Tracking and tracing: geographies of logistical governance and labouring bodies

Anja Kanngieser

Department of Geography, Royal Holloway, University of London, Egham,
Surrey TW20 0EX, England; email: akanngieser@yahoo.com
Received 8 December 2011; in revised form 27 December 2012

Abstract. Shifts in the production of national and global territories have coincided with new forms of biopolitical governance and surveillance, producing a simultaneous expansion and contraction of spatial and temporal mobility. In the logistics industries the mainstreaming of Radio Frequency Identification, the extended monitoring networks of GPS telematics, and the implementation of voice picking in warehouses have all had significant impacts on the mobilities of labour. Given the increasing scholarly interest in logistical geographies, this paper investigates these three advancements put to use for the regulation of bodies in the market environments of global capital from a techno-historical perspective, to provide a frame for further discourse on global supply chains, labour struggles, and security cultures.

Keywords: RFID, voice picking, GPS, surveillance, bodies, logistics

Introduction

"What you don't need is more information. You need information you can use."
<div align="right">Chief Executive of GS1, the standardisation body for barcodes and
Radio Frequency Identification (RFID); in Nusca (2011)</div>

"A 'political anatomy', which [is] also a 'mechanics of power' [defines] how one may have a hold over others' bodies, not only so that they may do what one wishes, but so that they may operate as one wishes, with the techniques, the speed and the efficiency that one determines."
<div align="right">Michel Foucault (1977, page 138)</div>

At the end of June 2012 Google released a Maps Coordinate tool to follow workers. The phone application was devised to allow employers to monitor the geolocation of workers in real time. Given the voluminous use of Google maps, said to attract an estimated 1 billion users a month, and the growing mobile workforce, estimated to be around 1.3 billion by 2015—over one third of the global workforce—it was unsurprising that Google expressed confidence that its tracking application would be picked up across the industry spectrum (Griffith, 2012). Google is not unfounded in its assertion; the ability to govern the movements of workers has long been the prerogative of employers, especially in the logistics industries. This has grown more acute in terms of both the technologies and the velocities of surveillance and control. A recent white paper entitled "Corporate irresponsibility: Deutsche Post DHL's global labour practices exposed" (ITF and UNI Global Union, 2012) outlined some of the concerns felt by workers in an industry typified by precarious labour conditions. Not only were violations occurring around freedom of association with union groups and breaches of health and safety laws, employers were adopting stricter monitoring activities including the use of lie detector tests in the warehouses and transport sectors in Colombia, Costa Rica, and South Africa. That inequitable labour conditions are rife along the supply chain is well known and has already been the subject of much discussion (Bonacich, 2005; McClelland, 2012; Sealey, 2009).

However, less visible are the technological systems and calculative regimes implemented to ensure the expedient circulation of capital along the chain.

This paper seeks to make visible some of these systems and regimes. While the interests of geographers have been captured by new technological innovations in the realms of (often urban) space and data consolidation (Crampton and Elden, 2006; Rose-Redwood, 2006) and surveillance (Der Derian, 1990; Graham and Wood, 2003), accounts of mobile and digital technologies to manage workers within logistics industries are lacking. This is a critical area for enquiry, not only because of the immediate interplay of technology, surveillance, and labour, but also because of the larger issues around the composition of workplace geographies as spaces of biopolitical control (Crang, 1999; Sharp et al, 2000), as the Google Maps Coordinate tool anticipates. I contribute a crucial perspective that brings the apparatuses of tracking to light and the effects they are having on the everyday experiences, bodies, and velocities of workers. I begin by situating the contemporary context within reconceptualisations of global and national space through market governance. I link these shifts to a rise in both logistical and informational economies. Drawing on literature that explores the connections between technology and lifeworlds, I argue that instrumental to the current logistics paradigm is the technological extension of governance onto the registers of bodily movement and expression. This form of electronic governance, which acts to redefine and normalise behaviour, displaces traditional disciplinary control (Graham and Wood, 2003). By assembling the histories of three of the most ubiquitous technologies found in the logistics industries, I aim to bring attention to some of the advances in sensing and recording techniques conjunctive to the transformations of macrogeographies and microgeographies of supply chain capital and its management.

Geoeconomics, surveillance, and the regulation of the labouring body
The logistics industry is part of a global process of geoeconomic redefinition. The production of national space has been of interest to geographers for decades (Bowman, 1942; Lewis and Wigen, 1997; Ó Tuathail, 1996), as have the newer lines and flows of territorial space in neoliberal capitalism (Agnew, 1998; Harvey, 2006; Sassan, 1991). More recently, there has been growing awareness of the formation and management of national and international border zones through supranational firms and supply chains (Coe et al, 2010; Cowen and Smith, 2009; Tsing, 2009). Within this paradigm we have witnessed significant changes in the geographies of governance. Put more precisely, the ways in which territories are being demarcated, and the control of these demarcations, are changing. The acceleration of the modern logistics industries since the Second World War has emphasised the mutability of nation-state borderlines (Aoyama et al, 2006). The particularities of neoliberal capitalism and the proliferation of supranational trade have necessitated an expression of control through logistical flow rather than through geopolitical territory; at stake is the differential transit of people, commodities, capital, and information across and through nation-state boundaries through the management of global supply chains (Allen, 1997; Busch, 2007).

According to Deborah Cowen, there is an increasing "tension between geopolitical and logistical models of spatial calculation" (2010, page 602). This tension arises in part through shifting parameters of border demarcation and an increase in border turbulence (Cresswell and Martin, 2012). For Cowen and Neil Smith (2009), traditional conceptions of geopolitical space are incapable of understanding contemporary national and transnational configurations. They suggest instead a principle of geoeconomics, which is attenuated to the logics of market rule and the ways in which space is regulated beyond the authority of national institutions (Smith, 2005). This is not to say that territoriality has become obsolete, rather that space is recast through logistics toward what Cowen calls "the production of space beyond territory" (2010 page 615). This notion is vital to an understanding of logistical governance.

Discourses of geopolitics have historically been conditional on nation-state authority. The processes of globalisation have complicated this, destabilising the historical symbiosis of national economic, political, and social securities (Cowen and Smith, 2009). In the contemporary situation, the conflict between national borders and global trade is leading to the rebordering of geopolitical terrain through the shifting and mobile spatialities of security (Aoyama et al, 2006; Cowen and Smith, 2009). The logistics industry has been influential in the ways that nation-states formulate security, so much so that it functions more as a forerunner than supporter in corporate and national security strategy (Cowen, 2010, page 602). The logistical systems of supply chains challenge the political and spatial logics of territory, moving anxieties about the disruption of trade from the economic realm to that of security.

Perhaps most important here is the impact that security cultures, logistics and political regimes and technologies of control have on the spaces and movements of labour (Cowen, 2010). The expansions and contractions of national and international borders, such as the maritime border, through the global logistics industries have reshaped citizenship and labour rights, in part through the conflicting demands of national security and trade. In conjunction, the growing collusion between private–public realms has radically altered traditionally perceived regions (Agnew, 2008; Gertler, 1992; Sparke, 2006). The effects of these global processes play out on multiple levels, from the geoeconomic to the cultural and the corporeal, and requires a sensitivity to scales of internal and external differentiation (Neilson and Mezzadra, forthcoming). The multiscalar dynamic is paramount, especially the ways in which internal differentiation becomes clear through all aspects of governance within territories, delineating 'bad' subjects from 'good' and marking out spaces of control that are no longer exceptional but permeate everyday mobilities. This is correlative to contemporary security cultures, which are no longer modelled on direct supervisory techniques such as that of the panopticon tied to its reliance on vision but, as Foucault makes clear, have become more about automated scaled control than "exhaustive surveillance" (2007, page 66).

The augmentation of security cultures has gone hand in hand with the technoscientific advances of the logistics industries (Cowen, 2010, page 613). As this paper will show, the rise of complex and networked global supply chains has coincided with a calibration of technologies used to monitor not only the consignments within those chains, but also the workers and machines that move them. Over the last decade, supply chain management has been employing information and communications technology (ICT) hardware and software to optimise performance and production. Through the logistics of transit and warehousing, just-in-time processing demands the capacity to determine and standardise the speed, rhythm, and flow of commodities and people. In this state the promotion of a particular kind of regulatory power is exercised on the level of life through the regimentation and increased velocity of each working moment. The management of bodies and commodities now encompasses the entire spectrum of movement, from the minute gestures of box packers and the pathways of cranes in the warehouse, to the rest breaks of freight drivers, the call content and duration of call centre workers, and the passage of commodities shipped around the globe.

The collusions of security and logistics can be tied to a new "paradigm of informationalism" (Holmes, 2011), the inception of which coincided with the development of the networked computer in the 1960s. According to Brian Holmes, the advancements of ICTs are inseparable from global labour processes typified by a spatial and temporal intensification of production, management, and distribution practices. It is even further apparent through the vast spatial redeployment and georegulatory change of globalising processes seen in the economies of India and China, and the outsourcing and offshoring of production into Asia, Africa, Eastern Europe, and Latin America (Hudson, 2000; Massey, 1995). This also plays out in terms of digital governance: the encoding of software to automatically determine access, risk, and punishment occurs far away from the point of actual contact, as increasingly does data

handling and interpretation, creating both space–time distancing and compression (Graham and Wood, 2003). In this condition information becomes not only a critical commodity but an administrative technique across all scales of life, resonant with what Nigel Thrift has termed "lifeworld inc." (2011).

The operation of technology in the informationalism and securitisation of labour and global production systems is critical at this time. However, as Cowen points out, while there has been interest in the cartographic functions of mapping and modelling in human geography (Elden, 2007; Lefebvre, 1991), "technical transformations in the conceptualization and calculation of the economic space of globalized capitalism have been almost entirely neglected outside the applied field of business management" (2010, page 612). By bringing the registers of technology, industry, and the military to questions of labour and governance, we can begin to think through the disciplining of logistics workers within the broader conditions of national and international security, migration, and biopolitical power. Such attention to the technological aspects of these global spatial and temporal shifts requires us to unfold the materialities and imbrications of apparatuses, bodies, labour, space, and social and economic reproduction (Bingham, 1996; Wilson, 2011) and look to objects and their mobility to help map out relational topologies (Latour, 2005; Law and Mol, 2001).

This paper analyses three technologies: RFID tagging, GPS (Global Positioning System) telematics, and voice-directed order picking. Looking at these, I discuss how they function, their historical–technical contexts, and their interactions with labouring bodies. Two sites provide illustration, the United Kingdom and the United States of America, chosen largely for the strong responses sounded out by trade unionists, workers, and legal and political scholars. Such constituencies are determining counternarratives to the transnational corporations and industry enterprises applauding these apparatuses for their high return on investment. They have also been chosen because of the significant role they have played in the development, dissemination, and normalisation of tracking and tracing cultures.

While there is research being done on global supply chains and spatial reconfiguration (Harvey, 2006; Hughes and Reimer, 2004), and some notable scholars in geography such as Cowen (2010) are looking to the securitisation of these chains and production flows, what can be further contributed is a focus on the technologies themselves, and their deployment to track and trace workers by constantly tying them to territorial and temporal location. This is nothing new; we can easily recall Foucault's accounts of liberal regimes of power and the evolution of the military and logistical sciences. What is new is the refinement of technologies to build microgeographies of surveillance that are precisely mapped out through bodily movement and rhythm, a "hyper-coordination" (Thrift, 2005) of Taylorist motion management (Adey, 2009; Cresswell, 2006). Key here is how developments in bio–techno–disciplinary techniques are refining the spatial and temporal existence of bodies, what Foucault referred to as the "temporal elaboration of the act" (1977, page 151), through a "positive economy" (page 154) of time that seeks the intensification and maximisation of efficiencies.

The technologies under investigation illustrate how this kind of hyper-coordination takes place through assemblages of mechanical devices and digital hardware and software designed to recognise a range of individual bodily rhythms and speeds. This is part of the "new doctrine of bodily signs" explored by Thrift (2011, page 10), who suggests the need for a "physical geography of bodily interactions". I would propose that a geography of bodily interactions would bring much to an analysis of labour and surveillance, and may act to further reveal the political implications of such a condition (Bigo, 2006). The information abstracted from the bodies of workers is translated into categories and definitions (Adey, 2004) that serve to delimit the subjectivity of workers from their labour output; the use of such technologies can reinstate lines of racism and ableism through the selective compilation and interpretation of data. However, this differentiation is often obfuscated; as Stephen Graham and David Wood

point out, "digital surveillance systems tend to be developed, designed and deployed in ways that hide the social judgements that such systems perpetuate" (2003, page 242). Technologies such as those examined here are employed by market rule discourses that stratify productivity over labour rights, and the definition of strict parameters of movement suggests that anything beyond these parameters constitutes disruption and failure. The framing of the unimpeded flow and security of commodities in the same breath as the unimpeded productive movements of workers requires ongoing engagement with the political prospects of these surveillance regimes. The mechanisms put to use within logistics warehousing and freight can illuminate something of the ways in which contemporary forms of capital are remaking geographies of production, management, and distribution through spatial calculation that articulates itself across geoeconomic, corporeal, and virtual scales.

I Radio Frequency Identification

> "The conception of a control mechanism, giving the position of any element within an open environment at any given instant (whether animal in a reserve or human in a corporation, as with an electronic collar), is not necessarily one of science fiction."
>
> (Deleuze, 1992, page 7)

Surveillance has been broadly defined by David Lyon as "any collection and processing of personal data, whether identifiable or not, for the purposes of influencing or managing those whose data have been garnered" (2001, page 2). We might begin with RFID, as it is perhaps the most ubiquitous and multipurpose technology for tracking and tracing contemporarily available. In supply chains RFID allows for the pinpointing of consignments as they pass through the entire production and distribution process, from the factory floor to the consumer. Resonant with what Deleuze identifies as elementary to 'control societies', RFID is a system of electronic tagging, which is used to identify and trace animate and inanimate objects and beings, and store information. It comprises three parts: the microchip tag, the receiver, and the back-end database required to manage the data from the tag. Its instantiation came from the early combination of radio broadcast technologies and radar. A notable innovation was its use by the British Royal Air Force during the Second World War to differentiate friendly aircraft from enemy aircraft (US Department of Commerce, 2005).

The late 1960s saw the first commercial applications of RFID, by corporations such as Sensormatic and Checkpoint, in the form of electronic article surveillance used to tag clothing against theft, which was expanded in the 1970s (Roberti, 2007). It was during the research and development boom in the 1970s that applications such as the tracking of animals, vehicles, and factory automation came to the fore. At the same time, tag size was decreasing and improvements in functionality allowed for the mass implementation of these technologies in the 1980s, resulting in the mainstreaming of RFID (Landt, 2005). In the USA tagging was deployed predominantly for transportation and personnel access, while in Europe interest remained with the tracking of animals, as well as in industry and business. An important factor in this global expansion was the coincidental advancement of the personal computer, which was crucial to the assemblage and analysis of the data being produced (Land, 2005).

Notable for the logistics industries and transportation was the implementation of RFID in tollways, expanded across the USA and Europe in the late 1980s and early 1990s (Bidgoli, 2009, page 242). This necessitated protocols for the standardisation of RFID, especially in the pan-European context, but also more globally.[1] Toll and rail applications quickly followed in Asia-Pacific, South America, Europe, and South Africa. The multiple use of a single tag (ie, for toll collection, entry to gated communities, parking lots, and so forth) ensued, linking

---

[1] As with much global standardisation, this has encountered various issues and permutations: see Adhiarna and Jae-Jeung (2009), CASAGRAS (2010), and Gerst et al (2005).

together different business ventures (Landt, 2005). In the 1990s a breakthrough occurred that saw the integration of RFID into supply chain management and article location, namely the shift to microwave tags with a single integrated circuit, resulting in a reduction in size and cost at the same time as an increase in functionality (Hunt et al, 2007). The use of RFID to individually identify an item surpassed the limitation of the barcode to identify only the brand and type of item, as did its ability to be read through surfaces, requiring no line of sight on a mass scale. The continued physical contraction of the tag, of late seen in the new adhesive 'smart labels', as well as ongoing decreases in cost, has seen unparalleled consequences for the inventory of goods, as Wal-Mart's logistics juggernaut shows (Brunn, 2006; Supply Chain Digest, 2009).

What is extremely noteworthy is the migration of a logistical logic, originally focused on the movement of resources and (non)human bodies, to the monitoring of workers within those industries (and beyond). What is at stake here is an equivocation of agency between workers and the objects they are required to move along the supply chain. As one can imagine, the use of wireless technology such as RFID and real time location systems has had significant effects in the workplace. Tags have been embedded in workers' accessories, such as ID cards and clothing, to authorise access and to oversee the use and movement of items and people around the premises (Pagnattaro, 2008, pages 241–243). Over the past several years stories have emerged of employers requiring employees to embed tags, such as the VeriChip, under their skin. The oft-cited example of the Mexican Attorney General implanting himself and 160 of his staff with rice-sized RFID chips in 2004 to regulate access in his offices stands as a good indicator of how even relatively early on the use of RFID has crossed into biometric terrains (Weissert, 2004).

While RFID tags are themselves privacy neutral, much has been written on the legal issues surrounding their application (Balkovich et al, 2005; Roth, 2006; Smith, 2007; Weinberg, 2008). According to Marisa Pagnattaro, the predominant concerns about RFID as a means to track employees can be categorised in three ways: "surveillance by any person with access to the reader or database, 'profiling' or maintaining a profile on a 'target' based on the information gathered, and actions that may be taken based on information collected by using an RFID device" (2008, page 244). It is unsurprising that concerns are voiced around data mining, spy ware and spy chips, and the possibility for exploitation of employees and the public. These concerns are founded given the increasing introduction of automated and RFID systems to intervene in the everyday governance of workers, especially in the public services and logistics (Ball, 2010, page 91). There have already been calls for the heavy regulation, even banning, of RFID and GPS to track staff by the UK GMB (General Municipal, Boilermakers, and Allied Trade Union) on the basis that it is dehumanising (McCue, 2005). A 2005 Rand report showed that RFID was used not to simply allocate access but to store very specific data on employees' activities. This information pertains to both the entire staff and the individual; information on individuals was used by companies to investigate infractions of work rules, for example, the misreporting of the amount of time spent working, and, in one instance, overseeing employees in a newly acquired company to check that they were adhering to the time patterns practised at the parent company (Balkovich et al, 2005).

Such evidence has shown that RFID tagging is explicitly critical to centralised database time and attendance recording. The digitisation and algorithmic surveillance within this process is crucial, because, as Graham and Wood indicate, "it allows the active sorting, identification, prioritization and tracking of bodies, behaviours and characteristics of subject populations on a continuous, real-time basis" (2003, page 228). Corporations such as Wasp Time, Control Module, and Active Wave offer entire management and security packages, including tracking tags to be worn by employees, and readers. The dual applications 'TrackmaX' and 'TimemaX' advertised by the Dubai-based company Absolute are examples

of perhaps the most comprehensive and pervasive developments in these technologies designed to record, track, report, and schedule workers. TrackmaX uses RFID to monitor the movement of people around "schools, hospitals, hotels, offices, airports and construction sites" (Absolute, no date a). In concrete terms this means being able to identify not only who employees are and where they are located, but also whom they are in contact with, when, and where. It can further register how long they take to move around the premises and prohibit movement to designated zones. TimemaX functions in conjunction with TrackmaX (and a third application, EquipmaX, to track equipment) to provide time-tracking software and hardware. It additionally operates as an employee database automating "day-to-day tasks such as tracking work hours and calculating benefits accrued" (Absolute, no date b). Both TimemaX and TrackmaX interface with the payroll system.

While these developments recall classic disciplinary techniques (Foucault, 2007), namely the capacity to monitor the spatial and temporal checkpoints of labour sites, the sophistication of digital mobility monitoring and its saturation of all aspects of the labouring subjectivity indicate a significant transition. The micromanagement of movement illuminates the key shifts that have occurred in the forms of discipline endemic to this paradigm of securitisation on the register of the techno–bio–political, subjugating the worker to the potential scrutiny of the employer at all times and in all situations. This renders the boundaries of work from nonwork increasingly permeable (even in industries still largely defined by material production or assemblage). Through the intense refinement of 'labour management analysis', such systems severely decrease the margin for human error, anonymity, decision, and mobility. For employers this means optimised productivity, limitation of legal liabilities, and decreased costs, as tighter controls are exercised over their staff. Applications such as TimemaX and TrackmaX are specifically conceived to inhibit tardiness, absenteeism, and 'unwarranted' overtime, and to regulate the time taken for seemingly mundane and administrative tasks through the digitalisation of clerical duties.

This has a number of significant consequences for employee behaviour and psychic, emotional, and physical wellbeing, in part because such models of control (Deleuze, 1992) repeatedly encroach upon the realms of 'private' and biological life, refining complex variables to a set of calculations and categorisations. Such digital sorting reduces identity to a dataset, what Deleuze has referred to as 'dividuals': abstracted data subjects that do not imitate the original (1992). Firstly, the work of human operators shifts from "direct mediation and discretion to the design, programming, supervision and maintenance of automated or semi-automatic surveillance systems" (Graham and Wood, 2003, page 228). The automation of roles designating sick leave, vacation, and benefits means that the heterogeneous realities of specific situations are reduced to a fixed set of conditions. Secondly, the possibility for breaches of confidentiality and manipulation of data is high, as is the encroachment upon an individual's personal activities (such as movements within showering rooms, toilets, changing rooms, break rooms) through the elimination of "practical obscurity" (Roth, 2006). Thirdly, the constant supervision of workers and the real-time flow of data on labour productivity means that there is greater potential for employers to penalise workers immediately rather than accommodating change over an accumulated period of time. In combination with the increased precariousness of life and labour, partially through casualised and flexible contracts and limited workplace organisation, this contributes to an even further decimation of worker security in the logistics and service industries. If workers have the possibility of being observed at each moment, it is at the employer's discretion to designate what constitutes a reasonable pace or a slow pace, reasonable movement or excessive movement.

This kind of system also encourages individualism and alienation, not only through the elimination of tactics such as 'buddy clocking' in which workers clock in for each other (Pagnattaro, 2008, page 242), but also through the generation of frequent detailed reports

on staff activity, and tailored incentives that encourage employees to compete with their workmates for bonuses and wage increases. Such forms of technoaffective control were precisely what Deleuze was indicating in his writing on control societies. With Foucault (2007), Deleuze saw a decrease in the governance of contained areas, replaced with an increase in mobile and affective regulatory techniques. This is managed by the corporation, which has taken over from the traditional factory model. In the corporation, writes Deleuze, control is performed as *modulation*; the corporation "works more deeply to impose a modulation of each salary, in states of perpetual metastability" (1992, page 4) through systems of incentives and challenges gained through the modification of behaviour. This operates in conjunction with a logic of competition, wherein rivalry and individualisation are presented as primary motivational forces. As suggested by Foucault (1977), individual and collective subjectivation incorporates the disciplinary urge: the social being of the subject of surveillance cannot be neglected (van Hoven and Sibley, 2008). This is precisely where the intersection of internal and external surveillance is deeply complicated, especially on the level of self-enforced complicities towards behavioural normativity.

II Voice directed order picking
This capacity for employers to determine the velocities and temporalities of the labouring body, and the aspirational self-discipline of workers in this process, is critical to all three surveillance mechanisms being examined here. Like RFID, voice directed order picking or voice picking primarily operates to manage the passage and pace of workers through the workplace with the aim of maximising efficiencies. Unlike the visual orientation of RFID and GPS, voice picking decentres the gaze of surveillance. Voice picking is a system for instructing workers through the use of headsets and microphones. It consists of a series of automated verbal commands issued from a company's warehouse management system, which recognises the response from the worker through speech recognition and speech synthesis software and converts it into data. It is commonly used in warehousing for order picking, goods reception, pallet storage, and inventory. By decoupling visual schema from disciplinary procedure, voice picking poses the greatest challenge to modern conceptions of the all-seeing panopticon model, it could be argued. However, I would suggest that this marks a further transition, rather than a break, from such conceptions of surveillance. The necessity for direct observation has long been supplanted by mobile and digital technologies unlimited by line of sight (Gandy, 1993, page 23), and voice picking marks an extension of these trends. Of most import, as with RFID and GPS, is the efficiency of bodily mobility—the capacity to normalise and standardise the pace, distance, and gestures of the body.

The inceptive explorations in synthesised speech applications began in the late 18th century (Flanagan, 1972). Interest in these technologies expanded from private industry into the military from around the 1940s, by the US Defense Advanced Research Project Agency (Klatt, 1987). The first commercially viable speech recognition software was launched in the late 1970s and 1980s but it was not until the late 1990s that it was mainstreamed (Juang and Rabiner, 2006). Over the past decade this software has been consolidated within global supply chains, as well as within communications, automotive, and computing industries. Distribution centres in the grocery and food sectors were the first to utilise speech recognition and synthesising programs (Wallis, 1998). Early adoption was evinced by Wal-Mart's voice order filling in 1998. Voice directed work has also been integrated into third-party logistics, manufacturing, and healthcare (Sweeny, 2011). Like RFID and GPS, these systems have been incorporated to maximise speed and minimise error in production and distribution. Voice picking relies on the constant interaction of employer and employee. Workers are supplied with a belt-worn voice terminal (wearable mobile computer), with a headset and microphone. The voice terminal communicates with the warehouse management software. Where voice

picking intensifies the proximity of surveillance more than RFID or GPS is in the immediate and constant interaction with a supervisory entity. The warehouse management system transmits entire 'pick lists' to the employee's terminal, and directs him or her to the item location. When the worker arrives at the location, he or she is required to verbally confirm he or she has the item. The worker is then directed to the next location and so on (Miller, 2004).

Voice picking has been both highly promoted in the management of facility inventory and criticised by unions and worker organisations. Order picking comprises one of the core components of warehousing, and as such directly makes up a large part of the labour budget, which is affected by the high turnover rate of employees and the often seasonal nature of factory labour. The standardisation and normalisation of bodily capacity has been cause for dissent at the UK store Asda (a subsidiary of the antiunion Wal-Mart corporation). It has been argued that because of the productivity pressures placed on workers, 'battery farm' conditions have been established, which threaten workers' physical and mental health and safety. The union has identified three areas of complaint: the expected speed of pick rates, the risk of repetitive strain injury associated with increased pick rates, and the tracking of workers. The demanded increase in productivity has been criticised as unrealistic by unions. In 2006 it was found that an operator at the Grangemouth distribution depot in Scotland had jammed the pedal of his truck to keep it moving without him inside, and it had subsequently crashed into the storage racking. This tactic was used by the operator to eliminate the time taken entering and exiting the truck while he was rushing between shelves and boxes. Given that the truck weighed around one tonne, the potential for fatality was high had a worker been standing at the racks (Labournet, 2006). Incidents such as this were taken as evidence by the GMB that Asda's increase in the target daily pick rate from 1100 to 1400 boxes was unsafe. While boxes have variations in weight and shape, the original pick rate meant that individual workers were already moving between approximately 2 and 10 tonnes of product by hand daily, with each box weighing between 5 to 20 kilos at a rate of around two to five boxes per minute. According to the GMB representative for Asda's distribution depot, "asking an Asda worker to shift 1400 boxes a day is equivalent of asking someone to work out in a gym for eight hours a day every working day. It is the equivalent of Asda asking their staff to work themselves to death" (Logistics Manager, 2006).

After assessment by Health and Safety experts, such as the Chartered Society of Physiotherapists, it was further ascertained that by raising the pick target, employers were also raising risks of long-term musculoskeletal damage through repetitive movements in the back and hips (Labournet, 2006). The use of wearable IT devices, such as "ring-style bar code scanners and wrist-mounted computer terminals" used in distribution centres in conjunction with voice picking systems, was also argued to lead to strain in the hands and wrists (Meczes, 2006). Given the economic scale of work-related injury and illness numbering in the billions of pounds each year in the UK, this was no slight cause for concern. Medical practitioners further flagged mental health issues surrounding the use of voice picking technologies to monitor and track workers, specifically the high levels of stress and anxiety experienced (Meczes, 2006), a conjecture affirmed by numerous scholars writing on mental health and surveillance (Ball, 2005; Carayon, 1993; Thompson, 2003). In 2006 the GMB issued a yes/no questionnaire trying to gauge workers' responses to the implementation of voice picking systems, including statements and questions such as: "voice pick makes me feel like a robot", "I prefer voice pick to paper pick", "do you feel voice pick is used to monitor your movements?", and "wearing the battery pack and headset cause me discomfort" (GMB, 2006). According to the GMB, workers did not respond well to the introduction of the new technology, a claim countered by employers, logistics, and warehousing trade associations and technology and software corporations (Meczes, 2006). This counterclaim was unsurprising given the stakes involved, voice picking being celebrated as a technology that has lifted the accuracy of item

picking from 99.3 to 99.8% or higher, increased productivity through hands-free picking, eliminated paper labels, speeded up training of new employees, and allowed for real-time inventory (KOM, 2002).

As with RFID, one means to assuage workers' apprehensions has been the introduction of bonus systems for workers who pick to, or above, the target rate. But as has been pointed out, such systems directly illustrate the use of these technologies to track how long workers take on particular tasks (Meczes, 2006). By concatenating the technology to wage systems, workers are allocated a set amount of time to move between point A and point B, and any surplus results in bonus pay being docked. This is the same in the case of toilet and rest breaks.

Despite the allegations being made against the working conditions under voice picking systems, proponents still claim that voice picking offers the most humane approach to communicating commands through the use of audio (Sweeny, 2011). This of course fails to address the fact that the 'voice' here is digitally generated, and is set to respond to recognisable stimuli through a series of inputted codes. There is a final point to be made here, on race, class, and pathology, and the biometrics of the voice in speech recognition. In a workforce that is significantly migrant, precarious, and itinerant, the ability for software to accommodate diversities of speech and language is imperative. Two kinds of voice recognition systems are used in warehouse operations: speaker-dependent systems, which require speakers to 'train' the application to identify their unique utterances by repeating characters, numbers, and words over time, and speaker-independent systems, which do not require calibration, relying rather on a preexisting archive of voice patterns from which statistical models are derived. Both are contingent on assumptions that may conflict with the realities of the distribution centre or factory labour force. Speech-independent systems, while theoretically being adaptable to anyone within minutes of activation, are necessarily limited in their capacity to accommodate any vocal or sonic 'anomalies' outside of the parameters of the software, including external noise. Speaker-dependent systems, while being far more exact in their ability to assimilate pathologies, accents, dialects, and even multiple languages, require duration for their programming and are thus incompatible with high staff turnover rates (Klie, 2009).

The potential for discrimination and manipulation through such technologies is as deliberately obfuscated by industry cohorts as it is in evidence, and it is likely that future contestation will emerge, especially within sectors that maintain a union presence. Indeed, it has been specifically in response to voice picking and GPS that the most documented conflicts have occurred to date, which is in itself notable given the relatively recent instigation of these disciplinary technologies and the general destabilisation of collective worker organising. Like voice picking, GPS is a mode of invasive technology that requires the training and compliance of workers in a more visible and concerted way than RFID, which might in part account for some of the tensions surrounding its deployment in the logistics sectors.

III The Global Positioning System

GPS is a solar-powered global navigation satellite system that pinpoints temporal (speed and time) and spatial (longitude, latitude, and elevation) location. It was originally developed for military purposes by the US Department of Defense and made its official debut during the 1991 Gulf War to target bombs and guide missiles, as well as being used for land, sea, and air navigation.[2] GPS works through transmitting data from satellites in space to earth-bound receivers that notify them of their location to within a distance of 3 to 15 metres. The system

[2] For an excellent analysis of the militarisation of space and surveillance, see MacDonald (2007).

consists of three components: space (satellites and transmitted signals), control (grounded facilities, telemetry, and computation), and user (applications equipment and devices available to the users) (Kaplan, 1996). When coupled with mobile systems such as geography information systems—the 'what' to GPS's 'where'—and advanced Internet applications, the data that localise and trace goods and people are made transparent and highly specific.

One of the ways that GPS has been assimilated into the logistics industries and supply chain management is through telematics or ICTs, the convergence of telecommunications and informatics. In this context telematics includes the sending and receiving of spatial and temporal location data, as well as the storage of such information. Automotive navigation systems stand as a central example. In logistics GPS telematics is combined with technologies such as cell site tracking, wireless tracking, and, of course, RFID. By 2010 55% of UK logistics companies were using inland vehicle-tracking systems, a significant leap from 25% in 2008. The most common reasons given for the installation of telematic devices were to increase productivity and to maintain environmental standards (Loughran, 2010).

The implementation of GPS technology within sectors of logistics, particularly in freight and fleet management, as well as consignment delivery (ie, UPS and FedEx), has prompted contestation.[3] As mentioned, the instantiation of tracking and tracing devices within fleet management has been leveraged through two key arguments, ostensibly to meet environmental standards and the capacity to increase productivity. Time-based technology allows employers to access continuous, up-to-the-minute data on vehicle speed, rpm, route reportage, time-stamp arrivals, and departures, as well as geofencing addresses; furthermore, it captures information on driver activity and the movements of ancillary equipment. This means that employers can supervise how drivers are driving and moving within the vehicle. Over the past five years increased attention has been paid to the environmental impacts of the logistics industries, especially in the transportation sections of the supply chain. This has led to what is referred to as 'ecotracking' policies targeting fuel emissions (as well as the coincidental reduction in fuel consumption), and 'green-band driving' or 'ecorouting' (m.logistics, 2010). Under these auspices, companies are using devices to check elements such as engine idling time and how often the truck is placed in reverse, and to eliminate 'unnecessary' movements within driver routes through a combination of GPS and route planning software. UPS, for example, has now reduced left turns in their delivery routes, which equates to 29 million miles of driving per year, saving 3.3 million gallons of fuel, and minimising emission by over 31 000 metric tonnes of CO_2 (Scarpati, 2011).

The potential environmental benefits of such monitoring are not to be negated. The ambivalence lies, of course, in the fact that telematics lead to comprehensive accounts of the vehicle's, and driver's, activities. When the power to monitor seatbelt use, to check the exact location and duration of rest breaks, and to dictate routes is exercised, then opposition will occur. This ties in closely with the other predominant arguments for telematics: productivity and customer demand. In combination with vehicle GPS, employees are tracked via cell phone GPS and PDAs (personal digital assistants). Various industry reports and sites are recounting narratives of workers 'misusing' company time and resources, and have embraced GPS as a means of detecting truancy and falsification of activities (Blish and Stiller, 2009; Ly, 2011; Nietermayer, 2010). The other side, however, is that 'objective' digital data are still interpreted subjectively, as was evinced in an event recounted to me by a UK Unite unionist during an interview on 10 May 2011. The event concerned a UK worker whose employer suspected that drivers were taking unauthorised breaks outside bakeries. The employer instructed the operators to notify him of all instances where drivers were

[3] Transportation of consignments overland is the primary mode in Europe, holding a market share of 45% of total freight transport; sea accounts for 41%, followed by rail at 8%, inland waterways at 4%, ,and pipeline at 3% (Brown et al, 2006).

parked within a particular radius of such businesses. Disciplinary action was begun against the worker on this presumptive basis, and it was not until the union assessed his delivery reports that it was made clear that the delivery location legitimately fell within the confines of the bakery radius, and that no breach had actually occurred.

A further contention is that automatic route planning (both geographically and temporally) does not accommodate the realities faced by drivers. In a preliminary e-mail survey I sent out through Unite to their members in May 2011, one driver responded to the question "can you recall any examples you have heard about where the monitoring by employers has had negative outcomes on workers?" with:

"Yes, members refusing a trip because they know it is unachievable. However, the printout before they leave is showing it can be done in the allocated time. One member received a final written warning for refusing a 'reasonable request'. At times the perimeters set by Paragon [a planning management application] are unachievable, it may be that road conditions, time of day, delays or even the way a driver feels can change his day. I am persistently resisting this robotic technology."

Another driver answered the same question with the comment that

"It was done as a joke, but the traffic office rung a member when he stopped to go to the toilet, asking him why he stopped. It was raised to more senior managers at the time and hopefully that will stop in future."

It is clear from such experiences that the apprehension logistics workers may feel about the pervasive nature of these technologies, and the disciplinary ramifications that follow their use, are not ungrounded. Protocols such as Working Time Directive compliance mean that management is updated each time a driver's status changes and each time the status of the vehicle changes, meaning that managers know in real time every moment that a driver is available for labour (Banner, 2007).

The invasive aspects of tracking and tracing workers have already been the subject of legal and employee rights scholarship (Baglione et al, 2009; Canoni, 2004; Cohen and Cohen, 2007). While employers are claiming that devices are not used to survey workers during nonwork hours, or in nonwork spaces, the technologies are so ubiquitous that data are produced regardless. This is partially because employers do not always inform workers how to turn devices off or notify them that devices may continue to be trackable when they are switched off, nor do they necessarily inform them of how the data are to be used (Marshall and Friedman, 2007). The ambiguity surrounding the collation and processing of data, and the border zones these data help to map out, deserves more analysis, and it is critical not only that the legalities are addressed in this process but that the technicalities of the devices themselves are demystified by those having to comply with their instruction, especially in the task of finding ways to navigate and resist these measures.[4] In addition, geoeconomic and political questions must be formulated on the capture and administration of data, as already pointed to by scholars investigating offshoring labour and HR practices to the so-called Global South (Chiang et al, 2010; Kuruvilla and Ranganathan, 2008; Ofreneo et al, 2007). Such trajectories for research are unequivocally pressing in an era of what Tsing has named "supply chain capitalism" (2009), especially those concerned with the intersections of economics, territoriality, security, and the organisational and affective aspects of labour.

Conclusion

Bringing a technopolitical perspective to current thought on geoeconomics is vital for three correlated reasons. Firstly, it is essential to understanding how security cultures affect the spaces and mobilities of labour and contribute to the remaking and rescaling of

[4] There has been resistance to surveillant technologies, more often documented from the creative fields— see McGrath (2004) and Albrechtslund and Dubbeld (2005).

territorial lines. Secondly, it significantly broadens the geographical discourses on supply chains and global production systems into directions that can extend how we think about work, economics, and contemporary capitalism. And thirdly, it draws attention to the ways in which bio–techno–disciplinary techniques are changing the spatial and temporal existence of bodies in very daily, nuanced ways. The recent global release of Google's geolocative app to track workers signals specific sociotechnical conditions conducive to the mainstreaming of mobile surveillance systems, which include technologies such as RFID, voice picking, and GPS. Given the pervasive nature of tracking and tracing technologies and the wider geoeconomic regimes they are part of, it is possible to contend that surveillance and monitoring are crucial to the exercise of power within global supply chains and logistics industries. It has been proposed that surveillance has become not only a technique of governance, but its substitute: surveillance as a regulatory mechanism, replete with assumptions and objectives beyond mere data collection (Catá Backer, 2008). This is an interesting proposition, and one we may consider in an era of outsourcing and subcontracting, especially when, as legal scholar Larry Catá Backer (2008) suggests, private institutions and corporations are undertaking sovereign functions and public bodies are engaging in the market. In this condition, the power to decide what information can be gathered, judged, and justified—and, as importantly, algorithmically mediated and analysed—to serve a particular purpose indicates that debates on how technologies are used need to comprehend the lines of race, gender, class, education, and physical ability that they map out.

In this paper I have focused on the technical and historical contexts of hardware and software ICTs, and some of the effects they are having in the monitoring and disciplining of workers in the UK and USA. It has been my objective, in part, to concentrate on material that is often isolated within industry or scientific realms, namely the actual mechanics of the apparatuses interfacing some of the dominant surveillance systems. I have done so in order to contribute a technopolitical perspective to wider debates on how tracking and tracing is changing not only the local geographies of workplaces but also national and transnational spaces. The geoeconomic aspect is imperative. If we are able to conceive of the transversals that such technologies indicate, from the minute gestures of a worker's hand or voice to the performance of corporate policy and global trade, we can get a better grasp on the multifaceted economic, political, and cultural iterations along the supply chain, paying attention to the differentiations that exist not only between 'rich' countries and 'poor' countries, but within those countries themselves.

The way that information is processed through the technologies that I have examined, along with the digitalisation and abstraction of surveillance analysis, reconfigures space and time in the actual sites of logistical labour. Further investigation is required into how these surveillance technologies and the governmentalities they produce, and are reproduced through, at the same time articulate new lines of power across national and international borders, while retaining aspects of more traditional economic and political hierarchies across the Global North and South. One thing is certain: we are witnessing how the demands for increased efficiency and productivity, ubiquitous regulatory mechanisms, casualised and subcontracted staff, flexible temporality, and decreased collective organisation are playing out in a variety of labouring sites along the chain, from the factory floor to the carrier, the warehouse, and, finally, the handover to the consumers themselves . It is here that we can find points of commonality amidst difference; and it is precisely why the expanding instigations of disciplinary techniques along the transnational nodes and networks of the supply chain require all the more attention in their complexity.

References

Absolute, no date a, "TrackmaX", http://www.absolute-it.com/RFID/TrackmaX/

Absolute, no date b, "TimemaX", http://www.absolute-it.com/RFID/TimemaX/

Adey P, 2004, "Secured and sorted mobilities: examples from the airport" *Surveillance and Society* **1** 500–514

Adey P, 2009, "Facing airport security: affect, biopolitics, and the preemptive securitisation of the mobile body" *Environment and Planning D: Society and Space* **27** 274–295

Adhiarna N, Rho J J, 2009, "Standardization and global adoption of Radio Frequency Identification (RFID): strategic issues for developing countries", paper for Fourth International Conference on Computer Sciences and Convergence Information Technology, Seoul, South Korea, 24–26 November, pp 1461–1468

Agnew J, 1998 *Geopolitics: Revisioning World Politics* (Routledge, London)

Agnew J, 2008, "Borders on the mind: reframing border thinking" *Ethics and Global Politics* **1** 175–191

Albrechtslund A, Dubbeld L, 2005, "The plays and arts of surveillance: studying surveillance as entertainment" *Surveillance and Society* **3** (2/3) 216–221

Allen B, 1997, "The logistics revolution and transportation" *Annals of the American Academy of Political and Social Science* **553** 106–116

Aoyama Y, Ratick S, Schwarz G, 2006, "Organizational dynamics of the US logistics industry: an economic geography perspective" *The Professional Geographer* **58** 327–340

Baglione S L, Arnold F, Zimmerer T, 2009, "Productivity vs privacy for an organization's workforce" *Journal of the Academy of Business and Economics* **9** 23–41

Balkovich E, Bikson T K, Bitko G, 2005, "9 to 5: do you know if your boss knows where you are? Case studies of Radio Frequency Identification usage in the workplace" (Rand Corporation, Santa Monica, CA)

Ball K S, 2005, "Organization, surveillance and the body" *Organization* **12** 89–108

Ball K, 2010, "Workplace surveillance: an overview" *Labor History* **51** 87–106

Banner S, 2007, "From spy in the cab to truckers friend" *Freight* March 18–19

Bidgoli H, Ed, 2009 *Handbook of Technology Management: Supply Chain Management, Marketing and Advertising, and Global Management, Volume 2* (Wiley, New York)

Bigo D, 2006, "Security, exception, ban and surveillance", in *Theorizing Surveillance: The Panopticon and Beyond* Ed. D Lyon (Willan, Cullompton, Devon) pp 46–68

Bingham N, 1996, "Object-ions: from technological determinism towards geographies of relations" *Environment and Planning D: Society and Space* **14** 635–657

Blish N A, Stiller S P, 2009, "Tracking employees using technology" *Association of Corporate Counsel Docket* **27** 84–92

Bonacich E, 2005, "Labor and the global logistics revolution", in *Critical Globalization Studies* Eds R P Appelbaum, W I Robinson (Routledge, New York) pp 359–368

Bowman I, 1942, "Geography vs. geopolitics" *Geographical Review* **32** 646–658

Brown M, Allen J, Woodburn A, 2006, "Developments in Western European logistics strategies", in *Global Logistics: New Directions in Supply Chain Management* Ed. D Waters (Kogan Page, London) pp 353–373

Brunn S D (Ed.) 2006 *Wal-Mart World: The World's Biggest Corporation in the Global Economy* (Routledge, New York)

Busch L, 2007, "Performing the economy, performing science: from neoclassical to supply chain models in the agrifood sector" *Economy and Society* **3** 437–466

Canoni J D, 2004, "Location awareness technology and employee privacy rights" *Employee Relations Law Journal* **30** 26–31

Carayon P, 1993, "Effects of electronic performance monitoring on job design and worker stress: results of two studies" *International Journal of Human Computer Interaction* **6** 177–190

CASAGRAS 2010, "The Internet of all things", final report, Coordination and Support Action for Global RFID-related Activities and Standardisation, http://www.grifs-project.eu/data/File/Casagras_Final Report.pdf

Catá Backer L, 2008, "Global panopticism: states, corporations, and the governance effects of monitoring regimes" *Indiana Journal of Global Legal Studies* **15** 101–148

Chiang F, Chow J, Hau-Siu I, Birtch T A, 2010, "Examining human resource management outsourcing in Hong Kong" *International Journal of Human Resource Management* **21** 2762–2777

Coe N, Dicken P, Hess M, Yeung H W, 2010, "Making connections: global production networks and world city networks" *Global Networks* **10** 138–149

Cohen C, Cohen M, 2007, "On-duty and off-duty: employee right to privacy and employer's right to control the private sector" *Employee Responsibilities and Rights Journal* **19** 235–246

Cowen D, 2010, "A geography of logistics: market authority and the security of supply chains" *Annals of the Association of American Geographers* **100** 600–620

Cowen D, Smith N, 2009, "After geopolitics? From the geopolitical social to geoeconomics" Antipode **41** 22–48

Crampton J W, Elden S, 2006, "Space, politics, calculation: an introduction" *Social and Cultural Geography* 7 681–685

Crang P, 1999, "Organisational geographies: surveillance, display and the spaces of power in business organisation", in *Entanglements of Power: Geographies of Domination/Resistance* Eds J Sharp, P Routledge, C Philo, R Paddison (Routledge, London) pp 204–218

Cresswell T, 2006 *Mobility in the Modern Western World* (Routledge, London)

Cresswell T, Martin C, 2012, "On turbulence: entanglements of disorder and order on a Devon beach" *Tijdschrift voor Economische en Sociale Geografie* **103** 516–529

Deleuze G, 1992, "Postscript on the societies of control" *October* **59** 3–7

Der Derian J, 1990, "The (s)pace of international relations: simulation, surveillance and speed" *International Studies Quarterly* **34** 295–310

Elden S, 2007, "Governmentality, calculation, territory" *Environment and Planning D: Society and Space* **25** 562–580

Flanagan J, 1972 *Speech Analysis, Synthesis, and Perception* (Springer, Berlin)

Foucault M, 1977 *Discipline and Punish*: *The Birth of the Prison* translated by A Sheridan (Vintage, New York)

Foucault M, 2007 *Security, Territory, Population: Lectures at the Collège de France, 1977–78* Ed. M Senellart, translated by G Burchell (Palgrave Macmillan, New York)

Gandy O H, 1993, *The Panoptic Sort: A Political Economy of Personal Information* (Westview Press, Boulder, CO)

Gerst M, Bunduchi R, Graham I, 2005, "Current issues in RFID standardisation", proceedings of the Score Conference Organizing the World – Rules and Rule-setting Among Organizations, Stockholm, Sweden, 13–15 October, http://homepages.ed.ac.uk/grahami/network/papers/interop2005.PDF

Gertler M, 1992, "Flexibility revisited: districts, nation-states, and the forces of production" *Transactions of the Institute of British Geographers, New Series* **17** 259–278

GMB, 2006, "Health and safety at work: R F voice pick survey", http://www.gmbindhl.unionweb.co.uk/view/PageView.aspx?Page=270

Graham S, Wood D, 2003, "Digitizing surveillance: categorization, space, inequality" *Critical Social Policy* **23** 227–248

Griffith C, 2012, "Google releases Maps Coordinate tool to track workers' movements" *The Australian* 22 June, http://www.theaustralian.com.au/australian-it/google-releases-maps-coordinate-tool-to-track-mobile-workforces/story-e6frgakx-1226405095911

Harvey D, 2006 *Spaces of Global Capital* (Verso, London)

Holmes B, 2011, "Neoliberal informationalism and the flexible personality", public lecture, European Graduate School, Switzerland, http://www.youtube.com/watch?v=IRbaeWUHxQI

Hudson A, 2000, "Offshoreness, globalization and sovereignty: a postmodern geo-political economy?" *Transactions of the Institute of British Geographers, New Series* **25** 269–283

Hughes A, Reimer S (Eds) 2004 *Geographies of Commodity Chains* (Routledge, New York)

Hunt D, Puglia A, Puglia M, 2007 *RFID: A Guide to Radio Frequency Identification* (Wiley-Interscience, New York)

ITF and UNI Global Union, 2012, "Corporate irresponsibility: Deutsche Post DHL's global labour practice exposed", May, http://www.respectatdhl.org/corporate-irresponsibility.html?lang=en

Juang B, Rabiner L, 2006, "Automatic speech recognition—a brief history of the technology development", in *Elsevier Encyclopedia of Language and Linguistics* Ed. K Brown (Elsevier, New York) pp 806–819

Kaplan E (Ed.), 1996 *Understanding GPS: Principles and Applications* (Artech House, Boston, MA)

Klatt D, 1987, "Review of text-to-speech conversion for English" *Journal of the Acoustical Society of America* **82** 737–793

Klie L, 2009, *"Speech declares its independence" Speech Technology* **14** 28–33

KOM, 2002, "Voice technology in the distribution centre", KOM International White Paper Series, May, http://www.idii.com/wp/kom_voice_technology.pdf

Kuruvilla S, Ranganathan A, 2008, "Economic development strategies and macro and micro level human resource policies: the case of India's outsourcing industry" *Industrial and Labor Relations Review* **62** 39–72

Labournet, 2006, "Asda Wal-Mart Grangemouth accident: GMB calls for independent investigation" *Labournet* 24 February, http://www.labournet.net/ukunion/0605/asda3.html

Landt J, 2005, "The history of RFID" *IEEE Potentials* **24** 8–11

Latour B, 2005 *Reassembling the Social: An Introduction to Actor-network-theory* (Oxford University Press, Oxford)

Law J, Mol, A, 2001, "Situating technoscience: an inquiry into spatialities" *Environment and Planning D: Society and Space* **19** 609–621

Lefebvre H, 1991 *The Production of Space* (Blackwell, Oxford)

Lewis, M W, Wigen, K E, 1997 *The Myth of Continents: A Critique of Metageography* (University of California Press, Berkeley, CA)

Logistics Manager, 2006, "Picking up the pace" *Logistics Manager* 21 February, http://www.logisticsmanager.com/Articles/4790/Picking+up+the+pace+.html

Loughran J, 2010, "Vehicle tracking uptake" *HGVUK* 5 March, http://www.hgvuk.com/03/05/vehicle-tracking-uptake/

Ly J, 2011, "Using GPS to reduce payroll expense" *Business Fleet* January, http://www.businessfleet.com/Article/Print/Story/2011/01/Using-GPS-to-Reduce-Payroll-Expense.aspx

Lyon D, 2001 *Surveillance Society: Monitoring Everyday Life* (Open University Press, Buckingham)

McClelland M, 2012, "I was a warehouse wage slave" *MotherJones* March/ April, http://www.motherjones.com/politics/2012/02/mac-mcclelland-free-online-shipping-warehouses-labor

McCue A, 2005, "Union calls for European ban on staff-tracing RFID" *Silicon* 19 July, http://www.silicon.com/technology/hardware/2005/07/19/union-calls-for-european-ban-on-staff-tracking-rfid-39150564/

MacDonald F, 2007, "Anti-astropolitik: outer space and the orbit of geography" *Progress in Human Geography* **31** 592–615

McGrath J E, 2004 *Loving Big Brother: Performance, Privacy and Surveillance Space* (Routledge, London)

Marshall D R, Friedman C S, 2007, "Stopping employees in their tracks: GPS tracking of employees" *Mealey's Litigation Report: Employment Law* **4** 1–5

Massey D, 1995 *Spatial Divisions of Labour: Social Structures of the Geography of Production* (Macmillan, London)

Meczes R, 2006, "Voices rise over picking technology" *Logistics and Transport Focus* February, 28–31

Miller A, 2004, "Order picking for the 21st century voice vs scanning technology", white paper, Tompkins Associates, http://www.slideshare.net/rmfuhr/voice-vs-scan-white-paper

m.logistics, 2010, "More than half of fleet operators now using tracking–Survey" http://www.mlogmag.com/magazine/45/More_than_half_of_fl.shtml

Neilson B, Mezzadra S, forthcoming "The border as method" (draft manuscript available from the authors)

Nietermayer L, 2010, **"GPS tracking systems on company vehicles can save fuel, labor costs, correct bad driving habits** *Drilling Contractor* 24 March, http://www.drillingcontractor.org/gps-tracking-systems-on-company-vehicles-can-save-fuel-labor-costs-correct-bad-driving-habits-4712

Nusca A, 2011, "Meet the kingmakers of global logistics" *Smartplanet* 4 May, http://www.smartplanet.com/blog/smart-takes/meet-the-kingmakers-of-global-logistics/13051

Ofreneo R, Ng C, Marasigan-Pasumbal L, 2007, "Voice for the voice workers: addressing the IR concerns in the call center/BPO industry of Asia" *Indian Journal of Industrial Relations* **42** 534–557

Ó Tuathail G, 1996 *Critical Geopolitics: The Politics of Writing Global Space* (Routledge, London)

Pagnattaro M A, 2008, "Getting under your skin – literally: RFID in the employment context" *Journal of Law, Technology and Policy* **2** 237–257

Roberti M, 2007, "The history of RFID technology" *RFID Journal* http://www.rfidjournal.com/article/view/1338

Rose-Redwood R S, 2006, "Governmentality, geography, and the geo-coded world" *Progress in Human Geography* **30** 469–486

Roth P, 2006, "Workplace privacy issues raised by RFID technology", http://privacy.org.nz/assets/Files/38873649.doc

Sassen S, 1991 *The Global City* (Princeton University Press, Princeton, NJ)

Scarpati K, 2011, "UPS telematics helps shave fleet fuel costs" *Supply Chain Digital* 13 June, http://www.supplychaindigital.com/global_logistics/ups-telematics-helps-shave-fleet-fuel-costs

Sealey R, 2009, "Power to the workers" *Transport International Online* issue 35, http://www.itfglobal.org/transport-international/ti35logistics.cfm

Sharp J, Routledge P, Philo C, Paddison R, 2000, "Entanglements of power: geographies of domination/resistance", in *Entanglements of Power: Geographies of Domination/Resistance* Eds J Sharp, P Routledge, C Philo, R Paddison (Routledge, London) pp 1–42

Smith J E, 2007, "You can run, but you can't hide: protecting privacy from Radio Frequency Identification Technology" *North Carolina Journal of Law and Technology* **8** 249–272

Smith N, 2005 *The Endgame of Globalization* (Routledge, London)

Sparke M, 2006, "A neoliberal nexus: economy, security and the biopolitics of citizenship on the border" *Political Geography* **25** 151–180

Supply Chain Digest, 2009, "RFID news: looking back at the Wal-Mart RFID time line" *Supply Chain Digest* 23 February, http://www.scdigest.com/assets/On_Target/09-02-23-1.php

Sweeny L, 2011, "Voice-directed work in the supply chain: what IT execs need to know" S*upply and Demand Chain Executive* 12 January, http://www.sdcexec.com/web/online/In-Depth/Voice-Directed-Work-in-the-Supply-Chain--What-IT-Execs-Need-to-Know/4$9539

Thomson P, 2003, "Fantasy island: a labour process critique of the 'age of surveillance'" *Surveillance and Society* **1** 138–151

Thrift N, 2005 *Knowing Capitalism* (Sage, London)

Thrift N, 2011, "Lifeworld Inc – and what to do about it" *Environment and Planning D: Society and Space* **29** 5–26

Tsing A, 2009, "Supply chains and the human condition" *Rethinking Marxism* **21** 148–176

van Hoven B, Sibley D, 2008, "'Just duck': the role of vision in the production of prison spaces" *Environment and Planning D: Society and Space* **26** 1001–1017

US Department of Commerce, 2005, "Radio frequency identification: opportunities and challenges in implementation 5", Washington, DC, April

Wallis W, 1998, "Speech recognition: instead of typing and clicking, talk and command" *Technological Horizons In Education Journal* **25**(6) 18–22

Weinberg J, 2008, "RFID and privacy", in *Securing Privacy in the Internet Age* Eds A Chander, L Gelman, M J Radin (Stanford Law Books, Stanford, CA) pp 245–271

Weissert W, 2004, "Chip implanted in Mexican judicial workers" *Associated Press* 14 July, http://www.infowars.com/print/bb/judicial_employees_implanted.htm

Wilson M W, 2011, "Data matter(s): legitimacy, coding, and qualifications-of-life" *Environment and Planning D: Society and Space* **29** 857–872

ρ