Governing Through The Network

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I, Amil Mohanan confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

ABSTRACT

This thesis examines the relationship between the state, computer networks and their relationship to the government of education. It explores the historical development of computer networks and the governmental rationalities of education, in addition to an ethnographic study of practices surrounding computer networks at a secondary school in London. This novel approach has looked at interactions between the materiality of networks, their presence in the discourses of national policies and the practices of its end users. It begins by focussing on an early public data network developed at the National Physical Laboratory called the NPL Network. This experimental network was built using the idea that networks had to be flexible and adaptable to the needs of its end users rather than the interests of computer manufacturers and network operators. It also looks at the effects that computer networks have had on governmental mechanisms used to regulate schools. The thesis argues that the introduction of the National Grid for Learning and the National Pupil Database have been used to intensify practices of performance management and intelligence testing. Finally, it looks at practices within schools that are afforded by networked forms of government. Broadly, the thesis problematises the idea that networked forms of governance are less coercive than the mechanisms they replace. The thesis demonstrates that networks have caused an intensification of power within the education system that has made its mechanisms more efficient whilst saturating its field of operation.

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Introduction

The education secretary Nicki Morgan, has recently announced that the 'true worth' of qualifications would be determined using data from taxation after students leave schools (Vaughan, 2015). It was argued by the education secretary that the adoption of new technologies could increase the efficiency of assessment and accountability mechanisms that would bring schools into the 'digital age' (see figure 1.1 overleaf). This announcement alludes to new ways through which students are being governed through technologies that are claimed to be more accurate and efficient than teachers' assessments of their students. This is an indication of how governmental activity has been transformed by the idea of networks, both as a sociological concept for thinking about the organisation of societies, and as a technical mechanism for linking together disparate physical entities. Computer networks promise a world free of hierarchy where all actors enjoy positions of equivalence through access to information and rights of participation. I argue in this thesis that computer networks could also be used to sustain or even intensify existing social hierarchies and relations. I do this by looking at the way that com-

Nicky Morgan: link qualifications to income to show 'true worth' of different courses

Richard Vaughan,
Times Educational Supplement,
21 January 2015

Qualifications could be linked to tax data to show the "true worth" of certain subjects as part of the government's drive to track students after they leave school, the education secretary said today…

Speaking at the education technology show Bett in East London this morning, Nicky Morgan said that technology could transform accountability, assessment and teachers' workload in the future…

Ms Morgan told the audience that change was needed in the way schools were held to account, adding: "We have an analogue system in the digital age."

League tables and Ofsted would always be essential, she said, "but there is so much more we can do". Parents and their children would demand more information as more "choice and competition" were injected into the school system, the education secretary added…

She also highlighted how technology could change how students are assessed in the future, citing the work of educationist John Hattie, which uses regular testing to ascertain how students are progressing.

"By using technology to administer regular standardised tests, he has transformed the way children learn and the way parents are able to monitor their child's progress," Ms Morgan said…

Figure 1.1—Excerpt from newspaper article covering the announcement to link qualifications to income (reproduced from Vaughan, 2015)

puter networks are used to coordinate the activities of secondary school education in England.

Over the past few decades in England we have witnessed education reflecting a shift from bureaucratic forms of organisation by Local Education Authorities to networks established between state and non-state actors. One result of this trend has been the recent controversial conversion of local authority schools into academies and free schools sponsored by a diverse range of charities, faith groups and businesses coordinated by central government. The growing involvement of non-state actors in education has been interpreted as evidence of the increasing blurring of boundaries between the state and the market (Junemann and Ball, 2013). Since the 1990s, it has been argued that government by the state has made way for governance through network relations based on heterogeneous actors who are self-organising and opposed to hierarchical forms of bureaucratic organisation (Rhodes, 1996). Junemann and Ball (2013: 426) point out that in the English education system, this process has involved a gradual decentralisation and in-

creased autonomy for schools whilst simultaneously increasing central control in classrooms through the prescription of the curriculum and the setting of performance targets for teachers simultaneously. One of the aims of this thesis is to problematise such simple notions of decentralising networks.

On an empirical level this thesis primarily addresses a lack of material and practice-oriented studies in the virtual geographies literature. Existing studies are either speculative in manner or lack an empirical focus on interactions between end users and the network itself. This thesis politicises the role of computer networks in the operation of the state, by looking at the nature of the relations they help produce and assess whether they enable forms of domination. It has been argued by Castells (2000) for instance that computer networks have weakened the state because of their ability to 'deterritorialise' the nation state. He argues that the 'network society' would lead to a displacement of the centralised power of political institutions with forms of decentralised power based on partnerships and alliances. Castells argues that the emergence of information technologies have allowed networks to coordinate action, disseminate information and decenter decision making. This thesis questions the assumption that the prevalence of computer networks necessarily leads to the decentralisation of state power. The argument that is often raised is that marketisation, privatisation and choice are a means through which these qualities of networks can be realised. The thesis raises these questions using Foucault's concept of governmentality, which looks at the state through the rationality used to justify its practices and the techniques it uses to govern its subjects. The computer network forms a technology of government that allows the state to calculate and direct the behaviour of its inhabitants.

One area where the relationship between government, networks and the state have received interest is in the Science and Technology Studies literature. For example it has been argued that technology is a 'reification of order' through which, government is able to replicate itself in a diffused and miniaturised form (Agar 2003). Another argument that has been raised is the idea that the technological connections and the regulatory regimes that go alongside them have created 'technological zones' through which governmental practices are mediated (Barry

2001). It has also been argued that networks allow state activities to become more decentralised, distributing its activities across space without the need for hierarchical centres. One explanation given for this process is the threat posed by a nuclear attack to central forms of organisation led nation states to distribute their activities and networks across space (Galison 2001). These concerns led to proposals for a distributed communications network that eliminated the need for a hierarchical centre are seen by many to be a precursor to the modern day Internet (Baran 1964).

Another body of literature that has addressed the relationship between technology, individuals and the state is the sociology of technology. This body of literature developed alongside the technological and scientific advancements of the 1970s and 1980s, placing an emphasis on individual choice and freedom from determinism as its central paradigm (Agar, 2008). Cybernetics was also an area of research that benefited from these shifts towards the individual. We will examine how cybernetic theories allowed societies to be thought of as self-organising and adaptive, displacing earlier ideas about social physiology which had conceptualised society through the hierarchies of disciplinary societies (Pickering 2010a; 2010b). Pickering uses Deleuze and Guattari's (2004) concept of nomadism to think about cybernetics and its influence on the structure of the state. Pickering (2010a) argues that cybernetics with its emphasis on the unpredictability of the systems it studied is synonymous with the notion of a nomadic science. The nomadic sciences can be opposed to the royal sciences which see the world through linear systems of measurement and prediction that create the striated systems of the state. Royal sciences assume a stable world that can be understood through cognition and knowledge, whilst the nomadic science assume a fluid world of heterogeneous objects that interact, conflict and produce tensions within the system.

Theoretically this thesis will look at the governmental role of the network through the use of Nealon's (2008) concept of the intensity of power relations. He argues that the intensity of power is determined by its efficiency and saturation in a given spatial field of operation. This concept gives us a starting point for thinking about the effect that networks have had on the regulatory activities of the state. On the

one hand they have made it more efficient for bureaucrats and administrators to know the territory that they regulate. On the other hand, computer networks have also greatly increased the points from which this regulation can occur. The possibilities opened by increasingly electronically mediated relations of power are characterised by Deleuze (1992) to have led to what he calls the societies of control. He argues that disciplinary mechanisms have been replaced by the mechanisms of control because control operates at its most efficient by 'modulating' the behaviour of individuals rather than 'moulding' their subjectivities. The concept of the control society allows us to see how computer networks have saturated the effects of power throughout the social body without necessarily needing sites of enclosure such as institutions for its exercise. The embodied forms through which this regulation of space through computer technology has also been the focus of much geographical research that we will explore (Graham, 2005; Kitchin and Dodge, 2011).

The broad aim of this thesis is to put together themes we have discussed above by using three different computer networks as our case studies. The three networks used as case studies are the NPL Network, the National Grid for Learning and the computer network of a London secondary school. I look at the three networks using different approaches; first, I look at the materiality of the NPL Network, the policy discourses which surrounded the National Grid for Learning (NGfL) and the material and embodied practices surrounding computer network use in a secondary school. Networks are present in an enormous amount of governmental activity, it will be clear from the choice of the above networks that the context of this thesis is the regulatory mechanisms within England, specifically the use of computer networks in the education system.

The NPL Network was a national packet switched network that was proposed in the 1960s at the National Physical Laboratory in Teddington. Technologically, it shares many similarities with the ARPA Network built in America at the same time, which later led to the modern day Internet. Looking at the NPL network allows us to focus on the materiality of computer networks. This network also allows us to look at the qualities that have allowed networks to become decentral-

ised without hierarchical centres. Archival research allows us to look at the historical development of this network through research reports from the NPL that are available at the National Archives at Kew. Using these documents, we are able to see the historical development of computer networks and the political implications afforded by the materialities of technology. In particular, we can extend Pickering's (2010a) use of Deleuze and Guattari to look at the development of cybernetics as a model for looking at the field of computer networking. The concept of the nomadic sciences allow us to think about how networks began as they decentralised and deterritorialised the general purpose computer, queuing the idea that computer manufacturers knew what its users wanted and rethought technology from the bottom up so that computers could be put together as needed by the requirements of the end user. This move shares the hallmarks of extending individual choice and decentralisation that have been characteristic of the development of technology since the 1960s.

From the material, we turn to the discursive by looking at the National Grid for Learning: a national network that was established during the late 1990s. This second network provides us with an opportunity to study the interactions between technologically mediated forms of regulation and their impact on state hierarchies and their representations in policy documents. The focus on the education system in particular allows us to see how computer networks have transformed the mechanisms of government regulation. The main emphasis of the chapter will be to look at how governmental practices in education have evolved over time. It also aims to show the contribution of neoliberal ideas to the techniques and technologies of government. The development of the NGfL can also be seen as the production of a new technological zone enable new forms of regulation (Barry, 2001). Authors such as Hunter (1994) and Donald (1992) have recognised the importance of bureaucratic mechanisms in the production of state education systems. Hunter (1994: 118) for instance argues that one of the historical achievements of state education was to enclose students in a 'uniform pedagogical environment' where they were subject to 'a common regime of observation, normalisation, testing and ranking' where educational ability could be problematised through statistical measurement.

These ideas allow us to look at how the network incorporated older forms of regulation and the efforts that were made to contest and negotiate a new technologically mediated domain of regulation. Discourse analysis on three documents that shaped the introduction of the NGfL will show us the processes through which this technological zone was established. This allows us to look at the important issues surrounding the relationship between the state and computer networks. In particular, we will look at how the political imagination behind Tony Blair's 'Learning Society,' a vision for a society that enabled its inhabitants to effectively participate in an information economy.

We also turn to the negotiation of standards and contents within the technological zone by looking at arguments made in the Stevenson Report. This report enables us to see how technological zones overlap and contest each other. The report defines the makeup of the proposed zone which incorporated devices such as computers and projectors. Although the report falls short of providing an exact technological specification, the intention of its author was clear: to make technologies in school reflect what was adopted by 'global industry' rather than develop domestic standards (Stevenson, 1997: 16). One of the primary functions of the network required by the Department for Education and Employment (DfEE) was the National Pupil Database, this development had many implications in allowing schools (and students) to be made comparable through the network. This case study allows us to study how the multiple, sometimes mundane objectives behind the NGfL adapted and extended existing regimes of governmental regulation. Unlike the nomadic nature of the NPL Network, NGfL offers us an opportunity to study a network that extended the state through the intensification of existing regulatory mechanisms.

Finally, turning the to the practices that surround the computer network in a secondary school allows use to see the embodied forms of transduction that are enabled by networked technologies (Kitchin 2011). Some of the existing geographical research into computers and schools originate the early 2000s, particularly a set of studies by Valentine et al. (2002) which looked at experiences of three schools using the NGfL. The emphasis of these studies was on the use of computers and the

Internet at home and at school (Valentine and Holloway, 1999). This thesis will instead use participant observation from the site of a secondary school to look at the impact that network technologies have had on regulatory practices used to manage teachers and students. This will be used to demonstrate how networks have intensified mechanisms in disciplinary institutions and established new mechanisms of control. Computer networks have extended mechanisms of government to non-state actors as well as transforming spatial practices within as well as extending governing practices beyond institutional enclosures, causing a transformation in the nature of the state itself (Deleuze, 1992). Using the case study of governmental practices within an educational institution provides us a way of examining why despite the claims that networks can enable us to organise without the state (Castells, 2000), unequal relations of power and control not only persist, but have intensified

Summary of Chapters

Chapter two outlines the literature review which examines the historical relation between networks and the state. It begins by looking at how states and various forms of networks have coexisted since the 17th Century. The telegraph played a prominent role in the expansion of the British empire by allowing disparate territories to be governed at a distance. With the emergence of computer networks in the late twentieth century, networks have enjoyed a renaissance in the 'post-industrial' narratives of network societies which envision self-organising utopian societies that are free from hierarchal mechanisms of the state. The spaces of networks have also been studied by geographers who have problematised common distinctions between virtual and physical spaces. Recent attention has turned to the role that the prevalence of computers and software in play in the constitution of everyday spaces. The review of literature into virtual geographies also reveals a lack of empirical studies that have examined the spatial practices of users in interaction with the materiality of networks.

I use the theories of governmentality developed by Michel Foucault who uses the concept to study the transformation of power from sovereign power to forms of biopower between the seventeenth and nineteenth century. He uses governmentality as a concept to study the way that the problem of the state was posed in liberal societies to justify rational practices of government. After the Second World War, a neoliberal rationality of government emerged that limited state intervention using the market as the site of truth. Although Foucault shows an evolutionary development of these techniques, he reminds us that they exist simultaneously, operating on top of each other within contemporary societies. Later narratives of governance would argue that governmental mechanisms of nation-states had been superseded by systems of global governance that were able to self-organise using networks. Governance refers to a widespread form of power that is not merely actions that correspond to the state. However, Deleuze (1992) also shows us that in contemporary societies of control, the withdrawal of institutions run by the state does not necessarily entail an absence of relationships of power. He argues on the contrary that the discipline of bodies has been intensified by forms of control, which did not aim to train, but to sort and order bodies between the wanted and unwanted using databases and networks. One of the key concepts introduced in the literature review is the idea that these historical transformations in the state can be explained through the intensification of power (Nealon, 2008). The intensification of power refers to the increasing efficiency and saturation of mechanisms of power that have occurred over time through the introduction of new rationalities, discourses and technologies. Chapter four looks at the methodology of the study, outlines the research questions of this research project.

Chapter four revisits the historical development of computer networks. It shows the significant social and political implications that have both resulted from and resulted in the development of public computer networks like the internet. It also looks at how computer networks have significantly influenced the commercial and military ambitions of various states. The first stage of my archival research looks at the inception of one of the earliest packet switched networks in the world developed at the National Physical Laboratory (NPL) in Teddington by Donald Davies and his team during the late 1960s. Despite the fact that they had built techno-

logies that were significantly ahead of their time, the network was not take up by the British state. The chapter looks at why this happened by making use of archival material that has not been covered in the existing literature on computer networks. My analysis of this material using Deleuze & Guattari's (2004) concept of nomadism contributes to the geographical debates about networks using a sociomaterial perspective. I have argued that the nomadic nature of the decentralised and flexible network built by NPL—designed around the needs of end users—did not lend itself to the hierarchically organised world of state actors such as national telecom operators. Earlier computer networks had been designed around proprietary standards of computer manufacturers and the interests of networks operators who had profited from the use of expensive leased lines.

The chapter also looks at the packet switched networks which continued to be developed in America, where it was initially found useful for a military network called ARPANET. This trajectory would lead to the development of the internet as a decentralised network of networks as we know it today. The form of decentralised network were significantly influential in the political climate of end of the Cold War and the active role of American state leading the form of financial and technological globalisation in the 1990s. The materiality of packet-switching as devised by NPL was a nomadic technology because it allowed the formation of heterogeneous assemblages through its standardised communication protocols. In its American reincarnation, the war-machine was appropriated by the state that directed it towards the intensification of forms of control under neoliberalism. In the same way that computer networks increased the efficiency and saturation of industrial control mechanisms in factories, computer networks were adopted initially by businesses and later by states to monitor and control activities that required regulation and government.

One example of the intensification of governmental regulation has been in education, where neoliberal forms of governance have come together with the affordances created by network technologies. Chapter five shows how these technologies of government have evolved over time: from techniques of biopower based on the statistical calculation of populations and races, to the technologies of control

that target the performance of individual bodies through computer networks. The chapter traces historical developments in the governmental rationalities that have animated state education. I use primary archival material of curriculum circulars, White papers and reports from the government to trace the continuities between these rationalities of government were being transformed from a logic of exclusion based on race to a meritocratic exclusion based on ability and intelligence of students.

I link the transformations of these rationalities to forms of neoliberal governmentality with the discourses of freedom introduced through market mechanisms and parental choice in the school system in the 1980s. These mechanisms were later intensified through the introduction of technological networks in schools using the National Grid for Learning (NGfL) in the 1990s. The NGfL network promised to create a 'learning society' which was lauded by New Labour as transforming education by extending learning beyond the walls of educational institutions. The introduction of computer networks accompanied the adoption of managerial techniques such as performance indicators that were borrowed from the business world to help steer the running of schools. These governmental techniques make use of networks and databases that could collect and access a greater range of data about individual students and their performance.

In chapter six, I turn my attention to how local practices of governing schools are enacted using network technologies. I have used an ethnographic approach to study the network from the site of a school to study the everyday practices of teachers and students who make use of these networks. I look at how technologies have transformed the spaces of classrooms and the practices of teaching and learning. Attention has been paid to how the practices of teachers and students are regulated using performance management technologies that make use of network databases. Some of these new forms of control involve the intensification of older practices such as classroom seating arrangements determined by student ability that is measured by network based mechanisms of assessment. I will also explore the more contemporary mechanisms of control such as network filters and surveillance systems that regulate the behaviour of students on computers and the

Internet. I also look at how technologies such as Virtual Learning Environments that have attempted to extend learning for students outside the classrooms ended up being used as mechanisms of accountability for teachers.

Governmental practices that make use of networked technologies have intensified forms of control, surveillance and discipline in operation within and beyond the school. Other spatial manifestations of these new governmental practices include the transformation of the school library which provided as a model for the future classroom. In the library we can see that the role of the teacher as educator has been overshadowed by her role as a security guard who is responsible for the discipline of students engaging in self-directed activity on their computers. I looking at the range of activities taking place in library from reading and literacy tests to the physical and electronic surveillance of students. Forms of electronic surveillance include the monitoring of computer activity by the teachers as well as automatic mechanisms of control that operate in the background. These automatic mechanisms range from network filters that regulate internet access and the automated systems of performance management that identify under-performing students. Finally, I turn to the lines of flight created in the network by students who adopt certain tactics to get around the internet filters and produce states of play by appropriating the capabilities of the network itself. I argue that these practices are not forms of counter-conduct that strategically oppose power, but make alterations to the disciplinary spaces of the classroom that open up opportunities for other ways of being.

In summary, the main contribution of this thesis will be to show how networked technologies play a fundamental role in intensifying the practices of power and government. I have examined these practices in the specific case of secondary school education in England. This thesis contributes to debates surrounding the interactions between 'virtual' spaces and physical spaces by looking at the materiality of the networks and the practices that are afforded by them. This thesis contributes to the lack of research into the material and spatial practices in the literature on virtual geographies. The study takes a novel methodological approach that combines archival research into the historical development of networks and their

adoption in government policies of education with an ethnographic study of practices of its users at a secondary school. This novel approach has looked at the materiality of networks, their presence in the discourses of national policies, and the practices of its users. It has also traced power relations across different temporal and spatial sites which constitute the state.

Networked Liberalism

This chapter looks at some debates that have looked at the relationship between networks (particularly computer networks) and the state. The structure of the review looks at three key areas of work: the state and its relation to ICT networks, Foucauldian and Deleuzian literature on power, government, technology and the state, and finally post-Foucauldian literature on the government of education. We begin with a historical look at the development of communication networks and their relationship with the state from the seventeenth century to the present. Barry's (2001) concept of technological zones provides us with a conceptual tool for thinking about the way that technological connections are generated between places that share relatively similar technologies. Technological zones create uniform 'domains of regulation' which enable the operation of a legal and technological regime within nation states. Tying together this issue of regulation and technologies of government, Foucault's (2007) work on governmentality looks at the state through the justifications and rationalities it uses for its mechanisms of regulation. It provides one of the key conceptual tools for looking at the regulatory functions of the state in this thesis.

One of Foucault's major contributions to the study of power is the idea that historical change can be explained by the growing intensity of power relations. Nelson (2008) argues that the intensity of power is determined by two factors within a given field: its efficiency, and its saturation. It can be argued that both of these factors have have been influenced by the increasing prevalence of computer networks in governmental regulation. I then trace how computer networks have contributed to the intensification of power relationships using Deleuze's (1992) concept of the societies of control. He argues that disciplinary mechanisms have been replaced by the mechanisms of control because control operates through the 'modulating' of individual behaviour rather than the 'moulding' of subjectivities. This shows us how computer networks have saturated the effects of power throughout the social body without necessarily needing sites of enclosure for its exercise. Similarly, geographers have also talked about the modulation of space through software. Kitchin and Dodge (2011) call this software mediates modulation of space transduction. Software is a means through which relational problems are mediated through transductive processes which transfer things from one state to another. These processes structure spaces iteratively in relation to instructions determined by software, maintaining these changes through an ongoing set of contingent and relational processes'. Finally, I will turn to Foucauldian literatures on education, which helps contextualise the case study of the secondary school education system in England. Foucault ideas about power and government have been particularly influential in this body of work. I argue that whilst existing work in this tells us much about the bureaucratic aims of education, forms of regulation and the production of subjects, there is a lack of focus on the impact that increased connectivity with computer networks have had on practices within schools.

Network Societies and the State

Networks are both symbols that represent and tools that organise the world of social interactions and economic transactions. Mattelart (1999) finds the genealogy

of the word 'network' in seventeenth century France, as a word used to describe the structure of needlework in the silk trade which later develops in three separate domains: as a metaphor for living organisms, for the exercise of power, and for representing utopian societies. The emergence of the network as a metaphor for living organisms began in the late seventeenth century with the discovery of the circulatory system. William Harvey's Anatomical Exercises Concerning the Motion of the Heart (De Motu Cordis) published in 1628 posited the theory that the heart circulated blood around the body through a network of capillaries (Wright, 2013). Harvey's ideas were groundbreaking because it broke with orthodox views of the human body that had persisted in Western thought since the Roman Empire. His views were influential on people like Francis Bacon and René Descartes— whose work on mechanical philosophy was influenced by the idea of circulation (Wright, 2013). Mattleart (1999) argues that Harvey's ideas allowed living organisms to be seen as the 'archetype of rationality' where each organ functions to enable the whole. The importance of these metaphors can be seen in the way that political anatomy, the predecessor of political economy developed by the Physiocrats such as Adam Smith and Kant, who conceived the circulation of wealth as links of wealth production, distribution and consumption that made up the hierarchal links between the sovereign and his subjects (Foucault, 2007). In this section we will look closer at how networks have historically developed as models for exercising power and models for representing societies.

Networks became material systems in the seventeenth century when Marquis de Vauban, Louis XIV's principal military engineer devised a system of tunnels under fortresses to function as defence mechanisms. The science of fortification developed from the convergence of cartography and defence, although Vauban never called his models 'networks', his ideas influenced the development of defence fortifications and underground tunnels that were later called networks (Mattleart, 1999). Barry (1996) argues that communication networks such as the telegraph performed a crucial role in liberal governance by providing the link between public authorities and the social body, especially across dispersed national territories that reconfigured the space of the state. Barry (1996) argues that the telegraph allowed

public authorities to monitor events at a distance which transformed the practices of the state.

The telegraph was also seen as a source of immense economic growth and political significance in the regulation of international space. It represented the convergence of the interests of capital and imperial government through a combination of advances in physics and politics (Wise, 1988). Funds for the first Trans-Atlantic cable, laid by Sir William Thomson (later Lord Kelvin) were raised from private shareholders in 1858. During the Industrial revolution, developments in technology became associated with the development of capitalism. Developments in the railways and the telegraph became sources of profit and investment as well as sources of state advantage. The telegraph played an essential role in the conduct of war and the development of industry in the late nineteenth century. The potential of near immediate communication around the world meant that it was used to maintain political and military order as a tool for ensuring the security of the empire. As the significance of the telegraph to state security began to increase, the operation and security of the network became increasingly regulated.

Barry (1996) argues that there were three main areas of concern surrounding regulation: first there were practical concerns such as the standardisation and development of the technology to increase its efficiency through scientific advances such as the reduction of electrical interference. Secondly there were organisational concerns, such as the the training telegraph of operators and structuring of the global workforce required into a co-ordinated and hierarchal structure. Lastly, the state was involved in the regulation of transmissions over international spaces and ensuring that different networks could work together whilst maintaing the integrity and privacy of telegraphs. These concerns led to the formation of the International Telegraph Union in 1865 which set global standards for the telegraph network. However, the formation of international standards did not diminish geopolitical concerns about the integrity of transmitted messages, Barry (1996) notes that during the 1890s the British government attempted to reduce its reliance on cables operated by foreign countries and pursued ambitions of establishing an all British network around the world. The telegraph was thought to be essential for the se-

curity of the Empire. An 'all-red line' need for the British network was thought to be necessary to ensure its security by removing its reliance on other countries.

Barry (2001) argues that the desire to create 'pure' national technological connections such as the British telegraph have proved impossible to sustain. He argues that technological connections between different entities and places create 'technological zones'. Technological zones are generated by making technologies between connections relatively similar, allowing them to have clearly defined ends. Barry argues that technological zones are never fixed, but always in the process of being generated. They require constant adjustment and reconfiguration for these connections to be sustained. He argues that nation states seek to produce uniform 'domains of regulation' which enable the operation of a legal and technological regime. The formation of this regulatory domain is related to the to development of science and technology, creating the striated spaces that facilitate the conduct of government.

Entities and places that are connected together enable forms of measurement and regulation to take similar forms, allowing comparisons to be made between different connections. Barry (2001: 40) describes a few defining characteristics of technological zones: firstly, they may overlap other zones, they are not territorially continuous, and are likely to be contested. Secondly, they may possess a certain degree of internal variation, even though they are marked by their uniformity. Zones are not structures of action bound by territories or regions, but are 'discontinuous spaces of circulation and regulation' which are 'interrupted by shifting restrictions and blockages and points of conflict' (Barry, 2001: 41). Thirdly, he argues that they are 'framed and reframed by instruments and markers' that establish out zones for political action (Barry, 2001: 41). This helps us to see the establishment of networks as a process of generating technological zones between different entities and places. The establishment of technological zones have facilitated the imagination of the nation state as a domain of regulation that regulates using systems of measurement and calculation.

Mattelart (1999) finds the evolution of the network from a technical network to a social utopia in the work of Henri de Saint Simon. Saint Simon coined 'social physiology' to describe (and prescribe) the the organisation of human societies. In late seventeenth century France for instance, there was an attempt to organise space to enable communication and exchange through the construction of canals and roads. Mattelart argues that the 'taming' of 'evil' nature achieved Enlightenment goals of creating a 'good' nature that united and allowed the easy movement of people and goods. The idea of networks emerged during the Enlightenment as a means of rationally comprehending a world that was becoming increasingly complex. The creation of the Bourgeois public sphere described by Habermas during the Enlightenment results from the idea that networks provided a means by which society could govern itself, increase the interactions within civil society and decrease the demands made on the state. Technologies such as the telegraph helped create an informed public which was one of the central tenets of liberalism. Barry's (1996) account of the telegraph in Britain differs from Mattelart's (1999) history of the French telegraph where it was primarily seen as a state tool for exercising control over its dispersed population much like the earlier technology of the semaphore. In liberal Britain, the telegraph was perceived as a populist tool for individuals as well as an administrative tool for the state that served the interests of the population (Wise, 1988). The telegraph was a tool of imperial cohesion that made it possible to run businesses as well as stay in contact with people around the empire.

Galison (2001) shows how the threat posed by nuclear bomb to central forms of organisation led nation states to distribute their activities and networks across space. He shows how the dispersion of German aircraft industry as a result of allied bombing of aircraft plants. allowed the Nazis to increase production whilst reducing the risk posed from having key centres of production. After the assessing the damage caused by American nuclear attacks on Hiroshima and Nagasaki by American, the Strategic Bombing Survey began to press for decentralisation of American industries as a way of minimising the consequences of a nuclear attack. One of the more examples of their influence can be seen in Paul Baran's (1964), an electrical engineer at the RAND corporation whose proposals for a distributed

communications network that eliminated the need for a hierarchical centre. This proposals which were published in the early 1960s are seen by any to be a precursor to the modern day Internet.

The rise of the British empire and the development of global communication networks are often illustrated as evidence of the emergence of an increasingly globalised world. Technologies that were developed during the Second World War such as nuclear power, jet engines and computer networks have had a significant impact on societies that developed in the latter half of the twentieth century. McMahon (2001) argues that globalisation is the result of an interplay between technology and prevailing societal processes. McMahon shows how globalisation is part of a long-term trend that has extended social control of the entire planet in service of institutional structures that oscillated between serving the various interests of economic efficiency or military security. He argues that institutional structures such as states, militaries and industries are related to their technologies of production, transportation and communication. He identifies four historical phases in the development of globalisation: the military-commercial, global-financial, industro-militarist and the contemporary form of cyber-financial globalisation.

The work of sociologist David Bell (1976) whose concept of post-industrialism is a recurrent theme in theories of information(al) or network societies that representing contemporary forms of globalisation. Bell (1976) argues that the emergence of post-industrial societies would result in the superseding of labour by theoretical knowledge: the industrial society of goods and manufacturing would be replaced by the information society of knowledge and information production that was made possible by the introduction of computers and telecommunications. This antagonism between labour and knowledge is based on the idea that the latter has become the predominant mode of production in modern capitalist societies, thus neutralising struggles over labour and capital. This was picked up in later theories of the 'information society' which began to present developments in information technologies as alluring solutions to economic and social problems. Building on the work of Marshal McLuhan, authors such as Alvin Toffler (1980) would build on these theories to imagine a new kind of society based information technologies

as a 'third wave' that succeeded agricultural and industrial societies. Toffler (1980) argues that globalisation has led to the decline of manufacturing in industrialised nations which has undermined organised labour and weakened the state. He argues that a new form of society 'challenges all the old power relationships, the privileges and prerogatives of the endangered élites of today, and provides the backdrop against which the key power struggles of today will be fought' (Toffler, 1980: 24). It is easy to see why this narrative was seductive then, as it is now, as technology promises to liberate people from the apparent 'drudgery' of industrial production. For instance, in this passage below, Toffler recounts his experience of working in a factory:

> I swallowed the dust, the sweat and smoke of the foundry. My ears were split by the hiss of steam, the clank of chains, the roar of pug mills. I felt the heat as white-hot steel poured. Acetylene sparks left burn marks on my legs… I watched the managers who kept the workers in their place, white-shirted men themselves endlessly pursued and harried by the higher-ups. I helped lift a sixty-five-year-old woman out of the bloody machine that had just torn four fingers off her hand, and I still hear her cries—'Jesus and Mary, I won't be able to work again!' (Toffler, 1980: 139-40)

His work came at a time when high interest rates made the future of manufacturing uncertain in America as industries (and jobs) began to close and relocate around the world. Toffler offers an inevitable explanation for the decline of manufacturing and offers the utopian promise of work in knowledge production in the newly developed industries that relied on Information Technologies. The state model was no longer relevant for the accumulation of capital which could operate more efficiently using digital networks and computers rather than state bureaucracies. The workers in Toffler's 'electronic cottage' industries are flexible, and adaptive to the demands of new technologies. The possession of knowledge, or information in its commodity form becomes the means of acquiring power for the technical elites of the post-industrial society.

David Lyon (1988) argues that there is no linear development of societies that lead to an informational economy. Instead of a dramatic shift, he argues that there is merely an increase in the range of 'information activities' (Lyon, 1988: 63). Lyon is

sceptical of the idea that technology by itself determines the shape of society, or of employment in general. Lyon (1988: 148-9) argues that the vision of the information society as a 'logical social advance' is reinforced by a characteristically occidental belief in 'unlimited economic accumulation'. Thus it becomes imperative that education systems should be transformed and markets freed in anticipation of delivering the promises made by technology. Lyons warns that the dangers of centralism and monopolies of capitalism do not disappear in an information society whilst warning of the long-term impact of new technologies and their unforeseen consequences such as the increase in surveillance enabled by new technologies.

Manuel Castells (1996, 1997, 1998) argues compellingly in a trilogy of books that increases in global connectivity have resulted in the emergence of a new 'network society'. Castells argues that in these societies, the production and processing of information using computers have replaced the manufacture and production of physical goods as the mode of production in these societies. Although this argument is iterative of Bell (1976) and Toffler (1980), Castells looks at the network as a form of society rather than mere developments in micro-electronics and computers. His predictions of massive societal change were made at a time when the Internet was growing significantly during the 1990s. Castells argues that developments in ICT are the primary driver of contemporary globalisation, resulting in the growth of 'knowledge-based economies' which rely on a mode of production organised around capturing and circulating flows of knowledge. According to Castells, access to global networks, particularly digital computer networks, have become key determinants of economic and social development in the modern world. It is unfair to abbreviate his argument to a discussion about the mode of production, many have argued that the network society implies social transformation in realm of human experience, power relations and culture in general that culminates in the reconstituted identity of the postmodern subject (Castells, 2000; Poster, 1990; 1994)—however, it is beyond the scope of this literature review to discuss these issues.

Castells (1996) argues that the network has been responsible for reconfiguring social life in a 'space of flows' rather than in the 'space of places'. He argues that the space of flows is the 'technological and organizational possibility of organizing the simultaneity of social practices without geographical contiguity' (Castells, 2000: 14). The spaces of flows are the deterritoralised spaces that are freed from by removal of the stratified boundaries of social formations and reterritorialised in the virtual spaces of the network society. One of the key arguments Castells (2000) makes is that the network society deterritorialises the nation-state, which leads to a decentralised means of social organisation. Castells (2000: 16) argues that networks are 'value-free or neutral' forms, that currently support a capitalist mode of production, but could be transformed to support alternative modes of production due to its decentralised structure:

> The fundamental dilemma in the network society is that political institutions are not the site of power any longer. The real power is the power of instrumental flows, and cultural codes, embedded in networks. Therefore, the assault to these immaterial power sites, from outside their logic, requires either the anchoring in eternal values, or the projection of alternative, communicative codes that expand through networking of alternative networks. (Castells, 2000: 23)

Castells envisions this as a model for the future of institutions as well as individuals. He has predicted some of the widespread transformations we have witnessed over the last two decades. He cites the examples of transactional production networks and social movements as characteristically relying on the 'network' mode of organisation (Castells, 2000). These entities are internally decentralised and rely on partnerships and changing alliances that differ from the territorially bounded, fixed entities of the past. Castells argues that these social formations are only bound to the territorial for access to technological infrastructure and for connecting functions and people located in specific places together. Instead of the state, the 'firm' is the organisation par excellence that Castells uses to demonstrate the network society. Firms act as an intermediary for customers and suppliers, processing supply and demand to generate a profit from its ability to process information such as market trends and consumer preferences (Castells, 2000: 20).

For Castells (2000: 15), networks create 'an unprecedented combination of flexibility and task implementation, of co-ordinated decision making, and de-centralized execution, which provide a superior social morphology for all human action'. This superiority is premised on the contention that networks are 'the natural forms of social expression,' that had until now been 'outperformed as tools for instrumentality' by social organisations based on centralised hierarchies like the nation state (Castells, 2000: 15). It is the emergence of information and communication technologies that Castells argues, allows networks to '[assert] their evolutionary nature'. Castells (2000: 15) argues that new technologies allow networks to co-ordinate action through the dissemination of information whilst allowing complexity to be managed and decision-making to be decentered, providing 'a superior social morphology for all human action'. We turn to the geographies of these new information technologies in the next section.

Network Forms and Forms of Government

In a series of lectures at the College de France during the 1970s, Foucault (1978, 2003, 2007, 2008) began to show how the form of power in the West has gradually transitioned from the dominance of an absolute form of sovereign power towards an era of biopower that became the dominant mode of power during the nineteenth century. Biopower refers to the way that life became the the 'object-target' of techniques and technologies of power (Anderson, 2012). I argue that the explosion of biopower after the nineteenth century coincided with the rescaling of power through technologies and new forms of infrastructure such as electromechanical networks (like the telegraph) that allowed power to act on human bodies through more capillary forms from a distance. In this section, we will define this transition, and discuss the impact that biopower has had on the state and governmental rationality. The historical development of biopower has much to tell us about the intensification of power in contemporary life. New forms of power are increasingly dependent on connectivity to an increasing range of electronic net-

works that are wireless and 'always connected,' acting on us through a number of discrete, lightweight practices of the state. We discuss these techniques in detail over the next three sections of this literature review.

Sovereign power originates from the Roman right of the father to take the life of his slaves and children. This is a 'deductive' form of power that levies life, either taking life itself (through torture or killing) or what is produced by life as taxation. Whilst the power to take life itself has waned over time with the development of the judiciary system, sovereign power has retained its ability to indirectly expose life to death in defence of the sovereign—through conscription for example. Since the seventeenth century, power has become more relative, deductive forms of power have become one amongst a number of productive functions intended to grow, order and administer life. Tasked to 'administer life,' it became difficult justify sovereign right to the death penalty (Foucault, 1978: 138), the right to kill underwent a parallel transformation whereby death could be exercised on the basis of making other lives live.

Foucault (2007: 338) argues that between the 17th and 18th Centuries a 'cluster of intelligible and analysable relations' began to emerge that allowed a 'number of fundamental elements to be linked together like the face of a single polyhedron'. These relations began in the seventeenth century with a form of *anatamopolitics* that was exercised on the individual body, later followed by a form of *biopolitics* simultaneously exercised on the body of the human species. During the nineteenth century, these two poles became coordinated to produce a form of *biopower* that took life the object of political strategy (Foucault, 1978). The procedures of *discipline* took the individual body as a machine to increase its performance through training and optimisation (Foucault, 1977). Biopolitics uses forms of regulatory controls to target biological processes (such as the mortality and birth rate) that were comprehended statistically at the level of the population. Foucault (1978: 140) argues that the the mechanisms targeting the body and the population were conjoined as 'agencements concrets' which I take to mean *concrete assemblages* (translated in the text as 'concrete arrangements') following Massumi's translation of Deleuze and Guattari (2004). Foucault (1978: 140-1) argues that biopower is

crucial to the development of capitalism, because it combines the disciplinary training of individual bodies (to efficiently operate the machines of production), with biopolitical mechanisms (to adjust the population for optimal economic growth).

One of Foucault's major contributions to the study of power is the idea that historical change can be explained through the growing *intensity* of power relations (Nealon, 2008: 32). The intensity of power is determined by two factors within a given field: its efficiency, and its saturation. Biopower radically changes both these factors of disciplinary power. The efficiency of power is the relation between the economic costs of its exercise and their overall effectiveness. The saturation of power corresponds to the widening of the spatial field of its operation. For example, the spectacle of torture in sovereign power is concentrated at the site of the gallows, whereas disciplinary institutions such as schools and hospitals exercise a more capillary form of power that is distributed in multiple segments throughout the social body. The intensification of power is argued to be 'both the useful *tool* and the desired *end* of power relations' (Nealon, 2008: 53 emphasis in original). Networks have contributed to the growing intensity of various forms of biopower by extending the spatial reach and efficiency of power. The telegraph network was a means by which power relations could become both more spatially saturated across the Empire, whilst operating at greater efficiencies and speed to intensify the sovereign and economic powers (Barry, 1996).

Biopower uses statistical norms as a continuously expanding field to include *all* of life, as opposed to discipline which use norms as a mechanism for identifying and excluding the abnormal. Foucault (1977: 184) describes the *norms* in discipline as a 'a principle of coercion' which began in education as a way of comparing a body against the normal. Norms made it possible to impose homogeneity and rank whilst individualising the powers that were bought to bear on the body by making it possible to measure gaps between norms and individual bodies. Biopower uses norms as the 'efficient and continuous calculations of alterity' rather than a binary exclusion of difference (Nealon, 2008: 51) expanding the field of knowledge to identify the 'norms' of relations between bodies. Norms establish a relation

between one body and all other bodies in a given social field. Within this field, disciplinary mechanisms become integrated into biopower's concern for life, the regulation of activity within institutional sites of enclosure becomes oriented towards ensuring the vitality of subjects who were subject to normalisation. These processes of normalisation incorporate both the concentrated saturation of power over individual bodies in disciplinary institutions as well as the pervasive power of social norms in a social body. Biopower operates on relations *between* bodies within a population. Foucault provides us with two examples of how biopower regulated sexuality (1978) and economic relations (2007, 2008). The saturation of norms can be seen in the way that nineteenth century discourses of sexuality constituted 'normal' practices of sex that allowed biopower to 'spread its net down to the smallest twitches of the body and the most minute stirrings of the soul' (Dreyfus and Rabinow, 1982: 169).

The state science of statistics was brought into the realm of biology as the concept of population migrated from an area of medicine to the statistical calculations of government. Initially, the statistical concept of the population was used to justify a whole range of biopolitical interventions as the improvement of the population became an aim of government. Central to these new techniques were the increased availability of information that gave rise to sciences of demography, sociology and political economy. These sciences 'emerged from a context which demanded information in order to guarantee the processes through which the state could be secured and the population made productive' (Legg, 2005: 140). It is not difficult to see the relationship here between the increase in an ability to know and the existence of new forms of networks that enable the state to know and act on the population. Foucault (1978: 144) argues that a power which takes charge of life needs 'continuous regulatory and corrective mechanisms' that have the ability to to distribute, hierarchise, and order the living according to norms.

Lazzarato (2002: 103) argues that the 'fundamental political problem of modernity is not that of a single source of sovereign power, but that of a multitude of forces that act and react amongst each other according to relations of command and obedience'. Biopower does not originate from a central source of power like sov-

ereign power, but is a form of power that can be adopted by individuals to co-ordinate and adjust their relations with others in reference to norms. Norms remain external to these relations, which is evident in the way that the population was relativised as a representation of the inhabitants of a state. The *économistes* of the nineteenth century began to argue that the population was a self-regulating entity whose existence was separate from the territorial claims of the sovereign (Foucault, 2007). Whilst population had originally referred to the inhabitants of a place, after the mid nineteenth century it began to refer to the degree to which places were inhabited (Legg, 2005). Through this shift, the inhabitants of place are both abstracted and deterritorialised. Norms derive from this abstraction became a useful concept for both limiting the sovereign, as well as justifying a whole range of calculative interventions on the population itself.

Foucault's (2007) lectures on the history of governmental reason show how liberalism sought to contain and define the state by problematising 'too much' government. *Governmentality* refers to how 'those who exercise rule have posed themselves the question of the reasons, justifications, means and ends of rule, and the problems, goals or ambitions that should animate' the mechanisms of government (Rose, 1996: 41-2). These practices of that were applied to the population would gave rise to the modern state. For Foucault (2007: 247-8), the nation state is merely an episode in governmentality: an unstable expression of the technologies and practices of government through which a state form is constituted and rationalised. The gradual transformation of the territorial state into a population state produced a form of political rationality that he called liberal governmentality which argued that the population was a self-regulating entity.

One of the fundamental objectives of liberal governmentality becomes the creation of security mechanisms that could monitor and ensure the security of these 'natural' processes. It is here that the population re-enters the territorial realm to reshape the concrete assemblages of the state which target both the population and the individual body (Foucault, 2007). Elden (2007) argues that Foucault (2007) overplays the transition from a territorial to a population state. He argues that the strategies applied to the population are also applied to the measurement, ordering

and normalisation of territory as a calculable entity, which enables space to be rendered as a political category. Elden (2007: 578) raises an interesting point about the relation between the calculation of the population and the calculation of territory which he argues is grounded in the relation between governmentality and calculation. I have argued so far that networks play a fundamental role in this relationship between the mechanisms of security that act upon the territory and the population.

The trajectory of biopower reaches a dangerous plateau during the early decades of the twentieth-century in the eugenic methods practiced by imperial states such as Belgium and Britain. Initially these practices were restricted to the colonies, and later leading to the concentration camps of the Holocaust in Nazi Germany (Levine and Bashford, 2010). This 'crisis of governmentality' forms the backdrop for the development of neoliberalism in the period after the Second World War (Foucault, 2008: 70). Scientific advances during and after the Second World War began to articulate a means by which society could govern itself using newly developed communications tools that increased access to knowledge and the ability to co-ordinate activity. Set against the backdrop of Nazism and Stalinism, neoliberalism sought to curtail the 'totalitarian' tendencies of the state through the active cultivation of individual economic freedom (Foucault, 2008; Lemke, 2010). Relying on the self-regulating capacity of the individual and the self-organising nature of populations, neoliberal forms of governmentality drew on libertarian ideas to dispose of overtly moralising tendencies found in disciplinary power. The progenitors of neoliberalism such as Ludwig von Mises and Milton Friedman of the *Mont Pelerin Society*, drew on classical liberal theorists such as Adam Smith to reorient 'how the overall exercise of political power [could] be modelled on the principles of a market economy' (Foucault, 2008: 131).

Foucault (2008: 313) argues that neoliberalism attempts to govern according to the rationality of norms found in the competitive behaviour of economic relations. The subjects of neoliberalism regulate *themselves* according to market norms through rational calculations of self-interest. Foucault (2007) argues that governmental rationalities overlap and come into conflict rather than replacing each oth-

er, neoliberal mechanisms do not exclude older forms of power such as disciplinary or sovereign power. Unlike classical liberalism, neoliberalism does not merely limit the state, but actively justifies state intervention to establish the operation of market norms. The state actively intervenes in society by producing markets (like the privatisations of British state industries during the 1980s) or to ensure the efficient running of market mechanisms such as anti-monopolisation measures. Justifications for a neoliberal art of government could only be made through knowledge about economic processes that were discovered or actively produced within the social body. As economic norms are the only legitimate mode of regulation in neoliberalism, state intervention is justified on the basis that it increases the saturation of market norms within a given relationship. This accounts for some of the violence inherent in neoliberalism, which is not laissez-faire, but a particularly interventionist form of government.

Neoliberalism became the dominant political rationality in America and Britain after the economic crises of the 1970s provided a political justification for drastic cutbacks to the Keynesian state. This story has been depicted in the well rehearsed stories of state disinvestment in activities to encourage their replacement with mechanisms from the market (see Harvey, 2005). However, neoliberalism did not just entail the privatisation of government services, it also remade relations within the social body into an entrepreneurial form, where people were encouraged to join as entrepreneurs of the self who capitalised on economic opportunities. Foucault differs from Harvey because he shows how neoliberalism is able to conduct our conduct by encouraging us to subjectify ourselves—as entrepreneurs who seek to gain returns on our capital, human and otherwise (Foucault, 2008: 221-26; Protevi, 2009). Rather than a hierarchal organisation of society, this relies on relationships based on competition, within this narrative the network emerges as a means of making us institutionally and individually more efficient through increased access to information for economic decision making.

It is against the backdrop of this world that Hardt and Negri (2000: 9) develop their concept of Empire as a paradigmatic form of biopower that emerges after the cold-war and gives birth to a 'single power that overdetermines' old divisions

between imperial powers. They argue that networks have been the 'effect and cause, product and producer' of this world that has expressed and organised the movement and direction of globalisation (Hardt and Negri, 2000: 32). They argue that communication networks have structured and multiplied interconnections within this new order. Globalisation since the 1970s has been dependent on technological innovations that have transversed and converged with the knowledges that inform neoliberalism and the practices that form biopower. They argue that communication networks have went from a sovereign tool of military expansion to finding its application in aggressive capitalist expansion after the end of the Cold War. This shows how networks have intensified the saturation and efficiency of economic activity across the globe. Networks accelerate the continued insertion of life into the machinery of production using digital networks, market norms and discourses of global efficiency. This insertion has had a subsequent effect on biopower as it intensifies its ability to account for all of life by electronically expanding the knowledge of processes in the social body. Norms can be established for larger spatial scales and at finer details about processes governed by market norms.

From Government to Governance

Authors such as Larner and Walters (2004), Ong (2006) and Sparke (2006a) have brought together concerns about technologies of power and economic transformations with the topic of subjectivity formation in neoliberal governmentality (Sparke, 2006b). As well as connectivity and globalisation, this area of work traces how neoliberal governmentality has extended a 'permanent economic tribunal' across multiple nation states. This work reflects Elden's (2005) argument that the calculative practices associated with the traditional capitalist state have become transnational in nature. Larner and Walters (2004) for instance, shift attention to the 'surfaces, practices and routines' of globalisation. They argue that the ability to abstract space at a global scale has been produced through the arrangement of socio-technical things such as bodies, computers and infrastructure that are both

spatially located within and performative of globalisation. Thus globalisation is contingent with different forms of knowledge and practices as a way of acting on and in the world that result in *situated* and *embodied* globalisations. They compare globalisation to other 'master narratives' such as civilisation or modernity, that relied on a governmental rationality which makes use of a particular regime of truth as a means of political action. Not only is 'global-governmentality' a particular way of thinking about the exercise of power, it is also a way of knowing and representing 'that which is to be governed' (Larner and Walters, 2004: 496).

One key area of development in the rationality of the state since the 1990s has been a shift towards systems of 'global governance' (Rosenau, 1992) that have entailed a shift away from governmentality as the global and the local are argued to overshadow governmental role of the nation-state. Concepts of governance emerge after the end of the Cold-War, events such as the fall of the Berlin Wall symbolised the destruction of boundaries and ideologies that had staunchly divided politics. Authors such as Francis Fukuyama (1992) declared the end of history and claimed that liberal values and democracy had emerged victoriously from the struggle. Rosenau (1992: 4) characterises governance as a set of non-hierarchical mechanisms that perform the role of achieving order—regardless of whether they are constituted by institutions of the state. Rosenau (1992) argues that these mechanisms are sufficient to ensure the survival of human systems because it allows them to cope with external challenges, prevent and mediate conflicts, provide resources and frame mechanisms to achieve these goals. In other words, governance allows some functions that were conventionally thought of as functions of government to be performed through activities that do not necessarily originate from the actions of governments. Rosenau (1992: 11) depicts this era as the triumph of citizens over hegemonic powers—moving away from bipolar rivalry between two ideologies during the Cold-War towards a *polyarchy* where different actors competed for global influence. Rosenau claims that that issues like environmental degradation, terrorism, epidemics and the 'shrinking of distance' created by communications technologies undermined state claims to sovereignty. This entails both a centralisation and decentralisation of sovereignty by rescaling of authority to supranational institutions such as common markets as well as de-

volving powers to subnational groups such as social movements and non-governmental groups whom Rosenau claims, have greater claims to legitimacy. Governance extends earlier forms of liberalism through the active production of freedom using the law and the decentralisation of power.

Rosenau (1995: 16) argues that networks of governance are capable of operating without hierarchies, 'global governance is the sum of myriad—literally millions of—control mechanisms driven by different histories, goals, structures, and processes'. The systems of governance makes a system for achieving social order intelligible without reference to the sovereign power of a nation-state. Influenced heavily by the development of global computer networks such as the Internet, governance attempts to realise in some form, the political structures imagined by Castells (2000) as network societies. Rosenau (1995: 20) argues that steering mechanisms operate through networks of actors rather than the hierarchies of states which do not produce stable or coherent global strategies, but 'mechanisms that fluctuate between bare survival and increasing institutionalization'. Fundamental to these mechanisms are the existence of communications networks that coordinate forms of 'inter-governmental management' (Rosenau, 1992: 6). These ideas have been widely translated into neoliberal models that have transferred state functions into the market.

It is within these models that we begin to find divergence from the ideals of governance, particularly within the mechanisms that are argued to replace the state. Peck and Tickell (2002; also Peck, 2010) distinguish the earlier stage of *roll-back* neoliberalism originating from the 1980s which made cuts to social spending and state industries with that of *roll-out* neoliberalism emerging after the 1990s that introduced more intense forms of technocratic state intervention. Rhodes (1997) shows how British public policy has shifted from a model of hierarchies and markets to being framed around a discourse of networks between public and private sectors. He suggests that socio-cybernetic systems are the heart of achieving policy outcomes without the mechanisms of a central government because they are argued to possess self-organising properties because they enable the autonomous operation of entities independently of central authorities (Rhodes, 1997: 50).

Enroth (2013: 63) argues that the trichotomy of hierarchies, markets and networks creates the perception of a step by step evolution over time that is no longer relative to a population or society, but produces solutions to problems. He argues that this has resulted in a move from a focus on the nature and role of the state towards generating 'systemic governing functions' in society (Enroth, 2013: 64). Whilst modern arts of government relied on a presupposition of a population that that was governed individually and collectively, Enroth (2013: 64) argues that there is an absence of these reference points in the discourses of governance. He argues that mechanisms of governance transcend 'beyond the institutional and spatial boundaries of the modern nation-state-society constellation' (Enroth, 2013: 61). The departure of governance from the social systems being governed creates a normative void which he argues, leads to a situation of *a-leigitmacy* (Enroth, 2013: 67) The concept of democracy which had provided justification for government is made irrelevant by a discourse of governance which presumes that society is no longer the result of institutions that operate according to a predefined concept, but as a series of problems requiring technological solutions and arrangements. This means that governing recast as solutions to 'transcendent imperatives that demand [immediate and efficient] responses' rather than democratic processes demanding justified reactions based on predefined rights (Enroth, 2013: 68). The discourse of democracy that had previously legitimated governmental action is replaced by labels such as output, performance or accountability (Enroth, 2013: 8).

Digital Servitude and Machinic Enslavement

Deleuze and Guattari (2004) present us with a world that is produced by various assemblages, apparatuses and machines that emerge out of the coming together of human and non-human components. Mumford's (1966) essay 'The First Megamachine' is particularly influential on the way that Deleze (1992) conceptualises machines. Mumford argues in his essay that the supreme feat of ancient societies that built monuments such as the Pyramids were the way they way in which they as-

sembled human beings as component parts of megamachines. Megamachines were established by kings who acted as gods (or their anointed representatives) who 'commanded power and performed labour on a scale that was never even conceivable before' (Mumford, 1966: 2). Mumford (1966: 3) argues that the 'collective entity' which operated under human command to perform functions was a real machine 'composed of human bone, nerve, and muscle' that was 'rigidly restricted to the performance of their mechanical tasks'. Two other components were crucial to the operation of the megamachine: 'a reliable organisation of knowledge,' what we call science, and an 'elaborate structure for carrying out order' that enable exercise of power though bureaucratic machines composed of supervisors, managers and executives who transmit the king's orders (Mumford, 1966: 3).

Deleuze and Guattari (2004: 157) interpret Foucault's modes of power as abstract machines that are 'neither an infrastructure that is determining in the last instance nor a transcendent idea that is determining in the supreme instance,' they are the virtual which provide the diagrams for 'concrete assemblages' (Foucault, 1978: 140) that exercise power. Deleuze calls Foucault the 'cartographer of power' (Deleuze, 2006) because he maps the cartography of power, for instance by showing how a diagram of disciplinary power can be found in the panopticon:

> "[The panopticon] is the diagram of a mechanism of power reduced to its ideal form; its functioning, abstracted from any obstacle, resistance or friction, must be represented as a pure architectural and optical system: it is in fact a figure of political technology that may and must be detached from any specific use" (Foucault, 1977: 205)

Foucault allows us to see that disciplinary power cannot be identified with a single institution like the prison, but as a technology of power that spans every kind of assemblage and causes it to operate in a distinct fashion. The form of the prison, as well as its contents are not reducible to the elements of its architecture, but to 'a complex state of things as a formation of power' such as regimentation and surveillance that create the effects of discipline by concentrating and distributing objects in space (Deleuze & Guattari 2004: 74). Disciplinary institutions ordered and distribute life spatially and temporally, Deleuze and Guattari (2004: 230) call the

social and spatial segregation of social functions *segmentarity*. Disciplinary institutions employ a linear segmentary where human bodies progress from one institution to the next. Institutions occupy distinct segments along this line. The welfare state followed a line from cradle to grave where life followed a path along its various institutions. These mechanisms acted on the bodies that passed through these institutions by assigning them various roles and duties. These linear systems involve the creation of rigid barriers and binary oppositions between the inside and outside of institutions a well as between segments.

The question of the nature of societies that replace disciplinary societies forms the topic of Delezue's (1992) essay the '*Postscript on the societies of Control*'. He offers us an insight into how disciplinary apparatuses of the state have been transformed by a new mechanism of power that he calls control. The rationality of control draws on scientific advances made during and after the Second World War in areas such as computers and communications technologies that used in the service of the state. Delezue (1992) argues that systems of control represent the introduction of a new system of domination that have made the linear segmentarity of disciplinary institutions redundant by breaking down and opening up the sites of enclosure. He argues that the use of digital communication networks have saturated the effects of power throughout the social body without the need for disciplinary institutions of linear segmentarity. Control creates porous and interchangeable sites of power that that may be signalling a return to forms of sovereign power. Control produces a continuous and pervasive exercise of power that can give '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)' without requiring the sites of enclosure needed by disciplinary mechanisms (Deleuze, 1992: 7). The segmentary division of power in disciplinary institutions located around the social body are not eradicated but intensified and made more rigid.

Contrary to the disappearance of disciplinary mechanisms, control intensifies discipline because it links up the various sites of power and allow various institutions to resonate together—a home can become a prison through an electric tag. We

have seen in our discussions of governance that networked institutions are argued to possess self-organising properties that allow them to operate without the mechanisms of a central government (Rhodes, 1997). Deleuze & Guattari (2004: 234) warn us not to make such an opposition between segmentary with the central because they are overlapping and entangled. Disciplinary institutions operated in segmentary sites both individually and collectively as a 'constellation of juxtaposed, imbricated, ordered subsystems' under the control of a central state (Deleuze & Guattari, 2004: 231). The mechanisms of control on the other hand intensify centrality and segmentarity by making disciplinary mechanisms more efficient, its hierarchies less visible, making the centrality of power less apparent. Fraser (1985: 179) argues that the lack of a visible hierarchy or asymmetry are not essential to the Foucauldian notion of power, 'only imperfections to be eliminated through further refinement'. The visible distinctions between institutions and hierarchies in disciplinary societies have made way for the less visible processes of control. This lack of visibility does not denote the lack of power, it can, and it usually does, coincide with an intensification of its effects.

Coupled with the *decrease* in the visibility of power has been an *increase* in visibility of the subject of power. The effects of the panopticon are intensified as surveilled operates throughout the social body not just within the sites of enclosure. Whereas disciplinary power dominated by subjection to its institutions, control demands servitude from the bodies it regulated, signalling the return to the modes of domination found in sovereign power (Holland, 1998). Deleuze (1992) argues that in the societies of control, individual behaviour is *modulated* through the use of databases, ID cards, passwords and biometrics. Control works through a modulation of power that attempts to continuously anticipate, or predict the emergence of external events before they occur. This is in opposition to the disciplinary *moulding* of subjects that register abnormal behaviour *after* it has occurred. The concept of societies of control has been developed by a number of authors such as Savat (2009) , who argue that control uses technologies such as the database as an extension of the 'writing apparatuses' of discipline. The writing apparatuses of discipline such as hierarchal observation, normalising judgement and the examination are intensified by the use of databases which increase the visibility of subjects and

are saturated throughout its field of operation. Poster (1990) also argues that databases have amplified the normalising effects of power, leaving its mechanisms intact in contemporary forms of governance. The intensification of power using databases have led to a greater degree of detail to be known about individuals, and subject to normalisation.

Mehta and Darier (1998) suggest that control has manifested in the production of new individual (and collective) subjectivities produced by the materiality of technologies and the transference of existing power relations onto the technology itself. Mehta and Darier (1998), call this 'electronic governmentality,' inching closer to realising Bentham's dream of total visibility through credit ratings, health records and ID cards that regulate relations in modern societies. They argue that the virtual space of the Internet creates an impression of a lack of central control, creating the impression that power has diminished. Examples of these forms of control include the 'dataveillance' (Amoore and Goede, 2005) of mass populations by governments and private companies for extracting marketing data on the Internet. These authors demonstrate how the practices of electronic governmentality can remain largely invisible whilst their capillary nature allows the rapid identification of problem populations or individuals who can be targeted for selective intervention.

Julian Ried (2009) politicises *connectivity* as a means of talking about the properties and capacities of technology. Ried argues that the utopian literature on globalisation and digital networks has created a distinction between the 'Connected' and the 'Disconnected'. He argues that the Connected are distinguished by their shared belief in the ability to bring about social and political changes through technology. In this utopian narrative, the 'Connected' derive their power from being 'informationally rich,' allowing them to be more socially and politically active than the 'Disconnected' who argued to be lack or reject the capacity to become connective. Reid (2009) argues that these codes have become 'transcendental' in determining the terms on which people connect in opposition to other codes of interaction such as affect and feeling. He offers us an alternative theory of connectivity which argues that a liberal interpretation of connectivity falls short of reflecting our po-

tential as creative beings as it only reflects the existence of a shared code. Ried argues that code of information has become dominant through a false belief that it has become the the *only* code of communication between individuals.

As we have seen, the network has been argued by authors such as Rosenau (1992) to be an evolutionary development in the human capability to be social. Reid (20009: 619) argues that we need to 'see beyond the practices of representation' on which the binaries of code depend, to 'make differently constituted bodies that are capable of connections more intense than the merely informational'. This perspective strongly questions the scientific assumptions of superiority that biopolitical governance of connectivity relies on. The saturation of connectivity in everyday life has intensified the presence of biopower. Connectivity has increased the efficiency of processes it directs and its saturation in the interactions of daily lives entangled with digital networks. The connectivity of individuals to the network has also saturated the mechanisms of government. Connectivity has found growing applications within a wide range of state activity from healthcare to education and policing that have adopted various techniques of control. It would be difficult today to find some area of governmental activity that is not dependant on connectivity. The widespread adoption of networks and databases in the art of government indicate that state institutions have been transformed and intensified by connectivity rather than made redundant by its presence.

Savat (2009) argues that control is experienced entirely differently from discipline as its ideal moulds of behaviour are replaced by the constant modulation of the environment, constituting people as a consequence of its actions. He argues that control is often experienced as a result of the choices you have made, giving you the impression that you are in charge—*in* control rather than *being* controlled. One of the reasons for the decrease in the visibility of power is that control increasingly does away with the need for (expensive) professionals such as teachers required to observe, train and punish individual bodies in the moulding process. Visible manifestations of power are replaced by technical machines that modulate using persistent mechanisms of power. Savat (2009) highlights how discipline and control work together even though they have divergent aims. Whilst the former seeks to

create a stable object, the latter attempts to create a flow. Its is this constant 'su-
perposition' of discipline and modulation that Savat argues, creates the effect and
experience of the *dividual*.

Deleuze (1992) argues that the individual of disciplinary society has been replaced
with the *dividual* in the societies of control. Disciplinary power depended on a ten-
sion between individuals and the mass; in control societies, individuals are replaced
by dividuals whose characteristics are based on data stored in databases, profiles
and market segments. Without a concern for the individual as such, control acts
on bodies through the continuous anticipation of events and adjustments of the
environment. The 'dividual' comes from an anthropological concept developed by
Marriott (1976: 111), he argues that the individual in Hindu societies were not 'in-
divisible, bounded units' but the result of transactional processes or interactions
that produced 'dividuals'. 'To exist, dividual persons absorb heterogeneous materi-
al influences. They must also give out from themselves particles of their own
coded substances' (Marriott, 1976: 111). I am not implying here that Western
thought adopts a Hindu conception of the self rather, that the concept of the self
mutates and takes on the form of a transactional becoming that is also found in
Foucault's work. Nealon (2008: 53) suggests that Foucault's work proceeds with
the Nietzschean notion that identities (and bodies) are the result of actions. The
self is no longer an 'ideal' to be moulded through discipline, but a 'variation in an
intensive parameter,' not a self-controlled subject, but controlled in advance (Bog-
ard, 2009: 22) and always in the process of becoming.

Drawing on Deleuze and Guattari (2004; 2013), Holland (1991) argues that the sig-
nifying regimes of subjection and discipline that produced modernity are being
replaced with an advanced form of capitalism that has bypassed subjectivity alto-
gether since the production of subjectivity is no longer the target of power. Discip-
linary power attempted to mould the whole of society '*omnes et singulatum*' (all and
one) by reforming and integrating the abnormal (Foucault, 2007). The dividual is
partial and fragmented, control abandons disciplines' attempt to reform, concen-
trating instead on securing against the appearance of the abnormal. The dividual is
coded into flows linked to dynamic relationships within databases and risk profiles

(Holland, 1991). The coding of these flows contribute to the rigidness of segment-arity within the societies of control. Walters (2006) and Amoore (2006) illustrate this using populations that are abandoned or placed outside the circuits of coded flows using technologies of control at border control points in the West. A coded strategy of social division creates a privileged population that are granted greater freedoms through biometric passports and electronic gates at airports, whilst an excluded population is subjected to the increased use of profiling and monitoring (Walters, 2006).

The emergence of mechanisms of control parallel transformations in the form of contemporary capitalism. Deleuze & Guattari (2004: 505) argue that in this form of capitalism relies less on the social subjection which has supplanted its depend-ence on disciplinary power for a mode of machinic enslavement. Discipline relied on the subjectification of bodies through external objects and institutions such as factories and schools that were used to mould the bodies that fit industrial capital-ism. These institutions were emblematic of the modern state that had substituted the servitude of sovereignty for the subjection of discipline. Deleuze & Guattari (2004) argue that the axioms of contemporary capitalism have reinvented in tech-nical forms a system where human beings have become enslaved as constituent parts of cybernetic and informational megamachines. They argue that the cyber-netic machines of control have created a 'generalised regime of subjection' (Deleuze and Guttari, 2004: 505-6) that has increasingly allowed tech-nical elites to manage the social body in service of financial capital. This form of digital servitude makes use of 'long term discipline' and 'high-speed control' (Hol-land, 1998) as mechanisms of regulation.

'Virtual' Geographies

The apparently 'virtual' spaces produced by networks has been a topic of study by geographers since the 1990s. This space has been known under various names that

allude to spatial metaphors such as cyberspace, the information superhighway and the space of flows that were alternatives to the physical world. In an early example of this kind of work, Batty (1997) draws on Castells to develop a concept of 'virtual geography' which encompasses the study of various spaces where digital worlds are expressed. As well as the 'cyberspace' of computers, Batty argues that the infrastructure or the 'real virtuality' that makes the digital world possible is an important component of its geography. Crang *et. al* (1999: 2) argue that 'technology does not come into being outside of the social, so the social does not come into being outside of the technological'. They argue that the subject of virtual geographies cannot be simplified to a debate over whether its spaces are more or less hierarchical or decentralising, but they show that it can take on different forms at the same time. Some geographers also began to argue against drawing distinctions between 'real' and 'virtual' geographies (Imken, 1999). Kitchin (1998: 403) for instance, argues that the geographies of 'cyberspace' exists in a symbiotic relationship with 'real space'. He argues that cyberspace depends on fixity to act as points of access to materially provide connectivity to these networks. Similarly, Graham (1998: 166) has pointed out that the kinds of spatial metaphors used to describe information technologies are 'ideological constructs' that have shaped the way that technologies are constructed, the practices associated with them and the power relations that surround their development.

John Law and Kevin Hetherington (2000) employ actor network theory to study the materiality of globalisation enacted by these technologies. They argue that global flows of capital, information, and their associated socio-cultural transformations can be understood more fully by looking at the *materiality* that makes up relations between flows. Materiality, or the 'stuff of the world' (Law and Hetherington, 2000: 35) is composed of the interrelations between objects, bodies and the material representations of information. Interactions between different things (such as people, computer networks and the knowledge of globalisation) shape each other as well as producing the social-spatial effects characterised by the network society. Law and Hetherington highlight the importance of the human and non-human elements relations which enact the spaces of globalisation. They encourage us to look at globalisation through the material forms in which its prac-

tices are enacted. Many geographers have argued that the spaces created by net-works have no predefined ontological status, but are produced relationally (includ-ing Massey, 2005; Amin, 2002a; Elden, 2005). Amin (2002a) argues that the onto-logy of place and territoriality are being shifted by the growth in connectivity and mobility. He argues that the spatiality of contemporary globalisation cannot be explained as an increase or decrease in spatial proximity, or the subjugation of the properties of place for spaces constituted by global networks. Instead, Amin argues that the notions of space and place themselves are being challenged rather than just becoming deterritorialised spaces of flows. A topological perspective allows him to view places as being already networked (not just digitally) spaces of organ-isation that are sites of situated practices and nodes in relational settings. He ar-gues that demarcations between these spatial forms are shifting as a result of 'world-scale processes and transnational connectivity' (Amin, 2002a: 387). This implies that the spatiality of these spaces cannot result from connectivity itself, but the practices and relations that it affords at greater spatial stretches and at shorter temporal durations to produce new kinds of space. These studies shift attention away from a focus on the 'dematerialisation' of life in virtual spaces towards the materiality and the practices that are transforming existing spaces.

As well as the material aspects of technology such as the infrastructure, bodies and practices, geographers have paid attention to role of 'software' in the co-produc-tion of space. These approaches look the at the material expressions of practices directed by software to produce certain spaces. Thrift and French (2002) have ar-gued that networks are increasingly involved in the 'automatic' production of space that work as background processes in technologically advanced societies. They problematise the role of human agency as the directive force behind these mechanisms and argue that software is 'becoming so pervasive and complex that it is beginning to take on many of the features of an organism' (Thrift and French, 2002: 311). Thrift and French argue that software is not a 'hegemonic' process that centrally directs the production of space, but a simultaneous operation of multiple pieces of software that inscribe space. Software is 'like a kind of traffic between beings, wherein one sees, so to speak, the *effects* of the relationship' (Thrift and French, 2002: 311 emphasis in original). An important contribution this makes is

that it allows us to see that software 'inscribes' and extends space rather than producing singular 'virtual' spaces. This contains favourable political potentials for these authors because they claim that software can extend political participation and produce a diversity of outcomes. This is because they see software as a lighter form of power that is 'writing' the spaces we inhabit (Thrift and French, 2002: 329).

Kitchin and Dodge (2011) call 'code/space' the mutual constitution of everyday life that is automated and controlled through software. They claim that 'spatiality is the product of code, and the code exists primarily in order to produce a particular spatiality' (Kitchin and Dodge, 2011: 16). Their work adopts an 'ontogenetic' view of space which acknowledges that space is not a fixed or static entity but something that is 'constantly being altered, updated, and constructed in ways that alter sociospatial relations' (Dodge and Kitchin, 2005: 172). They show how code affects space using two concepts: *technicity* to denote the emergent property of relations between humans and technology, and *transduction* to explain how spaces and place based practices are facilitated and modulated by technicity. They point to the more substantial ways in which technicity is embedded in the practices of everyday life though the objects, infrastructures, processes and assemblages where code 'induces a particular modulation of space' (Dodge and Kitchin, 2005: 172) by showing how the spaces of domestic life, work, and travel are modulated by code. From the code that controls toys in the living room to the computer in the microwave, spaces created by code pervade domestic life. They also look at how code is integrated into urban spaces through mechanisms such as the Oyster card that allows access to public transport networks and the surveillance systems which affect the perception of public spaces.

The concepts of technicity and transduction are further developed by Kinsley (2013) who problematises the distinction between the virtual and real spaces. He offers us a way to think about technology and being human in a co-constituted relationship. Kinsley (2013: 372) argues that technicity is a "'double-bind' between being both constitutive and a supplement of 'the human'". He makes the case that there is no separation between nature and technology, only one of 'imbrication

and becoming with a wealth of other entities' (Kinsley, 2013: 373). Like, Dodge and Kitchin (2005), Kinsley (2013) argues that the commingling between humans and technology articulated by technicity is an emergent property that is not limited to the effect of particular objects or functions. According to Kisnley (2013: 374), 'transductive process constitute milieus of association' between human and non-human entities that have particular characteristics and durations that are 'metastable'. The process of transduction is demonstrated in the sending of a text message:

> For a moment, a body is composed with energetic and clearly material systems to record and convey meaning, however trivial, to an-other. Circuits of connection, energy transfer, cognition and meaning are composed between bodies, devices, infrastructure, data and others into a milieu that not only performs the action of sending a text message but changes the composition or states of the variously composed individuals involved' (Kinsley, 2013: 375).

The transduction of space is an important concept for this thesis because it moves us closer towards understanding how technology facilitates the state by writing the spaces where it operates. Kitchin and Dodge (2011) highlight the role that software plays in disciplining people into 'certain grammars of action and enforcing more pervasive modes of surveillance' through the ways that it facilitates space (Kitchin and Dodge, 2011: 250). Graham (2005) argues that 'software-sorted geographies' are increasingly used to structure and separate groups of privileged and marginalised populations in advanced societies. He uses the term to refer to the selective configuration of space through software. Graham (2005) argues that the rise of software-sorting mechanisms are linked to the neoliberal, consumeristic models of the state. He uses electronic road pricing (like the London Congestion Charge), biometric identity cards, and electronic tagging of minor offenders as facilitating "the broad shift from Keynesian welfare state and public domains to 'splintered', post-Keynesian regimes of infrastructure, service and space production and consumption" (Graham, 2005: 565). He makes this argument with a caveat that he is not 'romanticising' the discursively egalitarian claims of Keynesian models of infrastructure provision based on monopolistic state control that were still subject to widespread inequalities. Graham (2005) claims that software-sorting has disposed

of pretensions of being egalitarian, social sorting between the 'good' and the 'bad' have become justified on the basis of allowing privileged actors willing to pay increased access and mobility within cities and networks. Favoured groups are offered enhanced services, rights and mobilities whilst individuals from marginalised groups and communities are constrained.

Thrift and French (2002: 331) argue that software has opened up 'new forms of technological politics and new practices of political invention, legibility and intervention that we are only just beginning to comprehend as political at all'. One of the reasons that the political nature of software is so underdeveloped in geography may be due to its taken-for-granted existence in the background. Kitchin and Dodge (2011: 250) argue that research has not looked at how 'software seduces and disciplines at the same time' as well as examining how and why people adapt to (or adopt) software. They argue that this is an important area to study because the discursive environment that surrounds technologies articulate a series of advantages ranging from economic efficiency and security to individual empowerment that are difficult to counter or actively resist. Kinsley (2013: 376) calls for more materially grounded studies that look at how 'immaterial technologies' become physically expressed in spatial formations. He calls for closer scrutiny of 'the forms of spatial experience that come about in the transductions of emerging technologies,' that asks how 'the material fabric and spatial practices of particular digital geographies [are] (continually) created and modulated' (Kinsley, 2013: 378). Finally, Graham (2005) argues that there is a lack of research into the ways that inequalities produced by software-sorting changes the nature of existing inequalities within cities. In particular, he argues that attention needs to be paid to how multiple systems of software-sorting come together to form feedback loops that favour some individuals at the cost of others. This section has identified an area of research within geography where this thesis is located and highlighted some of the questions that have been raised in the literature for future study. We will now return to the role of the state within these 'virtual' geographies.

Foucault and Education

Foucault's concept of genealogy and related concepts such as normalisation and governmentality have been particularly influential in education. Foucault's concepts have been used to rethink and resist notions of authority, power, discipline and pedagogy in education. Marshall (1995) outlines some of the key implications of Foucauldian thought on educational research. He argues that Foucault highlights the involvement of power in a diversity of processes in the school, which include its productive applications such as learning to read and write. Marshall's argument can be contrasted against liberal theories of education which have a negative conception of power that only operates against the interests of students. Marshall (1995) also highlights the need to become aware of the role that disciplinary institutions play in subjection and domination of subjects through practices of individuation and normalisation. This section will be in two parts, the first half looks at what genealogical approaches have told us about schools and the latter half looks the impact of changing subjectivities and the education system. I conclude by highlighting some of the ways in which this literature could be developed.

Similarly, Hunter (1996: 145) argues against liberal theories of pedagogy which posit that the ideal aim of education should be to produce the 'rational and moral capacities of free individuals'. Hunter also argues against critical of theories of critical pedagogy which portray the school system as an instrument used by dominant classes to reproduce social inequality. He argues that both these approaches depend on the Kantian idea of a universal morality which subordinates the school to a 'higher' principle of human development. He argues that these approaches relegate critique to a position of withdrawal and 'transcendence' from the actually existing school system. Hunter (1996: 148) employs Foucault's genealogical approach to avoid treating the school system as a failed attempt at realising a moral ideal which allows the school to be seen as an 'improvised historical institution' that provides 'contingent solutions to limited problems'. Hunter (1994) argues that the state education system emerges in Europe during the seventeenth century alongside the governmental mechanisms such as public health, security and eco-

nomic management which problematised the territory of the state and its population. He argues that the school develops as an assemblage of features and techniques that dealt with the mass training of children, arguing that it acted as a 'non-principled institutional arrangement' consisting of systems that dealt with training and supervision, technologies of administration, languages of analysis and procedures of decision making (Hunter, 1994: 90).

The organisation of state schooling was rationalised as an exercise that used moral training of the population for enhancing the prosperity of the state and the welfare of its people. Hunter (1994) shows how the instruments used for the moral training of the population were derived forms of Christian spiritual discipline and pastoral guidance. Christian practices indented for the salvation of the soul, which was designed to produce forms of self-reflection and moral conduct were used to instil spiritual discipline in daily life were taught in the Sunday schools and day schools run by the church. Hunter (1996: 160) claims that the pedagogy of Christian spiritual practices contributed the 'organising routines, pedagogical practices, personal disciplines and interpersonal relationships that came to form the core of the modern school' which helped to create the self-reflective subject of liberal democracies.

Bureaucratic administrators adopted these techniques of Christian spiritual disciplinary to create a space of 'ethical formation' where students were a placed under the supervision of a teacher who provided moral and pastoral care in accordance with a number of governmental objectives (Hunter, 1996: 160). Hunter (1994: 87) argues that the modern school system is characteristic of a 'bureaucratic-pastoral' form of governmentality that the state organised around rational objectives of managing social and economic life. Hunter (1994: 89) claims that the bureaucratic organisation of government allowed the creation of a sphere of political action and reflection where 'liberal' tolerance could be enforced and the disciplinary conduct required for this new type of society could be produced. He argues therefore that a self-reflecting subject is not the aim of education, but a product of practices that originated from Christian spiritual discipline optimised for governmental

aims. In adapting the practices for its own uses, the pastoral school made the principle of self-realisation into a 'central disciplinary objective' (Hunter, 1996: 149).

One of the key arguments put forward by Hunter is that the disciplines required for the development of these capacities were not themselves the results of reflection or free choice: 'the capacities of the reflective person only emerge after individuals have been initiated into the arts of self-concern and self-regulation' (Hunter, 1996: 160). Or as he puts it more generally, 'freedom becomes a characteristic of individual action only after conduct has undergone moral problematisation' (Hunter, 1994: 54). Therefore the self-regulating and self-reflective students formed by the modern school are the result of an 'unconditional initiation into the disciplines of conscience' rather than the result of a self-reflective discipline which gave students the capacity to conduct themselves as rational and reflective members of society (Hunter, 1996: 163). For Hunter (1994: 89), the principle of self-realisation in the school system is an ethical goal that seeks to produce a disciplined and obedient 'practice of the self' which makes it incompatible with the idea of a 'self-realising personhood'. Hunter calls on us to see the virtues of principles such as self-reflection and self-direction, whilst acknowledging that the modern school system had replaced a 'politics of principle' with an apparatus that combined bureaucratic technologies of governmental management within a pastoral pedagogy.

A similar theme is picked up by Donald (1992), who highlights the necessity of freedom in pastoral modes of power, emphasising Foucault's argument that a degree of agency through freedom is a necessary condition for the exercise of power. Thus, Donald (1992: 14) calls government a 'negotiation that produces individuation' —he adopts Foucault's approach as way of reflecting on the negotiation of authority in education whilst remaining sceptical of claims that rely on 'foundational or expressive categories' of being. Donald (1992) has three lines of enquiry in the genealogy of public education: the ideologies behind its establishment, the deployment of the human sciences in the practices of schooling and finally the organisation of knowledge as curriculum and its impact on the subjectivities produced by education. He shows how arguments in favour of state involvement in

education made since the beginning of the nineteenth century have been based on the an expanding need to police the state. In particular, he traces how early ideas such as those proposed by Patrick Colquhoun in 1806 in England were attempts to bring practices used in the 'monitorial schools' of colonial India for the management of the urban poor in Britain. Monitorial schools relied on a hierarchal system of teachers and older students who were responsible for the surveillance and regulation of younger students, aims are similar to the production of 'docile bodies' that Foucault (1975) had described in Discipline and Punish. He argues that in general, the ideological aim of state education was to 'moralise the working-class—disciplining it, studying it, diagnosing its ills and inadequacies, [and] tending to its welfare' (Donald, 1992: 29). These are aims which he argues allowed the mechanisms of the state to emerge and extend its ability to manage the population.

Donald (1992: 142) argues that education is an 'apparatus for instituting the social' rather than a tool that promises to liberate or escape human nature. He argues that the ideal of a universally educated public may not be achievable, but could operate instead as an 'imaginative horizon' that works 'though the liberty and aspirations of individuals' as something to be achieved. In some ways, this is similar to the case made by Hunter (1994: 89), for whom the self-reflecting person is formed within a 'highly specialised relationship of self-examination and guidance, self-control and obedience'. In contrast, Goddard (2010) claims that Foucault has a flawed conception of the subject which undermines the ability of Foucauldian research to outline possibilities for political intervention. Goddard (2010: 350) argues that governmental studies of education suffer from an 'incompletely formulated connection of subjectivity which makes is complicit with destructive neoliberal conceptions of the individual and society'. He argues that Foucault's category of the subject is an 'empty space' that is filled by endlessly flexible, atomised individuals who are 'all too readily contours itself to neoliberal notions of the kind of subject required by a market-oriented society (Goddard, 2010: 353).

Goddard contends that a flawed conception of the subject deprives Foucauldian studies from explaining how societies form coherence and stability thus making it unsupportive of a concept of society. He claims therefore that Foucauldian studies

are unable to offer a normative judgement that justifies one course of action over another. Goddard (2010) argues that educational research should address this shortcoming by conceiving of a subject who freely submits to democratic norms and governs their own behaviour through self-management. The ability to decide on its subjection, or what Goddard calls 'desubjectification', the choosing of the form one's own subjection differs from Hunter's (1994; 1996) view that self-reflection functions as a means of pastoral surveillance. The subject posited by Goddard (2010: 357) on the other hand, possess the ability to reflect on how it has been 'formed as a moral being' and critiquing the rationality of its own formation. However, the idea of a subject that can be assumed to 'willingly submit to governing its norms according to democratic norms' (Goddard, 2010: 357) is exactly the myth that Hunter (1996: 172) carefully dispels as the reflection of the intellectual's status ideal of the 'completely developed person'.

More recent followers of Foucault have shown concern with the kind of subjects that are formed by governments in contemporary societies. Peters (2005) argues that forms of governance under neoliberalism take on the form of an actuarial rationality that encourages the self-constitution of people as consumer-citizens. Peters characterises this shift in ontology of the self as consumer as the entrepreneurial self—a relation that he claims 'one establishes with oneself' using forms of personal investment and insurance which produce an individual, and privatised form of the consumer welfare economy. These processes of flexibilisation and individualisation are argued to have led to our submission to a 'permanent economic tribunal' where the conditions of our freedom are determined by our submission to this tribunal (Simons, 2006; Pongratz, 2006). Pongratz (2006) shows us how reforms that have redefined schools as 'learning organisations' or 'self-organising' reflect this trend in changing relations to the self. He argues that the linkage of the school system with the neoliberal need for self-management has reorganised the school into a market oriented service centre where 'educational processes are transformed into private property transactions with knowledge as a commodity' (Pongratz, 2006: 478).

The concept of lifelong learning has been used in the literature to capture the nature of changes to education systems in neoliberal states towards continuous processes of training. Olssen (2006) argues that the discourse of 'lifelong learning' entails the flexible preparation of subjects. He argues that this discourse has resulted in a shift in control for education from the collective to the individual which has involved an increasing in the responsibility of individuals for their educational and work careers. Olssen (2006) claims that as these individuals are now recast as 'entrepreneurs of the self,' who are personally responsible for adapting to and acquiring the skills necessary for an ever-changing environment. He argues that individuals are required to self-manage and keep records so that their knowledge can be rendered transparent to processes of audit. Lambier (2005) looks at the related discourse of the 'information society,' which he argues has allowed the concept of knowledge to be replaced by the concept of information which has to be continuously relearned and readjusted to meet new demands. Accordingly, this has resulted in an emphasis in education on information retrieval, dissemination and evaluation where learning is argued to have become 'the constant striving for extra competences, and the efficient management of the acquired ones' (Lambier, 2005: 351).

These arguments fit with the idea that computer networks have helped to create technological zones within schools, integrating them into the domain of the 'information society'. As Barry (2001) argues, technological zones require a continual process of adjusting domains, creating experts and adapting technologies to the environment to ensure their operation. Whilst existing work in this tells us much about the bureaucratic aims of education, forms of regulation and the production of subjects, there is a lack of focus on the impact that increased connectivity with computer networks have had on practices within schools. This literature suffers from a lack of specific case studies that look at what has happened at individual schools and networks. The English educational milieu was mapped, marked out and regulated through the generation of technological zone of government in the mid 1990s called the National Grid for Learning (NGfL) (Valentine and Holloway, 1999). Existing geographical research into computers and schools originate from ints introduction, namely a set of studies by Valentine et al. (2002) which looked at

experiences of three schools using the NGfL. The emphasis of these studies were on the use of computers and the internet at home and at school and its wider integration into what Tony Blair called the 'Learning Society' (Valentine and Holloway, 1999). The impact of this network on older forms of regulation and the way it has adapted to and extended regimes of governmental regulation is not immediately clear. Computer networks have also been argued to be extending governing practices beyond institutional enclosures, causing a transformation in the nature of the state itself (Deleuze, 1992), there is lack of literature that addressees how computer networks have extended mechanisms of government to non-state actors as well as transforming spatial practices within and beyond schools.

Conclusion

This literature review has looked at the growing relationship between networks and the state since the seventeenth century. We have discussed how the emergence of networks have transformed territorial practices of calculation and our relationship with space and place. We then turned to look governmental practices and networks using the work of Michel Foucault. I argued that networks have intensified the exercise of governmental mechanisms and given rise to new forms of governance that attempt to govern without the state. Nealon's (2008) shows how the intensity of power is determined by its efficiency and saturation in a given spatial field of operation. This concept has given us a starting point for thinking about the effect that networks have had on the state. We have also seen how the possibilities opened by increasingly electronically mediated relations of power are characterised by Deleuze (1992) to have led to what he called the societies of control. He argues that disciplinary mechanisms have been replaced by the mechanisms of control because control operates at its most efficient by 'modulating' the behaviour of individuals rather than 'moulding' their subjectivities. The concept of the control society has allowed us to see how computer networks have saturated the effects of power throughout the social body without necessarily needing sites of

enclosure such as institutions for its exercise. Then we turned to how the 'virtual' spaces of networks have been conceptualised by geographers who have highlighted the role that software plays in altering the composition of spaces. Kitchin and Dodge (2011) argue that the spatial formations of code/space—spaces that are mediated by or dependent on software—are modulated through transductive processes. Finally we looked at the Foucauldian literature on education, which has highlighted how concepts of governmentality have been used to think about schools. I highlighted a lack of studies in the literature on virtual geographies which look at the material and spatial practices of networks of regulation. I have also highlighted how looking at the the specific case of the secondary school education system in England allows us to see how computer networks have transformed governmental practices of the state.

In the chapters that follow, I will follow/trace the relationship between the state and ICT networks, using the post-Foucauldian and Deleuzian literature on power, government, technology and state, as well as the post-Foucauldian literature on education. The three empirical chapters will each look at a different site where these relationships are enacted. The first chapter looks at the materiality of networks through a reading of two different trajectories of the development of this technology to see how these material relations affect the potentials of networks for governmentality. The second chapter looks at the discourses of national policies on education to see the evolution of the rationality that justifies the modern use of networks in governing UK education. The third empirical chapter is an ethnography of how these materialities and discourses come to interact with the users within (and beyond) the bounds of an institution: a secondary school in the suburbs of London. This focus on materialities, discourses, and practices will allow me to think about how disciplinary power has been transformed and intensified by the technologies of control, a combined result of increased efficiency and saturation of the mechanisms of control in education.

Methodology

The literature review has highlighted many possible directions for this thesis. This study aims to politicise the role of networks through the analysis of their relationship with the activities of the state. Broadly, this thesis will examine why this relationship between the network and the state persists regardless of the claims that we have done away with the state. This thesis will make contributions towards geographical debates about the role of 'virtual' spaces in intensifying the processes of neoliberalism and governmentality. In this section, I will outline the research questions and methods adopted for this study, the processes used for the collection of data, and the methods used for their analysis. The literature review has highlighted the lack of research into the material and spatial practices of virtual geographies (Kinsley, 2013). Many existing studies that address the material role of networks have been somewhat speculative in nature or lack an empirical focus on the interaction between the users and the networks. I will use the specific case of the secondary school education system in England to look at how networks have transformed governmental practices of the state.

Education has been chosen in particular for this study because of its prominent place in governmental spending and its relation with the production of capacities for 'knowledge' that are vital to the idea of knowledge-based economies. The school system is an interesting example to study because it is such a prominent area of government intervention in the lives of most people during their childhood. In the year that I conducted research, the UK government spent £51 billion on schools, forming one of the largest areas of government spending (Datablog, 2012). For comparison, the next largest areas of government spending are only to be found in the health system and state pensions. On the other hand, the network has been central to government policies in Britain over the last few decades. As a way of producing a general transformation of society into the post-industrial economy, networks are claimed to play a significant role in knowledge-based economies and transforming the practices of the state in education. One of the flagship projects of the 1997 New Labour government was to connect every school in England to the Internet (Valentine et. al, 2002). The idea that the British economy was moving towards a knowledge-based economy—requiring workers that could operate Information Communication Technologies—was deeply rooted in these plans.

Research Questions

In this thesis, I will look at the networks using archival and ethnographic methods to ask the following questions:

1.   What can the historical development of computer networks tell us about the social and political implications of these technologies?

    •   What social and political affordances can be produced by the materiality of different networks?

    •   What role have states played in the development of computer networks?

- What explains the emergence of decentralised networks such as the Internet?

- Why has the Internet taken such a prominent place in contemporary discussions about networks?

2. How have the coming-together of networks and the state affected governmental practices of education?

- How have governmental practices in education evolved over time?

- What discourses have surrounded this relationship between the state and the network?

- How have networks contributed to the techniques and technologies of governing education?

3. How have disciplinary institutions been transformed by networked forms of government?

- What happens when we look at the network from the site of a school?

- How do teachers and students adapt to, and adopt, these technologies in their everyday practices?

- How does the network structure the spaces of the school and the classroom?

- What do these practices tell us about new forms of governing education?

These questions are structured in scalar terms, running from the question of global networks to the national policy space and local practices within a school. The scalar order within these questions only serve for purposes of clarity and does not

signify a conceptual separation of scales. This issue of scale has been further problematised in the chapters of this thesis. The three research questions have also been structured to pay attention to the material aspects of the network in the first question (chapter three), discourses on national policies in the second (chapter four), and practices of users in the final set of research questions (chapter five). I will explain how archival and ethnographic methods were used to answer these research questions.

Archival Research

I have used archival methods to examine the first two sets of research questions. I have relied on historical texts of policies and technical documents that have charted the development of computer networks and their role in education. By 'bringing the documentary and material properties of archives into play' I have studied the history of virtual spaces with a specific focus on the interfaces that connect the physical and the virtual (Dwyer and Davies, 2010: 90). I have done this by paying close attention to how the materiality of the networks studied in this thesis has developed over time. My interest in the materiality of the technologies originates from my background in computer networking, which has contributed to my interpretation of technical documents and diagrams as part of this research.

Conceptually, I have approached the archive through Foucault's (2004, 2007, 2008) genealogical approach which he uses to study the state in his lectures at the College de France during the middle of the 1970s. He argues that a genealogical approach must look at events outside of any 'monotonous singularity'; it should isolate different scenes where things and events have played different roles rather than searching for 'origins' (Foucault, 1980: 139). I have chosen not begin my work with the predefined idea that the 'virtual' spaces I am looking at only consist of the internet, because it restricts the field of study to a linear development of that network and its utility to the state. Foucault (1980: 142) argues that there is no 'time-

less and essential secret' behind things, only those 'fabricated in a piecemeal fashion from alien forms'. The research I have conducted has not tried to search for the origins of the internet, or the origin of networks within schools. Instead, I have focussed on the development of interfaces on individual computers, allowing us to acknowledge the fact that the network is always in the process of becoming rather than an end product that contains a pre-existing form of pure essence. Similarly, to look at education, chapter four looks at the governmental transformations that were afforded by computer networks. I look at the history of education, particularly Chitty's (2009) work on eugenics, to situate the network within a history of governmental practices of schools that date back to 19th Century forms of biopower.

Archival material for this research were found at the National Archives in Kew, the British Postal Museum & Archive at Mount Pleasant Sorting Office, the British Telecom Archives in Holborn, the National Computing Museum in Bletchley Park and the British Newspaper Archive in Colindale. Historical documents related to education policy in England were found at the archives held by the Institute of Education in London and the Education in England website (http://www.educationengland.org.uk/) maintained by Derek Gillard. My research began at the National Archives where I found progress reports about an early computer network developed at the National Physical Laboratory (NPL) in Teddington during the 1960s. I was aware of the network as an early predecessor of networking technology that had contributed to the modern day Internet (Abbate, 2000; Campbell-Kelly, 1987).

At the National Archives, I began with documents that I had found directly related to what was called the NPL Network and worked backwards and forward in time between records held about the laboratory. A number of documents were found that were dated between the 1960s and 1980s, which included progress reports, technical documents and conference papers. In my archival research on education, much of the material such as policy documents and government White Papers were available electronically on the Internet. Other documents I have referenced include National Curriculum circulars and newspaper reports that have surroun-

ded policy announcements by the government. These documents were found at the Institute of Education, the ProQuest online archives of The Guardian and at the British Newspaper Archive.

The procedure I followed for research in the archives involved using a notebook to write summaries about each document I found, dedicating a page for every relevant record. Each page contained reference numbers, titles, dates and a summary of key information. I also took notes about other documents linked to the record, which helped me build a picture of the relationships between the documents I had looked at. I also took pictures on a camera of interesting diagrams and illustrations that I categorised in folders on my computer by year and reference number for later reference. Dates of meetings and project start dates from progress reports were used to look for the relationships between NPL and other organisations such as the Foreign Office, the Post Office and British Telecom. Dates of meetings were used to look for records in the Post Office and BT Archives to track down meeting minutes and triangulate sources. After I had initially recorded the range of archival material available, I arranged the records in my notebook chronologically by transferring the data into a spreadsheet with dates, reference numbers, titles and page numbers in my notebook. This allowed me to develop an overall picture of the stories that I have recounted in chapters four and five.

Ethnographic Research

I chose to complement archival research with an ethnographic study of the function of the network in a school as a way of contributing to discussions about how people adopt and adapt to computer networks (Kitchin and Dodge, 2011). This method allowed me to look at the processes through which power circulates through the network and its role in the production of subjectivities within the school. The purpose of the study is not to examine what happens 'online,' but to look at how networks structure the spaces we inhabit. Ethnographic methods have

allowed me to look at the role that technology plays in the 'transduction' (Kinsley, 2013) of space in the school through the relationship between bodies and technology. This approach also responds to the call for more materially grounded studies of technology in geography by turning attention to the function played by the network itself. Ethnography has also helped me to avoid a speculative approach towards virtual spaces that has been prevalent in the literature. This has allowed me to probe beyond the intentions of policy makers and computer manufacturers, and to look at how people live with technology over time and the way it is integrated into their everyday practices.

Cloke et. al. (2004) note that ethnographic methods have a long tradition in geography stretching back to the accounts of colonial travel and exploration from the beginning of the nineteenth century. Crang and Cook (2007: 37) argue that 'ethnographic research has developed out of a concern to understand the world-views and ways of life of actual people in the contexts of their everyday lived experiences'. Ethnographic methods help to produce an interpretative and explanatory account of the behaviour of people using data gathered through participant observation by a researcher situated within the same social space. Participant observation entails that the researcher spend a period of time observing and interacting with a social group to generate data that can be analysed. The length of contact with those being studied allows the study to combine both emic and etic understandings of human behaviour, emic perspectives reflect the research participants' point of view, and etic perspectives reflect that of the researcher (Madden, 2010). These interactions help the researcher to 'understand how the group develops a skein of relations and cultural constructions that tie it together' (Herbert, 2000: 551). Herbert (2000) argues that ethnography reveals the moments where the micro and the macro scales of power interpenetrate at the site of daily life, allowing the researcher to interrogate meanings constructed by the individuals and within the socio-spatial contexts where they are placed. This makes ethnographic methods invaluable for studying the circulation of power in institutions through the in-depth study of processes that take place within them.

Since the 1970s, authors such as Peter Woods (1979), Michael Young (1971) and Stephen Ball (1981), have used ethnographic methods to study the micro level of classrooms, particularly in relation to the curriculum, issues of power, the conduct of teaching and learning activities. Walford (2008) argues that ethnographic methods are appropriate for investigating educational issues because it is suited to answering and documenting a range of questions related to teaching and learning processes. He identifies six key features that make ethnographic studies particularly suitable for studying education. First, he argues that ethnographers are able to understand elements of 'culture' within schools and identify 'that which has become tacit knowledge' of participants (Walford, 2008: 8). Second, he argues that ethnographic methods are able to encompass a diverse range of data as part of its investigation into learning and teaching processes. Data collected as part of the research may include documents, field notes, audio and video recordings, quantitative data from sources such as surveys.

The third strength of ethnographic studies Walford (2008) identifies is the depth of engagement with participants that are established by the length of time the research spends in contact with those being researched. Walford (2008: 9) argues that trust is built from 'positive personal engagement' over time and participants reveal more details of their lives. He argues that this allows the research to enter the culture of the school more deeply, opening up further avenues of investigation that can be followed by the researcher. Fourth, Walford (2008) argues that ethnographic methods benefit from mirroring learning as a very personal activity. He argues that the researchers' subjectivity is an essential part of the research. The ethnographer needs to continually review and reflect on the values and assumptions that are implied in the research, acknowledging 'the researcher as part of, rather than outside, the research act' (Walford, 2008: 11).

The fifth feature that Woodford (2008) highlights is high status of knowledge articulated by the participants. He argues that ethnographic methods can allow for relatively unheard perspectives to be articulated in research, such as those of students in schools who are able to talk about matters that concern them. Finally, Woodford (2008) argues that ethnographic methods allow researchers to cynically

develop theories and test hypotheses during the process of fieldwork. He argues that in this method, the process of building theory is more of a process rather than an event, which reflects the way that learning takes place through testing against existing knowledge.

Because the researcher is the main research tool in ethnographic studies, the objectivity of the claims made by this approach is often questioned. The fact that I have conducted research in a single school could also be interpreted as a problematic issue. However, much of what I was interested in the school are quite general to all schools, such as the curriculum, the Internet filtering systems and the Student Information System used in the School. These were often the products of outside actors, such as the Local Learning Grid (London Grid for Learning— LGfL), which provides computer networking for almost all of the schools in London. My research documented the manner in which these systems, policies and tactics come together in the site of a specific school.

Another reason I have chosen a school as a site of my research was because it was one of the examples used as a disciplinary institution by Foucault (1975) in his book Discipline and Punish. This book accompanied me during the fieldwork, and helped me think about how disciplinary power has been transformed and intensified by the technologies of control. State-run secondary schools were also at a period of transition during this time as large numbers of schools run by local authorities were (at times forcefully) converted into academies run by 'federations' that are separate from the state but are funded through central government (see Junemann and Ball, 2013). I visited a number of schools through a mentoring programme organised by University College London for secondary school students that I participated in as a mentor. I approached a number of schools through this programme that were in relatively deprived parts of London. I chose these schools because it allowed me to look at the way that existing inequalities are reproduced by what Graham (2005) claims are 'software-sorted' geographies. A number of these schools turned me down because of the political pressure on them at the time. The school that eventually did agree permitted me under the condition that it remained anonymous and that I remove any uniquely identifiable information

about students and staff from my thesis. Henceforth, I will refer to the school under the pseudonym of Ryedale Secondary School. Part of the reason that the head teacher allowed me to conduct research at the school was, as he explained on our first meeting, because the school had invested a large sum of money on technology in their classrooms and he was keen for me to evaluate the impact it had on teaching.

I spent a total of six weeks at Ryedale, comprising the last half term of the academic year. The last half term before summer differs from the rest of the year because students from year Eleven were absent because of their GCSE (end of secondary school) examinations. This meant that I was only able to witness a smaller cohort of students in the lower years of the school, between school years Seven and Ten. I observed the day-to-day life of the school, writing fieldnotes in a notebook. Longer word-processed diary entries with descriptions and events were written after I returned home from the school on most days. Entries in my notebook ranged from the layout of rooms, descriptions of student and teacher behaviour, and notes from conversations. I used observational research to contextualise the role of computers in education, and supplemented those findings with data from other sources such as policy documents. During the analysis of this data, I coded the notebook manually and the longer diary entries on my word-processor. I collated these codes into a spreadsheet that I colour-coded to draw out common themes from the fieldwork.

It was not possible for me to conduct research with the subject-position of being a teacher, so I followed Cook & Crang's (2007: 38) alternative and adopted the nearest unqualified position that the researcher is able access in the same spaces. The role I adopted was that of the teaching assistant, which allowed me to sit in lessons, help students, go on two school trips and occasionally stand in as the teacher. This also gave me the opportunity to become involved in the community of teachers and students in the school rather than taking the role of a passive observer. I was present at the school from about 7.30am in the mornings when I would help the teacher I worked with to set up lessons before school, and stayed there until about 5.30pm on most days. I observed teachers and students in ICT

and Geography lessons, and students in the library during lunchtime. The locations of my study were partly driven by my own areas of expertise, Geography and ICT. This was also because the specific teachers in these departments were more sympathetic to my presence in their classrooms. I had also visited the classrooms of Business Studies, History and English in the school, but it appeared to me that these teachers were uncomfortable by my presence in the classroom. They didn't know who I was, what my intentions were, if I was judging them, or if I was reporting back to the headteacher, or even worse, to OFSTED. I worked closely with two teachers who taught Geography and ICT. I built a rapport with these teachers and the groups of students that they taught. They became comfortable with me being in the classroom and that allowed me to fit in to some degree.

Although the students became accustomed to my presence in the classroom, it was obvious that they saw me as another authority figure when I first started my research. It took at least three weeks before I was accepted as an 'insider' and I felt like the teachers and students I worked with were at ease with me around. One of the challenges I faced trying to interview students was that it proved to be difficult to obtain signatures on the two clearance forms. The consent process required me to give students an information sheet about the research, one sheet for parents or guardians to sign and another for the students themselves to sign. Many of the students I approached for interviews lost or forgot the forms. Another problem was that in the few interviews I managed to conduct, I felt like the participants were telling me what I wanted to hear. It was obvious that the forms had intimidated them and the comments they made often contradicted my observations in lessons. Due to these difficulties, I opted to focus more on my observations gathered through my participation in lessons and the daily life in the school, which I found to be more fruitful for the research.

Reflexivity, Positionality and Ethics

Feminist and post-colonial geographers have raised questions of social position in research, critiquing the notion that neutral and universal forms of knowledge can be represented by academic texts. There has been growing awareness that geographic knowledge is produced within a wider socio-political context (Rose, 1997). There has been a growing awareness of the need for researchers to become conscious of the 'self' through forms of reflexivity which deconstruct the positionality of the researcher and the situatedness of the knowledges they are able to produce. Rose (1997: 315) argues that the research process can be seen as constitutive of both the researcher and the researched. This highlights some of the power relations involved in translating 'local' knowledges to academic knowledge and the process of negotiation between the authority of the researcher and their relations with the researched others.

Rose (1997) argues that since all knowledge is produced and understood in specific contexts, the 'all-seeing' and 'all-knowing' researcher should be subject to a reflexive examination of their positionality to this knowledge—taking into account our own position as researchers as well as those who we are researching. She suggests that this can happen through a process of making the researchers' position to the research explicit and to limiting the conclusions that are made to produce partial perspectives on the world which make the specificity of context and perspective clear. This typically involves shedding light on the research process, examinations of the relationships between the researcher and research participants to make the unseen relations of power visible. Butler (2001: 273) asks us to contemplate on the significance of autobiographical information about the researcher on the research findings and presentation in order for a 'reflexive awareness' of its impact on the writing of what is being researched. For others such as Matthews et al. (1998: 321) reflexivity is a means towards removing some of these obstructions in the narrative and ensuring that the project is 'grounded upon clear conviction' when attempting to balance participation and observation in ethnography with children.

Madden (2010) argues that questions of objectivity in ethnographic research can also be addressed through this reflexive process. This means recognising the influence of the upbringing and background of the researcher and understanding its impact on the conclusions drawn from the research. He argues that this is an issue of subjectivity, it is not an ambition to become seemingly objective, but about 'interrogating the influence of subjectivity and positionality of the author on the creation of the text,' that is used to challenge the influence of the researcher in the conclusions drawn from ethnographic research (Madden, 2010: 23).

Some have raised doubts about the extent to which this reflexivity can take place. Crang (2003) argues that reflexivity in ethnographic work can be quite problematic as it tends to reproduce the idea that the identities of the researcher and the researched remain tightly defined and stable between locations and over time. In order to avoid this pitfall it is important to stay mindful of the multiple positionalities and identities that are relationally formed. Similarly, Rose (1997: 309) argues that many have used reflexivity as a way of looking "both 'inward' to the identity of the researcher, and 'outward' to her relation to her research and what is described as 'the wider world'". However, Rose (1997: 311) is critical of attempts at 'transparent-reflexivity' which attempts to know and account fully for both self and context. She argues that the identities of the researcher and participants do not exist in isolation, but in mutually constitutive relations—emphasising that the self is always in a process of becoming that is not fully representable.

My identity as a young British Asian male who attended a state school in a socio-economically similar part of London has deeply influenced the way that I have interpreted my observations at the school. I believe that this has also contributed to the way that the teachers perceived me, as well as my interactions with the students. Despite our common backgrounds, I was aware of the unequal positions that the research participants and I occupied, so I was surprised at how the teachers and students were so comfortable with me being inside the classroom. These positions were made more complicated by the fact that they were used to frequent visits from government inspectors and other figures of authority, which I sometimes appeared to occupy. I also remained acutely aware of my position as a

friendly teaching assistant and the fact that this was going to end once I had completed my fieldwork.

Butler (2001) argues that qualitative research has attempted to overcome the distance of scientific research through offering the voices of the researched through the use of direct quotes from interviews and participant observation. The voices of those who are being research is a 'means to challenge the power relations of the research encounter' (Butler, 2001: 270). Butler warns that this process is also fraught with potential problems as researchers could misrepresent or misinterpret what is being said by participants. Butler (2001) suggests that the process of analysing research should involve the researcher supplying copies of transcripts to interviewees and opening up a dialogue with research participants about the analysis and writing of the research. She acknowledges that differences in opinions between these two parties during this process cannot always be reconciled, where this arises, she suggests that these differences are acknowledged in what is written.

Ethnographic methods are also susceptible of causing harm to those who they are used to study; this raises some ethical issues particularly as this research comes into contact with children. Morrow and Richards (1996) argue that concerns about research ethics with children typically fall into two categories: concerns over consent and concerns over the 'protection of research participants. They argue that consent for children to take part in research activities are usually sought from parents or other adult gatekeepers such as schools teachers, governors and head teachers in this instance before they become research participants. It is also advised that children should be involved in the consent process and allowed to take part in the decision making process, ensuring that they are given the choice to 'opt in' rather 'opt out' of the research as well as giving them time to make that decision for themselves (Valentine, 1999). During the fieldwork, I used a consent form for both parents and pupils before I interviewed individual children. Where I selected particular children for participating in the research, I talked through the various consent forms and information sheets used to notify them of the research. During this process I also took time to answer their questions and stressed that participation was voluntary and withdraw their participation at any point. Valentine (1999)

highlights the issue of institutional pressures placed on teachers and/or children to participate in research. To mitigate this to a degree I made it clear to the class teachers that I worked with their participation was optional, and that they could ask to me not to work in their classrooms if they were not comfortable. I followed a similar procedure when I introduced myself to new classes, I made my reason for being in lessons clear and allowed students to ask me about my work and gained permission from the class to be present in the room. As much of the research in the school was based on participant observation, there were limits to the degree to which individual students could withdraw fully from my research, however none of the students I interacted in the school had asked to be removed from my research.

Barker and Smith (2001) draw our attention role of gender in working with children. Drawing on their experiences with conducting fieldwork in school clubs and holiday play schemes, they argue that gender dynamics play a significant role in the construction of field relationships alongside other social relations such as ethnicity and social class. Barker and Smith show how the positionality of researchers were interpreted through gendered social relations of the fields that they studied. They show how a man (in this case, one of the authors) researching childcare settings which were predominantly understood as being female spaces was denied 'insider' status leading to a relationship that was 'situated between staff and children' (Barker and Smith, 2001: 143). This shows that researchers are not always in a position of power and authority and dependent on the social relations we develop with those we research. They also argue that researchers are vulnerable from unanticipated events in the field. Their experiences have highlight how 'researchers are constituted by, and placed within, particular power relations which need careful consideration' (Barker and Smith, 2001: 145). They argue that researchers should adopt 'cautionary practices' when working with children because of heightened fears over child safety. I have completed a Criminal Records Bureau (CRB) through University College London as well as through the school before commencing fieldwork as a way of allaying some of these fears. Barker and Smith (2001) argue that these checks provide some level of reassurance for parents and the school that I am a 'suitable adult'. They also advise that 'cautionary practices'

are taken when deciding where to conduct fieldwork with children, taking care to ensure that researchers are not the sole adult in a room with children to avoid allegations or misinterpretation of our actions.

Another area of ethical consideration concerns the protection of research subjects which complement the focus on the inherent rights of researchers participants discussed above. Murphy and Dingwall (2001) argue that there are ethical issues surrounding the outcomes of research, ensuring that people not been harmed, and if they have ensuring that it is outweighed by the benefits of the research. They argue that researchers have a responsibility both to protect participants from harm as well as to respect their rights. The harms posed by ethnographic research is often indirect, and not always immediately visible. There are a range of risks that ethnographers can cause doing the process of data collection which include: anxiety, stress, guilt and damage to self-esteem and the formation of close bonds with the researcher (Murphy and Dingwall, 2001). They argue that a lot of the harms from ethnographic research derive from the unpredictable responses of research participants rather than from the intentions of researchers themselves. The gravity of Morrow and Richards' (1996) argument that ethical considerations are ongoing and not just limited to the design stage of the research becomes extremely clear when placed against these concerns.

As part of my argument revolves around demonstrating that neoliberal forms of governance do not entail the increased freedom they promise, it cannot be assumed that this knowledge is beneficial for all research participants involved. There is also the risk of my ethnography increasing the knowledge of behaviours used to avoid and accommodate to structural and institutional mechanisms. This opens up the risk that my research offers insights to those who design mechanisms of control that make students, teachers, and schools more open to manipulation. Murphy and Dingwall (2001) also highlight the risk of causing offence to research participants after results have been published, especially about a politically sensitive subject such as a school that could be 'sensationalised' in the media.

Since my research is being carried out at a single school, there is the risk that the school can be identified from these publications. I have mitigated against this risk by recording as little identifying information as possible and ensuring that the electronic copy of my thesis is embargoed for three years. Because the fieldwork was overtly known to the students, staff and parents of the school, it would still be possible for people to identify the source of data after publication. In my representations of the school in this thesis, I could potentially threaten the jobs of the teachers as well as harm the life chances of the students. If I failed to anonymise properly when publishing this research I could bring the school into disrepute. As the reader will become aware in chapter six, I have taken every precaution to adhere to my original agreement with the head teacher to ensure that the school, the staff and its students remain anonymous. This has been done through the use of pseudonyms for people, the school, and avoiding direct references that may allow tracing actual places or characters.

Conclusion

This section has provided an overview of my research questions and methodologies adopted in this study. We began by delineating and justifying the decision to study networks and their role in education as a way of studying the state. Then, research questions pursued in the next three chapters of this thesis were sketched out alongside the archival and ethnographic methods that were used in this research. The use of archival methods was justified as a way of looking at the multiplicity of events that have historically led to the emergence of computer networks rather than trace the linear development of a singular network (i.e. the internet). The approach used for archival research was recounted, alongside the methods adopted for collecting, organising and analysing the data. Ethnographic methods used for the latter half of the study were also justified as ways of looking at how

networks are involved in our everyday practices and the role they play in constituting the spaces we inhabit. Finally, the experience of conducting fieldwork at Ryedale Secondary School was recounted as well as highlighting some of the challenges and issues surrounding researcher positionality and ethics and the ways chosen for addressing them.

Networks & Nomads

The Internet is the most important computer network ever to have been created. Over the past few decades, we have witnessed its ceaseless growth and increasing importance in our day to day lives. The history of this network is often linked to the growth of American networks and the triumph of its democratic values. Books such as Hafner and Lyon's (1996) Where Wizards Stay Up Late and Salus's (1995) Casting The Net, tell a story of the internet that originates with the ARPA Net, an early public network developed by research institutions linked to the American military. Campbell-Kelly and Garcia-Swartz (2013) have argued that we need to think beyond teleological explanations that point to a single cause that leads to the modern day Internet. They argue that 'the networked world was like a super-saturated salt solution. It just needed a single crystal of salt to make the whole change its state' (Campbell-Kelly and Garcia-Swartz, 2013: 18). This crystal happened to be the ARPA Net and TCP/IP, but they point out that it was one protocol amongst many other that could have created the Internet.

Figure 4.1—The node for the European Informatics Network at NPL, pictured with (L to R) Roger Scantlebury, Derek Barber and Donald Davies in 1977. (Scantlebury and Wilkinson, 2013)

In this chapter I argue that behind the modern Internet, we find a networked spatial imagination that emphasised the needs of its users rather than those who own its infrastructure. This allows the networks to be thought about as public rather than private space that can be shared between users using a technology known as packet switching. Packet switching allows end users to split messages into small 'packets' that can transmitted on shared public networks without relying on a central system to establish connections between different users. This decentralised virtual space eschews the hierarchy of centrally organised spaces of communication like the telegraph. This chapter contributes to Kinsley's (2013) calls for more materially grounded geographical studies of technology. I use Deleuze & Guattari's (2004) concept of nomadism to examine one of the first packet switched networks at the National Physical Laboratory (NPL) in Teddington and its relation to the modern day Internet. The contributes to the literature using new archival material about NPL held at the National Archives in Kew with a contemporary discussion of the the story told by Campbell-Kelly (1987) using a new theoretical light. It has been remarked that the pioneers of this technology, particularly Don-

ald Davies, have been 'airbrushed' from history (Scantlebury and Wilkinson, 2013). I show how their revolutionary ideas about computer network principles remain significant to this day.

NPL was founded in 1889 with the aims of producing physical standards of testing scientific instruments and carrying out research in physics for the state (Hutchinson, 1969). Its work on computers would mainly come from the Mathematics Division at NPL, which was formed after the end of the Second World War as a computing service for government and industry. One of the most well known examples of their work is the ACE Computer created by Alan Turing, his first civilian computer after he created the Bombe computer at Bletchley Park (Campbell-Kelly, 1987). Packet switching was developed at NPL by Donald Davies, who joined the lab in 1947 and worked on the development of the Pilot ACE Computer with Turing. During the Second World War, Davies had worked at the University of Birmingham on the 'Tube Alloys' project with Klaus Fuchs to develop nuclear weapons for the United Kingdom. In an interview, he hints that he had worked on a classified project during this time to send information securely over Telex from a testing range to a data processing centre (Davies, 1986: 4-5). Like many other technologies from the war that later found civilian uses, the technologies for computer communication also found their way into our daily lives.

I find the beginnings of this war-machine in work done by the cybernetics department at NPL, which created interfaces for using computers to regulate the outside world. The chapter begins with a discussion of cybernetics after the war and looks at the circumstances that lead Davies to propose a public packet switched network in the late 1960s. I then turn my attention to how those plans were received generally and discuss some of the early applications they found for the technology. In the latter half of the chapter, I turn my attention to the wider influence that NPL had on the development of ARPA Net in America. Their non-hierarchical ideas about the organisation of the network would have a significant influence on TCP/IP which would go onto become the protocol used on the modern Internet. The chapter finishes by looking at the growth of TCP/IP in the 1980s and 1990s, when the technology was captured by the axioms of capitalism.

Cybernetics: A Nomad Science

Cybernetics is closely associated with the work of Norbert Wiener (1961). He coins the term in the book Cybernetics, or Control and Communication in the Animal and the Machine to refer to the emerging field of control and communication theory. The term came from the Greek word kubernétés for steersman (Wiener, 1961:11). Wiener's involvement with cybernetics began at the Massachusetts Institute of Technology in the late 1930s. His expertise in mathematics and communications technology were put to use in developing anti-aircraft technology during the Second World War (Galison, 1994). Wiener was responsible for developing a system that could calculate the trajectory of missiles to match the direction of enemy aircraft using feedback mechanisms. Early examples of cybernetics adopted a 'behaviouristic approach' which directed actions using 'negative feedback' calculated by the difference between 'the state of the behaving object at any time and the final state interpreted as the purpose' (Rosenblueth et al., 1943: 24).

This shift, from moulding to modulating behaviour, helped create systems that could dynamically adapt to feedback from the milieu in which they operate. Galison (1994: 233) argues that after the war, cybernetics went from being a model for human-machine interaction, to a 'prototype for human physiology and, ultimately, for all of human nature.' Cybernetics allowed human behaviour to be thought of as processes that could be measured, predicted and governed through feedback mechanisms. Like disciplinary technologies, early cybernetics was used to create homeostatic systems that relied on negative feedback responses which reacted to changes to produce equilibrium. Later cybernetic systems produced self-directing mechanisms that could adapt to positive feedback which enabled systems to be responsive to changes in the environment.

Cybernetics would not just have technological implications on institutional forms, but philosophical implications for how societies could be imagined. On the one hand, cybernetics could be used to reinforce existing closed systems, and on the other, it had the potential to empower new forms of organisation that were open, decentralised and more responsive to the environment around them. Hodge (2013:

334) argues that positive feedback introduces 'exponential change' within systems that multiplied rather than suppressed difference as a means of adapting to change. Instead of axiomatic systems that closed off lines of flight using negative feedback mechanisms, positive feedback is a diagrammatic systems that produces new ways of becoming (Deleuze and Guattari, 2004: 159). Unlike the earlier systems of hierarchal command and control, cybernetic theories were used to think about ways of 'getting along with, coping with, even taking advantage of and enjoying, a world that one cannot push around' (Pickering, 2010a: 383). Compared to the ideas of social physiology which disciplinary societies replicated in their hierarchies, cybernetic theories helped create an image of society as a system of interactions between independent entities that were capable of governing, or steering themselves.

Cybernetic theories were applied in diverse fields outside military applications such as psychology, psychiatry and the social sciences by British cyberneticians such as Ross Ashby, Grey Walter, Gregory Bateson and Stafford Beer (Pickering, 2010a). Walter and Ashby's early work on cybernetics used physical models as a way of understanding the human brain, whilst later work by authors such as Bateson used cybernetic theories to explore notions of becoming in identity formation, social relations and adaptation (Pickering, 2010b: 156). In the 1960s, cybernetics became an interdisciplinary field that spread to other fields such as robotics, management and architecture. It was used as a model for understanding complex systems such as the economy and evolution. Stafford Beer, a prominent British cybernetician, was famously invited by Salvador Allende to create the system to manage Chile's economy called Project Cybersyn during the early 1970s (Medina, 2006). Pickering (2010b) traces the development of British cybernetics in the 1960s as it began to tackle radical transformations in institutional forms and social relations. Experiments like R.D. Laing's (1967, cited in Pickering, 2010b) symmetrical treatment of psychiatrists and schizophrenics at Kingsley Hall in London between 1965 and 1970 demonstrates how 'cybernetics was a different kind of social organisation—a self-organizing and adaptive institutional form [that was] quite different from the state form of hierarchal command and control' (Pickering, 2010b: 159).

Pickering (2010b) draws on Deleuze and Guattari (2004) to argue that later forms of cybernetics were nomadic forms of science rather than royal sciences of the state. Royal science is devoted to the discovery of abstract laws that serve the established state, whilst the nomadic (war machine) science deals with the application of science in 'concrete physical situations' (DeLanda, 2004: 15). Deleuze & Guattari (2004: 419-35) argue that the royal sciences are based on measurement, they use linear systems which deal with homogenous objects striated by the imposition of a 'metric' sovereignty. The nomad sciences on the other hand, conceive of the world as unpredictable and liquid in nature in opposition to a solid world that is expected to behave predictably. As we saw in nomadic cybernetic systems developed after the war, like Bateson's systems of social relations and adaptation, the systems they deal with are non-linear and non-homeostatic. They display multiple stable states which are periodic and chaotic rather than fixed. The royal sciences assume a stable world that is understood through cognition and knowledge, whereas the nomad sciences assume a fluid world of heterogeneous objects which constantly create new problems to be responded to. This 'problematic' conception of science deals with problems rather than proving or disproving theories. The war machines produced by nomadic sciences stand in opposition to the hierarchal and striated systems of the state which use the royal sciences to form an art of governing people and operating the state apparatus (Delezue and Guattari, 2004: 525).

Early cyberneticists were royal scientists who served the interests of the state. As the work of Wiener testifies, they created tools for ensuring the survival of homeostatic systems by producing systems that created states of equilibrium. Pickering (2010b) shows how the work of early cybernetic psychiatrists like Walter and Ashby created cybernetic models of the human brain to produce proof for existing psychiatric cures like lobotomies and shock therapy to demonstrate that they could restore the mental health of patients. Psychiatric applications of cybernetics after the 1950s would focus less on the production of tools for established practices of psychiatry and focus instead on the inner behaviour of patients. As the work of R.D. Laing at Kingsley Hall demonstrates, cybernetics became a nomadic science that destabilised the state science of psychiatry by questioning hierarchal relations between the patient and the psychiatrist (Pickering, 2010b: 158). Inspired

by the work of Gregory Bateson (1961 cited in Pickering, 2010b), schizophrenic patients at Kingsley Hall were cared for so that they could see their 'inner voyages' to their conclusion. R.D. Laing's cybernetic anti-psychiatry broke the hierarchy of disciplinary state institutions by placing patients outside the state mental health system and adapting their methods of treatment to the patient. Psychiatrists responded to patient behaviour by 'reciprocally adapting to their often bizarre behaviours rather than prescribing electroshock treatment' that served only to reinforce their illnesses (Pickering, 2010b: 158-9). Instead of trying to fix patients, they allowed the illness to run its course and help the patient to deal with it in their own way. This example illustrates how a science like cybernetics can exist in both nomadic and royal forms and play different roles in relation to the state.

Cybernetics at NPL

NPL's research into cybernetics led scholars to radically rethink the nature of computer systems from closed systems that were determined by computer manufacturers to versatile systems that could be reconfigured and adapted to the needs of the end user. These ideas were as radical as that of the psychiatrist adapting treatment to the needs of the patient. The NPL Autonomics Division extended the role of computers from tools for proving theorems of (royal) scientific calculations to include practical applications like those on factory floors for controlling industrial processes. The general purpose computers of that era had limited means by which they could be adapted to new applications; they were often restricted by their manufacturers to work with proprietary standards and devices. These limits would have been tested in an experimental laboratory like NPL where computers were used for a variety of purposes not originally envisaged by the computer manufacturers.

The 1960s when the network as developed were a time of great investment in scientific research in Great Britain. Even though there was a large amount of money

was invested research and development, growth in the British economy remained low (Edgerton, 1996). Edgerton (1996) argues that an unease around the perception of the British elite as traditional and anti-scientific became a central argument of the Labour party in the 1960s which had allied itself to social advancement through technology. In 1963, the newly-elected leader of the Labour Party, Harold Wilson announced at its annual conference that a future Britain had to be forged in the 'white-heat of the technological revolution'. This speech would have a lasting impact on British science, resulting in the shift of government spending from military to civil R&D. The British failure to take back the Suez Canal in 1956 led to a reappraisal of its military role, causing it to repositioning its scientific research to develop economic as well as defence interests (Bud and Gummett, 1999).

There was a shift towards 'applied' research in particular that could be shown to have identifiable benefits as products and industrial processes. Gummet (1980: 40) argues that during this period questions began to be asked about the efficiency of research spending, particularly the non-directive approach of the research council system and its relation to government R&D. The high cost of scientific research in Britain into areas such as high-energy physics and space exploration prior to the 1960s led to a questioning of expenditure on research within the research council system. Gummet (1980) argues that a debate arose around the role that science and technology could play in 'modernising' the economy.

Harold Wilson used technology to reorient Labour's commitment to nationalism by committing itself to investing in parts of R&D and industry. After Wilson's victory in 1964, the newly created Ministry of Technology (Mintech) headed by Tony Benn was initially small, comprising of the Atomic Energy Authority, the National Research Development Corporation and the Industrial research establishments of the DSIR (Department of Scientific and Industrial Research) which included the NPL. Whilst Mintech was particularly active during the latter years of the decade and emblematic of the socialist approach to science though the centralised planning of investment for the common good, it had in reality presided over a constraint on government spending on research (Edgerton, 1996). Towards the end of the 1960s, Mintech paradoxically shifted government spending away from gov-

ernment laboratories to the private sector as they realised that R&D spending did not correlate with economic growth. As I will show below, this explains some of the difficulties that NPL faced in obtaining government funding for their network.

The work of NPL can be seen as an instrumental step within a series of developments that gave birth to digital control applications and computer networking. Electronic industrial control systems that were developed by different manufacturers increased the efficiency of control over a variety of processes in manufacturing and processing plants (Galloway and Hanke, 2013). These electronic control systems replaced the monitoring of manufacturing processes that used to be done manually by individual workers. Later developments in digital control applications and computer networking would eventually lead to the inter-networking of business processes with industrial equipment leading to greater automation of manufacturing and responsiveness to control. Industrial control systems were invaluable anywhere that machinic processes required monitoring and control such as in manufacturing and chemical processing. It was also invaluable to the state for controlling its infrastructure in areas such as electricity generation and water distribution (Galloway and Hanke, 2013).

NPL's work in industrial process control had originated from the work carried out by its Ships Division during the early 1960s (Barber and Woodroffe, 1966; Barber and Blake, 1970). It is quite significant to my argument—about the nomadic nature of the science produced by NPL—that this work came from researchers that examined the interactions between ships and water. Their studies on the dynamic behaviour of fluids, as opposed to the predictable behaviour of solids, places them closer to the nomadic sciences rather than the abstract theorisations of the royal sciences. The ship is also significant, because as Foucault (2007) points out, it is a Greek metaphor for the act of governing, and the object of control by the helmsman who steers the ship in response to the uncertain behaviour of water: 'there is the metaphor of the king who is responsible for the city-state and must conduct it as a good pilot properly governs his ship, avoiding reefs and guiding it to port' (Foucault, 2007: 123).

A report from the Adaptive Control Group of the Autonomics Division of NPL in 1964 outlines 'A Versatile Data Processing System' composed of a modular system for computing functions, such as data collection, processing and display modules. Developments in cybernetic research relied on interactions with the world outside the mechanisms of the computer. These interactions took place through a 'standard set of control lines' that would allow the computer to respond simultaneously to changes in the processes it monitored (Barber, 1964: 2). This was a significant development because it deterritorialised the computer from a fixed machine designed by a computer manufacturer for a specific application, and reterritorialised into a system formed by the interconnection of individual modules. These modules were connected by a common interface to create 'versatile' systems of computing that could be reconfigured to the needs of practical applications. The NPL data processing system adapted existing modules such as paper tape punches or new modules to be developed for capturing and interacting with new data. NPL was in a unique position to develop a standard interface because they were not allied to a single computer manufacturer. This meant that they designed systems that were not specific to the computers of individual manufacturers, modules could be compatible with different computers as long as they all shared a common data standard for communication.

NPL made use of an existing connector, the Plessey Mark IV (12 pin) for the interface, to carry data and control signals between the computer and external modules. The are a number of reasons why the standard interface radically transforms computers. A common standard meant that equipment such as paper tape punches, readers, keyboards and plotters could be replaced, or linked together to form 'hybrid computing systems' (Barber, 1964: 8). Common standards also meant that modules would be compatible between different computers. This allowed smaller, more economical modules to be produced that could be used to collect and process data suited to specific needs and reconfigured according to changing requirements economically. This meant that it was particularly suited for smaller one-off tasks like those conducted at NPL which did not warrant the use of expensive commercially available data logging equipment (Barber, 1964). Common standards draw 'creative lines of flight' leading to a positive deterritorialisation of

closed and rigid computers (Deleuze and Guattari, 2004: 158) to create new heterogenous assemblages of adaptive cybernetic systems that were more versatile.
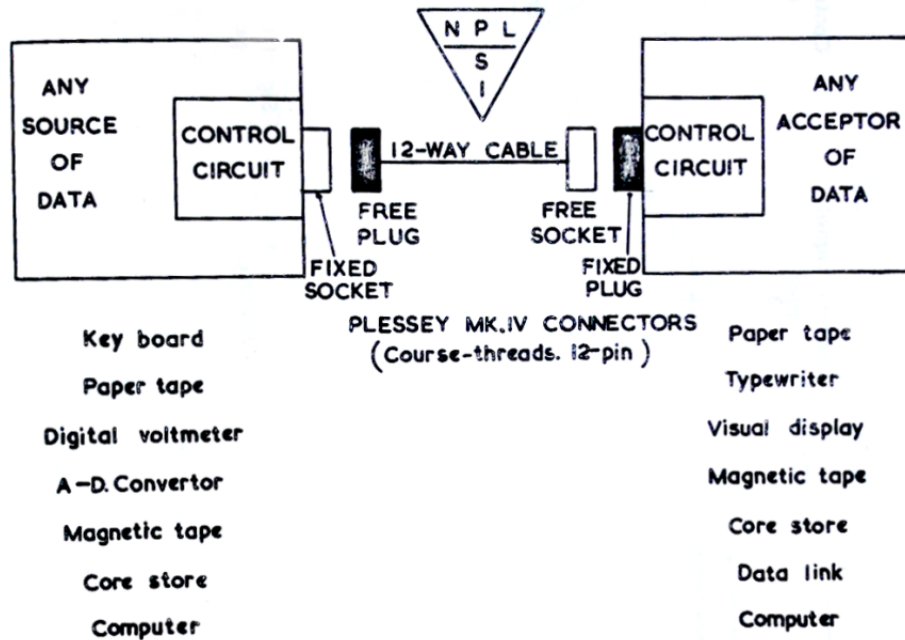
Figure 4.2—The NPL Standard Interface for a generalised data processing system (Barber and Woodroffe, 1966)

One of the authors of the 1964 report, Derek Barber, envisaged that the adoption of a common standard would result in the widespread availability and production of compatible modules that would 'allow even small projects to benefit from electronic data processing equipment, which may be borrowed rather than bought' and shared between different departments in the laboratory (Barber, 1964: 9). The original system would go onto become the NPL Standard Interface later becoming British Standard BS4421 (Barber and Woodroffe, 1966). The interface was adopted by a number of computer manufacturers and appeared on a number of commercial machines such as the DEC PDP8 and the Ferranti Argus 400.

The NPL standards were not built with the idea that they would solely be used for capturing data for industrial process control. The interface was also used for connecting to computers remotely. For instance, Barber and Woodroffe (1966) suggest that a standard interface could operate in parallel to send and receive data from keyboards and output interfaces:

> [T]he N.P.L. interface could serve for all connections to a computer… Any computer would be classified as having N input and M output interfaces and could then be used for many purposes by merely allocating interfaces as required (Barber and Woodroffe, 1966: Appendix 8).

Computers at the time were large, expensive and uncommon. Multi-access systems or time sharing allowed the resources of a single computer based at universities and research centres to be shared amongst multiple users or 'terminals' connected to the central computer from different locations at the same time. Barber and Woodroffe (1966) argue that a hypothetical number of 256 devices could be connected to a pair of input and output interfaces. A 1966 article from Electronics Letters shows that a company named English-Electric-Leo-Marconi Computers devised an 'NPL Standard Interface module for long-line driving' that allowed 'high-transfer-rate devices such as digital computers' to be interconnected with increased operating distances and data-transfer rates (Nicholson and Holmes, 1966). This module had been able be achieve a data-transfer-rate speed of 1 Megabits per second at a length of half a mile between interfaces. Packet-switching would develop on the basis of this idea; if processing power could be shared between users, the same principles could be extended to network infrastructure. In summary, the NPL Standard Interface is a vector of deterritorialisation for the computer, which reterritorialises initially as an assemblage for intensifying the monitoring of industrial processes on the factory floor, but the stretching of the NPL Standard Interface that allowed remote action and control, extended the lines of flight over greater distances. The following sections of this chapter deal with the next stages of reterritorialisation of these networks and their appropriation by the state apparatus on national and global scales, intensifying governmental practices of control.

From Interfaces to Packet Switching

The early adopters of computer networks were the American financial and travel industries. The advent of the Jet Age in commercial aviation and the rise of American multinational corporations in the early 1960s were both dependent on the deterritorialisation of the computer and 'real-time systems' that allowed users to interact remotely with computers to check balances or make seat reservations on databases. Early systems were developed to share access to a central computer that made use of expensive connections leased from telephone operators to link central computers and remote users. These systems were often called 'real-time' or 'time-shared' systems because they allowed multiple users to access a computer simultaneously. One of the first commercial networks of this kind—"SABRE" (Semi-Automated Business Research Environment)—was developed for American Airlines as an electronic seat-reservation system. It was developed in response to another line of flight, the jet engine—which allowed aeroplanes to carry more passengers and travel rapidly over greater distances. SABRE was developed jointly between American Airlines and IBM between 1959 and 1964. This network consisted of leased lines from AT&T which connected a central computer to more than 110 booking agent terminals. Plugge and Perry (1961: 593) sum up the scenario surrounding its development nicely: 'These airplanes, which can carry up to 150 passengers, can depart an airport and in some instances arrive at the next down-line city before our present day reservations system has adjusted the passenger inventory.' The development of SABRE was not just driven by advancements in aircraft speed and capacity, but also increasing labour costs and the growth of 'competitive conditions in the industry [which accentuated] these needs for more timely and accurate information and control' (Plugge and Perry, 1961: 595).

The growth of American multinational companies during this era depended on the the growth of these electronic networks, whose development costs were heavily subsidised by the state. The growth of these networks enabled these companies to quickly establish their operations around the globe (McMahon, 2001). These early networks were intertwined with the ambitions of the state helped to replicate an organisational form based on hierarchies and centres of command. The

connections in these early networks were also quantified in terms of space and time—metric units of the royal sciences—because the access to leased lines or dial-up links on the telephone network were priced according to the the physical distance between two points on the network and the duration of each connection.
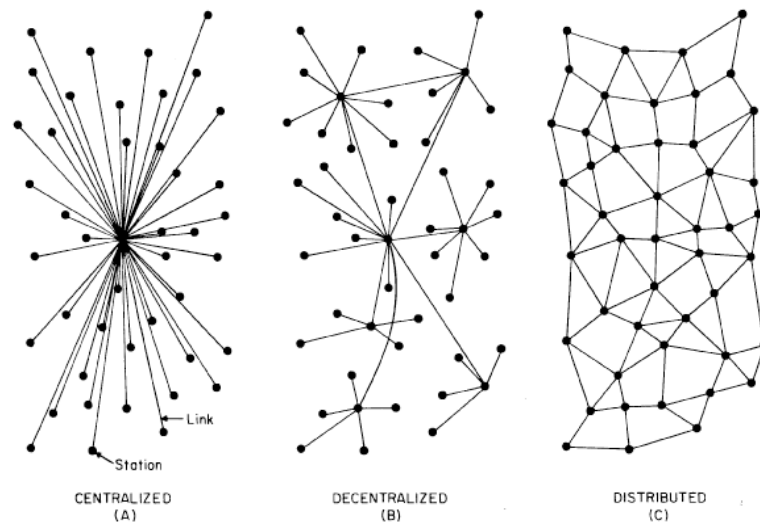
Figure 4.3—Centralised, Decentralised and Distributed Networks (Baran, 1964: 2)

Centralised networks such as the telegraph or the telephone are circuit switched networks which make use of dedicated connections between two points to transfer data. These 'royal' networks rely on central points to establish connections between nodes, an example can been seen in the centralised network in figure 3.3 (A). The limiting factor for these networks are the costs associated with maintaining connections to the central node. Packet-switched networks, like the network developed at NPL during the latter half of the 1960s, attempted to solve this by using a common infrastructure for transferring data that could be shared between users by using a decentralised network form rather than relying on a central node. As shown in figure 3.3 b, these networks are organised along a decentralised form. Packet switching transfers data within networks by splitting messages into small

blocks of data called packets. Much like the postal system, packets of data are passed between nodes on the network until they reach their final destination where the messages are reassembled. The paths taken by packets are not pre-determined, but calculated by intermediary nodes which relayed packets towards their final destination.

During a visit to the 1965 International Federation for Information Processing in New York, Donald Davies from NPL saw demonstrations of early real-time systems such as Project MAC at MIT, the JOSS Project at RAND and the BASIC project at Dartmouth College (Davies, 1986). Davies set up a workshop at NPL in November 1965 to discuss time-sharing at NPL after his return from America. One of the topics that emerged from the workshop was 'the mismatch between time-sharing and the telephone network,' which led Davies towards a packet-switching system (Davies, 1986: 6-7). He had noticed that computer communication took place in bursts of activity rather than fixed durations implied by circuit switched networks (Campbell-Kelly, 2008). In 1966 Davies published a paper calling for the 'development of a digital communication network' which made use of a 'character assembler and distributor' to interface between the network and its terminals using a 'store and forward' mechanism. He argued that data on the network could be broken up and 'carried through the network in relatively small units, which are stored at each node through which they pass' (Davies, 1966: 10). Davies (1966) used the term 'packet' to describe the units of transmission sent across the network.

It is not surprising that Davies uses the term 'packet' to describe blocks of data. Alan Turing (1950: 437) had used the same term in his influential paper on *Computing Machinery and Intelligence.* Turing uses the term to refer to the storage of information within a computer and the two had worked together on Automatic Computing Engine (ACE) project at NPL. The mechanism behind packet-switching was also developed independently by Leonard Kleinrock as part of his PhD thesis at MIT in 1962 (Kleinrock, 2002). Kleinrock had devised a model for data networks that used 'dynamic resource sharing' to allow multiple users to share a resource such as a communication links as it was needed (Kleinrock, 2002). Klein-

rock's ideas were largely ignored at the time because the telecommunications industry was invested in (and profiting heavily from) circuit-switched systems like SABRE.

Paul Baran's designs for a communications network that could survive an Intercontinental Ballistic Missile in 1964 are also closely associated with the history of the Internet. Baran was employed by the defence research organisation RAND with the mission to design a distributed communications system for the Air Force (see figure 3.3 C). His system used a system of 'message blocks' to transfer information across a distributed network (Baran, 1964). Baran had intended for his network to connect the US National Command Authority to its nuclear forces even if part of the network had been destroyed during an attack. Although the Air Force was keen on implementing the system in light of the Cuban missile crisis, the Department of Defence decided it was not feasible and the network remained unrealised (Lukasik, 2011). In contrast to this, Davies did not aim to create a network that could withstand a nuclear attack, but 're-invent[ed] packet switching in the context of inter-computer and person-computer communication' (Davies, 1997). Like the development of the NPL Standard Interface earlier, it was dependent on the unique position of the NPL as an experimental laboratory.

Davies proposed a hypothetical Digital Communication Network that consisted of users connected to Interface Units and Nodes. Nodes formed the core of the network and were responsible for transferring and routing data through the main network. Users were connected to the system using Interface Units which assembled input from end users and prepared packets for transit in the network. Figure 4.4 shows a

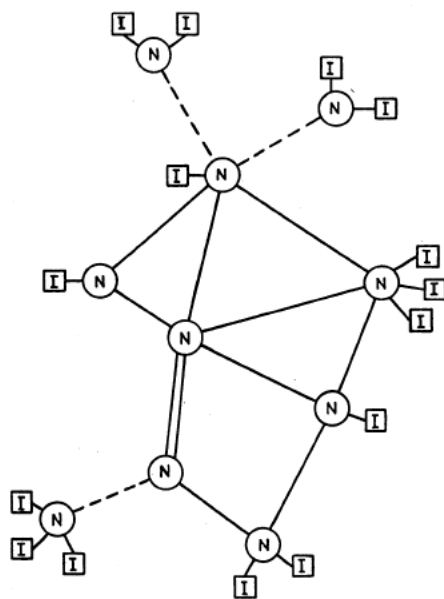Figure 4.4—Hypothetical NPL Digital Communication Network consisting of *Nodes* (N) and *Interface Units* (I) (Davies, 1966: 11)

network diagram used in the original proposal. Davies (1966: 11) remarked that it was intended to be ambiguous in scale as it could represent a nation, a town or an office building. This is a fractal-like iteration of the NPL standard interface, which featured prominently in the network as it was built on the Teddington Campus at NPL (NPL Com. Sci., 1971a). Crucially, the designed network was radically different from the centralised designs adopted by real-time systems discussed earlier because it was developed from the perspective of the end user rather than network operators or computer manufacturers.

A Rhizomatic Network

One of the most crucial differences between the NPL Network and other networks of the time was how it was priced. Davies argued that the cost of using the network should relate to the amount of data transferred rather than the time required to transfer the data (Davies, 1966: 10). This was a radical departure from the use of telephone networks that were based around the notion of time and distance. This was one of the major ways in which the NPL network broke away from the 'metric' sovereignty of 'royal' networks. During the 1960s telephone networks were hierarchal state-run monopolies. In 1960s Britain, the period also coincided with the transformation of the General Post Office (GPO) from a state department to a state-run public corporation—the Post Office. Although Davies's proposal was technological, it had political consequences. It questioned the very concept of a royal network that assumed networks had to be managed by a central authority. The NPL Network re-conceptualised this in a radically different manner, as demonstrated in the kind of space that this network produced. The royal sciences striate spaces using circuit-switched networks that are demarcated by geographic length and the time duration of network connections. The space of packet-switched networks on the other hand, is a smooth space where one node can connect to another node without the need for a central node to mediate connec-

tions striated by the metrics of time and duration. Data could be sent to any part of the network without consideration for where it was located geographically.

Deleuze and Guattari (2004: 406-7) argue that the state represses the nomad sciences because 'they imply a division of labour opposed to the norms of the State.' In an interview, Donald Davies and Derek Barber recount an incident where a man who was employed by a telecom company raised doubts during one of their first presentations at a conference in America. 'Look, what you are saying is very nice,' he said, 'it's very idealistic; you won't have a chance at making it work' (Davies and Barber, 1996). They faced two major struggles: First was that computer manufacturers such as IBM were invested in selling their own time-shared systems and mainframes which relied on centralised models that tied their customers to certain technologies. Second was that the operators of telephone networks were selling highly profitable services that complemented these centralised systems using leased lines or dial up connections.

The concept of a common standard would have seemed disadvantageous to computer manufacturers and telephone networks who were keen to maintain their prized monopolies. Davies and Barber (1996) summarise this succinctly in an interview: 'why should they [computer manufacturers] agree upon any sort of standards which would make people able to use anybody else's machine as well? And that's life, isn't it?.' It is clear that Davies (1966) had anticipated these difficulties early on. One of his primary concerns in the original proposal was the problem of generating demand for the network until its technical potential could be demonstrated. Whilst their initial plans were ambitious of both the impact and scale of the project, they cautiously emphasised the need to gain experience using field trials and simulations. Davies approached the project in a nomadic manner, aiming for iterative trials that would lead to a larger national project rather than embarking on a state-scale project. The fact that Davies chose to work on the basis of demand for the service, rather than from the basis of feasibility for the network operator, shows that his approach was problem-based rather that a top-down design that served the needs of the state or a central authority.

Davies's initial attempts in March 1966 failed to persuade the GPO or the Ministry of Technology to embark on the idea. Despite initial interest, Davies (1986) later recounted that they were reluctant to 'spend any money on the idea.' This forced him to pursue a different tactic of 'popularising' the idea of packet-switching widely so that the GPO received pressure from potential users. By July 1967, NPL had devoted more energy into the project by forming the Data Communications Research Group led by Roger Scantlebury to focus on work in computer networking. This story does not exactly follow Deleuze & Guattari's (2004: 400) account of the nomad sciences that continuously evade capture by the state which attempts to appropriate and transforms their elements in service for itself. Nevertheless, the lack of interest from the state shows that it remained nomadic for the time being as plans were drawn up for the initial network. A progress report of the Division of Computer Science from September 1969 (NPL Com. Sci, 1969) outlines a plan to build a network based on the needs of users rather than computer manufacturers or network operators. They adopt an overarching philosophy that eschewed the top-down model of network design which assumed that networks start at the centre rather than their users at the outer edges.

Rather than having the network determined by the designer, they moved away from the arborescent (tree-like) nature of purpose-built data networks towards a rhizomatic infrastructure made up of decentralised modules (Deleuze and Guattari, 2004). These were made possible by a relatively flexible design that could be adapted to the needs of end users (NPL Com. Sci., 1969). Their openness to experimentation is particularly evident in this passage from the report:

> The overriding consideration in the design of the NPL network is to provide as much flexibility as possible to meet unexpected requirements in the future. To this end, the communications links are based on the repeated use of standard modules which may be rapidly replaced should failure occur. In general, peripheral devices are joined to the network through British Standard Interfaces [the NPL Standard Interface]. This enables a wide variety of existing data processing equipment to be connected directly to the network, and facilitates the development of new peripheral devices. (NPL Com. Sci., 1969: 11)

This statement demonstrates that the need for versatility, or flexibility, was driven very much by needs within the laboratory. They stress the significance of its flexibility in the report: 'The most important benefits the laboratory will gain from having a versatile data communications network are likely to be those not yet foreseen. Once it is available, the ingenuity of users may be relied upon to exploit its possibilities' (NPL Com. Sci., 1969: 11). The NPL Standard Interface is one of the key components used as part of the larger network of interconnected computers that made it open to experimentation. Although it was never adopted by the International Standards Organisation, the interface continued to be in use across the UK, including a lot of the equipment in use at NPL (Campbell-Kelly, 1988). The first version, or Mark I of the NPL network, interconnected computers and peripherals sprawled across the laboratory in Teddington using a Message Switching Computer that negotiated connections between the interfaces of computers and peripherals. The NPL Standard Interface which had started life as as part of 'versatile data processing system' became part of a larger 'versatile data communication network'.

Further evidence of the NPL's resistance to older models of networks are found in a report by Roger Scantlebury (1969) about the network model:

> An attempt has been made to design a data switching system from first principles, ignoring the cold facts of existing communications economics and restrictions. It is felt that such an approach is long overdue and is justified since it may well reveal patterns of subscriber behaviour hitherto suppressed by the characteristics of existing data communications systems. (Scantlebury, 1969: 9)

As Scantlebury illustrates, the regard for flexibility was a clear departure from the ideologies of network design that had existed at the time. Davies and Barber (1973) expanded on these ideas in a later book, where they contrast the idea of a dedicated public data network with the restrictive practices of privately developed networks at the time. Common standards, like their original work with interfaces, increased the creative lines of flight that these new assemblages of computer networks were able to produce. In the book, they warn of the danger of proprietary networks developing due to a lack of common standards, 'the lack of standards

now for exchanging information between systems may be merely an inconvenience; in the long term the facilities available to the public may be severely restricted, or far more costly than necessary, if such standards cannot be agreed' (Davies and Barber, 1973: 132). Commonly defined standards of communication would allow the formation of heterogenous assemblages of their nomadic war machine. This war machine would be directed against the striated spaces of the networks created by computer manufacturers and network operators. This war machine would produce a relatively deterritorialised plane of consistency where different assemblages of computers could emerge as opposed to creating a plan(e) of organisation where the configuration of network forms are determined in advance (Deleuze and Guattari, 2004). Being positioned outside the world of computer manufacturers and network operators, gave them the ability to develop a network where computers from different manufacturers could work together using the same standards for solving various problems in the laboratory. This may sound contradictory, but standardised platforms of communication can help the formation of heterogeneous assemblages of a nomadic nature which could resist top-down rigid networks and ward off capture by the state.

The State Capture of Networks

The activities of the 'Real Time Club,' formed by Professor Stanley Gill from Imperial College London would begin to popularise the idea of computer networks in Britain. Although they were not directly associated with NPL, in this section I want to show how their activities demonstrate a transformation in the way that networks were imagined in Britain at the end of the 1960s. The group consisted of a number of academics and computer professionals who lobbied the telecommunications authorities in the UK to provide public data communication facilities in the UK. With the support of the NPL, the Real Time Club had organised a number of events in that year to popularise data communication systems which included a major event at the Royal Festival Hall called 'Conversational Computing

on the South Bank' on the 3rd of July 1968. NPL had demonstrated the network publicly at this event, but Davies recounted in an interview that the significance of the technology was lost to the public:

> I think the problem is: what's the difference between having one of these things at the end of a packet network and having it connected by a line into your mainframe just next door? What we were showing was actually pretty good, using a network and so on, [but] as far as the end users are concerned, it didn't look any different from having it patched right into the mainframe in the next room. So only if you knew what you were talking about, as it were, did it have the right impact. (Davies in Davies and Barber, 1996)

An article about the event in the *Financial Times* describes the tension between the industry and the General Post Office (FT, 1968: 9). It argued that there was considerable pressure from recent developments in America where it was expected that by 1975, seventy per cent of all data carried though ordinary communication channels would be transmitted through digital networks. The article frames Britain competing with America: 'What Professor Gill and users fear is the "too little too late" syndrome which has kept British Industry behind world competitors for years.' Gill is quoted in the article endorsing the NPL proposals, arguing that it was a 'second chance to stay in competition' because the first had been lost to 'politicians and industry bosses [who] had failed to understand what was happening.' Aimed at business readers, the article focuses on the potential of real-time systems in commercial applications, and expressed the dissatisfaction of current users who used the GPOs' leased line service, which is described as being unreliable and expensive at a cost of £30,000 for ten users per year.

Gill's comments demonstrate a different kind of concern than those of NPL; their wider implications are lost to a limited narrative of commercial interests and the necessity of technology for 'keeping up' in a competitive business environment. The growing interest in networks encouraged the GPO to conduct a user needs survey which was reported in *The Times* the following month (Owen, 1968). This survey is also referenced in a 1969 progress report from NPL as a member of staff was involved in the survey with the GPO's Telegraph and Data Systems branch (NPL Com. Sci., 1969: 10). The survey had found that demand for data services
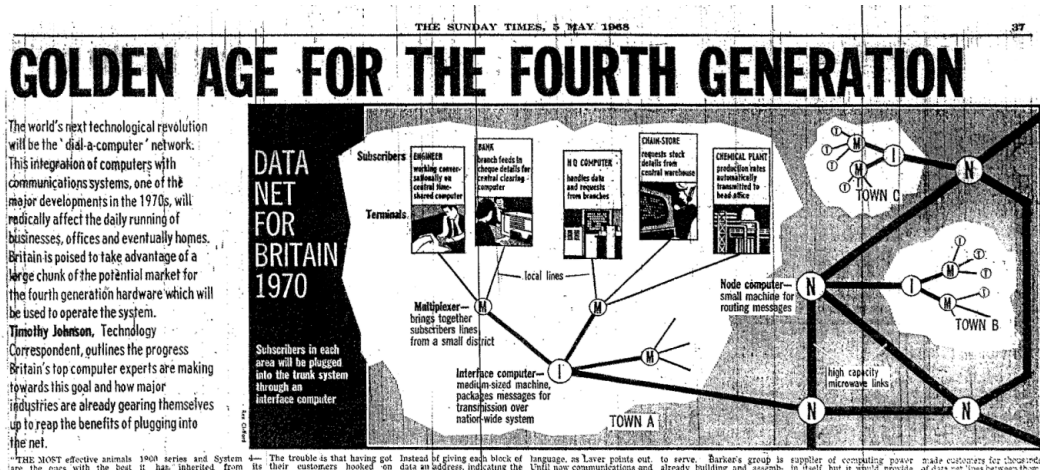
Figure 4.5—'Golden Age for the Fourth Generation' by Timothy Johnson from The Sunday Times, 5th May 1968 (Johnson, 1968: 37)

had grown because of the 'widening application of computers to day-to-day transactions of industry, science and business' including applications such as 'car insurance, vehicle licensing, aircraft, train and room bookings, paying bills and keeping medical records' (Owen, 1968), indicating how the network was increasingly important for businesses and the state. The article shows that the range of potential application for this technology were expected to grow as the development of a public data-network would make them cheaper and more flexible.

The anticipation for this technology is perhaps best captured in a full page article by Timothy Johnson, technology correspondent of The Sunday Times (Johnson, 1968). The illustration used in the article has been reproduced in figure 4.5. Published a month before the creation of International Computers Limited (ICL) in June 1968, it presented an overview of some of the issues which were at the forefront of computing. ICL was created through a merger encouraged by the government between English Electric and Elliott Automation. It was loaned £15 million from the Industrial Reorganisation Corporation (IRC) of the Labour government. The IRC was created 'to promote structural change which will improve the efficiency and profitability of British industry' (Hansard, 1968). ICL was provided grants for research and development to allow it to compete with the

American computer manufacturer IBM, which dominated computing at the time (Burden and Campbell, 1985). The article heralds the advent the of the 'fourth generation' of computing which could 'provide the British computer industry, in co-operation with Europe…a worthwhile share of the world computer market' (Johnson, 1968: 37). This indicates how developments in computing technologies were recaptured by the state as it began to frame its survival on the capture of war machines.

Johnson describes the NPL network plans as 'modest' in scale—he argues that they planned for thirty nodes, thirty interfaces and about 400 terminals in each interface area, which was expected to cost £10 million. The cost to subscribers were expected to be between £500 to £1000 a year for a single terminal on the network. He argues that the public network could serve the 'Central-File' service which was proposed for stockbrokers, a nation-wide hotel reservation system and national stock control for retail chains. Interestingly, Johnson (1968: 37) predicts that decreasing costs would ensure that 'almost all the daily business of offices could be computerised to some extent, if the price were right'. He added that one day 'visual display terminals could become useful tools even in the home—for paying bills or fireside shopping' (Johnson, 1968: 37). Murray Laver, head of the Post Office National Data Processing Service is quoted in the article employing the familiar analogy of organic mechanisms to describe the role of computer networking. His example is particularly telling of the way that technological progress quickly becomes allied to biological progress and the narrative of the survival of the fittest: 'The most effective animals are the ones with the best nervous systems. Perhaps the countries with the best nervous systems will be the most effective too' (Laver in Johnson, 1968: 37).

The author argues that the adoption of common standards would ensure that 'the brain and the nerves… speak the same language.' Johnson (1968: 37) goes on to argue that the 'ability to work as an integral part of a communications net as intimately as the brain does with the nerves of the body will be the main thing distinguishing the next generation of computers.' The network form reported by Johnson is one that is captured in service of the state, whose interests were linked

to controlling the standards that were adopted. Stanley Gill is quoted in the article arguing that the 'whole country's progress' was dependent on the technology. Johnson argues the 'international battle over data codes' had some powerful interests; the article states that the US Government was pushing for standards through the International Standards Organisation. These themes are an indication of what was about to come over the course of the next three decades as the Internet emerged from these political struggles over networking protocols.

Nomadic Applications

A progress report from the NPL Division of Computer Science of 1969-1971 details the successes they had with 'Mark I' of the network. Although it lacked a high-level nodal network, the Interface Computer (a Honeywell DDP 516) had successfully simulated the workings of a packet switched network within the NPL campus. By early 1970, about six terminals were installed on the transmission equipment. The report also shows how they began to make a number of improvements to the software used by the system. Encountering difficulties in adding new services to the network, whey wanted to redesign the software in a modular fashion so that it would be 'amenable to subsequent changes from the outset,' making it easier to maintain and modify (NPL Com. Sci., 1971: 35).

The modular concept also found an application in the development of the national data network they began to develop with the GPO. The impossibility of having national coverage with the introduction of such a network meant that they looked for practical solutions. A proposal put forward by Barber (1971) suggested a layered approach could ease the introduction of a digital network by making use of the existing telephone lines. Barber argued that a conceptual separation between an 'inner' layer of data carried by an outer physical infrastructure layer would allow the network to be adapted to the existing analogue telephone network. This was a pragmatic move which guaranteed that the interfaces for user computer hardware

and software would remain the same whilst potential subscribers waited for a national availability. The ability to adapt to restrictions defines the work of NPL as a nomad science. Layering allows end-user functions that interfaced with the outside layers of the network to be developed independently from the underlying infrastructure. Even in a scenario where the network infrastructure had changed, user applications in the inner layer would not be aware of the changes other than as performance improvements. The layered approach to networks shifted focus away from the core of the network and spurred a rapid process of deterritorialisation which allowed a range of applications to be built for the network.

Some of these applications were detailed in a paper presented at the Second International Conference on Computer Communications held in Stockholm on August 1974 (Scantlebury and Wilkinson, 1976). The paper shows that Mark II of the network grew considerably in size—there were twelve computers attached to the network with about 75 terminals. The layered approach eased development and allowed them to create new network services rapidly. A range of applications were developed that allowed users to access stored data on the network. One these services was called Scrapbook, a graphical information storage and retrieval database. Scrapbook allowed its users to create files and make links between them on a 'visual display unit' using a Modular 1 computer from Computer Technology Limited. Scrapbook is a precursor to the World Wide Web. It was a utility for managing documents, combining the features of word processing, electronic messaging and hyperlinking between documents (Campbell-Kelly, 1988; NPL Digital, 2009). Scrapbook is an early indicator of the kind of effect that computer networks would have on the world of work, transforming the way that people communicated and interfaced with information. Scrapbook was bought by a number of public and private companies including Shell, the Ministry of Defence, British Telecom and the European Commission. Within the European Commission, Scrapbook allowed people to work together in Strasbourg and Brussels to produce their annual reports (Davies and Barber, 1996).

From the 1970s onwards, a number of other packet switched networks were developed around the world, providing ample opportunities for collaborative work-

ing on the network. The European Informatics Network (EIN), originally known as the COST 11 project (FCO, 1971), started life in 1971 led by Derek Barber from NPL who influences the development of networks in Europe. The EIN project was originally intended to link five existing networks in Europe, including the one at NPL, the EURATOM centre in Ispra, Polytechnico di Milano in Milan, Paris (IRIA) and ETH Zurich. Other interfaces developed for the network included one for transporting information from the Teletext (BBC Ceefax) service which broadcast data on terrestrial television (Davies, 1977). Using an aerial mounted on top of the Computer Science building, data received by the UHF Tuner and a 'Data Acquisition Unit' was able to relay information from the aerial into the network. Teletext was also made available to a number of these new networks connected to NPL (including EIN and the GPOs' EPSS network). See figure 3.6 below for a special Ceefax page used for demonstration in Canada during the 1976 International Computer Communications Conference over the EIN network.
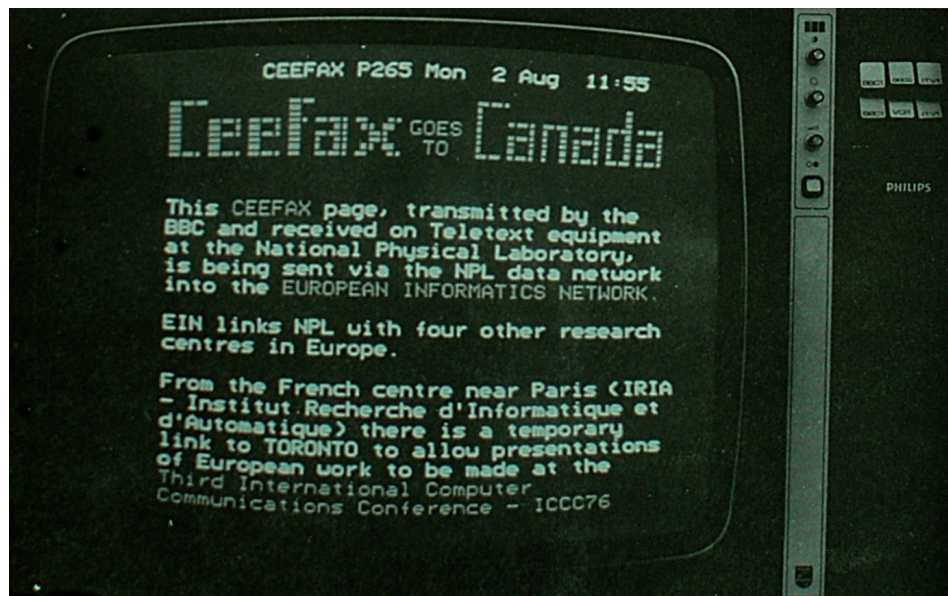

Figure 4.6—A special Ceefax page created by the BBC for transmission over the EIN Network via NPL (Davies, 1977)

There is a sense of playfulness about the development of the network, Derek Barber describes how network access to Ceefax allowed them to keep up with cricket scores when they were at a conference in Canada:

> Well, I don't remember. It's funny how you just jump around, but in 1976 at the ICCC meeting in Toronto, I had a display of the UK Teletext with the cricket results coming up…we had a six-foot rack of equipment which [Alan Davis?] had built just to do it all. And we piped…this thing from NPL through the EIN network …over this link into Toronto…eventually it came down to this display, and those who were in the know were coming by to find out what the latest cricket results were. [Laughter] (Barber in Davies and Barber, 1996)

There were more serious interfaces developed, such as one that connected with the GPOs' experimental VIEWDATA system (Davies, 1978). VIEWDATA was a system for home users to access 'simple graphical information' stored in a central database using a TV connected to a modem and a telephone line. Information available on the system ranged from news, TV listings, business services and stock quotes. Alan Davies (1978) states that there were about 200 terminals in the NPL network by that time, which were able to use VIEWDATA on NPL network using a modem connected to the GPO system.

During the 1970s, attempts were made to bring computer networks into the realm of the royal sciences. Many European networks, including the EIN and the British EPSS (the GPO's own Experimental Packet Switching System), began to follow the X.25 protocol, a jointly agreed standard from the CCITT (now a division of the International Telecommunications Union) which tried to accommodate the needs of telephone operators and computer manufacturers. Lawrence Roberts was a key figure behind X.25, as one the members of the original ARPA Net project and founder of GTE Telnet, a commercial data network based on the protocol. In a later interview, Davies highlighted how standards became detrimental as soon as they became rigid:

> [T]he X-25 [standard] was marvelous [sic] in the sense of getting it [packet switching] widely spread in use, but it also froze the technology, because everybody said, "That's the standard, you must stick to that." And consequently it never moved

forward, there was a big hold up until ATM [Asynchronous Transfer Mode] took over. And ATM represents the next big leap forward. (Davies in Davies and Barber, 1996)

In one of the last reports available in the National Archives about the NPL Network, Brian Aldous describes the implementation of the X.25 standard in the network (Aldous, 1979). In the report he describes a 'multi-processor interface computer' which was used to interconnect the X.25 interface networks with the EIN Interface. The era of interconnection would gain in pace over the following decades as various packet switched networks were established around the world, importantly, this gives rise to the modern day internet as various forms of networks competed for dominance during this period.

The ARPA Net

The ARPA Network built in America by the military research group in America would go on to become the most widely known of the early packet switched networks as it closely related to the modern Internet. In this section I want to compare the approaches that the two teams took in designing a packet switched network. I want to draw attention to how the network built by ARPA was designed to serve the interests of the state. Although its civilian applications would bring it fame, it was military aims that drove its development. I turn to the first of these encounters when NPL and ARPA had crossed paths at the stage of initial proposals in October 1967. This took place at a conference organised by the Association for Computing Machinery called the Symposium on Operating System Principles held in Gatlinburg, Tennessee.

The paper from ARPA was titled 'Multiple Computer Networks and their Intercomputer Communication' and given by Lawrence Roberts (1967). Roberts argued that computer networks would be particularly useful in scientific computer applications for sharing processing power and accessing data on remote computers.

Although their proposals were not solely aimed at the military, it was argued in their paper that a data network would be particularly useful for 'military command-and-control, information retrieval, logistics and war gaming applications' which could rely on remote access to common databases (Roberts, 1967: 1). Like the NPL Network, the ARPA Network originated from research into time-sharing, the proposed network used an 'Interface Message Processor' (IMP) as a means for implementing network connections between different time-shared systems. The proposal put forward a hypothetical network with 16 locations across America connecting to connect 35 computers. Roberts proposed dial-up connections over the telephone network to provide the infrastructure for the network.

The IMPs handled the dial-up, data transfer and store-and-forward mechanisms at each node using a shared protocol. Some IMPs would be responsible for concentrating messages from certain areas into one connection and would help grow the network by 'speed[ing] the realisation of a unified' cross-country network' (Roberts, 1967: 4). This network was closely related to the circuit-switched network that Roberts had worked on previously with Thomas Marill at the Computer Corporation of America (Marill and Roberts, 1966). Rather than a 'public' data communication network, the aim of the TX2/Q-32 project was to create a 'cooperative' network that allowed two time-shared computers, the TX2 computer at Lincoln Labs and the Q-32 computer at System Development Corporation, to communicate (Marill and Roberts, 1966: 426). Their new proposal shared many similarities with the TX2/Q-32 project, but was implemented on a larger scale and circumvented the need for auxiliary software on the computers by using IMPs to establish the connection.

NPL's paper began with a different problem: the 'mismatch' between time-sharing and telephone networks (Davies *et. al*, 1967). The paper was titled 'A Digital Communications Network for Computers Giving Rapid Response at Remote Terminals' and it proposed that a general 'common carrier network' would address many of these problems. They argued that a a high-level digital network could replace the existing analogue telephone networks, with voice calls transferred through digital transmission instead. This also serves as a clear illustration

of how nomadic and royal sciences approach problems in a different way. Roberts approaches this as an extension of the existing means of circuit-switched networks, whilst the NPL plans began from a different problem interfacing computers together by creating a new form of decentralised network.

NPL's work would go on to have a significant influence on Roberts and the development of the ARPA Net. In Campbell-Kelly's (1988: 232) interview with Scantlebury, he recalls discussions with Roberts after the lecture where he had persuaded him to split messages into small packets and use higher data rates as proposed by NPL. ARPA released the Request for Proposal for the equipment and operation of the network in July 1968 (Roberts, 1978). The IMPs used on the ARPA Net share many similarities with the plans for the NPL system. As Davies recalls: 'we were extremely surprised when we saw the IMP design to discover that they used the same message packet size as us, and they had many things in common' including the Honeywell 516 computers used as interfaces (Davies, 1986: 15). By December 1969, the first four nodes of the ARPA Net built by Bolt Beranek and Newman came into operation (Roberts, 1978), and the following month, Mark I of the NPL network became operational although it had yet to implement a full packet-switch (Davies, 1986).

The number of nodes on the ARPA Net grew at a rapid rate after it was established, from three nodes originally to sixty one nodes by July 1977 (Lukasik, 2011). Changes in the the structure of the ARPA compelled it to shift its focus from research towards practical applications for the state (Lukasik, 2011). In 1971, ARPA Net was used to connect together nuclear test detection equipment for Project Vela. The Nuclear Test Ban Treaty signed in August 1963 by America, Britain and the Soviet Union was prevented from being implemented due to a lack of accurate methods for detecting nuclear tests. Project Vela was a detection mechanism that could provide this data detecting nuclear detonations by distinguishing between seismic activity from earthquakes and nuclear explosions. Seismic activity was distinguished by analysing seismic readings from multiple sites located at specific 'teleseismic' distances from US and Soviet nuclear testing sites (Lukasik, 2011). Collecting data from these distances for processing was the first function that the

ARPA Net would play for the state. The network was used to collect readings from two places, the first was at an already established site called the Large Aperture Seismic Array in Montana near the US nuclear testing. The second was at a new site at Kejeller in Norway called the Norwegian Seismic Array (NOSAR) which was established in 1971. The data from these arrays were bought together and analysed at the Seismic Data Analysis Center (SDAC) in Virginia. In 1971, NOSAR and SDAC were connected by satellite to the ARPA Net to create its first international node (Kirstein, 1999).

The first satellite link went to Goonhilly satellite station in Cornwall and was connected to Norway by an under-sea cable from London (Kirstein, 1999). Although there was interest in joining the NPL and ARPA networks together through the link, government policy at the time focussed on the networking efforts with the European Council (EC). In particular NPL was heavily involved in project with EC called the European Informatics Network which was led by Derek Barber. Peter Kirstein at University College London, initiated a project to link the university network to the ARPA Net. Initially the Science Research Council and The Department of Industry were hesitant to fund the project, but in 1973, the link was jointly funded by NPL, the Post Office and the British Library for the duration of a year (Kirstein, 1999). Although initially successful, the funding for the second year could only be obtained after an 'urgent plea' to the Ministry of Defence (Kirstein, 1999: 41). The MoD agreed to fund the link on the basis that they could add their own networks to ARPA Net which included the Blacknest seismic array they employed for nuclear test detection, which begins to indicate the growing military applications for the technology in both sides of the Atlantic.TCP/IP and early Inter-networking

TCP/IP and early Inter-networking

The Transmission Control Protocol/Internet Protocol pair is the dominant communication protocol used on the modern day Internet. It began life as 'TCP,' in a paper written by Vinton Cerf and Robert Kahn called 'A Protocol for Packet Network Intercommunication' (1974). The addition of the Internet Protocol to make it TCP/IP was driven by the existence of multiple computer networks in the 1980s that were incompatible with each other. IP was added in a series of later proposals (Postel, 1981) that converted the original proposal into a modular framework to create an 'inter-network protocol'. IP handles network functions such as addressing and transfer between gateways through various networks, whilst TCP ensures end-to-end communication between different processes on host computers (Leiner et.al., 1985). TCP/IP provided a solution that made end users responsible for establishing communication rather than depending on infrastructural changes on the network itself. This was achieved through 'Internet gateways' that interfaced between different networks.

Concepts from the NPL network had a significant influence on the development of TCP/IP, Donald Davies has stated in an interview that NPL had significantly contributed to its initial development. He recounts a story where the two teams had met at a party: 'Roger [Scantlebury] had a party one evening, after a conference I think, in his house, in which they [Bob Kahn] all sat around inventing an early version of…TCP' (Davies in Davies and Barber, 1996). This is a claim which is supported by archival evidence. As I argued earlier, the specific problem of inter-networking between the analogue telephone network and a digital network had been addressed at NPL by Barber (1971) using a layered approach. The concept of network protocols, which had been employed on the first ARPA Network had also come from the work of Davies at NPL. This is supported by Campbell-Kelly (1987) who also argues that the word 'protocol' comes from NPL. Scantlebury and Bartlett (1967) use the word to describe the protocol used on the test network at NPL. They were also responsible for publishing a report the following year which details the 'Transmission Control Equipment' used within the network (Scantlebury and Bartlett, 1968). There also many similarities with work on the layered approach by

Derek Barber (1971) and others (Scantlebury and Wilkinson, 1971) that separated network and transport functions as a result of the specific difficulties with different computer manufacturers and a hesitant Post Office that they had encountered at NPL. The choice of word 'protocol' rather than the word 'procedure' that would have been prevalent in computer engineering at the time is significant, it connotes common convention rather than a specific directive. The encounter between NPL and Kahn that is recounted by Davies is a moment where the diagram for a war machine is given to one of the people who would go on to develop TCP/IP.

Townes (2012) argues that TCP/IP leads to the modern day Internet not because of American hegemony, but because of the 'prescriptive norms' of academia inherent in the protocol where it was developed. He argues that one of the consequences of allowing users to be responsible for network functions was that the TCP/IP networks were 'resistant to centralised control' (Townes, 2012: 51). This is because as Townes (2012: 51) argues that the protocol resulted from the the work of the scientists and researchers who were primarily interested in 'working to connect their computers' rather than motivated by economic or political interests. As Townes points, TCP/IP had the war machine like quality of facilitating 'one kind of political or social arrangement while precluding others' (Townes, 2012: 63) that is in many ways similar to the aims of the NPL Network. Campbell-Kelly & Garcia-Swartz (2013) lends this argument support by arguing that TCP/IP was important because it was an 'ad hoc' solution to the network standards battle because of the lack of bureaucratic obstacles to use the protocol (Campbell-Kelly & Garcia-Swartz, 2013: 31). As they point out, it was largely expected that the Internet would fade away as a 'transitional network' during the 1970s and 80s to be replaced by a centrally organised protocol (Campbell-Kelly & Garcia-Swartz, 2013: 25). Campbell-Kelly & Garcia-Swartz (2013: 31) argue that it continued to persist because its 'most important innovation was organizational, not technical,' it emerges as a global standard because 'it was designed and accepted by organizational consensus' rather than bureaucracy.

However, TCP/IP was only one amongst many other protocols around during the 1980s when it rose to prominence. Many public European networks and other

commercial packet switched data services, for instance, GTE Telenet adopted X.25 during the 1980s. As DARPA became opposed to the Open Systems Interconnection (OSI) architecture proposed by the International Standards Organisation (Leiner et.al, 1985: 33), the Department of Defence mandated that all packet switched networks use TCP/IP in 1983, including on weapon systems where it did not 'distinguish network performance' (Defence Communications Agency, 1983: 1). Computer communication technologies would have a profound impact on the 'military concepts and doctrine' concerning distributed command and communications (Leiner et.al, 1985). The Internet system provided a 'unified and interoperable communications structure' which could allow the military to make use of distributed networks across the world (Liener et.al, 1985: 33). I argue that it is difficult to discount Abbate's (1999: 5) claim that 'military concerns and goals were built into the Internet technology' as Townes (2012) has done. Whilst the suppleness of TCP/IP may have encouraged its rapid adoption, this was also a valuable quality for the state—particularly the American military—which saw it as a valuable tool for their command and control operations to take advantage of different networks around the world.

A paper presented by Michael Frankel (1982) on 'Advanced Technology Testbeds for Distributed, Survivable Command, Control and Communications (C3)' at the 1982 Military Communications Conference (MILCOM'82) in Boston, Massachusetts makes extraordinarily clear how TCP/IP was captured by the military as a war machine in service of the state. Frankel's paper provides is with an extraordinary glimpse at how the work on Command, Control and Communications had begun to dictate the future of war by allowing military operations to be controlled from a distance. Frankel (1982: 2-1) had presented the findings from an 'Army Data Distribution Testbed' at Fort Bragg in North Carolina which experimented with the 'problems of developing a military structure capable of surviving and functioning in a nuclear engagement' using the ARPA Net and Packet Radio. His findings highlight the importance computer networking had for the military, particularly as it demonstrated the utility of using existing computer networks for military use.

Davies (in Davies and Barber, 1996) singles out the X.25 as the standard that 'froze the technology' in order to create a centrality that favoured interests of network providers. The development of various network types in America grappled with this very problem, where the interests of network operators clashed with the interests of its users. TCP/IP becomes a different kind of war machine in the academic community that was directed against the striated world of network protocols which prevented their intentions to connecting different computers together. The fate of protocols such as X.25 and OSI were sealed by royal scientists who worked to remove the nomadic notions of packet switched networking and make them conform to static rules that fixed the parameters of technology in the interests of network operators and bureaucratic institutions. TCP/IP on the other hand, continues its existence as a war machine, avoiding the bureaucracies that captured other protocols that submitted them to the state, only to find its very nomadism of interest to the military.

The narrative of Internet as unified network of networks originates from the computer science departments of American universities. Various types of packet switched networks began to take off around the world in the late 1970s. During this period there was a mixture of publicly funded academic networks, commercial and military networks which used different protocols and standards like X.25, IBM's SNA and TCP/IP. These networks space was striated like individual states; each provided a number of services that were only accessible to other subscribers on the same network. The stated nature of these networks   prevented academics on different networks from collaborating with each other. There was also a 'growing split' in the academic community between computer science departments that had ARPA Net access and those without (Comer, 1983): The early adopters were the large universities who worked on military projects with DARPA. Comer (1983) argues that access to the advanced features such as mail and file transfer available on the ARPA Net could not be made available to newly formed networks between other universities.

The Computer Science Research Network (CSNET), was established to create an academic network that interconnected with ARPA Net by permitting its users to access hosts on different networks. The network had goals that were nomadic, and contain the qualities so often associated with the modern Internet (Comer, 1983: 139):

- Open to all computer researchers
- Logical net comprising physical subnets (initially ARPANET, Telenet, Phonenet)
- Advanced network services (initially mail, file transfer, remote login, name server)
- Self-governing, sustaining, and supporting
- Low Entry Fee[s]

DARPA offered CSNET the TCP/IP protocol in return for making their networks available to ARPANET (Comer, 1983: 139). DARPA also provided an X.25 to TCP/IP protocol adapter for interfacing CSNET computers that were on the Telenet network with the ARPA Net. TCP/IP was adopted by the entire network in 1985. The radicalism we associate with the Internet comes from the academics who deployed the war machine of TCP/IP to establish connections between different networks, striated by military and commercial interests. DARPA was in a powerful enough position to mandate its use, as well guarantee the resilience of its most nomadic elements. This allows TCP/IP to unify the computer research community with a commonly shared and openly developed protocol that was publicly funded and not limited by the commercial interests of network operators. The CSNET later became the National Science Foundation's NSFNET, which is the predecessor of the modern day Internet. As Townes (2012) points out, the reason that TCP/IP was popular around the world, where it was adopted in many networks without the intervention of DARPA, was because its was openly developed by its end users.

An Information Superhighway for a Neoliberal World

By the late 1980s, the notion of a publicly funded national network began to gain significant traction in America. Although the product of military engineers, once handed to the academic community, TCP/IP largely remained out of the reach of state organisations. Towards the end of the decade however, this perception began to change. This period was marked by a structural shift within commercial organisations made possible by the adoption of network technologies, that helped reorganise the production and management activity of large businesses. The idea that network infrastructure was as fundamental to the workings of the economy as other forms of public infrastructure began to recognise the role of computer networks in economic activity. One of the early indications of this comes from a report by the Office of Science and Technology Policy (OSTP, 1987) called 'A Research and Development Strategy for High Performance Computing'. The OSTP played a major role in the years ahead to establish political support for funding a national data network. The report argued that national networking efforts in the US were uncoordinated and quickly falling behind efforts in European and Japanese networks:

> Other countries have recognized the value of national computing networks, and, following the early U.S. lead, have developed and installed national networks using current technology. As a result, these countries are now much better prepared to exploit the new opportunities provided by distributed collaborative computing than the U.S. is at the present time. (OSTP, 1987: 18)

They recommended that the government, along with industry and universities, coordinate efforts in networking to 'foster and enhance the U.S. position of world leadership in computer networking as well as [providing the] infrastructure for collaborative research' (OSTP, 1987: 19). They argued that this could be achieved through the upgrading of existing network facilities and the expansion of networks run by DARPA. During this time we also begin to see the role of the state coming into question. Gordon Bell (1988), vice president of Ardent Computer Corp. and chair of the subcommittee on computer networking for the OSTP report wrote an opinion piece disagreeing with some of the conclusions made by the

Figure 4.7—American President Bill Clinton Installing computer cables at a school with Vice President Al Gore on NetDay (GPO, 1996)

report. He argued that a national network did not have to be thought of as a solely state-run network, '[a]ny one or a combination of the existing telecommunications suppliers could pre-empt Federal efforts to build a national research network by simply building the network and offering the service for sale' (Bell, 1988: 57). Bell argued that a 'radical approach' would be to 'select a private-sector company to manage and develop the network' funded by separate agencies in order to free different departments from individual control of the project (Bell, 1988: 57). We begin to be able to recognise the early beginnings of a neoliberal critique that redefines the role of the state and its involvement in public computer networks. From this perspective, the over reaching state was now the enemy, not the competing network providers.

The national network in the US was cemented by a later report from the Computer Science and Telecommunications Board (CSTB, 1988). Whilst it agreed with previous proposals, it began to articulate a more nuanced role for the state which acted as a facilitator, rather than operator, of networks. They argued that the state would play a role in transitioning existing projects to a unified network and upgrading and expanding the infrastructure of the existing networks. The state would 'benefit from the vast experience gained in industrial research…and in network service markets,' whist ensuring that the basic architecture and technology were determined by the users of the network rather than the forces of the market (CSTB, 1988: 28). In many ways, this argument is a reflection of the case made by Donald Davies and his colleagues at the NPL two decades earlier, with the crucial difference being that the network would be run by the market rather than the state. The debate clearly splits between the ambitions of its users (as represented by the academic communities), the military, and commercial interests.

The ending of the Cold War would radically alter the role of military and commercial interests of TCP/IP as it became a tool for promoting American interests as new markets opened up for networking technologies around the world. As Deleuze & Guattari (2004: 401) argue, the nomad sciences are only of interest to the state 'after restraining or disciplining them, after repressing their social or political conceptions.' By the early 1990s, we can see how emerging ideas around the relationship between state and the market effect the way networks were imagined within the public realm. Among the first initiatives outlined by President Clinton after assuming office was called 'Technology for America's Economic Growth.' It outlined how technology could act in service of the state. They promised 'bold and dramatic changes to harness technology to drive economic growth and job creation' (Clinton and Gore 1993: 1). Their strategy was to use defence technology developed by the military to 'play a key role in helping private firms develop and profit from [those] innovations' in the post-Cold War era. The creation of an 'Information Superhighway' was a prominent feature of this initiative, which was compared to the development of the railway in the nineteenth century. It promised 'efficient access to information' that was 'critical for all parts of the American economy' (Clinton and Gore, 1993: 16). This national high speed network was constructed by the private sector, encouraged by state funding and policy initiatives.

Spurred by the end of the Cold War, business and military opportunities arose in parts of the world that were once considered to be enemies. Changes in legislation removed exports bans on telecommunications equipment to former Soviet bloc countries, as a new wave of globalisation unfolded. As eagerly reported by Thomas L. Friedman (1994: 1) in the New York Times, these changes were 'expected to open up a market worth roughly $150 billion over the next decade'. A report from the Office of Science and Technology Policy (CSTB, 1994) called 'Realizing the Information Future, The Internet and Beyond' sums up how the discourse had shifted from talking about a National Research Network to that of a National Information Infrastructure (NII) 'a seamless web of interconnected, interoperable information networks, computers, databases, and consumer electronics that will

eventually link homes, workplaces, and public institutions together' (OSTP, 1994: 1).

The meaning of the word 'Internet' shifts in this report from referring to a loose collection of inter-connected networks, to explicitly classifying those networks which followed the TCP/IP or Internet Protocol. High on the agenda of this report was the international nature of the National Information Infrastructure:

> "Both the Internet and information infrastructure generally are fundamentally international. The international nature of infrastructure will have to be addressed in whatever technical, market, and legal measures are taken to assure smooth communication and interaction between most countries. International connectivity must be maintained and expanded as foreign networks develop and proliferate." (OSTP, 1994: 7)

The report contains a whole section devoted to the international dimension of the NII that is the blueprint for American ambitions for the Internet over next few years. One of the major obstacles identified by the report was the high cost of international connections which were incurred by US government agencies helping to 'internationalise the global Internet' (OSTP, 1994: 270). They argued that a 'lack of competition' in foreign government owned international links were responsible for their high costs, hinting that deregulation in some parts of the world has had the results of 'increased competition' on some international links. It argued that the lack of local infrastructure in certain parts of the world, such as Eastern Europe and Africa, was beginning to be addressed through investment by 'Western companies marketing products and services in telecommunications...encouraged in some cases by the World Bank' (OSTP, 1994: 247-5). Their goal of 'full international interconnectivity' depended on further reductions in export controls that would allow US vendors to compete with products from other industrialised nations (OSTP, 1994: 279).

Another major issue highlighted by the report was the competition American companies faced from other 'advanced countries' such as Japan and parts of Western Europe where problems were political rather than technical. It stated that their

state owned telephone operators were reluctant to use American protocols on their networks. They argued that 'for reasons of competitiveness or, in some cases, to avoid adopting what has been perceived as a U.S. standard (the Internet protocols), some governments and intergovernment groups have decreed that national networks must use the ISO/CCITT OSI-compliant protocol suite' (OSTP, 1994: 275). It portrays the development of international standards as 'flawed' and 'cumbersome,' and as an environment of 'religious protocol wars' waged by 'government bureaucrats' who were choosing 'politically correct' protocols (OSTP, 1994: 277). They hint that US export controls were being utilised by other nations to build 'economic walls' and 'information walls,' subtly evoking images of the Berlin Wall, to illustrate how it helped 'favour specific technical standards, products, and architectures, oftentimes initiated to limit the sales of U.S. technology abroad' (OSTP, 1994: 279). One of the explicit aims in the report is that '[i]nternational connectivity [with American networks] must be maintained and expanded as foreign networks develop and proliferate' (OSTP, 1994: 279). These economic and political aims significantly determine the course of TCP/IP.

Its dominance in computer networking ensured that military capabilities which grew dependent TCP/IP and the competitive advantages that American military contractors and networking companies had with the protocol were extended around the world. This was further cemented when the birth of the Internet was proclaimed by Al Gore during his address to the ITU World Telecommunication Development Conference in 1994 at Buenos Aires. He began by quoting Nathaniel Hawthorne's vision of wrapping the nerves of the telegraph around the globe. Gore had come to the conference with a vision of the Global Information Infrastructure which was an 'assemblage of local, national and regional networks,' an information superhighway that would allow the people of all nations to 'travel' and a 'metaphor for democracy' which enhanced the ability of citizens to participate in society. The 'Global Information Superhighway' was the highways of the first world extended to the developing countries present at the conference at the cost of adopting American technologies, values and markets:

> To promote; to protect, to preserve freedom and democracy, we must make tele-communications development an integral part of every nation's development. Each link we create strengthens the bonds of liberty and democracy around the world. By opening markets to stimulate the development of the global information infrastructure, we open lines of communication. (Gore, 1994)

Acutely aware that American developments in computer networking were being closely watched around the world, Gore used techno-utopianism as an 'ideological weapon' that not only opened the telephone networks of the world to free market capitalism, but created a vision of the world in which privatisation, deregulation and technology itself was equated with development. TCP/IP was not just a medium for transferring information, but became a political tool in delivering the free-market agenda. Techno-utopianism gave birth to 'the dream of unmediated planetarism' in an idealised civil society of free communication consisting of individuals that were opposed by an 'abstract and evil state' (Mattleart, 1999 p.190). In his speech, Gore had predicted the need for the protection of intellectual property in the global information highway which would become central to later debates about the Internet. Such protections were required to sustain American dominance, hinting at the resurgent role that the state had in his utopian vision as the guarantor of capitalism.

Conclusion

Whilst the development of the Internet was closely allied to the ambitions of the military, it would be inaccurate to view its technological development solely as a military or as an American project. We cannot ignore the conditions under which it was developed. Although Davies had devised a packet switched network earlier, it was ARPA Net which would eventually be built on a much larger scale; the adoption of the technology was clearly determined by the social circumstances in which they were developed. Its potential for application in nuclear monitoring and the constant political and military tensions between America and the Soviet Union

during the Cold War made available large amounts of research funding, making an ambitious project like ARPA Net feasible. Perhaps the key to understanding the history and development of the Internet lies in looking at the way that packet-switching acted as a war-machine for organising networks without hierarchies.

The economic crises of the 1970s and the rise of neoliberalism in the decades after transformed packet-switching into an economic tool—albeit, one that propagated a geopolitical narrative against communism. The network began to be seen as a harbinger of democracy that delivered the benefits of laissez faire capitalism. Mattelart (1999) argues that networks are ideals of organising society; the Internet promises a utopian society which transcends nation states and gives rise to the 'information society' that Norman Wiener had predicted in 1948. Realising this ideal resulted in the privatisation and deregula-
tion of state-owned telecommunications mono-
polies and materialised some of the ideas of a 'free' global market (Shahin, 2006). Commercial exploitation was one of the key drivers of packet-switching, particularly its adoption in Europe where it was seen as one of the key components of enabling the common market (Shahin, 2006). At the end of the 1990s, the European Union (EU) adopted neoliberal policies to help Europe compete with US companies on the Internet using the eEurope Project (Schulte, 2009). The Internet came to be seen as a tool for European integration, the project gave financial incentives to private corporations to invest in infrastructure that could increase public access to the Internet.

More broadly, this chapter has shown how some of the central ideas around the Internet of decentralised networks, are both social and technical. I have argued that the principles of packet-switched networking originated from ideas surrounding issues of control over network design. I remain sceptical that a nomadic network design and openness necessarily implies egalitarian applications for technology. In the following chapter, I turn my attention to how developments in technology began to redefine the role of the state, particularly within education as the discourse of a 'learning society' that could adapt to a landscape of radical technological change began to take hold in 1990s Britain.

Human Capital Technology

This chapter explores how governmental rationalities and technologies have evolved over time in the English education system. The chapter is split into three broad periods, we begin in the late nineteenth century with the introduction of compulsory state education in England, then we turn our attention to the post-war reforms of education, finally, we look at neoliberal reforms of education that were introduced in education after the 1980s. I offer a Foucauldian reading of this history using both existing literature and range of policy documents and news paper articles to show how computer networks have contributed to the intensification of governmental practices within education. We begin by looking at various forms of statistical knowledge were used to rationalise the need for the state to provide education for its citizens. These arguments often depend on statistical calculations which made the effects of poverty increasingly visible in Victorian England. Statistical methods also influenced the development of eugenics, which was used to reintroduce the sovereign right to kill in biopolitical mechanisms to increase the vitality of the population.

Labour goes for Net gain

**John Carvel
and Rebecca Smithers**

ONY BLAIR intends to steal the limelight on the first day of the Conservative conference next week by agreeing to a high-profile deal in Downing Street with Bill Gates, the multi-billionaire chairman of Microsoft.

As the Tories attempt to regain political momentum, the Prime Minister will produce a detailed plan to put the latest computers and software into Britain's 32,000 schools.

It will include free Internet connections, heavily subsidised telephone bills and an intensive programme of teacher training.

Mr Gates is understood to have agreed to oversee the scheme and broker deals with computer manufacturers and software firms — including his own — to keep costs down through bulk purchases. He will visit Mr Blair on Tuesday on his way to launch a Microsoft bequest for technological development at Cambridge University.

It was not clear last night whether Mr Gates would offer a cash contribution to supplement investment by the Government and national lottery

funding for training teachers to use the new technology.

However, his presence in Downing Street will enable Mr Blair to present himself as the man of action who gets on with preparing the schools for the 21st century while the Tories are only starting to pick up the pieces of their electoral defeat.

Mr Blair will meet Mr Gates on Tuesday to agree the final terms of the deal, followed by a series of parallel announcements from the telecommunications regulator, Oftel, and from the Department for Education and Employment.

A senior Government

Figure 5.1 — Labour goes for Net gain (Carvel and Smthers, 1997)

Education was also linked to the performance of economy during the recession of the 1870s. The technical instruction of labour was argued to result in economic growth. The national decline was blamed on racial degradation. These ideas would go on to influence the concept of 'general intelligence' and the adoption of selection tests for secondary schools after the Second World War which. These intelligence tests administered by the state were used to allocate students to secondary schools at the age of eleven. We then trace how comprehensive schools from the late 1960s moved away from selection tests towards systems of streaming within schools that separated by ability. An unbroken line can be drawn between Francis Galton's eugenic theories from the late nineteenth century and intelligence testing to the technocratic reforms of education that began with neoliberal forms of market regulation in the late 1980s.

According to Helsby and McCulloch (1997), the uncertain political and socio-economic climate during this period was instrumental in creating the socially divisive role for educational establishments around the world to '[produce] both the compliant citizenry and the skilled and flexible workforce necessary' for societies being

remade in the image of neoliberalism. The introduction of the market mechanisms and the National Curriculum formed part of a broader range of changes intended to create a smaller state by involving the market in the delivery of public services and forms of managerial government. During the 1990s, New Labour had a vision for education that was driven by a publicly funded, and privately operated computer network called the National Grid for Learning that would provide egalitarian access to knowledge for all students. The network was portrayed by New Labour as a technological solution for education. The Grid was part of the shift towards what New Labour called the 'learning' society. Looking at these discourses allow us to see the role that computer networks were imagined to perform.

Eugenics, Technology and Education

A compulsory public education system began to take shape in England during the end of the nineteenth century, much later than other industrial nations such as Germany or America. The beginnings of a national system for education was started by the Forster Education Act of 1870. Compulsory school attendance for all children up to the age of ten was introduced in 1880 and fees were completely abolished by 1896 (Roedrick and Stephens, 1982: 14). Campaigns for national education were spearheaded by a 'radical wing' of the middle classes emerging from the industrial revolution, who faced stiff opposition from aristocratic members of parliament (Chitty, 2009: 5). A Conservative MP famously remarked that educating the the working classes would be 'prejudicial to their morals and happiness' and would 'teach them to despise their lot in life, instead of making them good servants in agriculture and other laborious employments to which their rank in society had destined them' (Hansard, 1807 cited in Chitty, 2009: 5). Politicians were reluctant to increase state interventions in public education because it was a seen as an illiberal intervention into people's lives (Roedrick and Stephens, 1982). The hesitant attitude to public education was reflected in the regulatory mechanisms

such as 'payment-by-results' introduced in 1861 by Robert Lowe which tested for the 3Rs (Reading, Writing and Arithmetic) extended government funding of schools in 1861. We find in these early debates around public education, we find that early prototypes of governmentality were developed by bureaucrats as a case of the introduction state intervention rather than merely limiting an overreaching the state (Hunter, 1994).

The growing calls for public education also coincided with a time when the British economy began to decline during the 1870s. The economic lead Britain enjoyed from the early industrial revolution was lost to Germany and America as they began to develop more advanced forms of technology. Pollard (1989: 124) argues that Britain's early lead was made possible by a scientific and technological culture that relied on 'inspired tinkerers' who were not dependent on access to formal science. The early industrial revolution was made possible by the practical knowledge of artisans 'marked by originality, by freedom and independence of thought, unaided, but also unhampered by methodological and systematic research' (Pollard, 1989: 127). Following our discussion from the previous chapter, we can see how Pollard (1989) frames the early industrial revolution as the result of a nomad science that were later systematised as royal sciences in service of the state. the royal sciences of the Germans and Americans had developed chemical research and more advanced machinery than the British by end of the century.

The threat of an economic decline began to used during this era as an argument for supporting the introduction of public education. Pollard (1989: 117) shows how by the 1850s, the growing awareness of a 'national decline' had been highlighted by various 'scientific lobbies' as the result of insufficient investment in the 'technical instruction' of the British workforce. This is an argument that resurfaces a hundred years later during the 1970s recession as I will show. Lobby groups such as the National Education League, made up of businessmen from Birmingham, argued that the education systems of America and Germany produced intellectually superior workers who threatened the survival of manufacturing industries in Britain (Armytage, 1970: 122). The arguments for public education were also tied to national economic performance in the 1886 Royal Commission on the Depression

of Trade, it pointed the finger at the 'educational defects' of the nation and argued for improvements in the 'technical instruction' of the workforce (Roedrick and Stephens, 1982: 18). As Britain continued its slow decline into twentieth century, the arms race between Germany and Britain and the First World War served to highlight how far its industries had fallen behind its counterparts in Europe.

Arguments for increased state interventions were made using statistical knowledge of the population. Statistical societies in Manchester began to make a relation between education and reducing poverty as early as 1833. Statistical data generated from the registration of births and the inspection of factories came to be used to argue for the introduction of public education (Lawson and Silver, 1973: 267). Medical inspections conducted by school boards also made it increasingly clear that a vast number of working class children suffered from a range of illnesses (Lawson and Silver, 1973: 270). These tools were characteristics of early biopolitical mechanisms that began to think about the vitality of the population (Foucault, 1977). If the early uses of these ides were used make a rational case for the introduction of public education, later theories of 'racial degeneration' would use of statistical tools to justify who it was among the population that deserved to be educated. Charles Darwin's theory of evolution gave his cousin, Francis Galton, the idea that the human evolution, and the fate of the nation state, could be rationally controlled through the practices of eugenics (Searle, 1976). The eugenics movement was spurred by the publication of Galton's *Inheritance of Human Faculties* in 1883, which gave a racial explanation for Britain's decline. Eugenic theories held the promise that could create a rational regeneration of the nation. Importantly, it was also seen as a radically new scientific discourse that existed outside the ideological sphere of party politics (Searle, 1976: 2).

A growing awareness and concern for the conditions of the poor were inverted by eugenicists such as Galton as evidence that 'the national physique was deteriorating' (Searle, 1976: 21). Eugenicists used the idea of degeneration as a warning against the dangers of 'unreflecting humanitarianism' (Searle, 1976: 48) which wasted the efforts of teachers trying develop the minds of the genetically unfit who would not benefit from education. For most eugenicists, an unequal and hier-

archal society was not problematic as long as it was eugenically organised; they were opposed to unreflecting modes of helping others because this impeded racial efficiency (Searle, 1976: 53). Searle (1976: 54) argues that although eugenic theories claimed to be scientific, many had little to do with biological observations and more to do with preserving the status quo. Eugenic theories provided the scientific and moral justification for sustaining divisions between social classes. These divisions were simultaneously portrayed as the natural outcome of genetics as well as being essential for progress.

Foucault (2003: 254) argues that the emergence of biopolitics targeting the vitality of life prompted a mutation in the sovereign right to kill. Disciplinary power sought to optimise life in service of industrial capitalism of the nineteenth century. Eugenic theories introduced a fissure within biopolitics that reintroduced the sovereign right to kill when it functioned productively. Foucault (2003) shows how the function of race becomes used to indicate something that poses a threat, which justified the exercise of the right to kill. He shows how the race changed from a linguistic concept to biological concept after Darwin's theory of evolution. Foucault (2003: 254) argues that racism is 'primarily a way of introducing a break into the domain of life that is under power's control: the break between what must live and what must die'. Foucault argues that within disciplinary mechanisms, eugenic ideas began to separate the population into groups of those allowed to live, and those allowed to die. Eugenics began an era of biopower that Foucault (1978) characterises as bringing together of disciplinary apparatuses that worked on the body and the biopolitical mechanisms that worked on the population. Racism plays a function of optimising life within the mechanism: when you allow an inferior race to die, the more a superior race was allowed to live (Foucault, 2003: 254). Once again, this justified the 'murderous function of the state,' (Foucault, 2003: 256) biological threats, both internal and external to the population, could be eliminated to improve its overall vitality.

Victorian eugenics was more like a 'voluntarist social reform movement,' arguing for control of the reproduction of 'unfit' classes, rather than a science that established anthropological categories of race (Porter, 1999). During the period

between the two World Wars, Eugenics would become widely accepted as a science, the Vice Chancellor of the University of Liverpool called for a 'human stud book' that would contain records of the most intelligent in society (Adami, 1921: 432). He argued that statistical methods developed during the First World War greatly contributed to a growing confidence in eugenic thought: 'it has afforded material for testing on a great scale and demonstrating the possibility of devising accurate and satisfactory methods of measurement of physical and intellectual capacity' (Adami, 1921: 432). One of the more significant eugenic contributions to governmental rationality was the use of intelligence tests to categorise populations, below I turn to the work of the an early eugenic psychologist William McDougall (1914), who began to articulate a relationship between race and intelligence at the beginning of the twentieth century.

McDougall (1914) argued that eugenics needed to become a royal science by adopting scientific methods of examination and measurement. He argued that 'eugenics can only work towards its end by establishing its ideal in the mind of the community as an aim approved and accepted by public opinion' when it had developed specialised methods of research and detailed forms of knowledge (McDougall, 1914: 296). McDougall proposed that these were not just be found in the biological sciences, but also in the newly emerging science of psychology. He argued that as well as studying the internal processes of the mind, its tools could be used to create systematic study of 'individual psychology' through the application of statistical methods without the need for detailed individual psychological assessment. The statistical tool he proposes is a test of 'general intelligence' that was capable of measuring an innate ability of the mind. The concept of general intelligence is a significant form of biopower that could be adopted as governmental rationality for the state, but also as form of power that could be used to structure relationships between individuals.

Although early eugenic ideas in Britain were based around social class, we also find in McDougall (1914) eugenics transforming into a concern for race and Empire. McDougall (1914: 306) inverts the inward looking eugenics of Galton, whom he accuses 'was inclined to regard eugenics as properly concerned only with the life

of the highly civilized nations'. McDougall (1914: 306) makes the case that the British Empire could not observe that limitation when a concern for 'the future welfare of the whole human race' was required. He argued that in a world where the 'various subraces of mankind' were increasingly living alongside non-Europeans in countries such as America, Canada and Australia because of immigration. '[W]e seem to be approaching a period of universal miscegenation,' he argued, that there needed to be an 'attempt to regulate in some manner and degree these processes of racial mixture' to encourage 'blends of the human subraces' that were are 'admirable' and prevent others that were 'disastrous' (McDougall, 1914: 306-7). 'Are these great areas to be reserved for the European or North European stock? or should yellow and brown and black be freely admitted; eventually to form by blending new subraces?' it was for this task which McDougall had argued made psychology invaluable to establish 'exact knowledge of mental endowment and heredity' (McDougall, 1914: 307). His comments serve to highlight how eugenic ideas began develop into a more familiar conception of race. McDougall did not just create a separation between the genetically fit and unfit, but also expanded eugenics to study various 'subraces'.

A system for objectively testing general intelligence described by McDougall (1914) had been developed by one of his students, Cyril Burt (1909). Burt had conducted his tests on two groups of schoolchildren, he used their results to conclude that the superior performance of students with higher social status was genetic (Burt, 1909). Burt had a significant influence on the development of eugenics within English education, he was appointed as an 'educational psychologist' to the London County Council in 1913 where he worked until 1932 to become professor of Psychology at University College London (Chitty, 2007: 68). Chitty's (2007) history of eugenics shows how Burt contributed to the 1938 Spens Report on Secondary Education published just after the Second World War began which provided the blue prints for The 1944 Education Act (also known as the Butler Act) that extended compulsory state education to secondary school. Entry to secondary schools were determined by a selection test called the eleven-plus exam which was administered during the final year of primary schooling (so called because it was taken at the age of eleven). Children were assigned to a tripartite system of state secondary

schools that consisted of grammar schools for the 'able,' technical schools for vocational education (like previous attempts at the technical instruction for the working classes, these schools never materialised) and secondary moderns for everyone else (Chitty, 2007). Through the system of selection, eugenics were operationalised as a form of governmental rationality the concept of intelligence allowed eugenics to dispose of its earlier associations with race.

Although the appeal of eugenic theories appeared to recede after the Second World War, some of the key figures in the post-war establishment of the welfare state such as William Beveridge and Richard Titmuss were members of the British Eugenics Society (Hanson, 2008). Between the late 1950s and 1970s, the politics of selection came under scrutiny as protest began to rise from increasing numbers of middle class parents found their children rejected from grammar schools. A growing shift in public mood was reflected in the 1967 Plowden Report into primary school education, which argued influentially in its opening pages that '[at] the heart of the educational process lies the child' (Department for Education and Science, 1967: 7). In a fatal blow to intelligence testing, the report argued that 'the notion of the constancy of I.Q. is biologically self-exploding as well as educationally explosive' (Department for Education and Science, 1967: 20). An alternative model of comprehensive secondary education began to emerge during this period that led to the abolishment of selection in most areas and the creation of schools where all pupils were admitted, but could be streamed by ability within classes. Benn (2004: 23) has argued that comprehensive schooling was introduced at a time of 'profound if flawed idealism about the potential of human beings, political structures and collective action.'

Contrary to the claims that intelligence testing was a negative form of power, Hunter (1994) argues that towards the end the of the nineteenth century, the development of intelligence testing provided a scientific means through which a singular state education system incorporating older schools systems and became a means through which people entered and trained for employment in occupational hierarchies. These statistical surveys did not just represent reality, but they helped to intervene in it by quantifying and problematising the domain of equality as an

area of governmental concern. He argues that early educational surveys 'presented the challenge of achieving an optimal social and economic training of under-utilised sectors of the population, and of overcoming the social barriers standing in the way' (Hunter, 1994: 110). For Hunter, the rise of comprehensive schooling during 1940s could attributed to the success of state schooling in producing a population that could join the elites. He argues that new statistical surveys could draw in the students of public and state schools into a single filed of administrative calculation. This made uneven social trajectories between classes visible and problematised this divergence as 'social wastage'—a shortfall in efficient social training of the population.

Hunter (1994: 119) argues that intelligence testing provided a technical means through which the distribution of abilities within a population could be quantified and the formation of ability made into an 'object of expert-administrative intervention and knowledge'. For Hunter (1994: 118), intelligence testing was able to arise because state schooling had 'enclosed all children in a uniform pedagogical environment, and subjected them to a common regime of observation, normalisation, testing and ranking, that differences in educational ability could emerge as an object for statistical measurement and political concern'. Note the emphasis that Hunter (1994) places on milieu, he argues that the concept of intelligence was used by bureaucratic intellectuals as an environmentally specific, it measures differences in social environments where defined abilities were formed and intervened, rather than measuring innate capacities. Hunter claims that this development was crucial to the formation of comprehensive schools as it could demonstrate the failure of the tripartite system and provide an alternative comprehensive pedagogy that could draw on students from a mixture of social backgrounds. Contrary to claims that comprehensive education arose a response to working class demands or egalitarian reform, but as a bureaucratic innovation that problematised the practices of selection as a socially wasteful 'talent reserve'.

Although selection tests began to fall out of fashion, a new form of continuous testing inside comprehensive schools evolved to find and cater for 'gifted' children within schools. The concept of 'gifted children' had the advantage that eugenic

ideas could work within the rationality of the comprehensive school system without the need the expensive process of mass testing. It could also claim to be free from the bias of gender, race and class, the very codes that selection tests were accused of propagating. Burt (1959) had advocated for a similar mechanism in an article defending the selection system. He argued that 'it is in the interests of the nation as a whole' that the 'cleverest of the clever' should be identified and that attempts to identify the gifted should not be limited to one test, but 'begin at the earliest possible age…and should be continued throughout school life' (Burt, 1959: 177). 'Giftedness' implied more intensified of mechanisms replacing the selection tests that were used for entry into grammar schools. Instead of a single test at the age of eleven, mechanisms for finding giftedness made use of tests results to divide students within schools by ability. These made continuous use of tests that were lower in cost, and could claim to be more accurate as a greater number was used t calcite them. Benn (1982) argues that during the 1970s, the idea of 'gifted' children being left behind was so readily accepted because it was easy to believe that there are some children possess extraordinary talent who deserved greater attention from teachers than other students. The search for 'giftedness' inverses the eugenic concept of ability that was so central to selection tests of grammar schools. The 'gifted' were not a pathological category to be eliminated, but individuals whose capabilities needed to be productively developed. Benn (1982) argues that the concept is predicated on a form of guilt: comprehensive schools—whilst suitable for the vast majority of students—would let down the exceptionally talented students who needed to be found and catered for.

During the 1970s, the comprehensive movement faced stiff opposition in a series of pamphlets published between 1969 and 1977 known as The Black Papers on Education (Cox and Dyson, 1971). A range of academics and literary figures had articulated dissatisfaction with the comprehensive reform which they claimed had led to a decline in standards and called for a return to a selective education system. Although their academic arguments were widely criticised, they had a significant political influence on education policy (Jones, 2014: 95). Burt (1971) was among one of the contributors to the Black Papers. In an article titled The Mental Differences Between Children, Burt (1971: 47) reiterated his support for Galton's theor-

ies of inherited mental differences between individuals and argued for the continued use of intelligence tests. In the passage below, Burt picks up on the positive eugenic theme of giftedness:

> One type of segregation evokes hardly any criticism, namely, the provision of separate schools or classes for the physically handicapped and the mentally or educationally subnormal...On the other hand, the criticism most frequently urged by outside observers (and occasionally by the teachers themselves) is the scant provision for children of high ability. The types of pupils who seem to be nearly always overlooked are what have been termed the 'exceptionally gifted'—those whole Galton had described as 'potential geniuses'. (Burt, 1971: 56)

The concept of giftedness had captured the public attention of eugenic ideas that began with the work of McDougall on general intelligence. The concept relies on the idea that any student in possession of the trait of being 'gifted' justified the intervention of new mechanisms for detecting and developing their abilities. Shortly after Burt's death in 1971, it emerged that he had falsified much of his research and fabricated data to fit his own views about genetic heredity (Kamin, 1974; Chitty, 2007: 108). However, the discrediting of his research was not enough to stem a rapid shift in public opinion towards more formal methods of schooling. This was catalysed by the frequency of 'horror stories' in newspapers about conditions in classrooms, especially a series of disputes between managers and teachers at the William Tyndale junior school in Islington that had turned into a national controversy (Ellis *et. al*, 1976). Between 1974 and 1975, a public controversy erupted over child-centred learning methods used at Tyndale after a temporary part-time teacher publicly criticised the methods used at the school for 'neglecting educational basics' (Davis, 2002), and was a contributor to one of the Black Papers. This subject became part of a long and drawn out argument over accountability and control of schools which saw the dismissal of the Head teacher and five other teachers. The resulting public inquiry offered the template for future state interventions in schools. This became emblematic of the 'institutional crisis' that framed future discourse about schools an triggers the growing influence of conservatism within educational policies (Ball and Troyna, 1989).

In the background of these debates were the economic crises of the 1970s. Like a hundred years earlier, economic crises were used to frame the role of education as the transfer of prescribed knowledge and skills required for competing in a society based on market principles and competition. Chitty (2009) argues that the blame for rising youth unemployment was placed on the education system rather than the economy. The Confederation of British Industry called for the introduction of vocational training in schools for the 'less able,' John Methven, its Director General lamented in an article contributed to the Times Educational Supplement in October 1976 that 'It is a sad fact that, after one of the longest periods of compulsory education in Europe, many young people seem ill-equipped for almost any kind of employment and woefully ignorant of about the basic economic facts of life in Britain' (Methven cited in Chitty, 2009: 35). These sentiments were mirrored in a speech by by Labour Prime Minister James Callaghan at Ruskin College, Oxford on 18 October 1976, which began what was called 'the great debate' on education.

Callaghan (1976) argued that school leavers 'sometimes do not have the basic tools to do the job that is required.' In the speech Callaghan took aim at progressive teaching methods that he claimed spent too much time on academic subjects rather than practical needs of the industry. More importantly, his speech once again framed education as means of fix the economy, and argued that it was not just teachers and educational practitioners who had a say in school curriculum, but also members of industry (Callaghan, 1976). This debate would reframe education to deliver economic rather than social goals, and it was taken up with alacrity by Thatcher's Conservative government in 1979. Her ideas for education were modelled on some of the ideas put forward by the Black Papers included the abolishment of obligations of Local Education Authorities to pursue comprehensive education policies (Whitty, 2008). I turn my attention in the next section to the Education Reform Act of 1988, which bought together these ideas in a concrete form during Thatcher's last term as Prime Minister which adopting market mechanism as a rationality for the government of education.

The Marketisation of Education

The 'great debate' prompted by Callaghan's speech at Ruskin College resulted in successive governments shifting power towards increased centralisation and state involvement in the classroom. After 1979, educational policies were directed towards extending parental choice in market of competing schools rather than bureaucratic allocation by the Local Education Authorities. During this period, there was increasing hostility towards teaching unions and child-centred approaches to teaching. This period was marked by the introduction of market mechanisms and a greater diversity of schools and funding mechanisms that devolved power away from Local Education Authorities towards central government. Whitty (2008) argues that although educationally policy from the Thatcher era aimed to make schools more 'receptive' to parental needs, central government did not want to reduce control over outcomes that schools were expected to achieve. The Education Reform Act of 1988 (ERA 1988) introduced the National Curriculum and created some of the biggest changes to English education since the Butler Act of 1944. Based firmly on the principles of neoliberalism, it was part of the introduction of market relations within many aspects of everyday life in Britain. This era of *'roll back'* neoliberalism from the 1980s is characterised by an active programme of cuts in social spending, minimisation of the size of government and the maximisation of competitive forces (see Peck and Tickell, 2002; Peck, 2010). As part of the initial wave of neoliberalism, it prompted substantial transformations to the post-war welfare state which was used to restructure institutions and extend market relations throughout society. The creation of individual freedoms and a 'small' government transformed the relationship between state and citizen. Parents could take the role of informed consumers who were free to choose from a market of education providers using information about their performance from test results and league tables.

New forms of state control in education replaced eugenic ideas of intelligence with forms of knowledge based on labour economics that were developed during the 1960s and 1970s, redefining education as an investment in individual human capital. These theories originated in the work of economists linked to the Uni-

versity of Chicago such as Gary Becker, Theodore Schultz and Jacob Mincer. What made their concept unique was that education was made into a private good whose benefits were primarily enjoyed by its owner. Human capital models operated with the caveat that individuals could only make optimal investments in themselves when they were free to make choices in market for education. These ideas were heavily influenced by the work of Milton Friedman (1955), whose view was that the state should limit its involvement in education to inspecting and setting standards. These changes are characteristic of the development of neoliberalism as a dominant state strategy during that era. Education was no longer an involuntary intervention by the State into the lives of its subjects, but a function of choice made by informed and rational consumers. Its consumers were 'freed' to make decisions about the type of education they could choose from a market. This was also argued encouraged competitive behaviour between schools for optimal performance. Jacob Mincer's (1958: 301) models showed that a more equal distribution of earnings could be achieved if the process by which investments in human capital were made were subject to the free choice of individuals. Mincer (1974) also demonstrated that education had a significant impact on personal earnings, Becker's (1975: 232) seminal work on human capital had also supported these claims by estimating that returns on investments in tertiary education could be between 10 and 12 percent. Shultz (1971) had also linked the technological capabilities of labour with economic growth. He argued that economic growth did not merely result from investment in tools and machinery, but included the 'innate abilities' of labour to employ new 'techniques' (Schultz, 1971: 10-1). This enabled him to argue that capital spent on education and training created the most efficient returns on investment, making education a central tenant of national economic growth. Importantly, these theories demonstrated that individual choices about investments in education made in a market economy would lead to greater economic growth. These theories would help bring together a coherent form and response for some of the issues that had persistent in English education for the previous hundred years.

The early theories of human capital were directed firmly against the subjectifying practices of the state, such as racism. Gary Becker's (1957: 21) doctoral thesis on

the 'economics of discrimination' explored the implications of racial discrimination in the economy. His work was undertaken during the civil rights era in America. Although the critique was not entirely directed at the state, Becker showed that discrimination created social and economic costs. Becker makes the case for using markets as a mechanism for fighting the desire to discriminate. In 1950s Chicago, where the thesis was written, the segregation of African American neighbourhoods was a very visible manifestation of racial discrimination. Becker (1957: 159-160) makes the case for thinking about issues such as segregation, as originating from the self-interested behaviour of people living in places where they felt less discriminated. This allows him to argue that rent paid by African and White Americans were temporary and caused by the 'rapid influx' of migration, which would be 'eliminated a few years after the influx ceased' (Becker, 1957: 79). This argument is based on his belief that discrimination is not rational market behaviour because of the costs incurred from discriminatory practices. His argument shows that the anti-racist role of the state was not based on ensuring rights, but a technical one of allowing participation in a free market.

Foucault (2008) argues that neoliberal economists critiqued classical economic conceptions of labour as a passive factor of production abstracted in macroeconomic terms as man-hours alongside land and capital. Foucault (2008) shows how neoliberal economists were able to better account for economic growth through microeconomic analyses of those who performed labour—their individual capacities, conduct, calculations and ability to utilise available resources. Foucault (2008) argues that this was made possible through the saturation of economic analysis to domains that had previously been non-economic. Human capital theories allowed institutions such as schools and families to be identified as realms that contribute to the development of human capital that help to foster optimal economic behaviour. Becker (1968) for instance, is mentioned by Foucault as beginning to problematise the questions of crime and punishment as forms of economic behaviour that could be managed rationally. Foucault (2008: 31) shows how neoliberalism is able to limit the power of the state by using the market as a site of veridiction. In education, the argument could be made that the sovereign power of the state to subjectify labour could was limited by the introduction of choice—particularly

that of secondary schools—to optimise the returns on investment in human capital. Foucault shows that this is because the subject of neoliberalism is not seen a partner of exchange in a predetermined structure, but an active economic subject whose behaviour is determined by their own calculations of self-interest. As we have seen, these characteristics are particularly evident in the market reforms of education made during the 1980s.

Foucault argues that the theories of human capital resurrected the *homo œconomicus*—the rational, self-interested, economic man from classical economics as an entrepreneur of himself. The neoliberal subject is not a dialectical subject of rights who exchanges his natural freedoms for the voluntary bonds of society, but an individual freed to pursue their own interests through the income generated by their human capital (Foucault, 2008: 273-5). The subject is responsible for producing an optimum return on these investments through competition in the market rather than in exchange for their labour power. Foucault (2008: 230) argues that neoliberal theories conceive of human behaviour in terms of individual enterprise, rather than framing government around the 'immense machines' of the state that individuals did not have control over. In a nod to Deleuze & Guattari (2013), Foucault (2008: 229) argues that the neoliberal subject could be thought of as a machine which produces a a flow of earnings when connected to the economy. Human capital theory allows individuals to be thought of as 'enterprise-units' whose performance is determined by their individual 'capital-abilities' (Foucault, 2008: 225). Human capital, or the set of physical and psychological traits which neoliberal subjects have in their possession, determines this ability to generate capital. Therefore, education can be thought of as an activity that involves the 'strategic programming of individual's activity' that enables them to compete efficiently within the market (Foucault, 2008: 223).

Dean (2014) argues that Foucault preempts the future work of sociologists such as Anthony Giddens and Ulrich Beck who became influential to the 'Third Way' policies of New Labour in the 1990s. Foucault (2008: 231) argues that human capital theories had the positive impact of states reorienting their policies towards investing in human capital rather than physical capital. Foucault (2008: 233) argues

that the 'coefficient of threat,' from neoliberal mechanism comes from their intensification of power that they are able to produce. He argues that this intensification is found the effectiveness of the mechanisms it uses for analysis and its ability to strategically program those processes. In other words, the threat that arises from the concept of human capital originates in its ability to carry out its defined functions efficiently. Foucault frames neoliberalism as a lighter form of power that is more intense than disciplinary power because of its analytical ability to 'program' processes at an individual level. This means that if something like racism persisted in its mechanisms, it would take on a different form without relying on a a concept like race that operated at the level of the population. More concretely, as Harcourt (in Becker *et. al*, 2012: 9) points out, the question is one of exclusion: 'once we all have bought into the notion of human capital, once it is part of our collective imagination, it then produces these policies of growth that involve investing in some populations and not in others'.

ERA 1988 heralded the beginnings of a gradual shift from the state to the market for the operation of schools. Neoliberal reforms were accompanied by an increasingly punitive role for the state, which intensified its mechanisms for conducting inspections and taking actions against schools failing to meet government standards. Democratic control over schools started to decrease as school standards began to be thought of more technocratically. One of the more important changes was that the inspections body for schools OFSTED (The Office for Standards in Education) was made a non-ministerial department separate from government four years later in 1992. Whitty (2008: 169) argues that whilst these processes appear to give schools more autonomy, the overall control of education was intensified by defining the league table outputs required from schools, which enabled parental choice. The choices of parents exerted pressure on schools to act in adherence with 'steering mechanisms' such inspections and assessments whilst the the state retained the ability to govern at a distance.

ERA 1988 promised parents increased competition between schools, freedom of choice, and tougher targets for those aspiring for a 'good' education for their children as defined through norms. In effect, it created a 'market economy' for com-

peting schools which attracted customers for the increased funding attached to students numbers and employed test results as an indicator of institutional position in league tables. League tables became tools for consumers making judgements about schools, and for individuals, test scores become indicators of performance within national and global norms. There are many critiques of policies from this period in the literature which indicate that problems from the past persisted or intensified after these reforms. Ball (1993) has highlighted the preferential treatment of privileged groups at the detriment of others, Gerwirtz *et. al* (1995) have shown that 'parental choice' is often been exercised by those with the resources to choose, which has resulted in market forces which orient schools towards the interests of the privileged (Power et al., 2003). Cutler and Waine (1997) have argued that league tables emphasise hierarchies and exacerbate differences between schools performing above and below national norms. More recently, Hill (2006) has argued that these policies have led to the widening of inequalities based on race within schools both locally and nationally (see also Parsons, 2009; Ball and Troyna, 1989).

Another new introduction by ERA 1988 was the National Curriculum—a centrally prescribed programme of study for primary and secondary students in England, Wales and Northern Ireland which specified the knowledge that could be classified as human capital and had a particular emphasis on the teaching of technology. The National Curriculum faced widespread opposition from the teaching profession because it was seen as a return to the regressive aspects of the Victorian era that placed greater control of education into the hands of the state (Chitty, 2009; Lawton *et. al*, 1988). It increased the subjection of students though the introduction of programmes of study and attainment targets for a number of core and foundation subjects. Targets were assessed using a system of tests for ages 7, 11, 14 and 16, which engendered a climate of constant examinations as opposed to the previous system of public examinations which took place at ages 16 and 18. These reforms were not just a reflection of Britain opening up to a more globalised world, but a new form of capitalism that was increasingly reliant on technology. Information technology began to have a significant impact on many industries and coincided with idea of a broader transition from an industrial economy towards the 'know-

ledge' economy where employment was geared towards the handling and manipulation of information rather than tools and heavy machinery.

Yet again, these reforms emerged with the 1987 financial crisis in the background and held the promise that new forms of technical instruction would allow students to navigate a new economy based on the emerging service industries that required new forms of 'intelligence'. Although computer education in schools was pioneered through programmes such as the BBC Computer Literacy Project using the BBC Micro in the early 1980s (NESTA, 2012), it was the entry of technology as one of the core subjects of the first National Curriculum that would fundamentally shaped a new relationship between education and computers over the course of the next two decades. The National Curriculum was in part an attempt to use schools to impart skills for working with information, and the entrepreneurialism required to create a new breed of 'flexible' workers. The Conservative government of the 1980s were responsible for the privatisation of many state run industries that required the reshaping of the workforce according to the needs of profitability. By the late 1980s, it was widely became widely acknowledged that the future of the economy dependent on the ability of people and organisations to use and apply information rather than machinery and tools.

The subject of technology in the National Curriculum was designed to break down vocational and academic distinctions between subjects (Graham and Tytler, 1993). This rhetoric of breaking boundaries between vocational and academic subjects fits neatly with Thatcher's idea of a nation of individuals with the capability for self-improvement rather than a society based on class and social responsibilities. The development of technical skills acted as a panacea that would mould a new Britain leaving behind its industrial (and class based) past: 'Technology can be the beginning of that revolution as for the first time the thinkers will be forced to make and the makers will be forced to think' (Graham and Tytler, 1993: 53). Duncan Graham, chief executive of the National Curriculum Council, argued that technology 'neatly fell into Conservative philosophy as it had a clear link with industry and could be used to develop entrepreneurial skills in the youngest of children' (Graham in Graham and Tytler, 1993: 54). The first National Curriculum

circular for technology confirms this, revealing that the aims behind the subject were to generate in pupils the awareness of the 'needs of industry and the impact of technological change' (National Curriculum Council, 1989).

The increased prescription of the curriculum, the establishment of hierarchies using league tables and the publishing of examination results to motivate school performance reflect neoliberal ideas about the development human capital and the organisation of the state. Whitty (2008: 169) argues that Conservative politicians had described these mechanisms as an active form of intervention to 'expunge the debilitating effects of welfarism on education in preparation for a fully marketized approach in the future'. The increased government control of schools through mechanisms such as the National Curriculum and subjection to technology were contrary to neoliberal promises of increased freedom, but appeared to be more free from the point of view of the consumer making school choices. However, these reforms were accompanied by an increasingly punitive role for the state that operate within the intensified mechanisms for conducting inspections and taking actions against schools failing to meet government standards. The effect of free choice for the parent was increased control of teachers, and ultimately students. The increased use of subjection in schools through the curriculum and technological instruction preliminarily laid foundations for a more complete mechanism of norms to regulate control over schools.

Neoliberalism in Britain

Although the term neoliberalism is widely used to refer to the centrality of markets in governmental approaches, Larner (2000) has argued that we should pay closer attention to the situatedness and particularity of governmental forms. She argues against the tendency to see neoliberalism as a coherent and monolithic model based on shared ideologies and the replication of similar projects around the world. She argues that top-down interpretations of neoliberalism which see it

as the result of policy initiatives are incapable of explaining why people may choose to act as neoliberal subjects. Comparing the privatisation of government services in the UK and New Zealand, Larner and Walters (2000) have remarked that these projects were pursued not just with the goals of increased economic efficiencies that they promised to deliver, but British narratives of privatisation were also associated with the promotion of a 'popular capitalism'. They show how in the privatisation of British Telecom in 1984, the decision to sell shares publicly rather than to institutional investors was employed to widen share ownership in particular and helping to cultivate a new type of subjectivity of 'the small investor'. They argue that share ownership and market mechanisms were positioned as a superior alternative to public ownership for acting in the public interest. Larner and Walters (2000) argue therefore that share ownership was part of a larger political narrative that encompassed questions of citizenship and identity in Thatcher's Britain.

Larner (2000) argues that more sociological explanations of neoliberalism, such as the those provided by Neo-Marxist authors such as Stuart Hall about Thatcherism, are better able to capture its success in shaping individual subjectivities. She argues that Hall identifies how Thatcherism constituted subject positions, much like that of the small investor discussed above, that made its discourses intelligible to a wide range of groups in Britain. He called for the Left to come to terms with the rise of Thatcherism, ascribing the rise of the New Right to the fracturing of a hegemony based on the social-democratic consensus that began in social and political upheavals of the 1960s. Hall's (1988: 55) analysis was based on his interpretation of Gramsci, rejecting the traditional Marxist conception of ideology, he argued that role of ideology is as an 'educative task' rather than a functional end point. Hall (1988: 43) pointed out that the traditional Marxist position argued that the 'masses' were ideologically duped into 'false consciousness' by Thatcherism against their material interests whilst '[living] through an imposed but "false" structure of illusions'. He argued that whilst dominant ideas had the ability to shape, classify and set the terms of what appeared to be rational, it must be conceived of as a contradictory and contested process of ideological production.

Hall's focus on the mechanisms of ideology leads to an examination of the production and transformation of subjectivities and the production of new subject positions. He argued that Thatcherism had incredible success in constituting 'new subject positions from which its discourses about the world [made] sense' as well as appropriating 'already formed interpellations' (Hall, 1988: 49). However, Hall argued that the influence of Foucault had led to the analysis of discourse overshadowing analysis of ideological formations. Whilst Hall argued that some of Foucault's views—that all social practices exist within the realm of the semiotic and that the production of meaning is not dependent on ideology—are compatible with Gramscian ideas, he argued that it would be a mistake to presume that all social practices are merely discourses. Hall (1988: 53) argued that Foucault has a 'conception of difference' without a 'conception of articulation'. Whilst Hall acknowledges that there is a plurality of discourses surrounding Thatcherism, he attempted to explain why these discourses were able to come together, and stay together, as a contradictory unity. Hall (1988: 53) turned to the Gramscian concept of hegemony to show Thatcherism as a 'struggle to gain ascendancy over a whole social formation'. He argued that various struggles over ethical, cultural, ideological, economic and intellectual dimensions are at the heart of forming authority in a social block.

Hall's (1983) comments about education are more illuminating of the way he began to the understand the struggles that he claimed were at the heart of Thatcherism. Hall (1983) argued that the agenda for Callaghan's 'Great Debate' on education had been framed by the Right. He claimed that the panic over school standards, effects of immigration, the political motivations of teachers and violence in schools were indications that education had been articulated to the Right as a field of struggle. He argued that the terrain of this argument was recreated around a new kind of logic that framed it as a 'non political' debate around which there was a major reconstruction of the state. Hall (1983: 19) argued that this led to a 'recomposition' of state education and the redirection of state resources towards the demands of industry. He argued that there was consent from parents for these plans because they were glad to see their children receive training during a period of uncertainty and scarce jobs in a way that comprehensive education was

not able to deliver. He notes how increased competition is the only logical answer to the debate that had been framed under these terms:

> The shift in educational strategy thus says, in effect, to such parents: you are in the educational subordinate class; the way out is by moving up, through increased educational competition; what counts in this competition is a standard training, acceptable social skills, respect for authority and traditional values and discipline. In the face of the massive failures of social democratic policies on schooling to turn the tide of educational disadvantage, the positive aspirations of working people for the education of their children can be redirected towards the support for a traditional education, programmes of discipline and "relevance to industrial experience". (Hall, 1983: 19)

This is an example of Hall's (1983: 20) argument which shows that the success and effectivity of the Right did not rely on its capacity to 'dupe' members of society, but on its ability to 'address real problems, real and lived experiences, real contradictions' of people represented in these discourses and pull them into alignment with the strategies of the Right. Rather than beliefs, Hall argued that the practices of class struggle itself had changed. There were notable critiques of Hall from the Left, particularly those by Jessop and others in *New Left Review* during the 1980s. Jessop et al. (1984; 1985) argued that Hall had overstated popular support for Thatcherism and offered an alternative account that portrayed it as a state strategy for establishing conditions for sustained capitalist accumulation. Jessop et al. (1984) argued that audience reception of these discourses did not necessarily coincide with the intentions of those sending theses messages. They argued that Hall's approach had the tendency to homogenise the impact and appeal of Thatcherism, without being explaining where these messages had found appeal.

Larner's (2003) own approach more broadly corresponds to the governmentality framework developed by Foucault that emphasises the role of practices. She argues that in this body of work, discourses are not just frameworks representing lived experience or messages by hegemonic or political groups, but constitute 'institutions, practices and identities in contradictory and disjunctive ways' (Larner, 2000: 12). Instead of the state-based explanations provided by Marxist and Neo-Marxist analysis, Larner (2000) argues that the governmentality approach concep-

tualises neoliberalism as a process that involves the production of spaces, states and subjects simultaneously. She argues that neoliberalism is best understood as a process of 'profound experimentation' rather than a 'coherent programme' (Larner, 2003: 512). Importantly for our analysis, she shows how governmentality can inform our understanding of 'parental choice' which neoliberal education policies have been responsible for introducing. Whilst neoliberalism may entail less government, it does not necessarily lead to less governance as evidenced by the extension of network based governance mechanisms in schools documented in this chapter.

Larner (2000) argues that we should pay closer attention to how policy reforms have defined new objects of governance. Not only are companies expected to be competitive, intuitions such as schools as well the pupils that attend them are expected to conform to neoliberal strategies of rule which encourage people to 'see themselves as individualised and active subjects responsible for enhancing their own wellbeing' (Larner, 2000: 13). Instead of government from above, 'the citizen is re-specified as an active agent both able and obliged to exercise autonomous choices' (Larner: 2000: 13). This transformation of the welfare state is also reflected in the decreasing prominence of disciplinary mechanisms and their replacement with what Deleuze (1992) has the mechanisms of control which are dependent on the affordances created by technologies such as computer networks and databases.

The National Grid for Learning

The next major set changes to the English education system came with Tony Blair's New Labour government of 1997. The acceptance that advanced nations were transforming themselves into knowledge economies meant that educational policies focussed on adapting the workforce to rapid advances in computer networking technology and towards emerging high-tech industries. Computer net-

works were central to the transformation of education that New Labour had envisaged for the country in 1997. New Labour's optimistic perspective could be a reflection of the fact that their plans for harnessing new technologies in classrooms were not the result of an economic crash, but the growing influence of the mid 1990s dot-com bubble that promised to revolutionise society. This meant that they were able to talk about the benefits of technology positively as a tool for improving standards in education. In their 1997 election manifesto, *New Labour, New Life for Britain*, the education system was declared as the party's biggest priority and one of the central pillars of Blair's election campaign.

The National Grid for Learning (NGfL) was a flagship project for the newly elected New Labour government. Following Clinton's proposals for a 'National Information Superhighway' for American schools, Blair promised to provide Internet access for all schools alongside an online portal for educational resources. As alluded to by the name, the NGfL was expected to impact on lives as much as the national grid for electric power transmission. Plans for the NGfL were outlined in three reports, the consultation document Connecting the Learning Society; the 'Stevenson Report on Information and Communications Technology in UK Schools' and the 'Excellence in Schools' white paper from the Department for Education and Employment (DfEE) all of which show different perspectives of the Grid that deal with a grand vision for society, the market for education, and the role of technology in questions of government and bureaucratic administration. The analysis of these three papers are the main empirical contributions from this chapter which shows how the introduction of computer networks changed the discourses around schools. It will look at the utopian vision of networked societies, the introduction of non-state actors into education and the intensification of the mechanisms of power that was made possible by the network.

Connecting the Learning Society

The full scope of Blair's ambitions were presented in a consultation paper called 'Connecting the Learning Society' (DfEE, 1997a). It presents a vision for a new

Britain that would be able to realise 'the potential of new technology' through the National Grid for Learning. First announced by Tony Blair at the 1996 Labour Party conference before his election, it formed part of his agenda for Britain's 'age of achievement.' He established the party's focus on education at this conference, famously uttering the mantra: '[a]sk me for my three main priorities for government and I tell you: education, education, education' (MacAskill, 1996: 6-7). Behind these ideas were an abundant optimism for the potential of new technology to transform society. The narrative of the 'learning society' and the 'information age' formed part of the New Labour election strategy that embraced new technology as a form of progressive politics. Selwyn (2008: 708) argues that the 'semantic branding' of 'Information Technology' as 'Information Communication Technology' enabled New Labour to lay claim to what previously been an erratic area of educational spending through various initiatives rather than a central plan for introducing technology in schools.

New Labour portrayed the NGfL as a 'national focus and agenda for harnessing new technologies to raise educational standards, improve quality of life and Britain's international competitiveness' (DfEE, 1997a: 3). Such a technologically deterministic view of the future was well timed, as there was a growing interest in consumer technology fuelled by the increased availability of credit and the growing awareness that many jobs in the future would require proficiency in using computers. The benefits of technology were taken to be self-evident; the consultation document claims that the a previous study by the Education Departments' Superhighways Initiative (EDSI) showed that computers improved subject learning, vocational training, motivation and attitude to learning, independent learning and research skills, social development and the development of network literacy (DfEE, 1997a: 10). It argued that the NGfL network would linked together different learning institutions and training providers such as 'schools, colleges, universities, libraries, adult learning institutions, museums and galleries' into an 'agenda for developing the learning society' (DfEE, 1997a: 4). The report paints a picture of '[making] available to all learners the riches of the world's intellectual, cultural and scientific heritage' as well as 'open[ing] up learning to the individual and taking it beyond the confines of institutional walls' (DfEE, 1997a: 5). It is

worth bearing in mind that the World Wide Web was still in its infancy at this time. These plans were not just simple case of connecting schools to the Internet, as a model of the 'Third Way' its scope extended to establishing the entire range of network infrastructure and content that would be privately developed and funded partially by the state.

Whitty (2008: 171) concludes that New Labour did not deliver a substantially different education policy from the Conservatives, but extended the marketisation and privatisation of schools. The NGfL meant big business for telecommunication companies who were eager for government spending to help establish expensive network infrastructure and considerably increased the involvement of private interests in education (Selwyn, 2000). The report makes clear that government not only welcomed the involvement of private interests, but ensured that they played an essential and continued role in the initiative. In fact, the state required them to provide the content and infrastructure for the NGfL through a system of public/ private partnerships which utilised existing telecommunication infrastructure, much of which was private, to create a marketplace that would enable providers of learning and school administration software to attract schools and teachers. Private interests were lured with the possibility of an even bigger potential market—the home. The report envisaged that the Grid would eventually extend into homes, workplaces and hospitals making it as universally available as any other public utility. Other than the potential for telecommunications companies to profit from creating the infrastructure, content providers were promised a 'well-defined route into the home market' for an implicitly lucrative audience of parents and children (DfEE, 1997a: 22).

In a newspaper article from *The Guardian* reporting a £1 billion announcement for schools, sources from the education department were keen to stress that a 'kitemarking' scheme to certify educational websites were not to be mistaken for government 'seiz[ing] control of information that could be used in the classroom' but a vetting system to prevent students accessing 'unsavoury material' (Carvel, 1998: 7). The scepticism towards state intervention is congruent with the neoliberal political rationality of aiming to govern as little as possible and preferring to use

mechanisms that intervene indirectly. By publishing guidance on 'best-practice,' the consultation document argued that schools would be educated to 'become informed customers and users of the increasingly wide range of powerful net-worked technologies and services' (DfEE, 1997a: 10). Schools and teachers would become 'informed consumers,' not educators, who selected from competing 'managed services' that offered 'comprehensive curricular, training and adminis-trative facilities' (DfEE, 1997a: 7). What pervaded this logic was an economic ar-gument that the rationality of the market and competition would provide the most efficient content for the Grid given that schools were given the freedom, and the ability to choose from competing options.

On a broader level, New Labour also introduced an agenda of what Peters (2001) calls an enterprise culture and enterprise education in schools which adopted management theory for the administration of schools, and classrooms for teaching and 'managing' the behaviour of children. The White paper also indicates how the Grid could be used to link together institutions of welfare and education though its incorporation with the 'Welfare to Work programme' to help retrain people who were unemployed (DfEE, 1997a: 6). The acceptance of neoliberal orthodoxy in economic policy meant that instead of looking for alternatives to Thatcherism, the focus shifted towards managing the outcomes of its earlier contradictions. This distinct shift in governmental logic has been termed the 'roll out' phase of neolib-eralism (Tickell and Peck, 2003). Tickell and Peck (2003: 175) argue that an unques-tioned acceptance of neoliberal logic allowed it to take on a 'diffuse but consolid-ated' form. Tony Blair's 'Third Way' was characterised by the continued intensific-ation of market mechanisms in public services through public-private partner-ships. The blueprint for the significant increase in the number of private interests operating with schools was provided by a document called the Stevenson Report.

The Stevenson Report

The Stevenson Report, called the 'Information and Communications Technology in UK Schools: an independent inquiry', made the extent of private interests in the

NGfL network particularly evident. Dennis Stevenson, then chairman of Pearson, a British publishing company with interests in education, was commissioned by the Labour Party to 'conduct an independent investigation' into the use of computers in schools (DfEE, 1997a: foreword). The Stevenson report included considerable input from the consultancy firm McKinsey and Co. who had published a report at the same time about 'The Future of Information Technology in UK Schools' after their work with the Clinton administration on the National Information Infrastructure (McKinsey & Company, 1997; Stevenson, 1997: 5). The Stevenson Report goes as far as recommending that the McKinsey report be read in parallel. Stevenson's company, Pearson, later developed the Fronter Virtual Learning Environment used throughout schools in the UK and forms some of the best-practices recommended by OFSTED at present.

Technology is portrayed in the Stevenson report as an apolitical force that is independent from politics. Just as eugenic ideas were made about the interests of the race, Stevenson (1997: 5) argues that his recommendations on technology are 'non partisan' and relevant to 'politicians of all persuasions and all those with an interest in the education of young people'. The apolitical framing of technology obscures the technologically deterministic nature of the report's justification for State investment in the Grid. With a lack of evidence to justify a relation between learning and technology, Stevenson (1997: 14) makes the case that 'ICT brings considerable benefits to bear on the learning process.' He argued that 'there is no substitute for Government taking what we describe as a 'common sense act of faith'... It would, after all, be remarkable if school education turned out to be the one area in society where effectiveness and productivity were not dramatically increased by the application of ICT!' (Stevenson, 1997: 14). The role of ICT was framed in the report as 'serv[ing] education: in particular by helping students to learn more effectively and by helping teachers to do their professional job' (Stevenson, 1997: 15). Stevenson recommended that schools (and teachers) be given the freedom to choose products that were suitable for their own needs which allowed the free functioning of a market.

Stevenson (1997: 21) argued that the state trying to establish standards in technology would only 'impede rather than facilitate progress.' because domestic standards would 'prevent the UK benefiting from being part of a global industry.' Implicitly at least, Stevenson was making a reference to Acorn Computers whose computers systems were dominant in British schools at the time. The promise being offered is that embracing global standards, such as the IBM PC and TCP/IP would help prepare students for competition in a global market. Stephenson (1977: 8) argued that government should 'stimulate' the development of educational software in the UK and allow the market to operate rather than define what should be produced. He warned that initial funding of software may result in some 'inevitable' failures, but the 'virtual marketplace' would guide the development of software and allow 'teachers and others' to 'adapt and contribute collectively to the development of software packages' (Stevenson, 1997: 8).

Stevenson's (1997: 15) assertion that ICT is not the 'property of a particular educational philosophy' warded off questions about implicit values present in the technology, professional deskilling and the underlying basis of claims that technology increased teacher productivity (Arnold, 1996; Bigum, 1997). Stevenson retorts to the familiar position of focussing on how technology should be used rather than justifying why such large investments should be made in the first place: 'The role of ICT should be used in the service of the curriculum, and made available to help teachers to manage the learning process, however that is defined by them' (Stevenson, 1997: 15). According to Bigum (1997), the social framing of computers as 'tools' in service of education overplays the role of its application and excludes a discussion about learning methods that do not rely on technology. Although there was little evidence to support the pedagogical claims made by Stevenson, its more significant function can be found in the new forms of that management networked technologies afforded to central government.

Excellence in Schools

In a speech given by Tony Blair before he became Prime Minister at Ruskin College, Oxford on 16 December 1996 to commemorate the twentieth anniversary of James Callaghan's speech, Blair argued for the extension of accountability mechanisms in education:

> A new Labour government will focus on standards, especially in the basics of literacy and numeracy, in all our schools. We will expect education - and other public services - to be held accountable for their performance; we will urge teachers to work in partnership with parents, business and the community; and we will balance parents' rights with a recognition of their responsibilities. These ideas have one aim—to improve the educational experience, and raise standards of achievement, for the majority of children. (Blair, 1996)

The 'Excellence in Schools' White paper formed the basis of the *Schools Standards and Framework Act* of 1998 (DfEE, 1997b). The intensification of forms of auditing were a crucial, but underplayed aspect in plans for the Grid that formed the basis of Blair's promise to improve standards. The Grid allowed the state intervention in schools to be increased through new forms of surveillance and measurement afforded by networked technologies. These mechanisms extended of managerial control over teachers and students through the use of databases and performance target that relied on the Grid to collect data from schools.

One of the key plans outlined in the report was the adoption of technology for the administration and collection of all data on behalf of OFSTED and the Education Department electronically by the year 2002 (DfEE, 1997b: 24). The DfEE were keen to emulate a culture of managerialism and technological innovations in schools:

> Across many sectors of the economy and many aspects of our lives, the pace of innovation is dramatic. New thinking about leadership and management, operational research, new uses if ICT and the ever-increasing pressure for high quality have led to a transformation in many knowledge-based industries. Teaching and learning should not be exempt from this revolution. (DfEE, 1997b: 43)

Their ultimate aim was that in ten years, computers would have 'permeated every aspect of education' (DfEE, 1997b: 41) with the network playing a crucial role of extending its managerial control. A large part of New Labour's push for school standards have revolved around increasing rates of literacy and numeracy through a system of target setting and performance monitoring. The extension of tracking pupil level data across schools and LEAs along with a baseline assessment at age five is outlined in the Excellence in Schools White Paper, which that argues this could be used to measure and assess students throughout their academic career and compared with other groups and individuals. This increase in data collection was accompanied by the subsequent publishing of 'performance data' of schools made available to parents and LEAs which the DfEE argues 'acts as a spur to improve performance' (DfEE, 1997b: 25). The DfEE's rationale behind the increase in surveillance was that 'low performance in schools' were the result of 'low expectations [which] allowed poor quality teaching to continue' (DfEE, 1997b: 25).

Donald (1992: 151) argues that forms of audit are neither empowering nor oppressing because it 'entails both the institution of structures of cultural authority, and their negotiation'. He argues that by framing the concept in this form, it raises a different set of questions surrounding its benefits to the social good, the nature of its social practices, how and what problems it attempts to solve and the outcomes it is able to generate. Donald (1992: 151) shows how concepts such as emancipation and empowerment are unstable categories for 'assessing the purposes and outcomes of literacy' because they are often used to set the terms of subjection itself. As argued in the literature review, qualities such as autonomy and reciprocity or capacities for self-management and self-reflection are the very categories of behaviour that governmental mechanisms seek to develop (Donald, 1992; Hunter, 1994). These arguments present us with some problems if we are to use categories like empowerment or emancipation to critique these mechanisms.

The target setting and performance management systems introduced by New Labour can however be understood as technologically mediated forms of audit. Power (1997) argues that the general idea behind audit is to open up organisations to independent and external scrutiny, creating increased opportunities for their

control by authorities or 'stakeholders' who have 'legitimate' rights over these organisations. He argues that auditing is primarily a way to produce 'comfort,' comprised not just of technical tasks, but also existing as a 'programmatic idea' that is circulated in organisations which 'promises a certain style of control and organisational transparency' (Power, 1997: 122). Audit in this case can be compared with the surveillance mechanisms which are used to encourage forms of self-discipline. Power (1997) argues that surveillance is geared towards control rather than forms of evaluation emphasised by audits. He argues that one reason why surveillance evokes negative reactions where audit does not is because the former takes the individual as its object, whilst the latter tends to focus on the organisation as a whole.

Surveillance is what Power (1997: 128) calls a form of 'first order control' that operates directly on individuals, but audit is a form of 'second and third order control' that targets first order control mechanism indirectly. Power (1997) argues that audit forms a mechanism that verify the effectiveness of surveillance and teaching mechanisms within schools. In schools for instance, the NPD forms a process of audit that could verify the operation of surveillance and security mechanisms within schools. Power (1997) identifies a spectrum between coercive individual practices that make up surveillance on one end and a softer more consensual and negotiated style of audit at the other end. However, he argues that audit mechanisms also contain the possibility that they institutionalise practices taking the form of 'observation of other observation practices' (Power, 1997: 129). The key question this raises is how practices of inspection are institutionalised in practices.

Moss (2002) argues that target setting and performance management systems have had the intensified state control by speeding up the rate at which it has adapted policies to achieve its desired outcomes. The earlier Education Act of 1988 had created a set of standards for education that could be readily compared and monitored across the various education authorities in England. The standardisation of education formed the basis of statistical analyses for predicting and tracking performance over time as an accountability mechanism for teachers and schools. Attempts had been made to develop performance indicators for schools since the

early 1980s. The 'need for pupil level data' was articulated as a critique of previous statistical measures used by Local Authorities such as spending per pupil and examination results (Woodhouse, 1990). Models of multilevel analysis that were being developed began to think about individual student performance in relations to groups of students (Raudenbush, 1988). It began to be argued that that league tables of 'raw data' based on examination grades did not really indicate the performance of the school but only the characteristics of the student intake (Goldstein and Woodhouse, 2000). In other words, it did not measure the 'value' added by the school, but only gave indications of grades being attained by students above a certain threshold. The introduction of the Grid meant that larger amounts of data could be collected electronically for more sophisticated mechanisms that made use of multi-level analysis. The collection of pupil level data was eventually made possible by the introduction of the National Pupil Database (NPD) in 2002 which contains longitudinal data about individual students in England (DfE, 2013).

Selwyn (2002; 2008; Selwyn *et. al*, 2001) has widely critiqued the New Labour 'ICT agenda,' he had pointed out that the £5 billion spent between 1997 and 2007 has created the 'ideological presence' of technology in schools which was intended to transform British education for its place in a 'globally competitive economy' (Selwyn, 2008: 207-8). Despite the claims made by New Labour, Selwyn (2008) argues that technology was used in education to build the knowledge driven economy that they were trying to create rather than for its pedagogic significance. Livingstone (2012) has also disputed the benefits for learning afforded by the use of ICT and the desirability of technologically-mediated relations between students and teachers (also Dreyfus, 2001). Livingstone's review of studies that have looked at the relation between ICT use and student performance was unable to show any compelling evidence which linked the two. She argues that there are are methodological and practical issues related to studying the effectiveness of ICT use in education which obstructs the ability to draw a definitive conclusion. However, she argues that there is a technological determinism attached to ICT in the belief of students, parents and other stakeholders that it inherently leads to improved outcomes in education. However, she argues that ICT has the potential to support learning especially through radical approaches which transform the role of learner

and knowledge using peer learning. The underlying issue Livingstone outlines is that ICT is used in education to further an agenda of 'traditional' outcomes based on scholastic aptitude measurement and testing.

Human Capital, Control and Neoliberalism

Deleuze (1992) addresses the problem of what comes after disciplinary power in the *Postscript on the Societies of Control*. He argues that the state of modern capitalism is an axiomatic system of enslavement that simultaneously employs long-term subjection and high-speed control. This shows that even though capitalism develops an economic order which could operate without the state form, states continue to produce the 'after effects of deterritorialisation' that 'moulds citizens into producers and consumers appropriate for various regimes of capitalist axiomatization' (Holland, 1998: 68-71). Deleuze and Guattari (2004: 505) show that contemporary capitalism functions as an axiomatic system that does not need subjective codes such as race or class to operate. Modern capitalism is able to abandon these codes because they are substituted with operational meanings derived from the systems of control used to regulate populations at an individual level (Holland, 1998: 68). Human capital is thus an axiomatic machine that regulates individuals without the subjective categories required by disciplinary power.

Unlike subjective codes that are relative to the domain in which they operate such as the nation state, axiomatics are diagrams of functional elements where relations can be realised simultaneously in various domains (Deleuze and Guattari, 2004: 501). Foucault's (1977) concept of disciplinary power relies on the subjectification of bodies produced through external objects and institutions such as factories and schools which mould the labour of industrial capital. Institutions are used to optimise life, and are emblematic of the development of the modern state. Deleuze & Guattari (2004: 505) argue that the capitalist axiomatic recreates subjection in a technical form, where human beings are enslaved as 'constituent parts' of cyber-

netic and informational machines. They argue that the cybernetic machines of control have created a 'generalised regime of subjection' (Deleuze and Guattari. 2004: 505-6), where the technical elites have take command of the social body. As we have seen in education, the Grid was simultaneously portrayed as opening up the sites of education as well as being a mechanism that has increased extent of state control over individual children. It has been used to constitute a regime of subjection where long term moulding of the individual is supplemented with the high-tech modulation of the *dividual* reliant on new forms of networked technologies (Deleuze, 1992).

States are, according to Deleuze & Guattari (2004: 504), 'passional living forms in which the qualitative homogeneity and the quantity competition of abstract capital are first realised.' The state translates neoliberal axioms into the various mechanisms appropriate for regulating different parts of the social body. The state performs an act of collective subjectification or subjection as a compensatory reterritorialisation to moderate the deterritorialisation of capitalism (Deleuze and Guattari, 2004: 502). The diagrams of neoliberal axioms do not make reference to intrinsic codes such as race or gender, but it is within the context of the nation-state that processes of subjection or subjectification are found in what Deleuze & Guattari (2004) call the models of realisation.

In theory at least, the ultimate aim of neoliberal education is not inscribed in the form of a code (the disciplined worker), but as a set of affective attributes (such as rivalry, entrepreneurialism, confidence, flexibility, and mobility) which maximise the capital-ability of individuals when they act as entrepreneurs of the self. Many authors have shown that the development of human capital have gone hand in hand with the transformation of racism from a biological to a cultural mechanism. Gershon (2011: 541) for instance has argued that neoliberalism appropriates the anthropological concept of culture, not for explaining relations between people, but as a 'possession, or trait, that engenders alliances.' She argues that neoliberal states are only able to accommodate the claims of minority difference on the basis that minorities 'are willing to treat their culture as a corporation would, as an asset, skill, or commodity' to be marketed to the right buyer (Gershon, 2011: 542).

Pierre Bourdieu has also widely critiqued the concept of human capital for its imprecision. Bourdieu's (2002b: 282) contention is that human capital theory makes the mistake of reducing all investments in education in terms of monetary investments of time or money. He highlights the role that the education system plays in reproducing the social structure though the 'hereditary transmission of cultural capital' and the illusory nature of the meritocracy portrayed by human capital theory. He argues that human capital theory is unable to account for the 'differential chances of profit' that different agents or classes are able to make from their investments because, as it does not take into consideration the domestic transmission of cultural capital which significantly determines social gains from education. Bourdieu (1998: 42-3) has argued that neoliberal axioms of education have legitimated a form of 'social neo-Darwinism' where the 'competent' govern those who are judged to lack competence. He argues that an ideology of competence serves as the 'sociodicy of privilege'—a social justification for an opposition between the competent and the incompetent. This highlights the neoliberal obsession with educational qualifications which leads it to a reiteration of eugenic ideas. These qualifications, he argues are 'not merely a mark of academic distinction; it is perceived as a warrant of natural intelligence, of giftedness' (Bourdieu, 2002a: 33). Hardt (1998) argues that theories of human capital have replaced biological racism with a hierarchy of assimilation based on liberal values of intelligence. He argues that the shift from a biological racism to one based on cultural traits has made it increasingly difficult to identify the operation of racism in contemporary societies. Hardt contends that the end of slavery, the civil rights era and the abolishment of apartheid are evidence of the fact that 'traditional' practices of racism based on racial hierarchies have receded to make way for new forms of racism.

Hardt (1998) draws on Etienne Balibar (1991) to argues that a new form of 'differentialist racism' operates without the need for a biological justification as its foundational support. Differentialist racism can operate without the hierarchies of biological racism that eugenic ideas relied on. Hardt (1998: 145) argues that cultural racism, just as biological racism, continues to act as a theory of social difference that is able to establish an 'equally strong theoretical ground for social separation and segregation.' Pre-existing forms of social separation and hierarchy are given a

new justification that appears to result from a market meritocracy of culture. Balibar (1991) allows us to see that these rationalisations perform two vital functions: one, as an academic justification for domination, and two, as proof which provides the diagram for making social relations visible. Balibar (1991: 19) argues human capital theories articulate the 'visible facts' of 'hidden causes' which justify the domination of others.

Human capital theories have shifted the discourse about schools, but as we have seen it continue to justify a similar tripartite structure of domination that relies on economic rather than biological explanations of social relations. This is particularly evident in the mirroring of eugenic theories of intelligence in more contemporary discourses of ability that we have discussed in education policy. Whist human capital theory discards a racial explanation of social relations, it continues to elaborate an academic justification of difference which allows individuals to identify themselves and the position of others within its hierarchy. The second function of human capital theory is closely related to the first; it fulfils a desire for the immediate knowledge of social relations in order to justify the violence of dominant relationships. As Foucault (2014) has shown, this is the terror of truth governing in the open.

Balibar (1991: 19) shows how academic justifications of domination provide the 'interpretative keys' of what what individuals experience as well as where they *are* in the social structure, it the simultaneous threat *of* violence and the justification *for* violence that perpetuates the system. These rituals of threat and justification takes place through what Hardt (1998: 147) calls the 'everyday practices of subordination.' These practices are more intense than biological racism because of their flexibility and mobility and a ability to operate in various domains. Hardt argues that these practice are capable of creating systems of social separation and hierarchies that are just as brutal as the biological racism which it had replaced. Human capital theory recognises and accepts plurality on the basis that differences it defines are acted on and preserved—in other words, the consequences of cultural differences are accepted and internalised. This function of human capital fulfils what Balibar (1991: 17) has pointed out to be one of the constituent practices of

racism: prophylaxis—the need to purify the social body and to preserve an individual or collective identity from invasion by outsiders.

Conclusion

Chapter four looked at how computer networks have transformed governmental mechanisms used to regulate schools. It reframes existing studies and archival material about the National Curriculum and the National Grid for Learning to look at how governmental rationalities around education have evolved over the past 100 years. This chapter looked at the historical development of governmental rationalities around education and the impact that the growing importance of technology and computer networks has had on national education policy. It began by looking at how the idea of free public education began to be rationalised through ideas of human capital from the 1980s. Foucault (1978, 2004) argues that biopower was the dominant mode of power during this period. Biopower operates simultaneously through an anatomopolitics of the body using discipline, as well as a biopolitics that is directed at the population. Disciplinary techniques were the first to emerge that trained and optimised the body for industrial societies through various forms of observation, judgement and distribution of bodies. These were joined by a form of biopolitics of the species' body that made its vitality a target of power through new forms of measurement such as birth and mortality rates that allowed norms to be discovered in the social body. Deleuze (1992) extends Foucault's argument by stating that the machines in a society correspond to the social forms that generate and use them. His essay asks us to question mechanisms of control that have displaced disciplinary societies. He suggests that since the end of the Second World War, we have witnessed the 'progressive and dispersed installation of a new form of domination' (Deleuze, 1992: 7).

This chapter has discussed how governmental rationalities in English education have evolved over time. We began with a discussion of how eugenic ideas were

rationalised as governmental practices of education first through intelligence testing and later through ideas around ability and giftedness. These mechanisms were contrasted with the introduction of neoliberal forms of using the market to govern schools in the 1980s and the later introduction of the computer network called the National Grid for Learning which governed schools using mechanisms of accountability using the National Pupil Database. These mechanisms raise interesting questions about potential forms of domination that have been enabled by computer networks 'permeating every aspect of education' (DfEE, 1997b). The learning society promised to 'open up learning to the individual and take it beyond the confines of institutional walls' (DfEE, 1997a: 5). As they made clear in their idea of 'life-long learning on the widest possible basis' that this was not just a project for schools, but a new organising principle for the economy and society itself (DfEE, 1997a: 6).

This chapter has illustrated how decentralised networks that originally evaded the state form through nomadic organisation, like the example shown in the previous chapter, began to be used as apparatuses of capture by the state. The chapter ended with a discussion of how the development of these rationalities of government speaks to theories of human capital, race and governmentality. In this chapter we have found that the increasing prevalence of networked technologies in the operation of government has the potential to intensify the power of the state in our day-to-day lives. This is mainly because networks can contribute to the growing intensity of mechanisms of government that have retained their ability to sort, order and create hierarchies. These new forms of networks allow the state to govern at a distance, which is not always obvious as they paradoxically operate through freedoms of choice. In the next chapter we turn our attention to forms of networked government as they are practiced in classrooms and schools.

Networks of Government

The 2005 White Paper, Higher Standards, Better Schools For All, argued that teachers have the ability to 'tailor lessons' to the needs of individual students due to increased resources in schools, 'a reformed schools workforce' and the availability of ICT (DfES, 2005: 9). These technologies also allowed the state to take a 'light touch' approach with 'good' schools, which the Department for Education and Skills argued would be given greater freedoms a lighter inspection regime (DfES, 2005: 10). There are two general axes on which contemporary education is framed: increased individualisation and greater economic efficiency. In the third chapter we discussed the idea that networks could be used to produce freedom and in the previous chapter we talked about networks as a forms of government and their capture as apparatuses of the state. In this chapter, I ask what happens when we look at these technologies from the perspective of schools and teachers. What role does it play in the classroom? What role do they perform in the subjectification of teachers? I do so via information gathered from fieldwork using participant observation at a secondary school in London.

In the first part of this chapter, we will discuss the geographic characteristics of the particular school where the fieldwork was conducted, including the wider socio-economic factors that have a significant impact on the nature of the school and its students. Significantly, we find a school that does not fit with the imagined ideal that these mechanisms are designed to axiomatise. I argue that the population in this school is left 'untamed' in a space governed by the minimal state of totalitarianism. The minimal state makes use of electronic forms of government that increasingly rationalise the exercise of violent means of power that are deductive of life rather than productive. I will discuss the role that technology plays in a Geography classroom and how systems of audit and performance have transformed the role of the teacher to play an increasingly punitive role based on 'coercive' accountability. Finally I will turn to the school library as a model of the future classroom that employs the teacher as a security guard who is in charge of regulating her students. I finish the chapter by looking at the role of play in subverting and challenging mechanisms of control. The chapter is an account of the ethnographic fieldwork I conducted a school in London that is referred to under the pseudonym of Ryedale Secondary in this chapter.

Ryedale Secondary School

Ryedale Secondary is located in the town centre of a relatively prosperous London suburb that was home to a diverse range of ethnic groups. Although the town could not be described as being separated by ethnicity, minority groups were predominantly located in one part of the town. Predominantly, the divide was determined by house prices and access to 'good' schools. The different socio economic groups are quite markedly separated by postcodes within the town. Ryedale Secondary school is maintained by the local authority and has a comprehensive admissions policy for its students. The school was separated only by a few miles from a number of other schools just outside the centre of the town. Ball (2003a: 76) argues that 'class enclaves' are well established in English schools. Ryedale was

not targeted the middle class children who lived in the postcodes outside the main town centre. This was not the kind of school you 'chose' as a consumer. The school catered for the poor, including a small number of white working class children, but it was predominantly the children that were new migrants to this part of London who formed its intake. A large proportion of students in the school were first generation migrants from West African countries, particularly Ghana and Nigeria, and a significant number were also first generation migrants from South Asian countries. The numbers of students who used English as an additional language made up nearly 60% of the school. There were also many children who had been excluded from other schools 'ending up' at Ryedale. During my initial meetings with the head teacher, he was keen to impress on me the school ethos of giving children second chances and a 'space of consistency'. He was rightfully cautious about any unforeseen impact that my research could have on the school. The time during my fieldwork was also a sensitive political climate for schools in England; Michael Gove was Secretary of State for Education, and the performance of schools became significantly politicised. School inspections were increasingly used to threaten schools, and my presence in the school observing the teachers were viewed with a suspicious eye.

Although the school felt segregated, the concept of segregation as a model for understanding social patterns in Britain have been refuted by many studies in quantitative geography. Peach (1996, 2009) suggests that something similar to a 'ghetto' does not exist in Britain; he argues that the use of the term ignores its context in the ghettoes of American cities. Peach (1996) shows that unlike the diverse nature of some British towns and cities, there are distinct areas of American cities like Chicago where African-Americans make up more than 90% of their population (Peach, 1996). Other studies by as Johnston *et al.* (2002), and Finny and Simpson (2009) have challenged the political idea that Britain is becoming racially and ethnically segregated. Dorling and Rees (2003: 1299) argues that the phenomenon is more accurately connected to White 'flight' of self-selecting migration rather than self-selecting migration from within minority groups. Comparing data from the 2001 census with previous three decades, they argue that Britain has undergone a polarisation of incomes, not reflected in official figures of inflation and unem-

ployment because of the introduction of in-work and child related benefits. These factors hide the fact that levels of poverty have returned to levels seen in the 1930s. They suggest that the disparity of incomes and the increasing mobility (particularly in rising rates of car ownership) has contributed to a situation in towns and cities where 'people who can live apart, will live apart,' from the 25% of the population who live in poverty (Dorling and Rees, 2003: 1289).

This is particularly relevant in the town where Ryedale is located. The relics of an industrial past are still dotted around its landscape in the form of disused factories and run down industrial areas that were still operational into the early 1990s. The other major features of the landscape were the empty office buildings located around the town centre that once formed the service industries of call centres and other business services that supported the manufacturing industry in the town. After the 2008 financial crisis, many of the shops in the town centre closed and still remained vacant alongside the largely empty office buildings. It has been argued that the disorder of summer of 2011 was a result of economic and social justice that is prevalent in places like this town, where there was significant damage (Lewis et al., 2011). Problems such as a lack of money and jobs, vilification in the local area and mistreatment by the police are frequently experienced by young people at this school. Due to its location in near the centre of the town, conflicts between the students and the nearby shopping centre they frequent after school have contributed to their negative stereotypes.

The perception of the students as trouble makers is particularly visible from the veiled threats inside a letter from the police to the head teacher during my fieldwork. He had shared the letter via email to the teachers, one of whom gave me a copy. The teacher had taken offence to the letter as they felt they were being asked to do the job of the police. A copy of the letter is reproduced in appendix 1. The letter asked teachers to warn the students that 'policing operations' in the town would stay consistent over the summer despite the London Olympics and that 'significant lessons' had been learnt from the disorders the pervious year. The letter claimed that it had resulted in changes to policing 'tactics' that had a 'force mobilisation plan' with an additional 1750 officers trained in 'public order policing'.

The representation of large numbers in a militaristic language serves to emphasise the threat that the police were making to the students of the school a week before they left for their summer holidays. Even within the school, the presence of security guards, closed circuit television in the corridors and the fingerprint based payment systems for lunch (which is marketed by its makers as an 'anti-bullying' technology, see ParentPay, 2014) added to the sense of violence in the school.

There are some similarities between the riots of 2011 and the unrest between British Asian Muslims and the British National Party in northern mill towns such as Oldham, Burnley and Bradford during the summer of 2001 took place a decade earlier such the marginalisation of groups of young people and diminishing prospects for future employment. Amin (2002b) argues that local context is particularly important for coming to terms with these events in places like Oldham. He attributes the civil unrest to long-term of deprivation caused by the decline of textile manufacturing as mills moved from Britain to the Far East and South Asia. He argues that the disturbances are linked to declining economic opportunities in former industrial towns rather than race or ethnicity alone. However, the young men involved in the disorder were frequently portrayed as an underclass of 'ungrateful immigrants' or members of 'Asian gangs' involved in criminal behaviour (Amin, 2002b: 964). The outsiders who exhibit pathologies and actively chose to not fit in with the rest of society. This is a familiar theme from the 1870s, which I described in the previous chapter—the effects of economic crises are individualised as the pathological behaviour of an underclass who require intervention.

The 2001 riots brought to light the relative deprivation and segregation of ethnic groups in poor areas, as well as growing tensions around Islam after the September 11 attacks in America around a discourse of 'self-segregation' by ethnic and religious communities. This fear of ethnically segregated British Asian Muslim communities were highlighted in influential investigations into the riots, such as the Ouseley Report (2001) and the Home Office (2001) report on *'Building Cohesive Communities'*. The Ouseley report, for which the research was conducted before the unrests began, argued that segregation in schools were a contributing factor to intolerance in the area:

> There are signs that communities are fragmenting along racial, cultural and faith lines. Segregation in schools is one indicator of this trend. Rather than seeing the emergence of a confident multi-cultural District, where people are respectful and have understanding and tolerance for differences, people's attitudes appear to be hardening and intolerance towards differences is growing. (Ouseley, 2001: 6)

Both reports argued for programmes designed towards community cohesion, such as mixed housing and citizenship education in schools. Some evidence suggests that public services, especially schools, are segregated in particular areas where the riots had taken place in 2001 (Burgess et. al, 2005; Burgess and Wilson, 2005). Even in these studies, the authors suggest that the picture is more complex than something solely attributable to race, ethnicity or class. Phllips (2006) refutes the claim of 'parallel lives' and 'self-segregation.' Her interviews with British Muslims in Bradford revealed that these terms were being used to imply that ethnic minorities were choosing to remain insulated from British society. She argues that the terms give the impression that these young people were 'withdrawing from active citizenship, sustaining cultural differences, and choosing not to mix' (Phillips, 2006: 34). She claims that Asian youth in these town have taken the image of the folk devil that had been attached to African-Caribbean youth in the 1980s (Phillips, 2006: 26). Amin (2002b: 978) suggests that the Home Office response to build more cohesive communities is evidence of influence from American literature on 'communitarian values' which aims to erase antagonism between groups rather than seek to resolve conflict by making political compromises. He argues that 'community cohesion' projects are forms of multiculturalism which mask a 'nationalist practice of inclusion' based on Whiteness which is:

> all too well illustrated by the frequent reference to people of a non-White colour purely in terms of their ethnicity, the endless public talk about the rights, obligations, and allegiances of new and settled immigrants, the constant questioning of the Englishness or Britishness of non-Whites—with none of this asked of White Britons. (Amin, 2002: 978)

Bourdieu and Wacquant (1999) have also suggested that widespread use of segregation as a model for understanding urban issues results from export of American universals in academia and policy circles to the rest of the world. Following their

argument, we can see that British discussions about poverty, immigration and segregation are framed by this idea of an underclass. Both Bourdieu and Wacquant (1999), and Amin (2002b) demonstrate the growing influence of practices used for the management of the poor in American ghettoes being adapted for the rest of the world. According to these authors, these techniques are historically and contextually neutralised versions of the originals. Bourdieu and Wacquant (1999) argue that many of these mechanisms repurpose an American notion of the underclass, a behavioural category that is used to represent the characteristics of the most disadvantaged in society. Although these diagrams are presented as a rational mechanism, in the American context, this stands in for the racial category of African-Americans, who are held individually responsible for their inability to achieve the American dream. Resurrecting some ideas from eugenics, the notion of the underclass is a functional group created by the classifying practices of dominant groups which gives scientific legitimacy for the domination of others.

Spaces depicted as ethnic enclaves, or White working class estates are situated in, but not within the context of urban space. According to Flint (2009) 'the camp' serves as a better model for these extraterritorial spaces. It is not just their physical existence as segregated spaces, but as exceptions to the imagined space of the state which justifies them as targets of 'community cohesion' projects. Flint argues that camps exist simultaneously as fixed spatial formations, and as temporary exceptions to 'normal' urban space that are awaiting removal. As such, they are contingent spaces which interfere with the 'natural' order of an apparently coherent urban space. Whilst 'community cohesion' projects are a visible manifestation of capture by the state, they only appear in the 'exceptional' models of realisation where the normal operation of these mechanisms have been destabilised. Deleuze & Guattari's (2004) model of the capitalist state provide us with an additional model for understanding this destabilisation.

Deleuze & Guattari (2004: 517) argue that the social democratic model of capitalism breaks down as a result of exploitation and unequal exchange that is foundational to the axioms of capitalism. They argue that it gives rise to a totalitarian 'minimum' state of capitalism in the spaces of these vacuums. Former industrial

towns which have not successfully transitioned to economic activities that attract financial capital suffer from chronic unemployment and abandonment. Deleuze & Guattari (2004: 518) call these the 'internal Third Worlds' produced by the decline of industrial production in industrialised nations of the West. We have seen over the course of the last few decades in the economy of the centre, like parts of Central London, have become reserved for the post-industrial activities of knowledge workers. Labour intensive production such as manufacturing increasingly is relocated to developing countries where greater profits can be realised. The students at Ryedale are amongst the many young people in London suburbs who have little hope of joining the knowledge workers in the City.

Deleuze & Guattari (2004: 501) argue that the social democratic state operates through the continuous addition of axioms that are made in relation to sources of investment and profit in the domestic market. As well as welfare, these axioms subject labour to the machines of production, circulation and consumption in order to counteract the deterritorialisation of capital. On the other hand, they argue that the 'minimum' state of capitalism operates by subtracting axioms. Whilst these subtraction of axioms lead to a smaller state, it takes on a more intense form that operates through its increased efficiency and saturation in the social field. As the previous chapter has demonstrated, adoption of networked technologies had aided significantly to these new mechanisms of government. They refer to this as a 'totalitarian' state because of its exclusive focus on preparing the domestic market for integration into the global axiomatic of capitalism. The argue that, just like totalitarian states, minimal states are characterised by their rigid segmentarity and their reliance on centralisation (Deleuze and Guattari, 2004: 236). Deleuze & Guattari (2004: 510) argue that the state falls back on a limited number of axioms to regulate dominant flows, whilst other flows are given 'consequential' status or left in 'untamed' states.

Totalitarian states dispense with social democratic axioms of employment, leading to the abandonment of the unemployment to precarious employment or the conditional receipt of social assistance. Deleuze & Guattari (2004: 517) argue that untamed populations frequently appear in the zones of underdevelopment or in the

urban shanty-towns of totalitarian states. The abandonment of these populations have been justified by theories like that of 'endogenous growth' (Romer, 1994), which stipulates that productive human capital is only valuable in the hands of 'able' knowledge workers. As the letter from the police and the discussion about camps makes evident—the subtraction of axioms by the totalitarian state does not preclude its intervention into consequential or untamed populations. It demonstrates that all spaces fluctuate equally between potential poles of technocratic management or brutal servitude. I will demonstrate over the course of this chapter, the purpose of these interventions are not to integrate these populations, but are at best, attempts to select those who are 'intergrateable'.

Technology and the Classroom

The majority of my time at the school was spent working as a teaching assistant for Sonia, who was the Head of Geography at Ryedale. Sonia is an experienced and confident teacher who had been working at the school for the last four years. Her classroom was one of the first departments in the school to have its own ICT Suite. The specially equipped classroom which contained a computer for every student was ahead of its time when it was established by the previous head of department before his retirement. This was his legacy, as Sonia pointed out to me. He was an early pioneer in the school who had a computer in the classroom well before the era of the National Grid for Learning. The ICT suite represented the shifting presence of IT as an activity that took place separately from geography lessons, to playing an intrinsic part of the pedagogy. Owing to its popularity with teachers and students, and the growing presence of ICT in OFSTED guidelines, the facilities in the geography room were quickly replicated around the school. During my fieldwork, every department in the school had at least one classroom with its own ICT suite. This high 'pupil-to-PC' ratio of the school was one of the features that the the head teacher had initially pointed out to me about the school and one of the reasons that he permitted me to conduct fieldwork in the school.
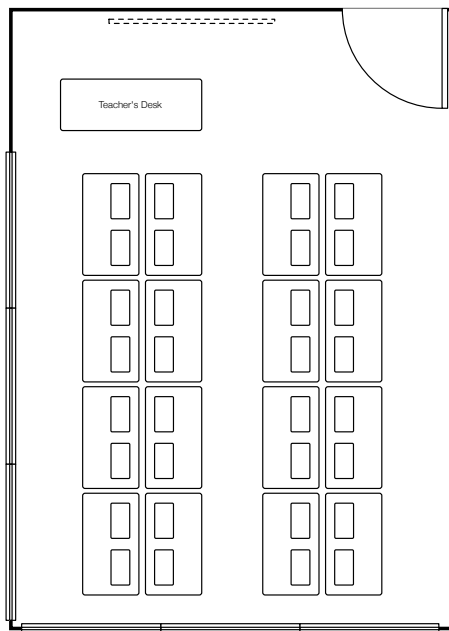
Figure 6.1—Layout of the Geography class-room

Sonia's classroom had a sign at the front which read 'work hard, someone's watching you!' A plan of her classroom is shown in figure 6.1. The teacher's desk is shown on the north-west corner of the classroom in the illustration above. Her table is perpendicular to two rows of tables for the students. In total the class has 32 computers. There were 16 tables, with each table having two computers. The monitors were mounted on a platform that was capable of lowering into the tables when they were not being used. The ability to hide the monitors from view prevented students from being distracted by the computers when they were not being used in the lesson. The computers themselves were large vertically standing towers, fastened near the floor on the inside legs of the tables. Their exposure made made them an easy target for students to vent their frustrations, especially as they were placed so close to their feet. Many of the computers were damaged—11 of the 32 computers in the room refused to turn on. The tables furthest away from the teacher (in the south east corner of figure 6.1) had the most damaged computers. At the front of the classroom was an 'interactive whiteboard' that Sonia used for teaching (illustrated by the dotted lines in figure 6.1). The 'interactive' properties which allowed markers to be used on the projected display had not worked for the past year because it required calibration. As the repair sat on the ICT technicians' ever growing to-do list, Sonia compromised with the regular whiteboard and markers, but continued to use presentations and videos on the projected screen. There were two ICT technicians for over 600 computers in the school; small problems like calibrating the screen had a long waiting time. Many small problems were forgotten about, and many were too expensive for the department to afford—like the 11 broken computers in the classroom. Money for the repairs had to come from the department's own budget. Without much left after buying textbooks and other equipment, it was hard to justify the luxury of an interactive whiteboard. Ultimately, there was only one vital

computer, which was Sonia's own, which she used for teaching and taking the electronic register.

When I asked Sonia about the role of the computers in her lessons, she enthusiastically told me that it was a 'useful tool' for her as to monitor progress as the head of department, and in her lessons to help teach her students. She said that ICT allowed her to to do her job 'efficiently' and that the proficiency of students at 'finding things even the teacher didn't know about' from the Internet contributed a great deal to her lessons. One of the first mistakes she said that she had made was spending a lot of time talking at the class. One solution she used were videos from YouTube. She argued that the videos were also a good way for her to have 'OFSTED-quality' lessons because it fit the short attention spans of her students. She used the videos as a way for her to talk less and the students to learn more. Our early conversations were filled with anxieties about my role in the classroom, I felt like in our early conversations she was telling me what she thought I wanted to hear as a researcher; Sonia was used to being observed in the classroom, I was assigned to her by her manager and I could sense her suspicions. The teacher needs to be seen to be in control of ICT in her lessons.

OFSTED (2011: 46) claims that ICT leads to 'increased staff motivation and improved outcomes for pupils' when it is 'deployed effectively as part of a strategic approach to the improvement and development of the school' that goes beyond the initial purchasing of the equipment. My experience at Ryedale suggests that they would not meet what OFSTED categorises as 'effective' use of ICT, largely because of the number of issues they were having with keeping the computers running once they had been purchased. Computers are both expensive and complicated to keep running as well as being easily susceptible to being damaged. This was readily evident in many of the day to day events of the school. Students were motivated to use the Internet, but mostly to do what *they* wanted rather than what the teacher wanted. Many of the software licences had expired, did not work, or had slowed down to the point of being unusable. Because of the looming costs of their repair, the computers were a source of anxiety rather than motivation in the classroom. One of the major problems was that Sonia did not have the skills to fix

problems with the computers, so these limitations determined how she worked with the computers. Largely this meant that her computer needed to work, because it had replaced the blackboard where she would have written down things for the students to copy into notebook a generation ago. I would argue computers are mostly replicating in this scenario the 'banking' model of education, where students are empty containers that are used to deposit knowledge by the computer (Freire, 1996). I found that Sonia was hesitant to use the computer because of the added problems it created for her to control her class. I will return to these issues later in this chapter.

The school day started at 8:30 am and finished at 3:30 pm. It consists of six 50 minute lessons with a 20 minute morning break and an hour long lunch break during the middle of the day. The ritual of sitting students down, taking the register and turning off the lights in preparation for playing a video were the recurring practices that I witnessed during the course of my fieldwork. During typical lessons, Sonia spent the first ten to fifteen minutes settling the students down and conducting the register as they came in excitably from their previous lessons. The ten minute intervals between lessons were filled with the chaos of running, shouting and fighting as students moved between classrooms. The curtains in the classroom were always drawn across the six large windows in the room so that it was dark enough for the projector to be visible. Once students were seated, Sonia would turn off the lights if she was playing a video unless she was using the whiteboard for a presentation. The typical videos she used lasted between ten to fifteen minutes. Lesson times were used for discussion with students and elaboration of concepts.

I found that the curtains were closed in most of the other classrooms around the school as well as even the rooms without an ICT suite had an interactive whiteboard. This was one of the 'unintended' architectural changes that had taken place with the introduction of interactive whiteboards in classrooms. The control of light formed a powerful disciplinary tool in many of Sonia's lessons. The darkness and the videos produced had a sleep-inducing effect on the students. As the lights are switched off, they slumped in their seats and became docile for its duration.

The darkness was occasionally pierced by anonymous groans, were quickly hushed by other students. Occasionally few of the students would also fall asleep. The videos also gave her an opportunity to multitask or leave the room whilst the students were watching the video. This was invaluable time; Sonia admitted at multiple points during the fieldwork that she lacked sleep, as she stayed up preparing for lessons at home. Most days, Sonia used the last fifteen minutes of the lesson to distribute the textbooks and asked students to copy keywords, diagrams and notes into their workbooks related to the topic. Light was reintroduced into the classrooms from the fluorescent lights as they were given exercises to complete or passages to copy from textbooks. The curtains were often left closed because of the difficulty in opening and closing them. The final ten minutes of the lessons were used to tidy, pack bags and get students out of the classroom in time for the next lesson.

The Electronic Register

One of the things that made Sonia's computer so vital for teaching was that it was used to record data for the pupil tracking system at the beginning of each lesson. The register was taken using SIMS (Schools Information Management System), a database of the students in the school which resembles the Customer Relationship Management databases used in businesses to manage interactions with customers. The SIMS database at the school could record and retrieve a vast range of information about every child in the school. The database contains detailed information about their school life from the moment they enrolled at the school to their current location as registered by the teachers. SIMS could record information such as behaviour notes, photographs, achievements, test results, report cards, linked documents and communication, history, special educational needs records, exclusions, behaviour management, timetables and attendance records. The database is a crucial element of the data collection apparatus used to manage schools and central to the proliferation of management techniques inside schools.

SIMS originally began life as the Bedfordshire School Information Management System, funded by the local council to automate its school administration in 1982. By the late 1980s, the system began to be used to produce the statistical data needed by various departments of government, providing information for school management and assisting in financial control (Barneston, 1988). SIMS was is invaluable to the forms of New Public Management that began to emerge during this period. It was initially developed by a local education authority, but SIMS was controversially bought by Capita Group in 1994 (Johnston, 1999); Capita is heavily involved in government outsourcing many areas. SIMS commands an 80% market share for educational Management Information Systems (MIS) in Britain (Vaughan, 2011).

The description of its contemporary role in a brochure called 'Freedom to Focus' encapsulates how corporate vocabularies has pervaded the world of education (SIMS, 2014a). A quote from the head teacher of a secondary school endorsing the software in is particularly telling: 'SIMS allows us to get on with the core business of teaching and learning. Its pupil performance data means that every child can have support when and where it is most needed' (SIMS, 2014a: 5 emphasis mine). SIMS is a particularly revealing example of how technology has reframed education through the language, materiality and practices of corporations. The brochure argues that SIMS helps improve attendance, reduce bullying, save resources and raise standards through a range of assessments, target-setting and tracking methods. This is concomitant with the rhetoric that target-setting, surveillance and competition borrowed from the business world are an efficient means of rationalising the practices of education.

Figure 6.2—Screenshot of sample student information from SIMS taken from the company website.

The existence of computer networks have been crucial to these governmental practices. The objectives of the original Bedfordshire School Information Management System were to 'create an authority-wide computer-aided administrative system which is integrated…and supported by an electronic communications network' (Barneston, 1988: 17). A national system of this scale would not have been financially feasible during the late 1980s when it was first developed because of the large cost of equipment and the leased lines required to inter-connect various schools and local authorities. The introduction of the National Grid for Learning (NGfL) has allowed it to become part of the data collection mechanism for the newly developed National Pupil Database (NPD) in 2002. The NPD is a longitudinal database of education statistics created in 2002. It is one of the 'richest educa-

tion datasets in the world' (DfE, 2013: 5), holding a wide range of information about students that is used to calculate educational performance.

Data is collected as part of the 'Pupil Level Annual Schools Census' (PLASC) from nursery, primary, secondary and special schools at three points during the school year (January, May and October) (DfE, 2013). Although the NPD and SIMS were developed separately, their functions are closely linked. The NPD is a national scale version of the SIMS database used within the school and contains uniquely identifiable, longitudinal data about students that covers pupil identifiers and characteristics (including personal attributes such as names and ethnicity) and exam results collected throughout the school year. NPD data encompasses the educational history of every student, regardless of movement between schools. This means that data can be analysed to compare one student to any other student or group of students within the entire state-maintained education system in England. NPD data is made available in varying amounts of detail to third parties such as public and private companies for research and for calculating performance management indices. Recent moves by the Department for Education have indicated that access to this data will be 'opened up' for third parties for a range of different applications, including the datasets required for the creation of personalised learning systems that are being developed for education (Deloitte, 2013).

Lying at the heart of managerialism in schools is the idea that competition drives the actors framed within its normative system and determines 'what counts as valuable knowledge, who knows it, and who is empowered to act in what ways as a consequence' (Clarke *et. al*, 2000: 9). Stephen Ball argues that the managers of education are both a subject and means of changing the state who '[rework] the organisational ecology of their organisation' (Ball, 2007: 27). The effect of their influence is evident in the way that Sonia has adopted the discourse of managerialism, describing technology as a 'useful tool' for her job as the head of department or as a teacher to deliver lessons based on a referent of 'OFSTED-quality' lessons in alignment with its requirements. In one of our discussions, Sonia had acknowledged that the data did not necessarily reflect a 'true reality,' arguing that the data was not 'specific' enough about the students. This was a different stance than taken

by Julia, the other Geography teacher in the school. Julia had spent her entire career of 35 years at the school and was about to retire at the end of the school year. Julia was more sceptical of technology than Sonia; she proudly told me that her classroom was the last in the school to have an interactive whiteboard. Julia felt that SIMS had diminished the role of the form tutors. Form tutors were once responsible for taking the morning and afternoon registers on paper before they were computerised. She argued that 'form time' provided a valuable space of 'consistency' for students because it brought them together and gave tutors the change to engage with them. Julia argued that after the introduction of SIMS, form time began to be seen as irrelevant. Although form groups were still used, their function had been largely consigned to a weekly assembly of year groups.

Technology has allowed some of the pastoral roles of the teacher to be downplayed, as the adoption of databases have been encouraged to improve 'standards' through assessments and improve attendance and behaviour by tracking and rewarding individual students. As a brochure from SIMS targeted at head teachers and managers states: these efficiencies are only be realised by 'harnessing your biggest asset'—data (SIMS, 2013). Massey (2013: 4) has argued that the reframing of the vocabulary used to talk about social phenomena as practices of management are underpinned by the idea that 'individual interests are the only reality that matters'. If students fail, it is because they failed to pay attention to their own individual interests—their interests are mitigated by the introduction of systems that detect and create opportunities for intervention. SIMS forms part of an arsenal of detection and intervention that has shifted from looking at broader causes of behaviour and performance towards detecting 'pathological' behaviour in individual students. These vocabularies of neoliberalism reclassify the 'roles, identities and relationships—of people, places and institutions—and the policies which enact them' (Massey, 2013: 5-7). As I have argued in the previous chapter, these discourses are relayed through the 'neutral' agents of neoliberalism (such as the OECD's Programme for International Student Assessment [PISA] rankings) that have a significant influence on governmental mechanisms used in education throughout the world.

Seated in Order

You could ask even the youngest students at Ryedale what grades they expected, or which ability band they belonged to and receive an hour long sermon about their 'progress'. I frequently overheard cries of 'Yes! I got what I was expected,' when test results were handed back in lessons. OFSTED encourages schools to help students understand their education through the frames of assessment and expectations. They argue that assessment improves 'learning and achievement' when students are 'made aware of their current level and what they needed to do to improve' (OFSTED, 2011: 37). This reflects the growing practice of targeting individual students for intervention so that they be brought into alignment with their expectations. In ICT lessons for instance, OFSTED encourages the use of 'comprehensive tracking systems' for the 'development of differentiated teaching plans to meet the needs of individual students' (OFSTED, 2011: 38). The growing use of these mechanisms are motivated by fears that teachers were disproportionally directing their time towards the 'average' student, which OFSTED (2011: 21) argues, leave the students who are 'quick to learn and ready to move on' insufficiently challenged.

Ability grouping became official government policy in 1997 when DfEE (1997b: 38) made the recommendation that 'setting [by ability] should be the norm in secondary schools'. New Labour's return to ability grouping has extended and deepened the contemporary return to 'traditional' aims of education through fixed curricula, testing and the idea that education should be responsive to the needs to the market. There is tremendous pressure on schools to adopt these methods as part of a government policy that focusses on a fear of not doing justice to the 'able' student. The reemergence of a social Darwinism based on performance resonates once again with the alignment of educational attainment with economic needs. A recent report from OFSTED (2013a: 4) began with the words that '[t]oo many of the most able children and young people are underperforming in our non-selective state secondary schools'. The technical language to describe deficiencies in the individual 'performance' of education paints a neutral, depoliticised account of the nature of schools. Part of their recommendation for resolving the

'crisis of under-performing children' relies on monitoring and tracking performance data collected about the students to identify the 'most able.' Whilst no evidence is presented to support these claims, performance tracking is presented as the solution to under-performance when used as a tool which can 'hold staff to account' when students fail to meet targets (OFSTED, 2013a: 26).
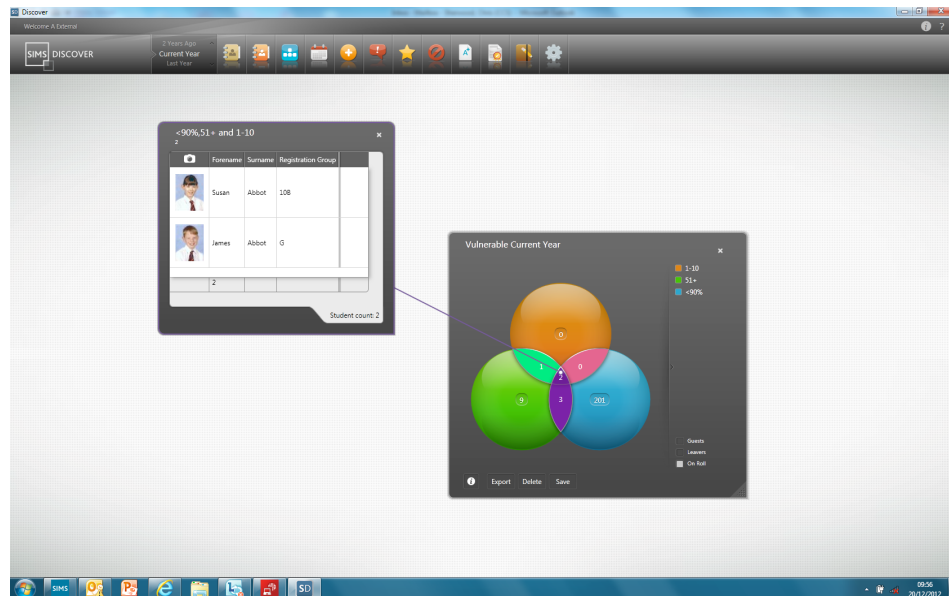

Figure 6.3—Venn diagram from SIMS Discover showing attendance, behaviour and lateness information taken from the company website.

Once again, looking at SIMS give us a better picture of how this mechanism works in practice. The Assessment and Reporting Suite, and the Discover Module in SIMS allows management to track and monitor specific groups of students using the data held in its database. One example on the SIMS website shows a search criteria to identify students with less than 95% attendance, more than 51 behaviour points and more than 6% late attendance. The video describes in length how the software allows the user to 'drill down' into segments and target individual students, inform selected groups of staff by email when students leave and join a specified group. Another case study from the SIMS website captures the state of unease created through the problematisation of individual performance:

> Locally and nationally, Hinchley Wood is a highly successful school, however its results at A /A⋆ GCSE were not as good as those at a nearby school with a similar intake. "We knew we were not supporting our high achievers as much as we could," says Gill. They were also committed to improving the achievement of students on the C/D borderline, who were often not achieving the 5+ A⋆-C at GCSE and missing out on further education (SIMS, 2014)

The familiar 'guilt' of needing to adequately support 'able' students is evident in this quote. This is a theme that I highlighted in the previous chapter with reference to the introduction of comprehensive schools. Contemporary arguments have shifted somewhat towards emphasising the needs of individual students, not just the able, as is evident in the OFSTED inspection criteria:

> Inspection is primarily about evaluating how well *individual pupils* benefit from their school. It is important to test the school's response to *individual needs* by observing how well it helps all pupils to make progress and fulfil their potential. (OFSTED, 2012: 25; emphasis mine)

Ryedale employed a combination of two methods called banding and streaming for grouping by ability. Students were allocated to bands of classes based on test results as they entered the school and separated into two streams consisting of five bands each. Students could be regrouped within classes for separate subjects in each band according to their performance and appraisals from their teachers during the school year. It was difficult for students to move between bands, as they were rarely reclassified. My experience during fieldwork suggests that it was class sizes rather than ability which determined the quality of teaching and learning; smaller classes of lower ability groups had better environments for learning in comparison to larger higher ability classes. Although there is little research to support the contention that ability grouping increases student attainment, there is, as one teacher described to me, a 'religious' adherence to its principles within the school. Previous research as summarised in Ireson and Hallam (1999) found that streaming tends to widen the range of attainment in schools, particularly in favour of those who were determined to possess 'higher attainment' at the detriment of those categorised as 'lower attainment'. They also suggest that ability grouping

produces an adverse effect on self-esteem and alienation amongst students, particularly those placed in 'lower' ability groups.

In Sonia's classroom, I found that the higher ability students tended to be seated near the teacher, and the lower ability students further away. This demonstrates how ability grouping affects the micro-scale arrangement of spaces within the classroom. This was particularly the case in the larger higher ability groups, where this distinction was more apparent. Seating did vary from day to day as students themselves moved around or because disruptive students were moved around by the teacher during lessons. As far as I was aware, it was not the teacher's intention to seat according to ability, but was instead a result of students identified as having low ability also having issues with their behaviour and being moved around to isolate their behaviour. It was rarer in the larger classes for students themselves to move around once an informal seating arrangement emerged.

Students were possessive about where they sat, particularly on tables that had a working computer. As I mentioned earlier, the computers furthest away from the teacher also happened to be the most damaged, and the students who sat at those tables did not do so out of choice. However crude it sounds, there were times—like the Year 8 class after lunch time on Tuesdays—when the whole system seemed to make sense. When more than half the class your class did not want to participate, reverting to disciplinary teaching seems like the only open option. Having the evidence that certain students were 'lower ability' and therefore unable help themselves made it easier to justify the ambivalent feelings I sometimes had for this class. Even if Ryedale adopted mixed ability groups, I would argue that it would have little impact when the proportion of students with various issues were so high. Davies and Evans (1984: 168) claims that core issue lies with a system that is oriented towards 'mastery and failure.' They argue that mixed ability grouping is insufficient to address these difficulties because it only changes the 'surface features' of teaching.

My observations found that lower ability groups disproportionally contained students with special educational needs (supported by a teaching assistant), individual

students with behaviour problems requiring support from extra teaching assistants and those who struggled with using English. Students seated at lower attainment tables participated less and tended to be more disruptive during lessons. I found that the students on the lower ability tables were less confident about explicitly asking me for help. Whilst it could be argued that they were put on those tables because of their behaviour in the first place, students often fulfilled these expectations once they had a reputation for being disruptive.

The concept of 'lower ability' in these school was also undermined by the numbers of students in the school who struggled with English. This is reflected in the disparity between higher levels of attainment in Maths in comparison to other subjects in the school. It was difficult to show evidence of progress in written and verbal communication for grading when the students struggled with literacy. Maths was one of the most coveted subjects in the school as a teacher because they could be more accountable for their work as it did not need written English skills to demonstrate learning. Measures of attainment are imbued with the social contexts which give rise to them, contrary to their claims of objectivity. As Daston and Galison (2010: 197) argue, '[o]bjectivity and subjectivity are as inseparable as concave and convex; one defines the other'. I maintain that these practices do not merely 'represent' attainment, but constitute the subjective position and production of both the student and the teacher.

The Performing Teacher

Ball (2003) calls 'performativity' a set of technologies, cultures and modes of regulation that control precede certain incentives for the performance and display of behaviour. He argues that these performances serve as the measures of productivity, quantity or quality and represent the worth or value of an individual or organisation (Ball, 2003: 216). This perfectly encapsulates the subjectivity of those who are responsible for performing in the mechanisms of control societies. As Ball

(2003: 217-8) points out, the reform agenda of education policies are enacted through the re-forming of relationships and subjectivities produced by changes in interaction and values that change what it means to be a teacher. These cultures encourage the teachers to become 'the instrument[s] of his/her own control' (Watson, 2010:102). I found teachers had limited room for manoeuvre in these mechanisms as they were expected to devote large amounts of resources to these mechanisms. This included both the number of hours required to create evidence for meeting standards and the large amounts of money from departmental budget spent to repair computers or acquire new technology that were required to produce this evidence. As I will describe below, I found that the subjectivity of the teacher is being influenced by these mechanisms though management systems and entrepreneurial behaviour they are required to adopt in order to secure targets and obtain equipment for their classrooms.

My experience trying to fix the computers in Geography classroom serves to illustrate this point. Sonia wanted the Year Ten class to begin the first part of the fieldwork for their GCSE Geography coursework before the end of the school year. but lacked enough working computers for the whole group to work on their coursework in her classroom. The lack of working computers meant that they could not do the first part of their work (research about the sites they were visiting) and write an essay about ecological footprints and sustainability. The majority of information they needed was inside their textbooks, but the students were expected to obtain maps and details about the places they were visiting using the Internet. As there were only eleven computers in the class that worked, Sonia planned on splitting her class into two groups so that I could supervise one half of the group in the classroom whilst she took the others to use the computers in the library. However, the librarian had refused to let Sonia book computers in the library there were few free slots available to book the library at the end of the school year. Having an an ICT suite in her department also meant that she was not on the priority list.

Sonia turned to the head teacher for help and requested repairs for the computers in her class, but was told that repair costs had to come from the department

budget as well as having to wait till the end of the year for the technician. She felt the situation was unfair because there was nothing she could have done to prevent the computers from being vandalised by the students because of the way that the tables were designed. 'When you tell them [the students] they can use the computers it's like giving them sweets,' she said, 'they treat them like toys, I wish they [the technicians] would just take them away, I don't want to be responsible for them any more.' The installation of computers in the classroom came with new responsibilities for the teacher that made her or him accountable for its maintenance. Another teacher had come to visit Sonia, she sympathised with her and explained that she faced the same situation with the broken computers in her own room. As a last resort, we decided to stay behind later than usual that day and see if we could try to move some of the broken computers around as a temporary measure. With a security key from the school's caretaker, we were able to open the tables and moved many of them around and plugged in loose cables so that we had 23 working computers by the evening that day.

One of the main things that stands out from this account is the number of anxieties that technology gave Sonia. The computers were a financial drain on the department budget which could not cover expensive repairs. In the hands of students, there as always the potential danger of being vandalised and the added difficulty of keeping the students 'on task' during lessons that made use of them. After they were fixed, Sonia reminded students on a number of occasions during lessons that she wanted them to stay that way. Over the course of the next two weeks we helped the Year Ten students find and put together their coursework. One of the biggest hurdles was getting the students to focus on the work rather than the myriad other distractions on the Internet during their lessons. Students had various levels of competence with computers; some had computers at home, whilst others used the computer in the geography room during lunchtimes and after school over the two weeks to complete their coursework.

During this time, I spent a lot of time with one student named Ade, who had recently moved to the UK from Ghana. He had a difficult time adapting to the computers and preferred to write in his workbook first and then type into a word pro-

cessor afterwards. Ade struggled because he was slow at typing which made it difficult for him to think about the work he was doing. Sonia was not able to make an exception for Ade to submit his work handwritten because all work coursework had to be uploaded electronically as proof on the Virtual Learning Environment (VLE). Mercieca (2012: 44) argues that performative discourses permit the teacher 'not to get involved in the lives of students' because these structures have diminished the role of the teacher to that of control and checking. We find a similar situation with Ade's coursework; Sonia needed to provide evidence that he had done work on the VLE. Virtual Learning Environments are web-portals which allow students to access the learning materials over the Internet. The adoption of VLEs are strongly encouraged by OFSTED (although not mandated), they claim that VLEs 'enhance' and 'support' learning (OSTED, 2013b). Fronter, the system used in the school is described as a 'learning platform for schools, delivered as a service over the Internet,' which acts as 'a classroom in a digital school building that runs alongside your regular building, creating a world of learning' (Fronter, n.d.). Fronter is owned by Pearson, whose former chairman, Dennis Stephenson, authored the Stephenson Report in 1997 (see previous chapter for a discussion), and is the most widely used VLE in English schools.

When the students were asked to upload their work to the VLE used in the school, we found that none of the students had heard of the system before. Sonia was required to show that coursework was periodically uploaded to the system as a portfolio of evidence for each student to show management and school inspectors the progress they made over time. In theory, its role is to allow students to access learning materials and give them the freedom to work from home. Sonia told me that in practice, these worked primarily as an accountability mechanism for the teachers. If it was alleged that they had cheated by assisting the students excessively with their coursework, the uploads could be used as evidence that the work was indeed carried out by the student. This underlies the importance of getting the computers working before the students could start their work. Sonia was not just responsible for looking after computers, she was a part of the mechanism itself. Her job was to provide evidence that the students had performed their work for the mechanisms of audit which supersede the pedagogical role of technology

in the classroom. The language of 'best practice' and 'personalised learning' that are characteristic of the discourse surrounding VLEs disguise a culture that relies on 'hierarchal relationships and coercive practices,' where 'challenging the terms of reference is not an option' (Shore and Wright, 2000: 62). As I discussed earlier, challenging the terms of reference for Ade was not an option for Sonia, as all coursework had to be completed electronically to be uploaded on the VLE as evidence. These mechanisms of 'visibility and coercive accountability' have created a feeling of distrust within a system that supposedly increases trust in the work of teachers (Shore and Wright, 2000: 77).

Thompson and Cook (2013: 254) argue that the processes of audit have caused the concept of 'good' teaching to change from non-statistical ideas such as understanding and depth of knowledge to one that is understood through data generated by testing students. I found that audit mechanisms have engineered a climate of competition and distrust between teachers, this can be illustrated by the consequences that teachers face when they fail to meet targets. One of the teachers at the school notified by the management that her test scores were inconsistent with the projected scores for this year and was asked to attend a review meeting where she had to present her marking scheme and samples from examinations. The teacher had confided in me that she felt that this had taken place because the targets for their subject was calculated in relation to scores students receive in another subject. The suspected that another teacher had employed a lenient marking scheme that affected the predicted scores of their students. Targets were calculated using a system called the Fisher Family Trust (recently renamed to FFT Aspire), which interprets the data collected by the school and produced individual targets for each student. FFT Data is a contextual value added measure (discussed below) used within schools to predict expected grades for students using longitudinal data about their performance in relation to students who have similar characteristics nationally (Fisher Family Trust, n.d.).

For this teacher, this mechanism was frustrating because of the lack of transparency in how it calculated these grades. Although this data is presented as an estimate of performance, at Ryedale they were translated into management objectives.

Another teacher had explained to me that they were asked to sign an document at the beginning of the year to agree that all of their students will meet the targets calculated by the trust. This incident strained the relationship between the two teachers. This uncertainty appears to be a function of this mechanism, it has been reported that teachers have found FFT data to be 'wildly inaccurate'. In particular, it has been pointed out by teachers that achievement in GCSE English were being used to produce targets for GCSE Drama (Mansell, 2009).

Performance targets for individual teachers and students only highlight one facet of this mechanism that began with the introduction of school league tables. There has been a simultaneous growth in the sophistication of mechanisms that measure the performance of schools. There have been three major phases of development in school performance indicators: threshold indicators, value added, and contextual value added measures. They have not replaced one another, but continue to be used simultaneously for different purposes. The sophistication of these measures reflect the increased recording and production of statistical data after the introduction of the 1988 Education Reform Act. League tables were first introduced in 1992 using threshold performance indicators like the proportion of students receiving five or more A★-C grades for their GCSEs. As in indicator it indicates the performance of the students that go to a school rather than the school as such. Due to its relative simplicity, these 'headline' figures continue to be widely reported and easily understood by parents they wanted to choose a 'good' school. Schools responded to threshold indicators by focussing their attention on students expected to receive borderline grades between C and D because they had the most significant impact on these figures (Wilson, Croxson and Atkinson, 2006).

Figure 6.4—Threshold indicators for a *random* school shown on the *OFSTED School Data Dashboard* Website

In 2002, value added (VA) measures were introduced to account for the performance of schools in relation to the past performance of the student population (or intake)
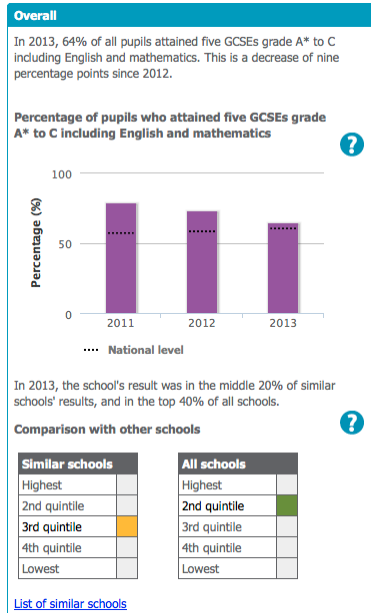
(Kelly and Downey, 2010). VA measures are particularly useful for the management of schools because they include the performance of the school itself. It takes into account the historic performance of the student intake compared against national averages. The increased complexity of this measure was made possible by the introduction of the National Pupil Database (NPD) and the NGfL. Data from the NPD could be used to calculate the 'value' added by the school by adjusting the performance of its intake with their past performance. In a hypothetical area with four 'good' schools and average performing students, this measure could tell how much each individual school contributed to the performance of its students. Although VA measures are intended to dissuade schools from focussing on students expected to achieve borderline grades, questions have been raised about the relevance of using past attainment to predict future progress (Gorard, 2006).

Contextual Value Added (CVA) measures were introduced to league tables in 2008. A system called RAISEOnline was jointly developed by OFSTED and The Department for Education (RAISEOnline, 2010; Mansell, 2006). CVA attempts to find a middle-ground between individual students and school performance by adjusting for the characteristics of individual students using contextual data from the Pupil Level Annual Schools Census. These characteristics include a range of socio-economic and other factors that are known to have an impact on student performance independently of schools. Attributes such as gender, special educational needs, ethnicity, eligibility for free school meals, first language, mobility between schools, age, whether the student has been in social care, and a measure of depravation based on the student's postcode (IDACI-Income Depravation Affecting Children Index) to adjust performance measures. CVA allows comparisons to be made between students with others with the same characteristics (RAISEOnline, 2010). The introduction of CVA measures within league tables were opposed by schools who used to perform well in threshold and VA indicators (Eason, 2006), but found that they had slipped down league tables as the contextual data was used to account for students from disadvantaged backgrounds. CVA figures were removed from school league tables in 2011 after Ministers paradoxically argued that '[it] is morally wrong to have an attainment measure which entrenches low aspirations for children because of their background' (Stewart, 2011).

Although parents have been encouraged to become sophisticated consumers of school performance data, questions still linger over what these measures are actually reflecting. Supporting my observations at Ryedale, a recent study by Gorard et. al (2013) suggests that both VA and CVA measures are unstable because they fluctuate without relation to prior scores. They argue that these measures are ineffective at detecting differences between schools. Their study looked at the variation in VA score over the course of five years and found no clear relationship between initial and eventual VA scores during that period in a large number of schools. They also found that CVA scores lacked consistency; of the 2,897 schools they studied, no school had five years of positive CVA scores. The data supplied for calculating CVA scores were also inconsistent, with some schools missing about 50% of their students from CVA calculations. The data used for CVA is also problematic as some have raised concerns the robustness of using measures such as eligibility for free school meals as a proxy for educational disadvantage (Hobbs and Vignoles, 2010). The proportion of students who were excluded from CVA calculations number about 5% nationally and rises to 11% within London, where there is a a disproportionate number of students from non-white ethnicities who use English as a second language (Leckie, 2007 cited in Kelly and Downey, 2010).

Regardless of its shortcomings, CVA measures continue to be used within schools to gauge teacher effectiveness and determine teacher performance targets as though they are objective measurements of performance. Since September 2013, teacher pay has been linked to performance management measures, a move which the Government had argued, allows schools to 'pay good teachers more' (GOV.UK, 2013). This has been adopted despite the OECD's own contention that there is 'no relationship between average student performance in a country and the use of performance-based pay schemes' whose ranking systems are otherwise used to justify reforms of state education (OECD, 2012: 2). The increased incentives for teachers to cheat or 'game' the system has received substantial attention in behavioural economics recently (Barlevy and Neal, 2012; Fryer et al., 2012; Jacob and Levitt, 2003; Neal et al., 2010).More recent work in this field has intensified the performance pay model using loss aversion mechanisms that pay teachers in advance and demand the return of that money if they fail to meet targets (see Fryer

et al., 2012). As the direction of this research suggests, there are multiple mechanisms developing to ensure submission to the system, transforming the subjectivity of teachers and incorporating them into overarching mechanisms of control.

This trend is an indication of the suppressive mechanisms and environments of insecurity and distrust that these systems engender. Although new managerialism encourages 'reflexivity' it is 'caught within the tightly fixed parameters that appear to render opposition futile' (Shore and Wright, 2000: 78). Teachers are forced to comply with the mandates of what is being audited, allowing little room to question or critique its practices. One unintended outcome is that of schools suspending students expected to perform badly on exams: an academy recently 'weeded out' 14% of its students before they took their GCSEs (Baynes, 2014; see also Mansell, 2014). Thompson and Cook (2013) argue that strategies used by teachers, defined as cheating, are a natural reactions to a system which reflects the logic of databases rather than the morality of teachers. They argue, teachers that 'cheat' are 'not attempting, and failing, to be 'good teachers', rather, they are 'initiating a new practice, as dividuated teachers' (Thompson and Cook, 2013: 134).

The Classroom of the Future

Looking at the role of the librarian gives us an indication of what the role of teachers will look like in the near future. The school's librarian, Lucy had worked at the school for ten years as a librarian and had seen the number of computers in the library multiply from five to twenty-seven during that time. The library had been one of the key sites of change in the school, undergoing a transformation which reflected the new role that information technology played in the school. In many respects, the library is a blueprint for the classroom of the future: a controlled space for students to consume information and become measured. Lucy's
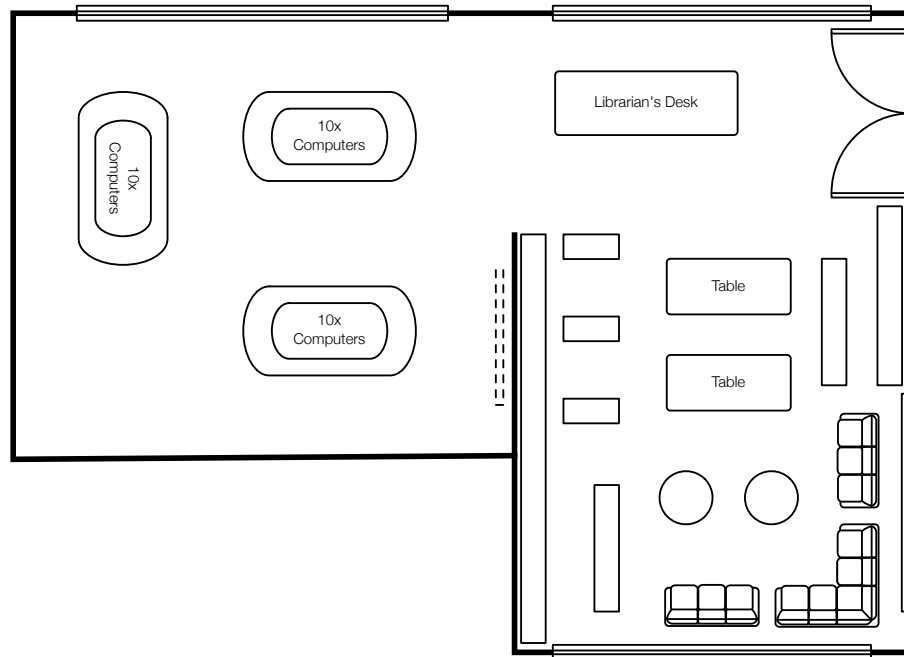
Figure 6.5—Plan of the school library

primary role could be described as being somewhere between an ICT technician and a security guard. One of the most strenuous jobs for Lucy was managing the behaviour of students within the library. Fewer and fewer books were being borrowed from the library as students relied more on the Internet than books for their coursework. The school no longer needed a librarian to direct students to the right books, but a vigilant guard who made sure the students 'behaved' whilst using the computers. Her role was also that of a technician who could put things right when the computers broke down. The librarians' internalisation of this role was reflected in the zealousness with which she ensured that students did not 'play' on the computers in the library.

The library is made up of two interconnected classrooms, its entrance is in the north east corner of the larger room, see figure 6.5. The larger room consisted of a reading area, an issue desk with some tables for quiet study. The main bookshelves were on two of its walls, with rows of tables and chairs located in the middle of

the space. The second room contained thirty computers, arranged on three tables with ten computers each and an interactive whiteboard on one of its walls (indicated by the dotted lines in figure 6.5). The computers retracted electronically into the tables when they were not needed. Unlike the Geography room, the computers were located within the tables, which prevented physical access to the hardware; their isolation inside the desks prevented them from being vandalised. The library was also unlike the Geography room in the sense that all the computers worked. Because computers were in high demand, the librarian could not afford to have any faulty computers as the library also made them available during the school day for other lessons.

Above every table there was a sign that read: 'WARNING: All Internet sites visited are monitored and recorded.' The sign contained a warning about the 'observation software' which was accompanied by a picture of a camera that informed: 'A screen photograph of your activities may be taken for safety, security or evidence purposes.' The use of computers was under strict supervision because it became a social space for students during break times and after school. The librarian took an active role in enforcing the rules that the computers were to be used for doing homework, research and coursework. Lucy was proactive in ensuring that the space was used for work and while keeping the space tidy, she frequently intervened in the space. Whilst it was in use she was typically seated at the issue desk where she could keep an eye on both rooms.

The many activities that took place in the library gave me ample opportunities to observe how technology was being used in different lessons throughout the school. During the school day it also played host to English lessons that used the 'Accelerated Reader' programme for their literacy lessons. Accelerated Reader is a 'reading management program' which assesses the reading ability of students using an electronic questionnaire conducted

Figure 6.6—Alphasmart NEO used to administer reading tests

after they have finished reading a book. The questionnaires were administered using a device called the Alphasmart NEO (see figure 6.6), their performance over time was recorded on a supporting website on the Internet. These tests determined the difficulty levels of the books the students should be reading by using questions based about books they had just finished. The books in the Accelerated Reader section of the school library were specially marked with the colours of the various levels used in the reading management software. The colours on the books reflected yet another form of banding and sorting of students within school. The students were free to choose from a selection of books in the library that corresponded to their reading level.

Lessons using Accelerated Reader frequently used the library, students were sat around a few of the large tables in the reading area of the library with their chosen books and the NEO close to hand. The teacher kept a close watch on the students to ensure that the they were reading, assisted them when they needed help or gave them permission them to leave their desks to collect their next book. The software acts as an accountability mechanism for the teachers to keep track of what their students are reading and provide an accurate measurement of reading ability. Systems such as Accelerated Reader are indicative of the commodification of public sector work. By objectifying the processes of education as a form of production, the 'soft' human elements of teaching can be removed and education can be remade as a 'hard' service that is brought in from external providers (Ball, 2007: 28). As this quote from the Renaissance Learning website illustrates, although education is remade as a 'hard' service, it is presented as a means of returning to a 'softer' teaching of the past:

> Our assessments use computer-adaptive technology and extensive item calibration to give you an accurate window into each student's academic progress. We do this as quickly as possible, and as easily as possible, providing the highest quality data in the least amount of time. So you can get back to teaching as effectively as possible. (Renaissance Learning, n.d.)

There is little empirical research that supports the claim that reading management software improves literacy. Hansen et al. (2009: 71) conclude from a review of re-

search that 'the most important incentives involved in reading management programs may be those provided for the adults, rather than for the students.' They argue that many positive effects arising from the deployment of reading management systems could be attributed to libraries stocking more books and teachers assigning more silent reading and measuring student progress rather than the software itself. These lessons were the biggest users of the library books in the school. Lucy told me that the library was issuing fewer books every year, other than revision guides and books that dealt with issues such as harm. Although Accelerated Reader markets itself as 'creating a culture of reading' (Renaissance Learning, n.d.) it appears that this has not readily translated into reading books outside the framework of these lessons. Reading had become an automated, audited process that students were forced to undertake as an exercise of measurement linked to the performance management of teachers. This technology indicates the future of 'personalised learning,' which makes use of more sophisticated devices, such as tablet computers to access learning materials tailored to individual students based on their data from the National Pupil Database (Deloitte, 2013).

Playing on the Computers

The library computers could be booked by the students during their break times and after school. The main users of the computers were a group of a younger students who regularly socialised in the library during break times and others who used the library occasionally for working. It was a difficult task for Lucy to manage so many students in the library. My own experience with students in Geography lessons served to highlight the difficulty of this job. The students capitalised on computers as a way to turn libraries and classrooms into spaces of play. A distinction between work and play was easier to maintain when the students were working on individual tasks with their books rather than the computers. The introduction of computers made it harder for the teacher to practice didactic teaching methods. Instead of listening to the teacher or reading their books, the computers

gave students the freedom to look around and talk to each other as well as doing work. This task was compounded in Geography lessons because many of the students had greater a mastery over the computers than the teacher. It was frequently evident that the teachers did not control the computers—I witnessed on many occasions Sonia turning to the students to help fix problems with the computer on the interactive whiteboard. Technology often worked against the the teacher establish most in a disciplinary space as an authoritative figure. Students frequently witnessed difficulties teachers had with the computers on the interactive whiteboard and shouted out solutions in the class. Sonia would also fail to turn off the interactive whiteboard from her computer when she was looking at the electronic register or did not want students to see what she was doing. It would be right to argue that from the students' point of view that it was clear that when it came to computers, they were in charge, not the teachers.

Holloway *et. al* (2000: 617) argue that ICT exists in 'highly gendered and sexualised institutional cultures' of schools. Their ethnographic study of ICT use by children in schools found that boys tended to segregate themselves when using computers. They found that boys tended to display a wide range of competence with computers in diverse contexts, especially in relation to a culture of video games. Gaming was a prominent part of my discussion with boys in the school: 'kill-death ratios' and weapons in *Call of Duty*—an online game that allows you to play as a solider who kills other players—were topics frequently used for bonding in the library alongside music and sports. Whilst this particular video game could not be played on the school computers, boys frequently played small games on websites that were available after bypassing the school Internet filters, a topic which I return to in detail later in this section. Holloway *et. al* (2000: 625) found that computers were used by boys in ways that tended to reproduce the hierarchies of masculinity within their groups. I found that across all ages, boys preferred to use the computer as a group activity. Groups of boys could often be witnessed congregating around one computer, showing each other jokes or videos they had found on the Internet. This behaviour was highly discouraged by the librarian, who forced the students to go back to their seats. Computers were used to reinforce their status within the group, as 'jokers' or to reproduce their ideas of masculinity. The older

boys also used music videos as a way of showing off to other boys or impressing girls in the classroom. My findings largely concur with Holloway *et. al* (2000), but I found that many girls were just as interested in using computers as the boys. Without doubt, this can be attributed to the increased prevalence of computers in our daily lives which has made ICT slightly less gender specific. Although they were fewer in number, many girls possessed high levels of technical ability and regularly used the library computers at break times. Unlike the boys, however, I found that most girls remained seated and worked individually on the computers. Their social interactions took place as they spoke across the tables rather than congregating together. I also found that girls were generally less likely to break the rules inside the library. Those who played games tended to stay on the educational games website the school subscribed to rather than risk bypassing the school Internet filters.

A number of mechanisms existed to regulate and discourage playing on the computers, the most important of which was the presence of the librarian whose role was not just to guard the physical space of the library, but also the 'virtual' one. To assist in this task, Lucy had two tools: AB Tutor Control and Netsweeper. AB Tutor Control enabled her to observe and control the activity of all the computers in the library remotely from her desk. I primarily saw this used by the ICT teacher and the librarian; although it was installed on the Geography teacher's computer, the license had expired and was not a tool I had seen Sonia use. Lucy used the tool to look at a live screenshot of every computer and username in the library. The software arranges these images in a grid, like CCTV images. She would often announce to the room when she observed 'infringing' activity and reminded the students that they were 'being monitored.' AB Tutor Control produces an intensified form of disciplinary power that gives teachers the capability to to view and even control computers in the classroom, control network access, and monitor the computer for keywords. The software is able to monitor the student keyboard for keywords such as 'facebook' which triggers an alert on the teacher's computer. This is symptomatic of societies of control, and one of the more extreme examples of intensified disciplinary mechanisms. Although the librarian was visibly the authority in power, the computers were also monitored by the ICT technicians

remotely and I observed multiple occasions where computer accounts were frozen for infringements by the students. The teachers did not know why accounts were blocked; the students had to visit the technicians to have the account reenabled.

The second tool, Netsweeper, worked in the background of the network to monitor the network behaviour of students and restrict access to certain websites without intervention from Lucy. Netsweeper is a centrally managed internet filtering service run by the London Grid for Learning, a (privatised) remnant of the National Grid for Learning which provides the internet access for schools in London. Netsweeper is a Canadian company that developed internet content filtering software to filter or manage internet access to networks. Filtering is used to primarily prevent students from accessing harmful content such as pornography, as well as social networking, online gaming and proxy websites which students used to bypass the filter. Using the Internet filtered by Netsweeper could be a frustrating experience. I witnessed many occasions where websites would be randomly filtered for both students and teachers. Pages that worked one minute could fail to work the next. As Netsweeper was administered centrally by the Internet Service Provider, there was little that teacher or students could do against incorrectly filtered websites. There was an option of contacting the local system administrator to allow access to websites that were filtered by mistake, but I did not witness this happen in practice. When websites were blocked, both students and teachers would move on and try another website, or find ways around the filters. One frequent occurrence was that videos from YouTube would intermittently become blocked and display an 'access denied' message, but often start working again if the page was reloaded a few times.

Netsweeper is part of a global mechanism that resembles what Deleuze (1992) called the machine of 'high-speed control'. It learns and adapts rapidly to capture the slightest shifts in behaviour globally. Netsweeper's database categorises data available on the Internet into categories that are used by systems administrators to block particular types of content, such as games and pornography (Dalek et al., 2013). Attempts to access blocked content are recorded by the system, Netsweeper

claims that their central database contains over 5 billion addresses, growing and adapting to the behaviour of its end users:

> Our cloud-based AIs scan and categorize new web content based on the usage patterns of Netsweeper users worldwide. This translates into 10 to 15 million new URIs categorized and added to our Master Category Name Servers every day. When you factor in the activity across all Netsweeper deployments, including both allowed and blocked content, Netsweeper servers are processing about a million URIs every second. (Netsweeper, n.d.)

According to Netsweeper, its filtering service is used by one in three schools in the UK (Netsweeper, 2014). Research has shown that Netsweeper is also used in a wide range of countries, particularly in the Middle East, to filter their internet access at a national level (ONI, 2011). Dalek *et. al* (2013) found that Netsweeper was used nationally in Qatar, Yemen and the United Arab Emirates. Their methodology found that filters were 'used to block a wide variety of content, including oppositional and critical political content, non-pornographic gay and lesbian content, human rights content, independent media, as well as content relating to minority groups and religious discussion' (Dalek *et. al*, 2013: 5). The term 'vertical portability' (ONI, 2011) has been used to describe the rescaling of technology designed for local filtering for larger applications such as mass filtering or 'state-sanctioned censorship' (ONI, 2011:2). Other commercial filtering software such as Blue Coat, McAfee SmartFilter and Websense are also widely used within both small and large networks. This means that 30% of data captured about the online behaviour of students from the UK contributes towards a mechanism that operates within a global network of control.

There was also vertical portability between tools used to bypass filters in totalitarian regimes and tools students used to get around the school network. Knowing about my work, the head teacher warned me about a piece of software that the students used to get around the filters on the first day I started my research. 'They have their ways around these filters,' he said 'even though we try to stop them.' This tool was *UltraSurf*, a well known secret in the school that allowed the students to easily bypass the school filters. This small application is widely distributed on

the Internet and available from a web search that was not blocked by Netsweeper. UltraSurf was originally developed for users in Mainland China, and has been linked to the Falun Gong movement (Beiser, 2010; Ball, 2012). The help page from the UltraSurf software describes itself as 'anti-censorship, pro-privacy software':

> Ultrareach Internet Corp., was founded in 2001 by a small group of Silicon Valley engineers dedicated to the promotion of the free exchange of information. In 2002, we launched Ultrasurf, one of the world's most popular anti-censorship, pro-privacy software. Ultrasurf enables internet users to protect their security and anonymity online while bypassing internet censorship, and is free to users.

When the program was running on the computer, it allowed the students to by-pass Netsweeper, making it possible to access online games or social networking websites. In practice, it meant that Netsweeper had a greater impact on the behaviour of teachers who were restricted by the filters rather than students. The use of the tool was not restricted by technical ability or gender of the students, it was a fact of life on the network in the school. UltraSurf was indispensable for some of their work related tasks, such as accessing personal emails which which were blocked on the school network. On many occasions, students legitimately used UltraSurf in front of their teachers to access their email so that they could download homework. It was an accepted fact that the network boundaries had to be made porous at times. Even in the library, I found that there were legitimate uses for UltraSurf—such as a student I witnessed arguing with the librarian to let him use it to find information about Nazi concentration camps. Ultrasurf was not the the only line of flight that students had to subvert the mechanisms of surveillance used in the school. Some of the older students also owned smartphones that they used for social networking without being controlled by the school. This meant that students used smartphones to access the Internet, check Facebook and chat on Blackberry Messenger (BBM) under the tables.

Kitchin and Dodge's (2011: 65) concept of code/space is a useful concept for thinking about the role that software plays in producing the space of the classroom. The library is and example of a code/space because software is able to 'modulate the conditions under which sociospatial processes operate'. Kitchin and Dodge (2011)

argue that code / spaces are produced using software mediated practices: instructions in software, or the code, plays an essential role in producing the form, function, and meaning of space. Furthermore, software catalyses the transformation of uncoded spaces into code / spaces through an 'ongoing process of contingent and relational processes' (Kitchin and Dodge, 2011: 72). They call the process through which spaces are modulated, transduction. We can see how various pieces of software such as Accelerated Reader, AB Tutor Control, Netsweeper, SIMS and Ultrasurf play a role in constituting the space of the library. Whilst the transduction of space through software implies a certain technological determinism, Kitchin and Dodge (2011: 75) argue that it its nature is never fixed, but something that shifts with time, place and context creating code / spaces that are relational, emergent and peopled.

Netsweeper and AB Tutor Control are two clear examples software that demonstrate the transduction of space in the library. Both Netsweeper and AB Tutor Control play a similar role of surveilling the code / space of the library to ensure that students are not accessing inappropriate websites, however, the transductions of space they produce are both different. Kitchin and Dodge (2011: 77) argue that code / space emerges as 'self-organising systems of relations stretched out across space and time,' produced as a result of processes that occur in may locales at once. They argue that code / space has an 'extensible' quality which occurs as a result of 'ongoing individuations across networks (assemblages of relations) of greater or shorter length, so that scales such as local and global become redundant (Kitchin and Dodge, 2011: 78). AB Tutor control works at the short length between the computers used by the students and the computer used by the librarian. The transduction of space occurred through responses made by the librarian to alerts from the software or activity that was visible on her screen. As I described earlier, the responses made by the librarian were dependent on context, such as letting minor infringements go unnoticed, or bending the rules based on the circumstances—as in the case of the student researching the Nazis for his history homework. One of the key points that Kitchin and Dodge (2011) make is that although software may be used to frame the unfolding of space, but it allows other social relations to operate and never fully determines the spaces it helps to create.

One of the differences between AB Tutor Control and Netsweeper is located in the scaling of code/space. Netsweeper operates from multiple locales at once, its forms part of a global mechanism that transduce code/space by modulating and learning from the behaviour of internet users. Kitchin and Dodge (2011: 78) argue that these configurations of multiple localities produce a constant and emergent from of 'time-space distanciation' where action in one part of the (global) network could have effects on another. For each individual however, the material effects of these transduction may be different. The categories of websites that are blocked by Netsweeper for individuals may be different for each user, the blocked website messages shown to students in the library may be different to those shown in another part of the world, and come with different consequences for infringing its policies. The transductions of space produced by Netsweeper are the localised instances of a geographically distributed network which are one amongst many instances that may be occurring at any given time. This can be contrasted with the singular and linear process of transduction produced by AB Tutor control which requires local intervention by the librarian to modulate code/space.

Netsweeper is part of the increasingly automated, automatic and autonomous forms of management used to govern people (Kitchin and Dodge, 2011). This form of governance is automated because software allows actions such as filtering internet aces to be enacted through technology, it is automatic because the transductions it causes are enacted by the software itself. Netsweeper is autonomous because its outcomes, such as the disciplining of students are enacted without the need for human intervention like that of the librarian. It can also be added that the pervasive nature of code/space has allowed power to be exercised with more intensity as it is more efficiently exercised, and saturated more pervasively in the code/space as it does not need the local presence of the librarian to operate. This is one indication of how traditional disciplinary technologies are being transformed by technologies of control. Kitchin and Dodge (2011) note that automated forms of management work differently from other forms of governmentality because of its ability to control, reshape behaviour or narrow the range of responses available to its subjects.

A number of authors have noted that these technologies have led to the objectification of those individuals that it seeks to govern by directly regulating what students are able to access on the internet (Agre, 1994; Deleuze, 1992; Graham, 2005; Kitchin and Dodge, 2011). Few students (or teachers for that matter) would be aware of the vast amounts of data being collected about their behaviour by Netsweeper. The transductions created by Netsweeper are characteristic of the mechanisms of control. When the only consequence most of the times was an on screen message that told them the website was blocked, it does not share the need to produce subjection that disciplinary mechanisms seek to produce. The students could not easily go appeal against its decision and more serious consequences arose only if the teacher also saw the message, or for more serious infringements, if Netsweeper had alerted the school's IT technicians. Compare this to the operation of the more disciplinary AB Tutor control, which requires the presence of the librarian at her desk and her pastoral interventions to modulate the behaviour of students. The fact that teachers have such little control over Netsweeper is an indication of the various relational problems are being mediated in code/space. These relations are being negotiated at multiple locales at once: the desk, the library, the school servers, LGFL and Netsweeper.

As the example of Ultrasurf demonstrates, code/spaces are open to subversion, the intended purposes of code/spaces can be subverted through software. This supports the argument that code/space is produced as a result of processes that operate on top of each other rather than being ordered by hierarchal scale. Ultrasurf exploits the cracks in the code/space produced and regulated by Netsweeper, allowing for 'unintentional sociospatial relations and formations' (Kitchin and Dodge, 2011: 75). It is important to note however that this from of resistance does not destabilise the entire code/space, in this instance, Ultrasurf is used to replace the relation between the student and Netsweeper. Ultra surf severs one relation for another, other relations in this code/space such as AB Tutor control, remain undisturbed and intact.

I had argued earlier that the Geography teacher described the computers as 'toys' in the hands of her students. Playing on the computers was discouraged in

classrooms, but the computers in the library were in an ambiguous space where the boundaries that separated work and play were less defined. Spending time in the library gave me a chance to witness how students used computers in the act of playing. There has been growing interest in 'ludic' geographies, or the act of being playful that shapes the spaces we inhabit (Brown, 2014; Mann, 2015; Woodyer, 2012). The study of play has not been restricted to studying the behaviour of children, but a study of 'being playful throughout the lifecourse,' that is not necessarily held in opposition to ways of working (Woodyer, 2012: 313). The concept of 'play' is usually employed to define student behaviour in opposition to 'working'—utilitarian tasks which the teacher defined as processes of 'learning'. Woodyer (2012) argues that play should been seen as an ambiguous category of behaviour that is unbounded from utilitarian and non-instrumental perspectives on behaviour.

Utilitarian perspectives view play as instrumental behaviour that leads children to adulthood. It allows the intervention of teachers to be legitimised as directing students to an adult state, where play is abandoned. Non-instrumental perspectives on the other hand, view play as purpose-free action that escapes direction. Viewing play as ambiguous behaviour allows us to see ludic behaviour in students as a fluid process of becoming which introduces lines of flight in these striated systems. I am hesitant to argue that ludic behaviour on the computers constitute a form of 'counter-conduct' (Foucault, 2007). Even though play questions the authority of the teacher in the classroom, its exercise is not a demand to be governed differently, but a way of transforming the network and the space to produce various states of play. Woodyer (2012: 318) argues that the 'politics of playing are primarily bound up in experiencing vitality rather than strategic oppositional endeavour.' The students I observed used the computers a way of pursuing activities that they found pleasurable or as ways of expressing their identities within a mechanism that often restricted their ability to be otherwise.

Conclusion

In this chapter we have discussed the role of networks from the view of teachers and schools. We found that they have been used to replicate systems of 'coercive' accountability. Giroux (2014) has argued that for the 'undeserved' in these systems, 'education is designed not to inspire and energize, nor is it designed to get students to think, reflect or question' but to 'disable the capacities of students to become knowledgeable, informed speaking agents.' This chapter has shown this to be case from the perspective of the teachers, where are being asked to conform to mechanisms of control. We find that networks have intensified the mechanisms of social sorting that were discussed in the previous chapter. This has taken place through the exponential amount of information that is now known about every child in the education system that is now enabling more individualised systems of education. An era of personalised learning is rapidly approaching that is requiring less and less involvement of the teacher; although these technologies replay the notion of a 'child-centred' education, they are fixed within the restriction of the machines themselves. Finally, we discussed the role that play shows us about creating lines of flight within these systems and networks. Deleuze & Guattari (2004: 522) have given us warnings of 'machinic enslavement' but were hopeful of the new 'becomings' that technology could produce. We have see how play acts as an 'undecideable proposition' that cuts across and disrupts these systems by coexisting with their mechanisms. These mechanisms provide us with many weapons that Delezue & Guattari (2004: 522) argue creates opportunities for 'the becoming of everybody, / everything, becoming-radio, becoming-electric, becoming-molecular' that are constructed in opposition to axiomatic systems.

Conclusion

This thesis has explored how contemporary forms of government have been transformed by networked technologies. It did so by looking at the interactions between the materiality of computer networks, discourses of national education policy, and the practices of network users in a school. The main theoretical influences for this thesis came from Foucault's work on power and governmentality and Deleuze and Guattari's concepts of nomadism and state capture, as well as Deleuze's concept of control. This theoretical assemblage has allowed me to study the way that computer networks have intensified the practices of government. I have used these concepts as a way of arguing against the prevalent idea that various 'networks' of governance have forced institutions of states to recede in order for self-regulating mechanisms from civil society to take their place. The term network has been widely used as a sociological concept to understand society as a network composed of interactions between actors, as well as a technical term referring to the infrastructure that interconnects computers. In this thesis, I focus primarily on the technical form of networks and their influence on mechanisms of government and

the implications that they have on the state itself by focusing on the their transformation of secondary school education in England.

Foucault's concept of governmentality has allowed this study to examine relationships of power as the 'conduct of conducts' (Foucault, 2008: 186). Foucault's lectures at the College de France during the mid 1970s looked at the techniques of government through the reflections and rationalities used to justify relationships of power through the state. He particularly focuses on liberal forms of governmentality and its transformation of the nation-state and subjectivity. Deleuze (2006) summarises Foucault's method as that of drawing diagrams of power. Governmentality gives us a diagram of the state that illuminates the linkages between various mechanisms, discourses, and practices that make up the state. This concept has allowed me to think about the network as the link between various mechanisms of government. I argue that Nealon's (2008) concept of the intensification of power is a good way to think about the way that networks have intensified these practices of government. Computer networks have saturated the exercise of power in a capillary form throughout the social body as well as making the exercise of power more efficient. Computer networks such as the Internet have allowed very detailed information to be known about the social body as well as a greater range of actions to be performed as acts of governing. Governmentality also allows us to see that forms of governance that are argued to be replacing the state do not necessarily entail that we have freed ourselves from modes of domination.

The addition of Deleuze and Guattari (2004) to this theoretical mix has enabled me to take a more nuanced look at modes of domination and means of warding off the state. For some time now, computer networks have been lauded as a means through which societies can self-organise without the need for centralising and hierarchal institutions such as the state (Castells, 2000). Computer networks are argued to enable forms of social organisation that eschew forms of central control for distributed forms of leadership and governance that produce more responsive and less coercive forms of conducting conduct. In chapter three, I looked at what the historical development of computer networks could tell us about their social

and political implications. I have drawn on the concept of nomadism to look at how a historically significant computer network developed at the National Physical Laboratory in Teddington, influenced the development of the modern day Internet. I conducted archival research at a number of archives which included the National Archives in Kew, the British Postal Museum & Archive at Mount Pleasant Sorting Office, the British Telecom Archives in Holborn, the National Computing Museum in Bletchley Park and the British Newspaper Archive in Colindale. These sources provided research materials about the development of the NPL Network between the late 1960s and 1980s which created one of the world's first packet switched networks. Packet switching is an important technology in the history of computer networks because it led to the creation of public digital networks. Prior to packet switching, computer networks were purpose-built by computer manufacturers and network operators for individual applications. Donald Davies, a scientist at NPL had the simple idea that messages could be split into small packets of data that could be sent across a network that was shared by many users sending each other data by following a shared protocol. This made it possible to imagine a publicly run network whose infrastructure could be shared among its users.

I have extended Pickering's (2010b) argument that cybernetics is a nomadic science to show how the development of computer networks and packet switched networks became more useful as they began to be designed around the needs of end users rather than pre-determined ideas of computer manufacturers. Deleuze & Guattari (2004) use the concept of nomadism to think about the deterritorialisation of space by nomadic societies who avoided reterritorialisation and codification by the state. They use the concept to look at how nomadic societies have existed in relation to states whilst opposing sedentary tendencies to form settlements. This tendency to ward off the state is a characteristic of a form of science that Deleuze and Guattari (2004) call nomad science, which they oppose to the 'royal' sciences of the state. They argue that the nomadic sciences work through a problem-based conception of the world that is understood as fluidic and changing rather than fixed and solid. I have used this concept to show how Donald Davies and his team at NPL approached computer networks nomadically by eschewing ideas about its final form and end use. I argue that the self-ordering capacities ascribed to modern

computer networks originate from this idea that these networks should be made so that they can be adapted to the needs of users. This idea was revolutionary at a time when most telephone operators were nationally owned and operated hierarchically. One of the more radical ideas developed by NPL was the idea that networks should charge their users according to how much they use the network rather than the distance or durations of their connections. I show that this amounted to a relative deterritorialisation of the network, and as a result, the NPL Network encountered resistance from network operators and computer manufacturers as they attempted to protect proprietary technologies and profitable sales of leased lines for private computer networks. I then traced this idea as it made its way to America and influenced the predecessor of the modern Internet, ARPANET. I trace how the nomadic science of packet switching was captured by the American military who used the concept of shared data protocols to create interconnected computer networks. After the end of the Cold War, these technologies would eventually become the basis of neoliberal globalisation and the worldwide expansion of American networking technologies. I make the argument in chapter four that this expansion of the Internet and its flexibility after the 1990s were afforded by the nomadic principles that had animated the NPL Network.

Chapter five looked at how computer networks have transformed the governmental mechanisms used to regulate schools. It reframes existing studies and archival material about the National Curriculum and the National Grid for Learning to look at how governmental rationalities around education have evolved over the past 100 years. This chapter looked at the historical development of governmental rationalities around education and the impact that the growing importance of technology and computer networks have had on national education policy in Britain. It began by looking at how the ideas surrounding free public education began to be rationalised towards the end of the 19th Century. Foucault (1978, 2004) argues that biopower was the dominant mode of power during this period. The mechanisms of biopower operate simultaneously through an anatomopolitics of the body through discipline, as well as a biopolitics that is directed at the body of the population. Disciplinary techniques were the first to emerge that trained and optimised the body for industrial societies through various forms of observa-

tion, judgement and distribution of bodies. These were joined by a form of biopol-
itics of the species body that made its vitality a target of power through new forms
of measurement such as birth and mortality rates that allowed norms to be dis-
covered in the social body.

Chapter five showed how eugenic ideas were initially established in education
through the use of intelligence testing as a scientific means of establishing biolo-
gical superiority. Selection tests for secondary schools in England were introduced
after the Second World War to allocate students to secondary schools on the basis
of an intelligence test administered at the age of eleven. We then followed the rise
of comprehensive education during the late 1960s which moved schools away from
selection tests towards systems of streaming within schools that separated students
by ability. This extended a more a capillary form of power that used continuous
forms of testing to move students between streams according to their performance
over time. Although intelligence tests had fallen out of fashion, the functions of
hierarchal sorting and order remained. This also gave rise to a renewed emphasis
on the 'gifted' child that justified new forms of intelligence testing on the basis
that it was used to find and devote more resources to certain students who could
be identified as being gifted.

During the 1970s and 80s, neoliberal theories of human capital became more in-
fluential in public policy. Education became reorganised around the market
through the use of parental choice in school selection, the introduction of league
tables and a standardised National Curriculum. Over time, the power of Local Au-
thorities were diminished and replaced by the growing power of the central state
in the classroom. This process has taken place through the introduction of statist-
ical forms of management that have been intensified through the introduction of
the Internet into schools. The chapter illustrates how decentralised networks that
originally evaded the state form through nomadic organisation began to be used as
apparatuses of capture for the state. The chapter ended with a discussion of how
the development of these rationalities of government speaks to theories of human
capital, race and governmentality. Networks have contributed to the growing in-

tensity of mechanisms of government that have retained their ability to sort, order and create hierarchies.

The final empirical chapter looked ethnographically at how a school has been transformed by networked forms of government. In this chapter I address a range of issues that had been identified in the literature review of 'virtual' geographies as lacking significant attention such as the lack of studies into the material and spatial practices surrounding networks and their role in the social sorting of urban space (Graham, 2005). Participant observation for this chapter was carried out in a relatively deprived secondary school within a London suburb which allowed me to observe how these networked mechanisms for sorting individuals were enacted in the practices within schools. The chapter began by discussing some of the issues around segregation between schools in urban areas and the role of computer networks in sorting populations between schools. I then turned to look at how these mechanisms were enacted through the practices of teachers and students. More broadly, the chapter looked at how technologies have affected the spaces of classrooms and the practices of teaching and learning.

The study found that networked technologies have had many spatial effects within schools. Specially equipped classrooms have been organised around Interactive Whiteboards and computers for students' learning. I found a range of changes in the school library that accommodates computers and the electronic testing of reading abilities. More generally in the school, I witnessed the extension of technology to govern students in more unusual spaces such as the use of fingerprint readers to pay for lunches in the school canteen. I found that databases have extensively altered the work of teachers who devote large amounts of resources in order to capture data for performance management systems. I found that a range of mechanisms such as the Student Information Management System and performance metrics are used to record data about individual students and regulate the conduct of individual teachers. I also discussed how technologies such as the Virtual Learning Environment which were argued to extend learning outside the classroom through the network are used as forms of 'coercive' accountability in order to regulate the relationships between teachers, managers and students.

These systems of accountability anticipate and produce distrust within these relationships as a condition of their operation. Finally the chapter looked at the library as a model for the future of the classroom. In the library, I observed that the role of the librarian had intensified into the role of a security guard who guarded the conduct of information consumption by the students. Some subjects, such as reading lessons for English already use the library space computers for testing students' reading comprehension. I described the use of the Accelerated Reader program in the school which is used for monitoring the reading performance of students in the school that made use of electronic tools and networks to capture data and organise students.

The mechanisms used for regulating the behaviour of students on the network demonstrated in the chapter show how contemporary systems of control have intensified disciplinary surveillance. One such mechanism operated as a background process on the level of the network by filtering the range of websites available on the school network. The Internet filter blocked access to websites that contained games and social networking sites using a system of keywords. This mechanisms was provided by an external service called Netsweeper which operates a global system of internet filters institutions ranging from schools and offices to the networks of entire countries. This demonstrated how systems of governance and the transductions of code/space operate at global and local levels simultaneously. Netsweeper 'learns' from the behaviour of its users worldwide to adapt its filtering mechanisms around the network. The second mechanism used to regulate student behaviour on the network operated closer to the network within the library: The librarian monitored the behaviour of students in the library by looking at screenshots of their activity from the computer on her desk. This intensified her role as the watcher from the panopticon as the students were not aware when she was watching. I found that teachers were the most severely impacted by the greater presence of technologies in the classroom as they were increasingly asked to be responsible for the maintenance of expensive computers and to meet the expectations of performance targets.

On the other hand I found that students used play as a creative means of reconfiguring the spaces of the classroom and the network. I witnessed how they employed tools for getting around network filters and evading the gaze of the teachers in order to find opportunities to create states of play using the computers. This is not intended to set up a simple dichotomy between 'bad' government by the teacher and acts of playing by the students as 'good,' but as a way of thinking about how the coercive nature of these mechanisms are being challenged by the students.

Future research on this topic could greatly benefit if the researcher can gain access for a longer duration of fieldwork at the site of a school. The time limitation of five weeks was imposed on me as a precautionary measure by the head teacher who felt uncomfortable with a stranger in school over a longer duration of time. I believe that a longer duration would have given me greater opportunities to study the technology from the perspective of students. I also believe that a future study would benefit from a comparative approach that could look at the role of technology from the perspective of a school that is judged differently from the school I studied, especially in terms of assessments by OFSTED. Looking at the way parents use performance data—as they are being encouraged to—is also a possible direction for future work.

My observations of technology within the school have not left me with positive feelings about its future role. I have shown in this thesis how teachers are spending more time tending to the needs of machines, and keeping the students docile for technological forms of didactic teaching. I argued in chapter five that the 'totalitarian minimum state' being produced by these technologies is geared towards the abandonment of marginalised populations who are given 'consequential' status or left in 'untamed' states while the systems of control ensure their docility (Deleuze & Guattari, 2004: 510). The growing reliance on technology to teach students means that we are losing the teacher who had the role of providing moral and spiritual guidance to students in modern societies. The 'poisonous pedagogies' historically prevalent in totalitarian regimes have reappeared in a new guise to create submissive individuals that function reliably without the need for anyone to guide

their behaviour; as Miller (1983: 83) suggests, the mere existence of hierarchy and authority is enough to produce obedience. The dangers of control originate from the fact that it encourages the suppression of conflict rather than the resolution of differences. In Deleuze and Guattari's (2004) words, these technologies pose the risk of producing new forms of machinic enslavement returning these 'untamed' populations to resurrected forms of sovereign servitude.

The expansion of academies and free schools which operate outside local authority control (but funded by central government), are the contemporary ways through which the education system in England are transforming towards models of governance. These schools are given more 'freedoms' than state schools in terms of their curriculums, staff pay and qualification requirements, and their admissions and timetables. Junemann and Ball (2013: 433) have shown how some academies have emphasised the role of discipline and behaviour management as 'solutions' for improving educational performance. The 'troops to teachers scheme' (http://troopstoteachers.ctp.org.uk) introduced by the coalition government signals the worrying acceptance of the idea that what is lacking in underperforming schools is a lack of discipline and a need to introduce a military ethos.

Since the introduction of performance management systems in education, teachers have devoted more and more time towards activities that demonstrate characteristics of performance. The amount of time teachers spent on existing forms of performance management systems is being problematised by the state, the software companies, and the teachers themselves (Vaughan, 2015). New(er) computer technologies are once again being lauded as time-saving solutions that enable continuous testing and assessment electronically to allow teachers and parents to monitor the performance of students. These include systems of continuous assessments made possible by the latest iteration of tablet computers intended for use in classrooms. These technologies have been used to automate the entire process of teaching, testing, and monitoring through electronic learning materials that are personalised for each student according to their historical performance data. Based on my experience at the school, I believe that there may be benefits to these forms of technology; the personalised delivery of curriculum to individual

students is novel in the sense that it individualises the banding and streaming of ability grouping. However, I believe that in marginalised schools like the one where I conducted my fieldwork, the automation of teaching could be increasingly used as an economic justification leading to larger class sizes taught by less qualified teachers who are pressured to prioritise discipline over learning in the classroom. Some of the policy implications of this research revolves around how we can decentre the governing of education in a different direction. Creating more nomadic networks of education would involve reinstating the role of teachers and local authorities. To a certain degree this would involve limiting the purvey of computers networks, to use their benefits without allowing them to reign supreme: the impersonalising effects of networked technologies and performance criteria, creating space for more personal care within schools. This also has implications for how teachers could made accountable to schools, parents and students. The processes of audit need to be negotiated locally, and include forms of peer to peer assessment which incorporate these actors rather than norms of performance that are mandated by the state.

Deleuze and Guattari (2004: 522) are hopeful about electronic technology; they argue that it contains the potential for making 'revolutionary connections' that provide weapons for the 'becoming of everybody'. A later essay by Deleuze (1992) offered a more cautionary warning about technologies of control that were replacing discipline. This thesis has led me to ask if at present, we possess the emancipatory weapons that Deleuze (1992) had urged us to develop. At present, greater amounts of data are being collected about students from a very young age. There are existing plans to link school data with the records of Inland Revenue, so that the true 'value' of individual qualifications can be determined by their contributions to future wages (Vaughan, 2015). I believe that this reflects more generally an erasure of boundaries between work and education which is potentially problematic. A form of electronic caste system is being gradually established that prepares students from a young age for forms of employment that the system has preordained for them, but in this case individually. Allowing a greater number of third-parties to access the National Pupil Database has already been indicated by the government (Hansard, 2012).

It is not hard to imagine a future where access to this data forms conditions of employment which potentially leads us to new forms of machinic enslavement. The blanket surveillance being conducted by security services in Britain shows that we have a joined-up state—where different apparatuses have come together through the network—that extensively collects data about its population. Network technologies have contributed to the intensification of both sovereign power and forms of governance that no longer require institutions to be run by the state. In summary, this thesis has charted the transition of computer networks from a nomadic science to an apparatus of capture for the state. I remain sceptical of arguments claiming that forms of governance are less coercive than forms of government. This study has shown that a greater danger lies in our need to order and separate populations using the concept of ability, which has resurrected the concept of intelligence from eugenics. Whilst network forms may be nomadic, we have yet to deal with greater questions brought about by the intensification that they cause in mechanisms of power

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METROPOLITAN POLICE **TOTAL POLICING**

13 July 2012

Dear Head Teacher/Principal

I am writing to you ahead of the summer holidays. As you will no doubt be aware, last August saw some of the worst disorder in ███████ and across London and England in living memory.

There were a number of young people involved in the looting and disorder last summer and many of those involved have already been arrested and dealt with by the criminal justice system. However, it is also important to note that the majority of young people were not involved and would have been affected by the scenes that we all saw last year.

With this in mind, I am requesting your assistance in reassuring young people in ██████ that the Metropolitan Police in ████ and across London has learnt some significant lessons in the way it dealt with last August's disorder and that we are much better prepared to prevent and deal with any recurrence in the future. We have made changes to our tactics, altered our force mobilisation plan and also trained an additional 1750 officers in public order policing.

Summer 2012 will also see the largest sporting event in the world come to our doorstep. Whilst the policing operation for the Olympic Games is the largest peacetime policing operation ever put in place in the UK, we are keen to emphasise that the day-to-day local policing of ████████ and other boroughs will continue as normal.

There may be some misconceptions that all of our officers will be at the Olympic venues during the Games, leaving ████ unattended. I can assure that this is most definitely not the case. We have taken a number of measures to ensure that we have sufficient officers in ████████ to deal with the day-to-day policing requirements of the borough. Annual leave has been restricted, shift patterns have been altered and training has been cancelled - all with the effect of swelling the numbers of officers on duty over the summer.

Add to this the officers that will be coming to London and ████████ from other police forces, it means that - rather than less - there will be significantly more officers on the streets over the summer.

I would be grateful if you could convey this message to your pupils and students in any way you feel appropriate before the summer break. As I mentioned earlier, the majority of young people were not actually involved in last summer's disorder and from feedback we've been getting, many young people have concerns ahead of August and the Games.

Appendix 1—Letter from Police to School, see overleaf for side two

If you have any questions, or would like to speak to us to clarify any points, or if you would like an officer to visit your school to address this subject, then please do not hesitate to contact █████████ in our Partnership office, who will be happy to help in any way he can.

Yours sincerely,