforcement is complemented or even replaced by the 'machinic' seeing of 'targets'. 'While civilian images are embedded in processes of identification based on reflection', writes Crandall, 'militarised perspectives collapse identification processes into "Id-ing" – one-way channel of identification in which a conduit, a database, and a body are aligned and calibrated' (Crandall 1999). Again, this is central to the relationship between the application of identical surveillance systems in both homeland and war zone securitization. Crandall suggest that the new capacity of anticipatory seeing involves a kind of 'armed vision' where the capabilities of vision are 'upgraded and made safe against an unprocessed exteriority, a dangerous and unreliable outside' (Crandall 1999).

Technophiliac imaginings: perfect power

As is common in the development of new US military capabilities, technophiliac fantasy plays a major role in discourses surrounding new ambient technology projects. Invariably, these portray perfect technological omniscience against the new challenges of asymmetric warfare as ushering in a new world of 'clean' war overcoming the Clauswitzian fog and friction of war. Crucially, after the horrors of the streets of Iraq, US personnel are removed from the increasingly automated and cyborgian projection of perfect power into the metropolitan spaces which hide America's new enemies.

In 2004 *Defense Watch* magazine, for example, developed one scenario in response to the news about the 'Combat Zones That See' programme discussed above. 'Several large fans are stationed outside the city limits of an urban target that our [*sic*] guys need to take', they begin:

> Upon appropriate signal, what appears like a dust cloud emanates from each fan. The cloud is blown into town where it quickly dissipates.

> After a few minutes of processing by laptop-size processors, a squadron of small, disposable aircraft ascends over the city. The little drones dive into selected areas determined by the initial analysis of data transmitted by the fan-propelled swarm. Where they disperse their nano-payloads.

'After this, the processors get even more busy', continues the scenario:

> Within minutes the mobile tactical center have a detailed visual and audio picture of every street and building in the entire city. Every hostile [person] has been identified and located. From this point on, nobody in the city moves without the full and complete knowledge of the mobile tactical center. As blind spots are discovered, they can quickly be covered by additional dispersal of more nano-devices. Unmanned air and ground vehicles can now be vectored directly to selected targets to take them out, one by one. Those enemy combatants clever enough to evade actually being taken out by the unmanned units can then be captured or killed by human elements who are guided directly to their locations, with full and complete knowledge of their individual fortifications and defenses. . . . When the dust settles on competitive bidding for BAA 03-15 [the code number for the 'Combat Zones That See' programme], and after the first prototypes are delivered several years from now, our guys are in for a mind-boggling treat at the expense of the bad guys
>
> (2004, *sic*)

Art and activism: re-enchanting and reanimating the city?

Amid these commercial and military dreams there are increasingly widespread calls – and this is our third area – to try to realize and reclaim the potentials of augmented spaces through art and activism. Explicit calls have been made to both use these technologies to create an oppositional vision of urban space and simultaneously to render visible the systems of knowledge production that are increasingly rendering our lives transparent. 'The new hybrid space also calls for new forms of public action. These can only be created and facilitated if the users of hybrid space learn to see the influence of relatively invisible digital structures and appropriate their technology where possible for alternative use' (Kraan 2006, p. 39). In this section, then, we want to outline some critical praxis and interventions that have aimed in various ways to challenge or subvert (some aspects of) the dominant commercial and military visions.

In this we want to point to the attempts to both foster social contact but also to focus upon the sorts of spaces created and envisioned. We want to highlight that the places created involve less of the 'anticipation' of action

than the inscription of memory. This is connected to enabling specific new social performances. We want to take these through three overlapping registers. The first take the data coding of the environment and seek to make it transparent and/or aesthetically problematic. The second are those that seek to re-enchant the environment through multi-authored overcodings. That is they take augmented space but seek to pluralize the authorship. The third are those that seek to foster new engagements with the environment by promoting new practices of direct contact and association. In this sense both the last two draw on the notions of social networking and collaboration through dispersed and networked devices, taking virtual community out of the wires and onto the streets.

Art, transparency and augmented environments

There are some deliberate attempts to counter some of the hegemonic practices we have laid out in the preceding sections. Thus the New York based Preemptive media project aimed to challenge the tracking of products with its intervention 'Zapped!'. This entailed fitting hissing cockroaches with RFID tags and then releasing them in Walmart. The effect was to pollute and corrupt databases as the creatures broadcast digital 'noise' as they moved though the store (Kluitenbrouwer 2006, p. 54). The associations of dirt and pollution carried over to digital pollution are a direct challenge to the visions of sanitized and transparent corporate spaces. However, our interest is less with direct challenges than the many interventions that together form an alternative animation of the environment.

More projects work on the augmented environment now around us to render it visible, as in the Intelligent Street that monitored pedestrian activity levels and used these to produce a responding ambient sound reflecting the bustle of the street. Others employ the embedded technology of bio-surveillance. Christian Nold, for instance, sees Bio Mapping (http://www.biomapping.net/) as about enabling individuals to make use of gathered information about their own bodies. Instead of security technologies that are designed to control and watch over our behaviour, his work envisages new tools that allow people to selectively share and interpret their own bio data. By sharing these data we can construct maps that visualize where we as a community feel stressed and excited. Thus in both Greenwich Emotion Map (October 2005–April 2006 http://www.emotionmap.net/) and San Francisco Emotion Map (March 2007–April 2007, SoEx gallery) projects, local residents borrow a 'bio mapping' device, that records galvanic skin responses, to go for a walk. The data generated are used to produce an interactive Google Mashup to provide a different encoding of urban space. The Social Tapestries and Urban Tapestries projects (http://urbantapestries.net/), with tools such as the Feral Robot (automatically sensing and posting

pollution data) alongside people posting stories, thoughts and experiences, aim to build up an experiential spatial database which can be tapped into on the move via mobile phones. As you walk through the city a range of additional supporting information of both interest and use is available and passed to you on a hand-held screen. The aim is to show how pervasive technologies do not have to pacify us as consumers but can allow us to claim and mark our territory.

In part these artistic experiments with locative media can be characterized as responding to a depiction or criticism of the built environment as disenchanted and alienating. The locative media aim to offer a re-enchantment and reworking of the spaces through refashioning the overlaying of informational environments onto the landscape. In one sense this is not a unique task or ambition for locative media and yet the tailoring of response may be as below:

> the overlaying of different spaces is a conceptual problem that is not connected to any particular technology, we may start to think about which architects and artists have already been working on this problem. To put it another way, the layering of dynamic and contextual data over physical space is a particular case of a general aesthetic paradigm: how to combine different spaces together. Of course, electronically augmented space is unique – since the information is personalized for every user, it can change dynamically over time, and it is delivered through an interactive multimedia interface, etc. Yet it is crucial to see this as a conceptual rather than just a technological issue.
>
> (Manovich 2006, pp. 225–226)

Manovich thus gives the guided audio walks of Janet Cardiff as an example that attempts to overcode the present city with memories of the past, to produce a space that is not quite of the now but is rather haunted by ghostly, technologically preserved or recalled presences (Pinder 2001).

Collaborative authoring, locative media projects and haunted places

Collaborative authoring and locative media have greatly expanded the possibilities for these attempts to re-enchant the world. Some projects such as 'Pedestrian: A Walking Tour for Multiple Voices and Portable Phones – New York City' (http://www.pedestrianproject.com/id1.html) stage the aural publicity of new media that has turned us all into audiences of one half of so many conversations. Three guides set out to take a walking tour around the East Village in New York pointing out lost elements of landscape (such as gay bathhouses replaced by petrol stations), with audiences choosing to follow one of the guides but being able to overcode this by listening to two

others taking different routes. Here we have a double play of presence, haunting and topography. De Certeau's alternative mode of knowledge was through travel where practices have no place of their own but move in the territory of the other (1986, p. 202) which speaks to the unstable, multiply coded and fleeting geographies of these tours. Other projects push the collaborative sense of new media allowing them to record the multiple memories and histories of places. They thus attempt to record and give a voice to the myriad of invisible histories and myths of places. Where once there were official and dominant memories inscribed on the city now these stories from below can be added. In de Certeau's terms, the hidden knowledges of practices composed of the world's debris interrupt transparent, ordered space (de Certeau 1997, pp. 107, 116). Human and meaningful places are composed of 'fragmentary and inward-turning histories, pasts that others are not allowed to read, accumulated times that can be unfolded but like stories held in reserve, remaining in an enigmatic state' (de Certeau 1984, p. 108). Far from a single meaning, competing registers and forms of memory overcode one another to produce a 'piling up of heterogeneous places. Each one, like the deteriorating page of a book, refers to a different mode of territorial unity, of socioeconomic distribution, of political conflicts and of identifying symbolism' (1984, p. 201).

Locative media offer a way then of making visible all these hidden stories of place. Thus, projects such as Murmure (http://murmure.ca/) first launched in Toronto's Kensington Market in summer 2003, then Vancouver's Chinatown and then Montreal, allows people to take a web based map and tag sites with stories and memories of what the places mean to them in a form of 'intimate commemoration'. Many other projects have developed this theme, especially the possibility of collaborative authoring connected to locative media. Perhaps we might see this as evidence that if 'as is so often claimed, content is king, then surely the most valuable and relevant content about local places for local people is not going to come from media companies, but directly from their peers and neighbours?' (Lane 2004, p. 4). The German-based Yellow Arrow project (http://yellowarrow.net/index2.php) describes itself as a Massively Authored Artistic Project (in a parody of Massively Authored Online Games) which sets out to add depth to our world. It seeks explicitly 'alternative' accounts to be attached to places, as in its Guerrilla Innsbruck Map project, with Yellow Arrow stickers pointing to sites. These stickers are registered with your specific code and your thoughts on the place to which they point – that could be in prose, video or audio format. Anyone dialling in the code via phone or Web can call up this material.

Other Social Tapestries and Urban Tapestries projects, meanwhile, attempt to document the world as we experience it at street level and add a sense of bodily motion moving through and between sites. They draw

upon de Certeau's formulation of evasive memories and urban myths through pervasive location based authoring. But the aim is allow a community to share knowledge in, as the title suggests, interwoven layers of discourse over the topography of the city (Jungnickel 2004, p. 3). In this it takes inspiration from work on 'Songlines' in both Aboriginal contexts and other multimedia projects (such as that by Naureckas, Jim (n.d.) *New York Songlines.* URL: http://www.nysonglines.com/) that attempt to disrupt 'flat' visions of space and community (Silverstone & Sujon 2005). It is perhaps significant to note that despite claims and accounts of ubiquity, processing power and control issues meant this was an experiment restricted to a small number of registered users.

However de Certeau was sceptical of attempts to stabilize such knowledge, suggesting it ossified and drained the very life he celebrated, cautioning us that science could never make princesses of all these Cinderellas (1984, p. 67). Technological optimists would say multiple-authored websites can make our stories visible and not ossify them. These initiatives do not aim to provide merely a linguistic supplement or record of our daily engagement with the world. Rather, in de Certeau's terms, they show the little narratives that organize, frame and enable our engagement:

> These narrated adventures, simultaneously producing geographies of actions and drifting into the commonplaces of an order, do not merely constitute a 'supplement' to pedestrian enunciations and rhetorics. They are not satisfied with displacing the latter and transposing them into the field of language. In reality, they organize walks. They make the journey, before or during the time the feet perform it.
>
> (de Certeau 1984, pp. 115–116).

The above projects thus take these to be spatial stories and work on how they act in the world. The system builds connective tissues of threads linking places following people's movements – both mental and physical.

Effects of animating spaces

As these spatial annotation projects move from online sites to interact with embodied practice we come to the third kind of intervention with a stronger sense of fostering new engagements with the environment. Here the media are not just location based but mobile to foster what de Souza e Silva calls 'hybrid-reality' where networked communities move into hybrid spaces. Perhaps the best examples are hybrid-reality games. These are multiuser games played with cell phones equipped with location awareness and Internet connections that allow players to use city space as the game board. The most celebrated, and first commercially released, is perhaps *Botfighters*, produced in

Sweden in 2001 by It's Alive, though *Mogi* in Japan, released in 2004, is a similarly hybrid reality game. In Botfighter, a first-person shoot-'em-up game moves into the city as people tag each other in real space with mobile phone texts. Opponents track each other down in urban neighbourhoods and streets as their mobile phones provide them with information on where other opponents are (Shirvanee 2006). In Mogi, the main goal is to look for virtual creatures and objects spread around the city of Tokyo, which can be caught and uploaded into players' cell phones. However, some creatures go out only at night, so players must go to specific places at specific times to capture particular creatures (de Souza e Silva 2006, pp. 266–270).

In terms of animating spaces, then, we can see two key effects. First, both these games transform the city space into the game board so that the familiar space of the city is transformed into a new and unexpected environment. So it is 'as if the game creates an imaginary playful layer that merges with the city space, connecting people who previously did not know one another via mobile technologies according to their movement in physical spaces' (de Souza e Silva 2006, p. 272). Second, they work to create and foster new social communities, or sociotechnical communities through locative performances. They bring people together into new formations – in the case of Urban Tapestries for using and understanding the neighbourhood, or for new socialities around games for *Mogi* or *Botfighters*. Thus, as Shirvanee comments on *Botfighters*, we might say that as 'paths of social activity are made possible by the augmentation of geographic space with locative information, an invisible layer of association emerges. One prevalent activity of the mobile street culture is to engage in locative games' (Shirvanee 2006). There are many more such games that range from impromptu art or dance to developing shared knowledge on the haptic qualities of skateboard routes (a good starter list is provided by Galloway 2004).

We might then try and think this through with a sense of what this does to movement in space. Shirvanee (2006) picks on the metaphor of viscosity to try and describe the technosocial world of pervasive computing. By viscosity she is pointing to speed of events and resistance – where the denser the fluid the greater the resistance to velocity. These artistic media are trying to densify the liquid – not solidify places. Thus:

> When information can actively find you on the street, there is a viscosity of space that forms between strangers with locative media, creating landscapes charged with traces of others that have inhabited the same space. In this early stage of location-based media, a greater connectivity and interaction between people who share a common interest, is thought to hold the promise of invigorating the public sphere to create an awareness and, therefore, a vitality of activity and public dialogue in spaces that might otherwise remain stagnant. This density and cohesion is more or less

> explicitly opposed to notions of disorientation and distractedness in contemporary urbanity.
>
> (Shirvanee 2006)

They may offer the possibility of enriched community formation. Not indeed the embedded and static version of community but community as assemblage in flux, as turbulence and eddies in the data stream.

Conclusions

One of our aims in this wide-ranging survey has been simply to emphasize that there is a great deal of work going on developing and exploring urban pervasive computing from commercial, military and artistic angles. We have also wanted to show that all of these offer significant contributions to thinking about both what the urban environment might become but also into how we think about the role of ICTs in it.

The developments addressed in this paper suggest that – in a world of augmented, enacted, transduced or 'blogjected' space – we will no longer, even if we ever could, be able to see the environment as a mere passive backcloth for social action. At the very least the environment has always recursively influenced and been influenced by action. What these technologies do is to change the temporality of that action. Much writing has focused on the real-time nature of links – such as drawing down locationally sensitive data for transactions. But in this paper we have, rather, tried to add a sense that environments are now being saturated with *anticipatory* technologies. These profile users in more sophisticated ways that in the end possibly pacify that user by creating a delegated agency. They also constantly use surveillance data to categorize users, a process which strongly links imaginations and anticipations of future behaviour(s) to categorical renderings from computerized memory. Such a technological politics, of course, risks delegating whole sets of decisions and, along with that, the ethics and politics of those decisions, to invisible and sentient systems. These blur seamlessly into local, urban environments, and enact and organize global and transactional flows producing an ongoing geography of distanciated, technological performance (Graham 2005).

We have tried to highlight, then, an emerging politics of visibility as these technologies make our habits and practices visible. Technologies are shaped to recognize us and make us knowable as individuals. Military technologies are designed to render human subjects trackable and create a visual field where this can be used to distinguish friend from foe. Consumer technologies are also clearly designed to make our preferences for, uses of, and indeed thoughts about, products traceable. In the newly visible field of practices

they, too, can then deploy algorithmic agency to target the most appropriate or profitable consumer.

We have also suggested how artistic works are trying to play around this visibility to make alternative worlds accessible to enrich our environment. However, we have tried to suggest that these moves risk making what was formerly protected by its opacity and transitoriness, visible and recordable. As such, there may well be an issue where rendering our tacit sociospatial practices visible is an uncomfortably close echo of commodified and surveillant systems. But these artistic endeavours in turn offer a second politics of visibility, that is these technologies themselves need to be made visible. If they simply become buried infrastructure without ever being visible to most users we shall surely miss the chance for many people to influence their development.

The second axis across the examples is the structuring of time into spaces through technologies of anticipation and memory. Military technologies, we have suggested, invest in a form of anticipatory seeing, being concerned with what people might do in the future based on profiles of past behaviour. The same is in many senses true of consumer technologies whose aim to offer a customized landscape depends upon anticipating people's desires based on surveillance of previous consumption habits.

Both military and commercial systems use the tracking of visible actions to try and peer inside people's psyches. They both work by using the capacity for logging actions and connecting memories and stories of people so as to predict future behaviour. But these logs are but the bare bones of lives – the full gamut of the social world rendered as mere transaction and movement.

Other emerging ubicomp technologies, however, are being established to try and to re-enchant human links to place by recording and sustaining the personal and transient meanings of places. These artistic practices suggest that the effect of memory is not the creation of perfectly known environments. Rather, it involves a destabilization of spaces, a haunting of place with absent others. The double, indeed triple and quadruple, coding of spaces and people through narratives and information carried in digital networks may thus actually serve to disperse our notion of both person and place.

This, then, points to our third recurrent theme. In a sense, following de Certeau, it is clear that the urban ubicomp experiments reviewed here very often involve an erotics of knowledge and a fantasy of perfect vision. We need to recall that these dreams of perfect spatial and urban transparency and omniscience are longstanding. Such dreams always remain unrealized, however, as the contradictions of urban technosocial change always render them rather naïve. As McCullough suggests, experience should tell us that

> omniscience is elusive. As anyone who has ever tried to resolve a simple billing dispute will know, even the telephone company lacks enough internal coordination to make sense of its data to you. And anyone who has ever dealt with a state-level bureaucracy knows, the odds of omni-competence remain low. Generally, as information becomes more and more abundant, clear views through it become less and less possible.
>
> (McCullough 2004, p. 15)

We want to suggest this is not just a technical issue that will be overcome through further technological refinement. What is notable is that, for capital and the military, ubicomp is being invoked as a technical fix or 'silver bullet' to somehow magically address complex and deep-seated social and political issues. Urban ubicomp clearly has a fetishistic power in appearing to finally offer solutions by rendering place and space utterly transparent in some simple, deterministic way. Indeed, we would argue that there is a danger that locative media are equally seen as a technical fix for oppositional voices and alternative histories in art projects.

In this sense the myths matter and have effects. But they are only mythologies of a perfect, uniform informational landscape. In reality, the seamless and ubiquitous process of pure urban transparency that many accounts suggest will always be little but a fantasy. In practice, the linking of many layers of computerized technology is generally a 'kludge', as software designers call it. That is, a bricolage of component middleware, none of which is really designed for the task to which it is put, nor perfectly configured to work with the other middleware or devices it encounters. Computerized systems thus run 'sub-optimally' but normally function adequately nonetheless (Mackenzie 2005). Indeed, Matt Locke eloquently describes the complex granularity of this new digital terrain:

> Mobile networks have to negotiate the architecture of spaces that they attempt to inhabit. Although the interfaces have removed themselves from physical architectures, the radio waves that connect cell spaces are refracted and reflected by the same obstacles, creating not a seamless network but a series of ebbs and flows. The supposedly flat space of the network is in fact not flat, pulled into troughs and peaks by the gravity of architecture and the users themselves.
>
> (Manovich 2006, pp. 228–229)

Quite the opposite of perfect transparency, a 'global brain', or total vision, then! In practice, we may find that temporary and 'good-enough' approaches to urban ubicomp may lead to 'local aggregations of self-connecting systems [that] can become islands of coherence in the chaos raised by pervasive computing' (McCullough 2004, p. 71).

Far from the pure vision of what de Certeau calls the 'concept city', we may find the production of myriads of little stories – a messy infinity of 'Little Brothers' rather than one omniscient 'Big' Brother. Some of these may be commercial, some personal, maybe some militarized. There is a real issue about proliferating knowledges circulating routinely and more or less autonomously of people. But it would seem to us that the political options are not those of rejection or romanticizing notions of disconnection. Rather, it is to work through the inevitable granularity and gaps within these systems, to find the new shadows and opacities that they produce.

Arts media websites

Grafedia, [Online] Available at: http://www.grafedia.net/ (March 2007).
Murmure, [Online] Available at: http://murmure.ca/ (March 2007).
Naureckas, J. (n.d.) *New York Songlines*, [Online] Available at: http://www.nysonglines.com/ (March 2007).
Nold, C., 'Christian biomapping', [Online] Available at: http://www.biomapping.net/ (March 2007).
Nold, C., 'Greenwich emotion map', [Online] Available at: http://www.emotionmap.net/ (March 2007).
Pedestrian: A Walking Tour for Multiple Voices and Portable Phones – New York City, [Online] Available at: http://www.pedestrianproject.com/id1.html (March 2007).
Yellow Arrow project, [Online] Available at: http://yellowarrow.net/index2.php (March 2007).

References

Amin, A. & Thrift, N. (2002) *Cities: Reimagining the Urban*, Polity Press, Cambridge.
Amoore, L. (2007) 'Algorithmic war: everyday geographies of the war on terror', *Antipode* (forthcoming).
Andrejevic, M. (2003) 'Tracing space: monitored mobility in the era of mass customization', *Space and Culture*, vol. 6, no. 2, pp. 132–150.
Andrejevic, M. (2005) 'Nothing comes between me and my CPU: smart clothes and "ubiquitous" computing', *Theory, Culture & Society*, vol. 22, no. 3, pp. 101–119.
Beer, D. (2007) 'Thoughtful territories: imagining the thinking power of things and spaces', *City*, vol. 11, no. 2, pp. 229–238.
Bleecker, J. (2006) 'A manifesto for networked objects — cohabiting with pigeons, arphids and aibos in the internet of things', [Online] Available at: http://research.techkwondo.com/blog/julian/185 (May 2007).

Burrows, R. & Ellison, N. (2004) 'Sorting places out? Towards a social politics of neighbourhood informatization', *Information, Communication & Society*, vol. 7, no. 3, pp. 321–336.

Burrows, R. & Gane, N. (2006) 'Geodemographics, software and class', *Sociology*, vol. 40 no. 5, pp. 793–812.

Castells, M. (1996) *The Rise of the Network Society*, Blackwell, Oxford.

de Certeau, M. (1984) *The Practice of Everyday Life*, California University Press, Berkeley.

de Certeau, M. (1986) *Heterologies: Discourses on the Other*, Manchester University Press, Manchester.

de Certeau, M. (1997) *The Capture of Speech & Other Political Writings*, University of Minnesota Press, Minneapolis.

Crandall, J. (1999) 'Anything that moves: Armed vision', *C Theory*, June, [Online] Available at: http://www.ctheory.net/articles.aspx?id=115 (1 June 2007).

Cuff, D. (2003) 'Immanent Domain: Pervasive Computing and the Public Realm', *Journal of Architectural Education*, vol. 57, no. 1, pp. 43–49.

DARPA (2003) *Combat Zones That See Program: Proper Information*, [Online] Available at: http://www.darpa.mil/baa/baa03–15.htm (February 2005).

de Souza e Silva, A. (2006) 'From cyber to hybrid: mobile technologies as interfaces of hybrid spaces', *Space and Culture*, vol. 9, no. 3, pp. 261–278.

Defense Science Board (DSB) (2004) *Transition to and From Hostilities*, Office of the Undersecretary of Defense, Washington DC, December.

Defense Watch Magazine (2004) 'Combat zones that "see" everything', [Online] Available at: http://www.argee.net/DefenseWatch/Combat%20Zones%20that%20'See'%20Everything.htm (March 2005).

Dodge, M. & Kitchin, R. (2004) 'Flying through code/space: the real virtuality of air travel', *Environment and Planning A*, vol. 36, no. 2, pp. 195–211.

Dodge, M. & Kitchin, R. (2005) 'Code and the transduction of space', *Annals of the Association of American Geographers*, vol. 95, no. 1, pp. 162–180.

Dodge, M. & Kitchin, R. (2007) '"Outlines of a world coming into existence": pervasive computing and the ethics of forgetting', *Environment and Planning B: Planning and Design*, vol. 34, no. 3, pp. 431–445.

Friedberg, A. (1993) *Window Shopping: Cinema and the Postmodern*. University of California Press, Berkeley.

Galloway, A. (2004) 'Intimations of everyday life: ubiquitous computing and the city', *Cultural Studies*, vol. 18, nos 2/3, pp. 384–408.

Galloway, A. (2004) 'Postcard from the urban frontier', *Space and Culture*, vol. 7, no. 4, pp. 446–449.

Graham, S. (2004) 'Beyond the "dazzling light": from dreams of transcendence to the "remediation" of urban life', *New Media and Society*, vol. 6, no. 1, pp. 16–26.

Graham, S. (2005) 'Software-sorted geographies', *Progress in Human Geography*, vol. 29, no. 5, pp. 562–580.

Houlgate K. (2004) 'Urban warfare transforms the Corps', Naval Institute Proceedings, November, [Online] Available at: http://www.military.com/NewContent/0,13190,NI_1104_Urban-P1,00.html (February 2005).

Jauhiainen, J. (2006) 'In post-modern technologised landscapes', in *Landscapes of a New Cultural Economy of Space*, eds T. S. Terkenli & A.-M. Hauteserre, Springer, Amsterdam, pp. 193–211.

Jungnickel, K. (2004) 'Urban tapestries: sensing the city and other stories', *Proboscis Cultural Snapshots* London: 8, [Online] Available at: http://proboscis.org.uk/publications/SNAPSHOTS_sensingthecity.pdf (14 May 2007).

Kluitenberg, E. (2006) 'The network of waves: living and acting in a hybrid space', *Open*, vol. 11, pp. 6–17.

Kluitenbrouwer, K. (2006) 'RFID & agency: the cultural and social possibilities of RFID', *Open*, vol. 11, pp. 50–59.

Kraan, A. (2006) 'To act in public through geo-annotation: social encounters through locative media art', *Open*, vol. 11, pp. 38–49.

Lane, G. (2004) 'Social tapestries: public authoring and civil society', *Proboscis Cultural Snapshots*: 9, [Online] Available at: http://proboscis.org.uk/publications/SNAPSHOTS_socialtapestries.pdf (14 May 2007).

McCue, C. (2005) 'Data mining and predictive analytics: battlespace awareness for the war on terror', *Defense Intelligence Journal*, vol. 13, nos 1/2, pp. 47–63.

Mackenzie, A. (2005) 'Untangling the unwired: Wi-Fi and the cultural inversion of infrastructure', *Space and Culture*, vol. 8, no. 3, pp. 269–285.

Manovich, L. (2006) 'The poetics of augmented space', *Visual Communication*, vol. 5, no. 2, pp. 219–240.

McCullough, M. (2004) *Digital Ground: Architecture, Pervasive Computing and Environmental Knowing*, MIT Press, Boston, MA.

Pinder, D. (2001) 'Ghostly footsteps: voices, memories and walks in the city', *Ecumene*, vol. 8, no. 1, pp. 1–19.

Pratt, A. (2002) 'Hot jobs in cool places: the material cultures of new media product spaces: the case of South of the Market, San Francisco', *Information, Communication & Society*, vol. 5, no. 1, pp. 27–50.

Pruett, R. (2005) *Identification – Friend or Foe? The Strategic Uses and Future Implications of the Revolutionary New ID Technologies*, US Army war College, Research Project Report, Carlisle Barracks, Pennsylvania.

Sassen, S. (2006) 'Public interventions: the shifting meaning of the urban condition', *Open*, vol. 11, pp. 18–27.

Shirvanee, L. (2006) 'Locative viscosity: traces of social histories in public space', *Leonardo Electronic Almanac*, vol. 14, no. 3, [Online] Available at: http://leoalmanac.org/journal/vol_14/lea_v14_n03-04/lshirvanee.asp (14 May 2007).

Silverstone, R. & Z. Sujon (2005) 'Urban tapestries: experimental ethnography, technological identities and place', in *MEDIA@LSE Electronic Working Papers*, eds R. Gill, A. Pratt, T. Rantanen & N. Couldry, LSE, London, pp. 1–72.

Smith, M. A. (2006) 'Microsoft hopes its AURA aids shoppers: application aims to give consumers on-the-go information on products', B. Bergstein, Associated Press.

Sweeting, C. (2005) 'Location-based service: the killer app of the mobile world?', in *Asia Unplugged: The Wireless and Mobile Media Boom in the Asia-Pacific*, eds M. Rao & L. Mendoza,Response Books, New Delhi, pp. 87–107.

Thrift, N. (2004a) 'Driving in the city', *Theory, Culture & Society*, vol. 21, nos 4/5, pp. 41–59.

Thrift, N. (2004b) 'Remembering the technological unconscious by foregrounding the knowledges of position', *Environment & Planning D: Society and Space*, vol. 22, no. 1, pp. 175–190.

Winter, S. & Nittel, S. (2006) 'Ad hoc shared-ride trip planning by mobile geosensor networks', *International Journal of Geographical Information Science*, vol. 20, no. 8, pp. 899–916.

Woodward, J. (2005) 'Using biometrics to achieve identity dominance in the global war on terror', *Military Review*, September–October, pp. 30–34.

Zook, M. (2002) 'Hubs, nodes and by-passed places: a typology of e-commerce regions in the United States', *Tijdschrift voor Economische en Sociale Geografie*, vol. 93, no. 5, pp. 509–521.

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