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Code, space and everyday life

Martin Dodge
Rob Kitchin

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T +44 (0) 20 7679 1782 • T +44 (0) 20 7679 1813 • F +44 (0) 20 7813 2843 • E casa@ucl.ac.uk

Centre for Advanced Spatial Analysis • University College London • 1 - 19 Torrington Place • Gower St • London • WC1E 7HB

Code, space and everyday life[1]

Martin Dodge, Centre for Advanced Spatial Analysis, University College London, 1-19 Torrington Place, London

Rob Kitchin, Department of Geography, National University of Ireland, Maynooth, Co. Kildare, Ireland

Abstract

In this paper we examine the role of code (software) in the spatial formation of collective life. Taking the view that human life and coded technology are folded into one another, we theorise space as ontogenesis. Space, we posit, is constantly being bought into being through a process of transduction – the constant making anew of a domain in reiterative and transformative practices - as an incomplete solution to a relational problem. The relational problem we examine is the ongoing encounter between individuals and environment where the solution, to a greater or lesser extent, is code. Code, we posit, is diversely embedded in collectives as coded objects, coded infrastructure, coded processes and coded assemblages. These objects, infrastructure, processes and assemblages possess technicity, that is, unfolding or evolutive power to make things happen; the ability to mediate, supplement, augment, monitor, regulate, operate, facilitate, produce collective life. We contend that when the technicity of code is operationalised it transduces one of three forms of hybrid spatial formations: code/space, coded space and backgrounded coded space. These formations are contingent, relational, extensible and scaleless, often stretched out across networks of greater or shorter length. We demonstrate the coded transduction of space through three vignettes – each a day in the life of three people living in London, UK, tracing the technical mediation of their interactions, transactions and mobilities. We then discuss how code becomes the relational solution to five different classes of problems – domestic living, travelling, working, communicating, and consuming.

Key words: code, ontogenesis, transduction, technicity, space

[1] A version of this paper was presented by Rob Kitchin at the Association of American Geographers Annual Conference, Philadelphia, March 2004.

Introduction

For many years, geographers have been interested in the relationship between technology and the production of space. Principally, attention has focused on the technologies of transportation and communication and how over time these – through on the one hand sailing ships, canals, railways, the car, air travel, and on the other mail, telegraph, telephone, fax and Internet - have induced conditions of space-time convergence, compression and distanciation that have facilitated constant re-organisation of human activities across scale from the home to the global. In the past decade this has led to a sustained analysis of the relationship between networked infrastructures and cities, and processes of economic and cultural globalisation more generally. Most particularly, analysis has centred on the rapid growth of Internet technologies, their accessibility and availability, and their effects on socio-spatial relations generally, and especially their effects on the organisation and restructuring of businesses and urban-regional economies (see Brunn and Leinbach 1991; Castells 1996; Dodge and Kitchin 2001; Graham and Marvin 1996, 2001; Janelle and Hodge 2000; Kitchin 1998; Mitchell 1996; Wheeler *et al* 2000; Wilson and Corey 2000).

Rather than rehearse this literature, in this paper we want to shift the focus from networked infrastructure per se – whether that be the Internet, water, electricity, sewerage, traffic management systems, logistics, and so on, to the role of software (code) in producing, monitoring, surveying, controlling these infrastructures and, in turn, producing space. By software, we mean a set of instructions and rules (codes) that when combined together produce programs capable of complex digital functions that operate on computer hardware. These programs take multiple forms including hardcoded applications with no or limited programmability (e.g, embedded on chips in alarm clocks, GPS receivers), specialised applications (e.g. banking software, traffic management systems), generic applications (e.g. word-processing, spreadsheets, web browsers) and operating systems (e.g. Windows, MacOS, Unix, Linux), that run on a variety of hardware (e.g., embedded chips, dedicated units, PCs, workstations) and can distribute, generate, monitor, control data exchange and flow across a range of infrastructures (e.g. printed circuit boards, coaxial and fibre-optic cables, wireless, satellites) using a variety of forms (e.g. electrical, light, microwave, radio). The coding itself within these programs varies from abstract machine code

and assembly language to programming languages, applications, user created macros and scripts.

These codes, and the hardware and infrastructures they operate and communicate across, we contend, following Latour (1993), need to be recognised and theorised as the outcomes of 'complex interactions involving the commodity production, organisational life, technoscientific knowledges and enterprises, the organisation of work, manifold identities and geo-political-technological zones of contact' (Mackenzie 2003a:3). In other words, code does not simply exist and work in easily defined and examined ways. Code is bound-up in, and contributes to, complex discursive and material practices, relating both to living and non-living, humans and technology, that work across scales and time. In this view, society consists of collectives which are hybrid assemblages of humans and non-humans (Latour 1993), wherein the relationship between human and technology is complex, contingent, relational, productive. Here, it is recognised that the indeterminacy, the contingency, that technology induces 'neither belongs solely to human life nor belongs to some intrinsic dynamism of technology' (Mackenzie 2002:10) but rather human life and technology are produced through, or *folded* into, each other in complex ways. In other words, it makes little sense to conceive of either without reference to the other. As such, the distinction between living and non-living (technological), wherein humans shape or are shaped by technology, is rendered problematic (Mackenzie 2002). Instead of there being an interface between humans and technology they become entwined – hybrids, so to understand technology means to comprehend the ways in which technology is plotted, designed, made, and to understand humans means to comprehend their relationship with the non-living (e.g. technology) and non-humans (e.g. landscapes, animals) (Whatmore 2002).

Since technologies increasingly rely on code, code has become central to the ways in which collectives operate and function in Western society; code represents, processes, monitors, controls, operates, augments, supplements, facilitates, produces (Lessig 1999); code makes a difference to how we see ourselves and how we live our lives. As we illustrate throughout the remainder of this paper, code is becoming increasingly embedded into all aspects of daily life as an essential element, as the global panic surrounding Y2K 'millennium bug' demonstrated. This embedding means that the

material and virtual are becoming produced – brought into being - through each other. And yet, the growing use and pervasiveness of code, as opposed to the technology it enables, has largely been ignored (Thrift and French 2002).

In the following sections we detail an initial theory of the relationship between code, space and everyday life, drawing in particular on the concepts of transduction and technicity. We identify four ways in which code facilitates and alters the technicity of objects and infrastructures, and detail how the interrelationship between this technicity and people transduces space in at least three ways. In the second half of the paper, we illustrate our theorisation through three vignettes of daily life in London and an extended discussion.

Code and the Transduction of Space

> A 'happening in the world' is what needs to be understood. From time to time, and always in time, new forms emerge that catalyse previously existing actors, things, temporalities, or spatialities into new modes of existence, a new assemblage, one that makes things work in a different manner and produces and instantiates new capacities. A form/event makes many other things more or less suddenly conceivable (Rabinow 1999:180; cited in Mackenzie 2003b)

Our premise is that as people traverse space, individual mobilities, interactions and transactions in combination with code beckon particular forms of space into being. Here, we conceive of space as a form of ontogenesis (always coming into being); space as practice; as a doing; as an event (rather than an absolute, geometric abstraction or simply a social construction; see Hubbard *et al* 2002). Such a notion has started to be examined by others, notably through Gillian Rose's reworking of Butler's theory of performativity. Rose (1999:248) argues that 'space is a doing, that does not pre-exist its doing, and that its doing is the articulation of relational performances … space then is not an anterior actant to be filled or spanned or constructed … [i]nstead, space is practised, a matrix of play, dynamic and iterative, its forms and shapes produced through the citational performance of self-other relations'. To her space itself, and thus its production, is brought into being through performativity.

While we think that Rose's formulation has utility, we feel it is more profitable to think of the on-going production of space as one of *transduction* - in which performativity is one component, but which also recognises the salience of objects and non-humans - as developed by Adrian Mackenzie (2002, 2003b) from Gilbert Simondon's (1989a/b, 1992, 1995) work. For Mackenzie 'transduction is a kind of operation. It is an operation in which a particular domain undergoes a certain kind of ontogenetic modulation. Through this modulation *in-formation* or individuation occurs. That is, it involves a domain taking-on-form, sometimes repeatedly' (2003b: 10, his emphasis). Transduction then is the process of ontogenesis, the making anew of a domain in reiterative and transformative individuations. According to Simondon (1992:313), '[t]he simplest image of the transductive process is furnished if one thinks of a crystal, beginning as a tiny seed, which grows and extends itself in all directions in its mother-water. Each layer of molecules that has already been constituted serves as the structuring basis for the layer that is being formed next, and the result is amplify-ing reticular structure'. Individuation can consist of speech acts, physical actions, occurrences, memories, perceptions, and so on. The process of individuation results in a modulation in conditions of the person and their milieu. Most individuations are ordinary, reiterating previous individuations (e.g. placing one foot in front of the other), others are singular and result in radical transformation (e.g. starting, stopping, changing direction). Ordinary individuations are routine and banal. Individuations are citational in that they imperfectly cite previous individuations, as in Butler's (1990; 1993) theory of performativity. The process of individuation in domains of living things is on-going – an individuation may provisionally solve a problem within a domain, but these are replaced by new problems. For example, a person travelling through a city constantly changes their relation to their milieu thus posing a continuous supply of new problems such as maintaining a bearing, avoiding obstacles, and reacting to situations around them. As such, '[t]hrough transduction, a domain structures itself as a partial, always incomplete solution to a relational problem' (Mackenzie 2003b:10).

This process of transduction recognises that life is generative and the relationality and contingency of generative processes, wherein diverse realities are knotted together to produce new conditions. It recognises that individuations are historically,

geographically, institutionally and individually situated – time, place, context and personal circumstance and characteristics (age, gender, race) matters. It also acknowledges that people are thinking subjects who can initiate and seek to regulate individuation. Moreover, it shifts the focus of analysis of spatiality from meaning and narrative to operation and process (Mackenzie 2003b). Transduction thus allows us to rethink both technology and space. Technologies are conceived 'processually … as events rather than objects, as contingent the whole way down'; 'as networks of social-material interactions rather than simply reflections of human capacities or innately alien objects' (Mackenzie 2003b:4,8). Technologies are thus 'folded through collectives and cultures' (Mackenzie 2002:xi). Space is similarly conceived as a practice, a doing. In other words, space is produced through transductive individuations. *Space is not a production, but rather a transduction*. Space is constantly being bought into being 'as an incomplete solution to a relational problem'. In the case under examination here, the relational problem is an ongoing encounter between individual and the urban environment – navigation, negotiation[1] and management[2] - and the solution, to a greater or lesser extent, is code. As such, for the entire period that code is employed as the solution to a problem a particular kind of transduction is occurring. In other words, code induces a particular modulation, that which is technically induced.

Technicity: Coded objects, infrastructure, processes and assemblages

> '[m]ore and more … the spaces of everyday life come loaded up with software' (Thrift and French 2002:309).

The word technology stems from the root Greek word *techne*, meaning 'art', 'craft' or 'skill' which in turn can be traced back the Indo-European root *teks*- meaning to 'weave or fabricate' (Winner 1977, 12). These roots are clearly suggestive of the idea of technology as a generative process – something in the process of being created or crafted - rather than a static object, and thus hints of technologies ability to transduce space and society. Here, technicity is an important concept. Technicity refers to the extent to which technologies mediate, supplement, and augment collective life; the extent to which technologies are fundamental to the constitution and grounding of human endeavour; the unfolding or evolutive power of technologies to make things

happen (Mackenzie 2002). For an individual technical element such as a saw its technicity might be its hardness and flexibility (a product of human knowledge and production skills) that enables it in conjunction with human mediation to cut well (note that the constitution and use of the saw is dependent on both human and technology; they are inseparable). As Star and Ruhleder (1996:112) note, '[a] tool is not just a thing with pre-given attributes frozen in time – but a thing becomes a tool in practice, for someone, when connected to some particular activity … The tool emerges in situ.' In large scale ensembles such as an automobile engine, consisting of many components, technicity is complex and cannot be isolated from the sum of individual components (and their design, manufacture and assembly), its 'associated milieu' (e.g. flow of air, lubricants, fuel), and its human operator(s), 'that condition and is conditioned by the working of the engine' (Mackenzie 2002: 12). In this way, both technical elements and ensembles need to be conceived in terms of a process of becoming, not as stable entities.

Here, we are interested in elements and ensembles where code is present in some form. To us, code is embedded in collectives in at least four main ways, producing what we term coded objects, coded infrastructures, coded processes and coded assemblages, each with variable technicity.

Coded objects refer to non-networked objects that use code to function or permanently store digital data which cannot be accessed without software. The former range from simple household items such as alarm clocks, 'smart' irons/kettles, televisions, washing machines that use basic code to augment their use, through to complex, but isolated machines, such as DVD players and PCs. The latter include credit and cash cards, floppy disks and CD-ROMs. Though these coded objects vary in their scope, sophistication and programmability, the importance of code to their function is such that if the code (or hardware that supports it use) fails or miscomputes[3], the object ceases to function as intended (e.g. a cashcard ceases to be a cashcard) – their technicity shifts from high to low. In all cases, unless networked, the remit of the code is limited purely to that object.

Coded infrastructures refers both to networks that link together coded objects and infrastructure that is monitored and regulated, either fully or in part, by code. Such

coded infrastructure (or ensembles) includes distributed infrastructures such as computing networks (e.g. Internet, intranets), communication and broadcast entertainment networks (e.g. mail, telephone, mobile phones, television, radio, satellite), utility networks (e.g. water, electricity, gas, sewerage), transport and logistics networks (e.g. air, train, road, shipping), financial networks (e.g. bank intranets, electronic fund transfer systems, stock markets), and security and policing networks (e.g. criminal identification databases, surveillance cameras), and relatively localised and closed systems such as localised surveillance (say within one building complex) and small but complex systems such as a individual car. The extent to which the geographical coverage of distributed infrastructures varies from global coverage as with GPSs (which literally can be accessed from any point on the Earth) to more localised coverage.

In all these cases, code is now an integral component in complex systems that consists of electronic, electrical, mechanical and physical components. Within an infrastructure these components are organised hierarchically with components becoming more complex and more significant towards the top of the hierarchy at the same time tending to become less numerous and less visible. If we take the example of the car as a relatively closed coded infrastructure, the physical components would be the body shell, the wheels, the seats, and so on, as well as the fuel; the mechanical would be the pistons, the gears, the brakes; the electrical would be the ignition system, the battery, the lights, the radio; the electronic would be the fuel gauge, the engine temperature sensor, the alarm and immobiliser, and so on; the code would be the various 'black boxes' such as the engine management system that monitors the car, continuously adjusting for performance, road conditions, and driver demands. The result of the latter means that for most modern day cars there is no longer a direct electro-mechanical connection between the key in the ignition key and the start of the engine – code mediates and dominates this transaction. In the case of a distributed network such as a water utility system[4], while the vast bulk of the infrastructure is still 'dumb' (i.e. uncoded), consisting of pipes, valves, pumps, taps and so on, the network is now likely to be operated and regulated by code (software programmes for monitoring water quality, reservoir levels and channelling water supplies through network of pipes; measurement and billing software for charging customers). Water is

still water, and the network still 'dumb' pipes, but the flow of water is now dependent on code.

Coded processes refer to the transaction and flow of digital data across coded infrastructure. Here, the flow of data consists of more than simple instructions to regulate coded objects within an infrastructure. Rather, the flow consists of the transfer of information. Such flow becomes particularly important when they involve the accessing, updating, and monitoring of relational databases that hold individual and institutional data. Such databases can be accessed at a distance and used to verify, monitor (say for billing purposes) and regulate user access to a network, update personal files, and so on – they are transductions in progress. An example of a coded process is the use of an ATM. Here, data and transaction flow is transferred across the coded infrastructure of the bank's seceure intranet based on access via a coded object (the customer's bank card), verifying the customer based on a pin number, determining whether a transaction will take place, instructing the ATM to complete an action, and updating the user's bank account. Part of the technicity of relational databases is that they hold common fields that allow several databases to cross-referenced and compared. Other coded processes centre on databases relating to mortgages, shares, taxation, insurance, health, crime, utility usage, service usage, and so on, all of which can be accessed across open or more commonly closed networks. While such coded processes are largely invisible and distant, they are revealed to individuals through letters, statements, bills, receipts, print-outs, licenses and so on, and through unique personal identification numbers on the coded objects used to access them (e.g. bank and credit cards, library cards, transport season tickets, store loyalty cards).

Coded assemblages are where *several* different coded infrastructures converge, working together - either in nested systems or in parallel, some using coded processes others not - and, over time, become integral to each other in producing particular environments, such as office complexes, transport systems, and shopping centres. For example, the combined systems of billing, ticketing, check-in, baggage routing, security, safety, customs, immigration, air traffic control, airplane instruments, work together to create a coded assemblage that defines and produces airports and passenger air travel (see Dodge and Kitchin 2004). Similarly, the coded

infrastructures of water, electricity, gas, banks and mortgage lenders, commodities, Internet, telephone, mail, television, government database systems, and so on, work together to create an assemblage that produces individual households. The power of these assemblages is their interconnection and interdependence creating systems whose complexity and power are much greater than the sum of their parts. That said, we would contend that these assemblages congeal out of contingency, rather than being the result of coordinated planning (any such planning would itself be a contingent and relational exercise).

Taken together, it is clear that code is something that is very difficult to avoid; code makes a difference to the constitution and material and discursive practices of collectives. It is now almost impossible not to live within the orbit of code, even in non-Western countries. To do so would mean being born outside of collective life so that one does not appear in government databases, does not use any utilities (e.g. water, electricity), does not use modern convenience items (e.g. kettle, washing machine), does not watch or take part in entertainment or recreational activity (e.g. television, cinema), and avoids consumptive and societal activities such as shopping (thereby avoiding barcodes, credit cards, surveillance cameras, and the like).

Transduced space

We posit that coded objects, infrastructures, processes and assemblages, the technicity they engender, transduces space – beckons new spatial formations into existence – in three related ways.

Code/space refers to a transduction wherein 'the problem' *cannot* be solved without code. Here, code dominates the transduction of space to the extent that the transduction is dependent on code; they are mutually constituted and hence dyadic (see Dodge and Kitchin 2004). This domination is so pervasive that if one half of the dyad is put 'out of action' then the entire *intended* transduction fails (see endnote 3). For example, the experience of drawing money from an ATM is one of transducing code/space through the assemblage of retail banking. Here, if the network is 'down' or the bank's software system is not working (or working incorrectly) the space – in this case access to your bank account or the location of the ATM - fails to be a cash

machine and the individual is forced to seek another means of obtaining money. In other words the space cannot perform as intended to solve the relational problem posed; the transduction is alternatively modulated.

Coded space is a transduction that is mediated by code, but whose relationship is not dyadic (mutually constituted). Here, code matters to the ontogenesis of a space but if the code fails the space continues to function as intended, but not necessarily as efficiently or least costly or safely. Here, code mediates the solution to a problem, but it is not the only solution. In other words, the code's role is one of augmentation, facilitation, monitoring, and so on, rather than control and regulation. For example, a networked surveillance camera in a store affects the transduction of space, but if the camera is non-operational the shop still functions as a shop. However, if the networked tills (code/space) fail to work then the store cannot sell any goods as it has no way of processing payments. Similarly, although an in-car navigation system alters the transduction of space, if it fails the car can still be driven. However, if an engine management system (code/space) fails then the car will not start.

Background coded space is where code has the potential to mediate a solution if activated. Potential codings include local, but turned off, sources of code such as coded objects and infrastructures (e.g. water, electricity), and GPS, radio and mobile phone signals which are always present, but mute until activated. Once the code is activated the transduction of space is alternatively modulated to one of coded space or code/space. In the case of water or electricity, code does not obviously or explicitly mediate the solution of accessing supply (e.g. turning the tap), but it is an important component that is several steps removed from the remit of the individual filling a glass with water.

Given that coded infrastructures are distributed, the extensibility of the transduction of space is an important aspect to consider. The transduction of space by code does not simply consist of localised individuations. Instead, we believe it is more productive to conceptualise the coded transduction of space as ongoing individuations across networks of greater or shorter length. In this sense, a complex, progressive conception of place is produced (Massey 1991), wherein people and things are located within complex networks of mobilities, interactions and transactions that bind them

together across scales. In the case of the instantaneous nature of coded infrastructure and processes, scales such as 'local' and 'global' become redundant with each network simultaneously connecting together all locations within the network. Such a conceptualisation thus renders fixed spatial boundaries and scales obsolete (Whatmore and Thorne 1997; Amin and Thrift 2002). Moreover, it recognises that each network is just one of a multitude of networks, thus creating multiple, simultaneous but partial spatial-time configurations that are at once 'local' and 'beyond'. This induces a constant mode of time-space distanciation, although this does not necessarily mean that decisions or actions at one location produces outcomes at another. This is not to deny that for each individual that these networks and the transduction of space they help induce occurs at the site at which they are physically located. Rather, it is to acknowledge that this localised transduction is the grounding of one part of a (or several) complex, geographically distributed network(s), and that this grounding might be just one of a number that are simultaneously happening across the network. Here, the network becomes 'a mass of currents rather than a single line of force' (Whatmore and Thorne 1997:291) and is a 'performative ordering (always in the making) rather than a systematic or structural entity (always already constituted)' (Whatmore and Thorne 1997:289).

Further, it should be noted that the relationship between code and the transduction of space is not a simple one, deterministic (i.e. code determines in absolute, non-negotiable means the production of space and the socio-spatial interactions that occur within them) and universal (i.e. such determinations occur in all such spaces and at all times in a simple cause-and-effect manner), rather, as noted, it is contingent, negotiated and nuanced. For example, there is no neat marriage between coded objects, infrastructures, processes and assemblages and particular transductions of space. Moreover, during a transduction the modulation of space through code is not consistently even and universal. Rather, the relationship varies as a function of the nature of code, people and context.

The extent to which code is embedded in everyday society (as objects, infrastructure, processes and assemblages) is not the same thing as the extent to which it manipulates, augments, regulates, and so on. The difference that code makes then is not simply one of extent or pervasiveness or visibility, but also of power, its

technicity. In the case of code we conceive of its power as a function of autonomy and consequences. Here, autonomy relates to the extent to which code can do its 'work' without direct human oversight or authorisation. The degree of autonomy code has is a function of the amount of input (knowledge of its environment), sophistication of processing, and the range of outputs it can produce. If code fails, then its consequences can range from mild inconvenience to serious economic and political impacts to life-threatening situations. As such, all code/spaces do not have similar qualities or impacts. For example, the code/space of an ATM transaction is radically different to a hospital intensive care unit in its form, function and consequences.

Further, the relationship between space and code varies as a function of people. Not everyone experiences or interacts with the same code in the same way depending on their own personality, characteristics (e.g. gender, class, race), status, individual reflexivity, their personal history and experience, memories, whether they working or passing through, their intention, their technical competency, whether they are on their own or in a group, and so on. To this extent code and its effects are peopled. This means that different people experience the same transduction differently. For example, in the case where two people, say parent and child, are connected by phone, one might experience the call positively and be empowered, the other negatively and be disciplined.

The relationship between code, people and space also varies as a function of wider context. Mobilities, transactions and interactions that involve code are historically, geographically and institutionally embedded and do not arise 'from nowhere'. Rather, the code works within conventions, standards, representations, habits, routines, practices, economic climates, discursive formations, and so on that position how code engages and is engaged with. The use of code is then always prefaced by, and contingent upon, this wider context.

Given the creation of coded assemblages and complexities of people's lives it is often the case that people are modulating their domain in relation to multiple coded objects, infrastructures and processes simultaneously. For example, they may be using their mobile phone (code/space) at the same time they are cooking their dinner (coded

space). Here different forms of code interact or coalesce to produce a particularised transduction of space. Alternatively, the same locale might be transduced differentially for different individuals, for example as coded space for a pedestrian and code/space for a car user. This means that the coded transduction of space is never fixed and shifts with place, time and context. Here, the combination of many individuals occupying or interacting with the same locale, plus the many coded infrastructures and processes they are at that moment connected to, each beckoning space into being in relation to code, transduces a complex spatiality. This means, of course, that the experience of individuals transducing backgrounded coded space can be mediated by others transducing code/space. For example, a person talking loudly on a mobile phone on a bus shapes the experience of the journey for the other passengers. In this sense, spatiality is a 'collaborative manufacture' (Crang 1994: 686); a collective, heterogeneous transduction.

This conceptualisation of space as an ontogenetic, collaborative manufacture does not deny the salience of structural forces such as political economy or capitalism or neo-liberalism, or institutional structures such as the state and its bodies, rather it refigures them as sets of on-going, relational and contingent discursive and material practices, that are citational and transformative. Hence, these too are in a state of ontogenesis, always being remade in an ongoing process, and inducing transductions in collective life. These structures do not sit outside of collective life, they are (re)made through its performance providing citational context at the same time as they are perpetuated.

Three Vignettes

In this section we illustrate how code and space are mutually constituted, facilitating the transduction of complex spatialities, through three vignettes. Each vignette provides a day in the life of an individual living in London. Each individual lives in a different part of London (reflective of their income and class) and works in a different occupational sector. (Table 1 provides part of the ACORN geodemographic profiles of the residential locations.) While the individuals themselves are fictions, the coded assemblages of homes work places, recreational sites, and the routes between them, along with coded objects, infrastructures and processes encountered in those assemblages, are real (and were observed in situ through fieldwork on 25th and 26th June 2003). We believe that vignettes are not extreme or exceptional cases and are

representative of the technicity of code and how it transduces the daily lives of individuals living in the city. While the vignettes concentrate on the individual narratives it should hopefully be clear that the transductions that occur are not simply one of individual and code, but are largely manufactured collectively, mediated by the presence of others. Here, for purposes of illustration, we want to concentrate on individual rather than collective production.

Naomi

Naomi is in her early thirties. She is married with three children and lives in Draper House, a tower block close to the Elephant and Castle in inner south London (Table 1). Her day starts at 6.30 when her youngest child wakes her. For the next two hours she prepares breakfast and gets the children ready for school. The two youngest children watch satellite television while the eldest stays in his bedroom playing on his Xbox. Her husband returns home from working a nightshift at 8.10. She checks the electricity meter to see if the payment card needs topping up and at 8.25 the children and herself leave the flat and wait for the lift. In the ground floor foyer of the block she is filmed by the council housing security camera network, installed to deter strangers and vandalism. They leave through a security door and head towards the Elephant and Castle Day Nursery on Hampton Street. She drops off the youngest child, being filmed at the door by a single, miniature security camera. She then walks down Canterbury Place, onto Peacock Street, leaving her other two children at Crampton Primary School.

At 8.45 Naomi largely retraces her steps, passing Draper House heading towards the Elephant and Castle Shopping Centre. She negotiates the busy road via a pedestrian underpass which is equipped CCTV cameras at entrances and exits. At street level she passes workmen excavating the pavement to repair cables. At the entrance to the shopping centre she is filmed by the private security system for the centre, and three more large dome cameras cover her passage through the centre. She enters the Tesco Metro supermarket where she works and is assigned a checkout station by the store manager. Logging onto the checkout she is recognised by the store's computer system and her performance starts to be logged. The store itself is covered with a number of dome surveillance cameras monitoring the customers and also the staff. She spends the day seated at the checkout serving customers, scanning products, processing

payment, and logging customer loyalty cards. Her checkout screen informs of her of required actions.

At lunchtime she eats a sandwich in the canteen whilst speaking to her sister on a prepaid mobile phone, arranging a weekend family get together. She also pops into the KNS News and Food Store, on Newington Butts, the nearest PayPoint facility to work to top-up her electricity payment card and to buy a lottery ticket. She is filmed by the store's interior CCTV. She returns to work for short the afternoon session before leaving at 3.20 to collect the children from nursery and school. Arriving back at Draper House at 4.00 she accesses the tower with an electronic key fob. She charges up the electricity meter and then prepares dinner, while the children watch satellite television. At 6.30 she takes the kids to the playground next to tower block where she chats with neighbours for an hour. At 8.30 she puts the children to bed and at 9.30 her husband leaves for work. She watches television for an hour and then goes to bed herself.

Elizabeth

Elizabeth is in her late 20s and lives on her own in a one bedroom flat on lower Eldon Road, in Noel Park, near Wood Green in the inner suburbs of north London (Table 1). She works as an anaesthetist in St Bart's Hospital, near to St Paul's in central London. Elizabeth's day starts at 7am. After an hour of getting ready she heads out of the house and walks down Eldon Road, crosses Lordship Lane and walks along Moselle Street. At the end of the street she turns right onto The Broadway under the gaze of two private security cameras stationed above an estate agents. She waits at the kerb of Bull Road as three double decker buses pass, which unrecognised by her transmit their location to a small transponder box mounted on a lamp post that then updates the estimated arrival time on the 'Countdown' digital displays along the buses' routes. She crosses the road and walks past one such bus stop, another transponder, under the gaze of a cluster of six security cameras that provide full coverage of the front of a cinema and entertainment complex. She skirts a council information kiosk which gives details on local services, ignoring the electronic screen, and waits at the crossing of Lordship Lane for the traffic lights to change. On the other side of the road she waits at a short queue at Barclays Bank ATM and withdraws fifty pounds, her account

automatically being updated with the time, place and amount withdrawn and prints a receipt.

Just after 8.10 she heads into the Tube station. She waves her smart card ticket over a transponder and the ticket barrier opens, a debit is taken against her card and she is logged into the Underground monitoring system. Around her a cluster of five security cameras, part of the Underground's integrated passenger management and security system that covers the entire network, tracks her and the other customers' movements as she descends to the platform where four more cameras are located. After a couple of minutes wait, glancing up at an arrivals information display, she boards a south bound train, and standing, reads her book. For twenty minutes she travels on the Northern Line to Holborn where she changes to the Central Line, passing eight cameras as she wanders through the connecting tunnels between platforms and listening to the background noise of an automated security message not to leave baggage unattended. As she walks onto the platform an eastbound train arrives and she travels the short distance to St Paul's station where she again passes under the gaze of several cameras and exits, swiping her smart card ticket again to open the barriers. She reaches ground level at 8.40 and her mobile phone bleeps to let her know a text message is waiting. As she waits in the throng of commuters for the lights to cross Martin's Le Grand she uses her mobile to call her friend Sally about meeting up that evening. She crosses the road and as she heads up Newgate Street she chats away, turning into King Edward Street. Again she passes several security cameras before turning into the entrance of St Bart's.

She enters the hospital 8.55. After checking her internal mail, she gossips with colleagues, checks her schedule, makes sure her bleeper is activated, and then starts her rounds to liase with patients, first looking up their records on a computer database. As she passes through the hospital she passes under the gaze of a plethora of surveillance cameras and uses a swipe card to pass through doors that have restricted access. She leaves the hospital at 12.30 with a colleague and has lunch at Caffe Nero on Newgate Street, paying with cash. She makes two mobile calls to friends and rings up insurance company to query her home insurance bill. The insurance agent explains that the rate has been set using a computer package that uses demographic and crime data. She returns to the hospital at 13.20. In the afternoon she is on duty in theatre,

administering the anaesthetic to patients she consulted earlier. The effects of the anaesthetic and the progress of the operations is monitored by sophisticated healthcare equipment.

After a last minute bleeper call, she leaves the hospital at 5.12 and retraces her Tube route to Wood Green station. On exiting the station she crosses the road beneath a traffic cam and enters Safeway. She buys some groceries for her evening meal paying with an credit card, which logs her transaction and its location, and heads home. On opening the door she finds two letters and a small parcel on the doormat. One letter is an itemised mobile phone bill (which has been paid automatically by direct debit), the other a targeted junk mail inviting her to open another credit card account. The small parcel is two CDs from Amazon.co.uk plus a discount coupon as an incentive to buy other CDs selected by their customer profile system based on previous purchases. She cooks dinner using a microwave and watches some television before going online using a dial-up connection to check her email. After typing some responses and deleting some spam she looks up responses to her advert on an Internet dating service, the web pages for the local cinema to see what films are playing, and browses the BBC news site. At 8.15 Sally calls on her mobile and she heads out to The Goose pub near to Wood Green station to meet up with her and some other friends. She is filmed by the cameras on The Broadway and when entering the pub. She receives several text messages while with her friends. She returns home at 11.30.

John

John is forty eight years old, married with two teenage children. He lives in a large detached house in Chislehurst in the outer suburbs of south east London (Table 1). His day starts at 6.45 when the digital radio alarm clock sounds. After a shower, he dresses, has breakfast, and checks the mail. He has an electricity bill that has already been paid by direct debit. He then collects his laptop, PDA and 3G picture phone from his study and heads to the garage. Passing under the discrete CCTV camera they have mounted on side of garage to monitor the driveway. As he approaches the car, using a remote control he opens the garage door, and unlocks his BMW with a remote radio fob. On starting the car, the vehicle's management system undertakes a series of system checks.

He turns onto Manor Park and switches on the digital radio, automatically picking up real time traffic reports. He has his in-car navigation system turned off. He drives into the city centre along the A20, A2 and through the Blackwall Tunnel passing through a series of traffic cameras, red light cameras and speed cameras, responding appropriately. He receives a call on his mobile phone from the office in Singapore giving him a progress report on a merger negotiation. As he approaches Aldgate East a congestion charge camera recognises his license plate and automatically checks that he has pre-paid the fee. At Bishopsgate he passes into the 'ring of steel', a concentrated set of high security cameras that surround the City, again his license plate is again logged. At the base of his work place, a large office complex on Finsbury Square he turns into a small side street and a barrier raises in response to a transponder in the car. He drives into the subterranean car park, parking in a designated slot. He stands under a security camera, calls the lift using a swipe card and ascends to his office floor. He gains access to his corridor again using a swipe card. Once in his office he checks the fax and logs onto his computer to check email and docks his PDA to update his shared diary. At 9.00 he confers with his secretary to confirm his schedule and liase about work.

From 9.00 until 10.10 he answers email and takes a couple of phone calls. At 10.15 he moves to a small board room for a meeting. On the table is a speaker phone that connects the room to colleagues in Singapore. From 10.50 until lunchtime he works on compiling a report and producing tables and charts. For lunch he goes to lunch with a client to a small bistro where he pays for the meal with his credit card. In the afternoon, he catches up with his email, monitors financial transaction data, takes calls from colleagues and clients, and continues to write his report. At 4.30 he receives a text message from his wife to say that she and the children are going to the cinema. At 5.35 he uploads his updated diary to his PDA, shuts down his computer and heads up to the top floor to a private gym where he works out on machines equipped with fitness and health monitors. After showering he descends to the car park and heads out the city to his home, retracing his earlier route. On arrival, he enters the house and turns off the motion-sensor alarm system using a keypad. He connects his laptop to the broadband Internet connection and checks email from the New York office, replying where necessary. He then checks his share prices on a

financial website. At 8.00 his wife and children return. He and his wife retire to bed at 11.10.

Discussion

From the vignettes it is clear that while there are substantial differences between Naomi, Elizabeth and John in personal circumstances, income, employment, lifestyle, housing, and so on, in all three cases code is integral to how they perform incomplete solutions to ongoing relational problems. Rather than discuss each individual in turn, in this section we use the vignettes to discuss the transduction of space through code in relation to particular classes of problems – domestic living, travelling, working, communicating, and consuming.

Domestic living

In all three cases, it is evident that tasks and routines of everyday home life are augmented, mediated and regulated by code. For example, John is awakened by an alarm clock. Elizabeth cooks her evening meal using a programmable microwave while listening to the radio. Naomi and her children watch satellite television and play a computer game. Entertainment and play is increasingly reliant on transduction of coded objects. All of these coded objects are enabled by the localised grounding of several coded infrastructures. All three examples use electricity, which is delivered through a complex physical system that employs code in its operational management and which uses coded processes, for example for the purposes of customer billing. Other such coded infrastructures include satellite television and broadcast radio signals. These coded objects 'make a difference' in that they transduce what is primarily backgrounded coded space (as a result of the electricity) into code/space while they are being used (e.g. the computer game fails to be playable if the code fails).

While the use of code here is enabling, it facilitates cooking and entertainment, in other cases code is used in domestic settings to regulate and discipline. This is most obviously revealed when Naomi checks the status of her prepaid electricity meter to determine whether the payment card needs topping up. Here, the code disciplines her use of electricity against her means to pay. In Elizabeth and John's case, their use of domestic utilities are monitored centrally and the bills (or receipts if direct debited)

mailed to them. Further, both Naomi's and John's homes are subject to a different kind of surveillance. In Naomi's case the entrance to the tower block is surveyed by cameras linked into a wider public housing surveillance network. John's home is protected by a alarm system, with software monitored motion sensors, networked into a private security company who will respond to its activation if it is not turned off within thirty seconds of someone entering the house.

Surveillance systems can be seen as a key assemblage in the 'societies of control' (Haggerty and Ericson 2000), of which video surveillance is a key form of coded infrastructure that, because of its growing pervasiveness, is featured in all classes of problems, relating to public space (e.g. on the street; road traffic), semi-public space (e.g. shopping mall; public transportation; hospital; pub), and private space (e.g. home, office building). A recent statistic is that on a typical day the average person living in London is 'filmed by over three hundred cameras on over thirty separate CCTV systems' (Norris and Armstrong 1999:42). McCahill and Norris (2002:20) make an educated 'guesstimate' that there are some half a million cameras in London, giving around one camera for every fourteen people. The geographical distribution of cameras across space is uneven and their level of ownership and technical sophistication also vary (Graham 1998, 2002). Most are basic analogue systems (and may not even be recorded), some are dummy cameras hoping to exploit the deterrent effect, and others are networked systems. In the later case, these are highly coded infrastructures, increasingly built around software algorithms to sort and classify the observed. Surveillance in different contexts is discussed further in each of the following sections.

Travelling

The movement of people and goods is essential for society to function. Even though all three of our cases used different modes of travel throughout the day - walking, Underground train, lift, escalator, car - all three's journeys were at some point facilitated and regulated by code. In the case of Elizabeth's use of the Underground and John's use of car transport, these transport systems have become dense assemblages centred around a particular coded infrastructure. Here, code is primarily employed as an operational management/control related (e.g. payment, flow, maintenance) or surveillance/regulation related (e.g. security, safety,

taxation/licensing) tool. These functions are often highly interlinked, so that management is augmented by surveillance that not only monitors flow and speed, but aims to discipline passenger and driver behaviour.

The London Underground network handles 3 million passenger journeys daily and is a transportation system that is reliant on code for its complex day-to-day operation on over 253 miles of track and 275 stations, from the ticketing of passengers (payment by credit/debit card or Elizabeth's use of a smart card or the validation of tickets at station turnstiles) to the operation of lifts and escalators; track management using a transponder system that monitors the real-time location of trains; control and monitoring of signalling; fire and smoke detection and alarm systems; displays that update passengers on the arrival of trains; the computation of timetables and routes; staffing schedules; revenue and account databases; and embedded code in the trains themselves. Further, Elizabeth is subject to the gaze of a raft of networked surveillance cameras that monitor the entrances, passageways, platforms and train carriages. These are accompanied by automated, loud speaker security messages that play every few minutes. As a result, as Elizabeth traverses the foyers, escalators, passageways, and trains of the coded assemblage of the underground, she (and her fellow passengers and staff), beckon into being a mix of coded space and code/space as a series of collective transductions. The London bus network consists of a similar assemblage.

John likewise travels through a road system that is increasingly managed and surveyed using code. Strategic planning is done using traffic simulations and software models of the road system; road maintenance and upgrading is planned using a GIS. Transport for London[5] have network of 45 cameras in order to monitor and co-ordinate traffic flow at strategic locations. This system also feeds the media with congestion reports and to update its website. Traffic light sequencing is controlled via a comprehensive traffic management system. This is augmented by speed cameras (there are approximately 650 speed cameras on London roads; McCahill and Norris 2002), mobile speed camera vans, red-light cameras, bus-lane and bus mounted cameras that aim to discipline driver behaviour (in these cases from not driving too fast, not jumping red lights, and not occupying bus lanes). Most of these cameras are networked and use an Automatic Number Plate Recognition (ANPR) system to

pattern match license plate numbers with owners and automatically print and post fines. Because John is driving to the centre of the city, he is also subject to two special systems. The 'ring of steel' consists of a sophisticated set of surveillance cameras that continuously monitors *all* traffic entering and leaving the City (the financial services area of London), introduced after IRA terrorist attacks in 1993. In addition, eight square miles of central London is regulated by a congestion charge introduced in February 2003, again monitored and coordinated using a set of 688 networked cameras at 203 sites[6] that uses a centralised ANPR system to ensure payment. Even the final few yards of John's journey is regulated by a transponder-operated barrier into his office car park. Further, John's car is a sophisticated coded infrastructure reliant on an engine management system, and augmented by digital radio that updates him with real time traffic reports and an in-car navigation system that plots his position and can guide him along a route. Such is the 'power' of the code within the engine management system that if the system fails, the car will not function. John's use of the car is also mediated by coded processes related to driving licenses, vehicle ownership, insurance, road tax, road worthiness. Similar to Elizabeth's use of public transport then, John and his fellow drivers, beckon a mix of coded spaces into being. Thus all mechanised elements of mobility in large Western cities are coded to some degree and the level of coding is increasing as more and more sophisticated telematics schemes are designed and deployed in an effort to 'fix' the capacity constraints in congested urban areas.

While the walking of Naomi and Elizabeth is not subject to active management via code, they are subject to the disciplinary gaze of a variety of public and private cameras that survey the street and underpasses. These cameras while producing a high coded space are little noticed by either woman due to their familiarity and their effect on the individuations of spatial behaviour is minimal. As such, in this case, while the code does affect the transduction of space, the awareness and impact of this transduction is low. That said, without surveillance both women might feel less safe and more insecure as they traverse the city, and might have taken different routes (see Koskela 2000 for discussion). Moreover, this is not to say that the street is not managed by a number of overlapping coded processes (e.g. local government software for scheduling of street cleaning and GIS inventory for signs and street furniture, pollution monitoring, police databases on street crimes, etc) and coded

infrastructures (e.g. computer managed street lighting, centrally controlled sequencing of pedestrian crossing lights, and so on).

Working

The workplace is an environment that is increasingly reliant of code, with most workplaces (particularly large organisations and multinationals) nodes in an extremely complex and dense assemblage of coded infrastructures and processes. These include utilities, logistics networks, customer, employment and product management systems, intranets, and so on. Code is now the structural 'glue' that binds distributed and distanciated corporate activities together. In all three of our vignettes, the jobs performed - the transduction of workspace - is highly code dependent, with large portions of their day consisting of code/space. For example, Naomi spends most of her day sat at the checkout scanning barcodes, updating loyalty cards, and processing customer payment by credit/debit cards. In the first two cases, the barcodes are the visible component of complex coded processes and provide data important for logistics and store stocking and for customer profiling. Elizabeth uses code dependent specialist machines for monitoring patients in theatre and coded processes for looking-up and updating patient health records. John uses a computer to compile a report, a PDA to organise his meetings and transport files, and a company intranet to monitor the financial markets and the trading of stocks and shares. Moreover, all three work in environments that are heavily surveyed. Naomi's store employs surveillance cameras in the shopping area, the stock rooms and loading bays, her use of the till is monitored (indeed, a number of companies now monitor number of key strokes, length of breaks, telephone calls, email and review computer files, see Ball and Wilson 2000), the customers credit/debit cards are checked for their status and balance. Elizabeth and John have to use swipe cards to gain access to certain parts of the hospital or office building, respectively, which means all movement can potentially be logged, tied to individuals records and recalled and analysed at some future time. All three gain access to the computer systems they use using usernames and passwords. For Elizabeth and John code-dependent communication, using email, phone, fax, is also a vital component of workplace practices.

Communicating

Code is absolutely central to the operation of communication infrastructures, many of which exist purely as a result of developments in software engineering. In all three vignettes, with the exception of face-to-face conversations, all communication between people took place via the coded infrastructures of telecommunications: mobile phones, conventional phones, fax, pagers, email, video conferencing. As noted by others, these technologies have profound impacts on space-time by allowing instantaneous communication across distance, and in the case of mobile phones and pagers between moving devices. The latter enables 'always-on' communication that is transforming work and leisure practices, and is engendering new spatialities. For the duration of any call a transduction of code/space occurs as the call alters individual performativity at the time a call is initiated or answered until the call is terminated with regards to the activity they were undertaking, such as walking, driving, shopping, and so on. Consequently, any call, text, page, fax and so on means a transduction of code/space, with this transduction occurring simultaneously at the two places connected. For example, Elizabeth's phoning of her friend Sally led to a simultaneous transduction that altered the performativity of Elizabeth's walk to work and whatever activity Sally was doing when she received the call. In the case of text, a transduction occurs for one party when sent, and the other when read (see Adams (1995) on issues of technology and human extensibility).

While the above communication infrastructures are entirely dependent on code, the delivery of conventional mail has also been massively augmented by code. Given the depth of embedding of code into mail systems, code has become vital to the day-to-day sorting and delivery of mail. Interestingly, most conventional mail now consists of bills and statements related to coded processes, along with junk mail targeted by customer profiling and geodemographics, as illustrated by the delivery of Elizabeth's books and targeted vouchers, and John's utility bill.

Consuming

Consumption increasingly consists of the intertwining of the coded assemblages of financial services, logistics, and shop/leisure facilities. Elizabeth's use of an ATM connects her into the bank's coded infrastructure and uses coded processes to assess her status and dispense cash. John's use of his credit card to purchase lunch performs a similar operation. Naomi's use of electricity is defined by how much credit has

been charged onto a payment card. These coded dealings leave a personal, digital, traceable trail of transactions, as opposed to Elizabeth's cash purchase of lunch (although this transaction appears in the coded processes related to the café such as VAT returns). These transactions are constructed into a product in the form of customer profiling and geodemographics and used in marketing campaigns (hence Elizabeth's targeted marketing and John's junk mail). (See Goss 1995; Curry 1997 for discussion of some of the implications of geodemographic profiling) In addition, purchases are increasingly tied into stock and logistics systems that track sales and place orders. Consumption of services and leisure themselves now occur across coded infrastructures. Elizabeth buys her insurance by telephone, she buys books and checks her dating agency service online, she consumes other webpages. Naomi buys a lottery ticket using a dedicated intranet accessed via a shop. And conventional leisure services are now augmented by code, such as the monitors that track John's performance and health in the gym. The spaces of consumption are also coming more and more under the gaze of surveillance with in-store, networked cameras a common occurrence, though in most small stores they are non-networked, analogue systems. In all these cases the transduction of space is directly shaped by code.

Conclusions

> 'Transduction aids in tracking processes that come into being at the intersections of diverse realities. These diverse realitites include corporeal, geographical, economic, conceptual, biopolitical, geopolitical, and affective dimensions. They entail a knotting together of commodities, signs, diagrams, stories, practices, concepts, human and non-human bodies, images and places. They involve new capacities, relations and practices whose advent is not always easy to recognise' (Mackenzie 2002:18).

'[T]echnicity and transduction account for how things become what they are rather than what they are' (Mackenzie 2002: 16). Here, the focus shifts from ontology (what something is) to ontogenesis (how something comes to be), hence in this paper we have been interested in the ontogenesis of space through technically mediated, an in particular coded, transductions. From this perspective, space is a continuous process

of matter-taking-form as divergent realities - technical and non-technical, human and non-human, living and non-living - constantly come into contact to transduce new spatial formations. In this case, those divergent realities have primarily constituted code, technology, people, and environment.

For us, Mackenzie's development and extension of Simondon's concepts of transduction and technicity provides a useful means to think through the contingent and relational relationship between humans and technology, and how that relationship is mutually constituted in a generative process. In turn, we have tried to advance these ideas with respect to space and in particular the role of code in collectives. Our premise has been that space is constantly being bought into being through transduction 'as an incomplete solution to a relational problem'. In the three vignettes we detailed, the relational problem was an ongoing encounter – navigation, negotiation, management - between individual (Naomi, Elizabeth, John) and environment (home, work, public space) and the solution, to a greater or lesser extent, was code. Code is, we believe, diversely embedded in collectives as coded objects, infrastructure, processes and assemblages. When the technicity of code is operationalised it transduces space to that of code/space (wherein the transduction is dependent on code) or coded space (wherein the transduction is mediated by code, but code is not fundamental). In the case of background coded space, code has the potential to mediate a solution to a problem if activated. As the three vignettes illustrate, the pervasiveness of code means that code is increasingly central to many different transductions of space and the constitution and life of collectives. While we have sought to provide an initial analysis, this pervasiveness warrants extensive further investigation.

We believe that re-thinking space as ontogenesis provides a way of theorising the complex spatialities of collectives in a way that is sensitive to relationality, contingency, indeterminacy, and extensibility, and which recognises the generative nature of spatial formations and relations. Importantly for us, conceiving of space as an ontogenesis does not deny the salience of structural forces such as political economy or institutional structures such as the state, rather it views them as also ontogenetic in formulation, similarly always in a state of becoming and composed of relational, contingent and citational discursive and material practices. These

structures do not sit outside of collective life, they are (re)made through its performance providing citational context at the same time as they are perpetuated. While we have made a start in this paper to think through how space is transduced, the challenge is, we believe, to develop this initial foray both theoretically and empirically; to rethink the diverse ways in which space is bought into being.

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Table 1: Geodemographic details of the three vignettes based on their residental postcode location
(Source: ACORN geodemographic, produced by CACI, from http://www.upmystreet.com)

Vignette	**Naomi** (postcode - SE1 6SX)	**Elizabeth** (postcode - N22 5DT)	**John** (postcode - BR7 5QE)
ACORN type	Type 47: Estates with high unemployment	Type 38: Multi-ethnic areas, white collar workers	Type 1: Wealthy suburbs, large detached houses
Socio-economic profile	The unemployment rate is nearly double the national average. The proportion of people working in the service sector is 14% above average, and there is a correspondingly lower than average proportion of manufacturing workers. The level of secretarial and clerical workers is 28% higher than average. There are also 61% more unskilled workers than average. The proportion of people travelling to work by public transport is 2.7 times higher than average; in particular, 3.6 times more people than nationally travel to work by train.	The unemployment rate is 56% higher than average. The proportion of people working in the service sector is slightly above average, but there are 30% fewer than average manufacturing workers. There is a broad mix of occupations across the socio-economic scale, but the largest concentration is in the skilled, non-manual category. There are also above average numbers of students in these areas. Public transport is the dominant mode of travel to work; in particular, the proportion of people using rail is 4.7 times higher than average.	ACORN Type 1 comprises a highly educated population - almost 3 times the national level of residents have degrees. In terms of employment, these are largely professional and managerial people. Unemployment is around a third of the national level.
Durables	Car ownership levels are very low - 64% of households have no car. The proportions of new and expensive cars and company cars are very low. A number of durable products are purchased at above average rates by people in these areas - computer games, microwaves, washing machines, washer/dryers, tumble dryers and fridge freezers. Other products are purchased at well below average rates. Home improvement activity is practically non-existent.	34% fewer households than average have a car. Company car ownership is 29% higher than average. Typically, cars are small, 2-4 years old and costing under £10,000. People in this ACORN Type are more likely than average to purchase the following Durables: hardback books, computer games systems and games, video cameras and ski clothing. Purchase rates for most household Durables are very low, with the exception of fridge freezers. The proportion of homes having secondary glazing fitted is 50% above average.	Levels of car ownership are very high: there are 3.5 times the national level of households with 3 or more cars. Cars are likely to be new, large and very expensive. The proportion of cars costing over £20,000 is nearly 10 times higher than average and the proportion of 2500cc+ cars is nearly 4 times higher than average. The incidence of company cars is also above average - at 13%, this is 3 times higher than the national rate. There is not a great deal of home improvement activity in these areas. Purchase rates of white and brown goods are average. Installation rates for new central heating and double glazing are well below average.

Financials	Although there are 37% more people than average with incomes under £5,000 per annum, over a quarter earn more than £25,000 per annum. Ownership of Financial products is very low, and there are scarcely any new current or savings accounts being opened.	The income profile of these areas peaks in 2 places. The proportion of people earning £10-15,000 per annum is slightly above average, and there are 47% more people than average earning £30-40,000 per annum. Ownership of Financial products is generally lower than average - much lower than might be expected, given the income profile. The rate of new savings account opening is 32% above average, while people are 15% more likely than average to have a mortgage from a lender other than a building society.	These are extremely high income areas - the proportion of households earning more than £40,000 per annum is 5.4 times higher than average. Ownership of National Savings Certificates is 2.8 times higher than average, and there are also well above average holdings of stocks and shares, all plastic cards and personal pensions.
Media	The proportion of homes with cable television is over double the average, but satellite television ownership is 5% below average. Readership of daily newspapers is concentrated basically on 2 titles - The Mirror and The Sun. The Sunday papers with the largest readerships are The News of the World, The Sunday Mirror and The Sunday People but The Observer is read by twice as many people here as average. Both ITV viewing and commercial radio listening are heavy.	The number of homes with cable television is almost 3 times higher than average, while satellite television penetration is 10% up on the average. A wide range of newspapers are popular in these areas. Readership of The Independent is 2.3 times higher than average, while that of The Guardian, The Mirror and The Sun are all around 60% above average. All the national Sunday titles except The Sunday Express and The Mail on Sunday have higher than average readerships. ITV viewing is light, but commercial radio listening is heavy.	By far the most popular daily newspaper is The Telegraph, which has a readership level 3.5 times higher than average. The Times is read by almost 5 times more people in these neighbourhoods than nationally, and readership of The Financial Times is also over 3 times higher than average. The most widely read Sunday newspaper is The Sunday Times, which is read by 3.3 times more people in this ACORN Type than nationally. The readership of The Sunday Telegraph is 4.2 times higher than average and both The Observer and The Independent on Sunday are more than twice as popular as nationally. ITV viewing levels are very low, with 57% of people classified as light viewers. Commercial radio listening levels, however, are average.

Leisure	50% of people do not take holidays at all. Those who do are 31% more likely to go to a far- flung destination. Their propensity to visit pubs, clubs and wine bars regularly is roughly average, but they are much less likely to eat out. Participation rates for most sports are very low, but football, cricket, fishing and table tennis are more popular than average. Activities which are extremely popular are betting, bingo, darts and snooker.	The proportion of people taking holidays is about 13% less than average. People who do go on holiday, however, are much more likely than average to go away in the winter, to take a long holiday and to go to far-flung destinations. People are less likely than average to go to pubs, clubs, wine bars and to eat out during the day. Their propensity to eat out in the evenings is average, and a wide range of restaurant types are popular. Italian and British cuisine is less popular than average in these areas though. These are very active, busy people. Sporting and other activities which are particularly popular with people in ACORN Type 38 are: running, cricket, athletics, squash, skating, skiing, climbing and going to the cinema and art galleries.	Winter holidays and long holidays are very popular, and the proportion of people holidaying in their own holiday home or timeshare is over 3 times higher than average. Gardening is a popular activity. People are less likely than average to go to pubs, clubs and wine bars, but much more likely than average to eat out, with French, Italian and Greek cuisines all being highly favoured. People in these neighbourhoods are very active, with above average participation rates in many sports. Tennis, skiing, sailing, windsurfing and ten-pin bowling are particularly popular. Theatre attendance is over twice the national rate and people are much more likely than average to visit stately homes.

[1] E.g. negotiating barriers or complex systems such as the Underground.

[2] Whereas navigation and negotiation refer more to individual problems, management also refers to the problem for managers in managing large number of people using an environment.

[3] It is important to note that while the code might 'fail' in terms of providing a specific transduction, another transduction is initiated by this 'failure'. In other words, there is no failure but rather an alternative modulation.

[4] Much of the infrastructure of the utilities has evolved over many decades as a patchwork of systems have been installed, upgraded and interlinked. Their true extent and complexity remain largely hidden from public view (see Clayton 2000).

[5] Details from Transport for London, http://www.tfl.gov.uk/tfl/capitalcams/index.shtml (accessed 30 July 2003).

[6] Details from Congestion Charging fact sheets: camera enforcement, Transport for London, http://www.tfl.gov.uk/tfl/cc_fact_sheet_enforcement.shtml (accessed 30 July 2003).