Information and Control: Inventing the Communications Revolution in Post-War Britain

Jacob William Ward

UCL

PhD History of Science and Technology

I, Jacob William Ward, 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 undertakes the first history of the post-war British telephone system, and addresses it through the lens of both actors' and analysts' emphases on the importance of 'information' and 'control'. I explore both through a range of chapters on organisational history, laboratories, telephone exchanges, transmission technologies, futurology, transatlantic communications, and privatisation. The ideal of an 'information network' or an 'information age' is present to varying extents in all these chapters, as are deployments of different forms of control. The most pervasive, and controversial, form of control throughout this history is computer control, but I show that other forms of control, including environmental, spatial, and temporal, are all also important. I make three arguments: first, that the technological characteristics of the telephone system meant that its liberalisation and privatisation were much more ambiguous for competition and monopoly than expected; second, that information has been more important to the telephone system as an ideal to strive for, rather than the telephone system's contribution to creating an apparent information age; third, that control is a more useful concept than information for analysing the history of the telephone system, but more work is needed to study the discursive significance of 'control' itself.

Acknowledgements

There are many people to whom I owe thanks for making this thesis possible, and here I can only name some of them. For those who aren't named, all I can say is: if you remember my name and recognise my project, thank you for listening and talking.

My first thanks must go to my supervisors: Tilly Blyth from the Science Museum, and Jon Agar from UCL. I am particularly grateful to Jon for also providing so many opportunities for me to teach, present, and publish my research. I have been fortunate to be a collaborative doctoral award candidate between the Science Museum and UCL on a project on Post Office and British Telecom research, and my fellow CDA candidates from this project, Rachel Boon and Alice Haigh, have been fantastic companions to have along this path.

From UCL's Department of Science and Technology Studies, I have benefited at one point or another from the advice and support over the past few years of Joe Cain, Chiara Ambrosio, Brian Balmer, Carina Fearnley, Phyllis Illari, Frank James, Tiago Mata, Carole Reeves, Jack Stilgoe, and Simon Werrett. Lori Coletti Campbell and Susan Walsh have both also been extraordinarily helpful with various funding, employment, and organisational tasks. I have also enjoyed a welcoming and supportive graduate student environment, and owe particular thanks to Elizabeth Jones, for passing on the History of Science Reading Group, which I greatly enjoyed chairing; Alex Mankoo, who has been a great friend and conference partner; Oliver Marsh, for organising the Work-in-Progress seminars; and Erika Jones, for her advice on the AHRC international placement scheme.

I have also been lucky to enjoy another institutional home in the Science Museum's Research and Public History Department. From the Science Museum, Tim Boon and John Liffen have both made time to talk through the past, present, and future of my research. Bergit Arends, Adam Boal, Alison Hess and Laurie Michel-Hutteau have also all helped greatly along the way. Finally, my fellow Science Museum scholars have been great friends to have, and I particularly want to thank Stuart Butler, for all his advice and for The Bree Louise British History group, and Caitlín Doherty, for setting up the Museums and Society Reading Group together, and for being a great friend in Washington D.C.

I have been very fortunate to have had access to BT Archives throughout my PhD, and wish to thank all the staff there who made that possible, particularly David Hay and James Elder, both of whom have been tremendously helpful. I have used many archives throughout my research, and want to thank their staff here too: the British Postal Museum and Archive, the National Archives, the Bank of England Archives, the National Museum of American History Archives Center, the National Air and Space Museum Archives Center, and the George Washington University Special Collections.

I spent four months of my PhD living in Washington D.C. on an AHRC-funded fellowship at the National Museum of American History's Lemelson Center. Mary and Thomas Edsall were wonderful landlords. Eric Hintz was a great fellowship adviser, and everyone else at the Lemelson Center was incredibly welcoming and supportive. Bernard Finn and Hal Wallace, also at the National Museum of American History, kindly made time to talk with me about my research. Across the National Mall, I was also very fortunate to make new friends and acquaintances at the National Air and Space Museum: Teasel Muir-Harmony has been a great friend and helped me find accommodation in Washington D.C., and Martin Collins and Paul Ceruzzi both provided advice on my research. Finally, I had the opportunity to present my research at Cornell University's Science and Technology Studies Department whilst I was in the USA, and so I want to thank Annie Tomlinson and Alana Staiti for organising that, particularly Alana, who also hosted me during my visit to Ithaca.

Finally, this thesis is dedicated to my family, particularly its newest member: Louisa, whom I married in July 2016 and could not imagine life without. Thank you.

Table of Contents

List of Additional Material

Figures

Tables

1 Introduction

Subjects and Methods

On October 31st, 1967, James Merriman, the Engineer-in-Chief for the British telephone system, delivered a speech to the Institution of Electrical Engineers (IEE) in which he argued that 'the concepts of information and control are fundamental to any telecommunications system'.[1] These concepts have both become prominent over the twentieth century, in popular and scholarly accounts of an 'information age', 'information society', and 'information revolution', widespread applications and ownership of 'information (and communication) technology', wartime emphases on 'command and control' and 'control systems', the disciplinary emergence of 'control engineering' and 'control theory', and scholarly accounts of a 'control revolution' or a 'control society'. And yet, as Merriman points out, these concepts have also been linked as 'twin concepts': for example, *Information and Control* was the name given to a cybernetics and information theory journal founded in 1958.[2] Information and control have, together and separately, accrued rhetorical – and perhaps practical – significance, and telecommunication networks have been cast as fundamental to this significance.

The history of the British telephone system is not just one of information and control, but also public and private. The successful privatisation of the state-owned telecom monopoly, British Telecom (BT), in 1984 was a key plank of Margaret Thatcher's industrial policy, which emphasised information and communication technology's (ICT) market power, as well as a pivotal moment in the privatisation movement, which gathered pace both in Britain and abroad after BT's successful sale –

[1] J.H.H. Merriman, 'Men, Circuits and Systems in Telecommunications', *The Post Office Electrical Engineers' Journal* 60, no. 4 (1968): 250.
[2] Merriman, 249; Ronald R. Kline, *The Cybernetics Moment* (Baltimore: Johns Hopkins University Press, 2015), 183.

the largest stock flotation the world had seen. BT had itself only been created three years earlier, in 1981: the British telephone system had been, from 1912, a state monopoly operated by the Post Office (colloquially, the 'GPO', for General Post Office) as a branch of government, a Civil Service department, until 1969, when the Post Office was separated out from the Civil Service and turned into a nationalised corporation. In 1981, the telephone and postal businesses were separated: posts remained with the Post Office, whilst telecommunications was transferred to a new corporation, British Telecom (BT). The government simultaneously terminated the state's telecommunications monopoly and opened the sector to competition; a private competitor, Mercury, was set up to compete with BT. A history of the post-war British telephone system is thus central to two important changes in twentieth-century Britain: the rise of the so-called 'information age' and the enacting of neoliberalism.

Whilst there are various histories which address the post-war British telephone system – broader Post Office histories, histories of telecoms regulation, labour histories, and histories of technological aspects of the system[3] – there are none which directly address the relationship between the sociotechnical characteristics of the telephone system and its privatisation, nor how 'information and control' came to be so apparently central to its engineering management. This thesis thus focusses on how the post-war technological history of the telephone system intersected with its privatisation in 1984 and became central to Thatcherist information technology policy, paying particular attention to the themes of 'information' and 'control'.

I undertake this through various chapters, which I shall briefly outline here and explain in more detail later in this introductory chapter. In the next chapter, I explore the histories of 'information' and 'control', as relevant to telecommunications engineering and management, and undertake a critical review of information and control theorists, noting how this thesis draws positively from their work and how it might help inform or critique their conclusions. The subsequent chapters represent my primary historical

[3] Duncan Campbell-Smith, *Masters of the Post: The Authorized History of the Royal Mail* (London: Penguin, 2012); Mark Thatcher, *The Politics of Telecommunications: National Institutions, Convergence, and Change in Britain and France* (Oxford; New York: Oxford University Press, 2000); Frank Bealey, *The Post Office Engineering Union: The History of the Post Office Engineers, 1870-1970* (London: Bachman & Turner, 1976); D.G. Tucker, 'The Early Development of the British Underground Trunk Telephone Network', *Transactions of the Newcomen Society* 49, no. 1 (1977): 57–74; James Foreman-Peck, 'The Development and Diffusion of Telephone Technology in Britain, 1900–1940', *Transactions of the Newcomen Society* 63, no. 1 (1991): 165–79; Graeme J. Milne, 'British Business and the Telephone, 1878–1911', *Business History* 49, no. 2 (2007): 163–85; Peter Scott, 'Still a Niche Communications Medium: The Diffusion and Uses of the Telephone System in Interwar Britain', *Business History* 53, no. 6 (2011): 801–20.

research, and I start with an organisational history of the telephone system up to the creation of BT, which provides a background history for the thesis. The next several chapters are organised by scale, starting with local history and working up to international history, to explore how the broader changes studied by this thesis were worked out at various levels.

First is a history of the Post Office and BT's research and development centre, which is important because it became part of a quintessential 1980s 'information age' development – an IT park – and so studies the cultural and organisational dynamics behind that formation. Second, I explore the history of the computerisation of the British telephone network, specifically telephone exchange computerisation – a programme which originated Merriman's 'information and control' speech and so is central to the growth of both concepts in engineering management's thought. I then explore how an information discourse proliferated through the development of new transmission technologies and intersected with BT's privatisation and move to competition. In the next chapter, I study the telephone business's Long Range Planning Department, a futures research group which was key to both sustaining visions of an information age and, through computer modelling, enacting notions of computer control. I then move to the international scale, exploring the history of transatlantic communications projects which the Post Office and BT participated in, identifying how these projects produced the idea of an 'information age' which enabled instantaneous, dematerialised communications.

I then move onto study the history of BT's privatisation in more detail, exploring the extents to which the Thatcher government's emphases on denationalisation and popular capitalism, on the one hand, and information technology's market power, on the other, informed and were shaped by BT's privatisation. Finally, I conclude by reflecting on what this thesis has demonstrated about the roles of 'information' and 'control' within the British telecommunications system and more broadly.

However, before I move onto more fully introducing these chapters and their evidential bases, I shall first explain the methods I use to write this history. In the next section 'Methods', I highlight influential works from business history and the history of technology, and explain methodological steps I have taken to provide a more complete history of information and control. In the following, and final, section, 'Subjects', I outline each chapter's subject of inquiry and the evidential sources from which I draw to sustain that inquiry.

Methods

The British telephone network can be approached as both a technological system of information and control, and as a large business, moving from public to private. I thus draw on approaches from business history and the history of technology for this thesis. In this section I first spend some time covering classic approaches from both fields, and then turn my attention to alternative approaches and methods which address some of the classic approaches' limitations.

The landmark work in business history is Alfred Chandler Jr.'s *The Visible Hand*.[4] Chandler argues that the invisible hand of the laissez-faire nineteenth century free market was displaced by the visible hand of corporate management. In his history of nineteenth and early-twentieth-century American business, which influenced Beniger's account of the same period, Chandler outlines how the expanding scale of production, distribution and retail, partly enabled by revolutions in transportation and communication technologies (the railway and the telegraph), necessitated a novel organisational form – the decentralised, hierarchical managerial corporation – to co-ordinate commodity flows. Chandler argues that the top and middle managers, as the social group tying spatially extensive units into the corporation's larger hierarchical structure and co-ordinating these commodity flows, replaced the invisible hand of the market.[5] Chandler's work has been criticised as technologically determinist and for its implicit support of corporate business's control over the market, but, despite this, Chandler does insightfully show the relationship between corporate form and technology.[6]

Louis Galambos locates Chandler's work within a broader 'organisational synthesis' in American history which, from the 1960s, took the organisation as the primary subject for exploring historical change.[7] Like Chandler, Galambos points to the increasing functional specialisation inside and between organisations, the centralisation of authority, and the development of managerial hierarchies, which argues served two organisational functions: control over the organisation's social, political, and economic

---

[4] Alfred D. Chandler Jr., *The Visible Hand: Managerial Revolution in American Business* (Cambridge, Mass.: Harvard University Press, 1977).
[5] Chandler Jr., 1–4.
[6] Louis Galambos, 'Technology, Political Economy, and Professionalization: Central Themes of the Organizational Synthesis', *The Business History Review* 57, no. 4 (1983): 473; David A. Hounshell, 'Hughesian History of Technology and Chandlerian Business History: Parallels, Departures, and Critics', *History and Technology* 12, no. 3 (1995): 210.
[7] Galambos, 'Technology, Political Economy, and Professionalization', 472–74; Louis Galambos, 'The Emerging Organizational Synthesis in Modern American History', *The Business History Review* 44, no. 3 (1970): 279–90.

environment, and the promotion of technological and organisational innovation.[8] Galambos has also reframed the organisational synthesis for the information age, arguing that bureaucratic institutions still predominate, but he locates his analysis within as Castellsian framing of society, viewing information technology as the 'new innovative force powering capitalism' and arguing that the stabilising institutions of the pre-1970s have been remade into the nimble, creative, 'transformative' institutions of the information age.[9] I think Galambos's useful point here is to emphasise the still dominant role of the organisation, particularly the bureaucratic business organisation, in contemporary society but, as I will show in critiques of information age theories in the next chapter, it is difficult to substantiate the existence of a novel information age.

I turn now to the history of technology, and to Thomas Hughes' concept of technological systems, which he developed in his history of electrical power networks in late-nineteenth and early-twentieth-century USA, Britain, and Germany.[10] Hughes divides the development of technological systems into several phases: first, invention and development; second, technology transfer; third, system growth, characterised by attention to the 'reverse salients' of critical problems lagging behind overall systems development; fourth, technological momentum – as historically contingent decisions are taken in system design and development, the system gains momentum, meaning it is harder to reverse or resist those decisions taken in system design.[11] It is important to note that Hughes conceived of technological systems, despite their name, as essentially sociotechnical in character: they are not just composed of physical, technological artefacts, but also social components such as organisations, engineers, and legislation. There is some similarity here to James Beniger's systems of control, which I explore in more detail in the next chapter, but Hughes does a far better job of providing a model of technological change which sees technology and society as mutually shaping, thus avoiding the pitfalls of technological determinism. Whilst I do not take an explicitly Hughesian framework in this thesis, his influence is still present in the way I pay attention

---

[8] Galambos, 'The Emerging Organizational Synthesis in Modern American History', 280; Galambos, 'Technology, Political Economy, and Professionalization', 492–93.

[9] Louis Galambos, 'Recasting the Organizational Synthesis: Structure and Process in the Twentieth and Twenty-First Centuries', *The Business History Review* 79, no. 1 (2005): 35–38.

[10] Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Baltimore; London: Johns Hopkins University Press, 1983).

[11] Hughes, 14–17; Thomas P. Hughes, 'The Evolution of Large Technological Systems', in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch (Cambridge, MA; London: MIT Press, 1987), 51–82.

to the different stages of the technological system, from research and development to the management of mature systems, as well as socio-political context.

The Hughesian approach has similar limitations to the Chandlerian approach, which has previously been noted by David Hounshell, who points out that both look at the inter-relations between organisational form and technological change, and both effectively take a meso-level approach – Chandler, the business corporation; Hughes, the technological system.[12] It is along these lines that this thesis can address these limitations.

I will first start with the macro-scale given this chapter's attention to macro theories. Hughes' *Networks of Power* only very basically engages with the entanglement of power networks and broader societal transitions, uncritically using the concept of a second industrial revolution to delineate Chicago and Berlin, centres of this supposed revolution, from London, which was apparently ignored. As apparent revolutions of information and control are central to this thesis, I look to other approaches in history of technology which critically engage with the entanglement of technology and macro-scale transitions beyond the 'system' approach.

Paul Edwards addresses technology and the macro through analysing the interlinkage of technological infrastructures with modernity.[13] Edwards suggests that meso-scale technology studies, such as sociotechnical studies of telephone systems, reinforce the modernist settlement by implicitly casting these infrastructures as compressing time and space, and so producing modernity.[14] However, micro-scale studies, Edwards points out, such as Claude Fischer's social history of telephony, complicate this view, showing the ways in which users engage with technology outside of the modernist subject/alienation viewpoint.[15] Finally, on the macro-scale, Edwards turns to Beniger's macro-account of the control revolution as an example which, although problematic, fleshes out the modernist conception of technology by linking together infrastructural change on a broader historical scale.[16] Edwards suggests that it is not that these different standpoints are mutually exclusive but rather, to reconcile them, these scales need to be 'mutually oriented', by looking not just at small groups on the one hand

---

[12] Hounshell, 'Hughesian History of Technology and Chandlerian Business History'.
[13] Paul N. Edwards, 'Infrastructure and Modernity: Force, Time, and Social Organisation in the History of Sociotechnical Systems', in *Modernity and Technology*, ed. Thomas J. Misa, Philip Brey, and Andrew Feenberg (Cambridge, MA: MIT Press, 2003), 185–224.
[14] Edwards, 198–201, 221.
[15] Edwards, 202, 222; Claude S. Fischer, *America Calling: A Social History of the Telephone to 1940* (Berkeley, CA: University of California Press, 1994).
[16] Edwards, 'Infrastructure and Modernity: Force, Time, and Social Organisation in the History of Sociotechnical Systems', 204–7; James R. Beniger, *The Control Revolution: Technological and Economic Origins of the Information Society* (Cambridge, MA: Harvard University Press, 1986).

and large institutions on the other, but the relationship between them. The example Edwards gives is the small communities and networks of engineers which developed ARPANET, the US military's internet precursor, and the relationship these communities had with their large military sponsors; each group's goals were shaped by their experiences of different scalar dynamics, but through mutual orientation, a more comprehensive history of ARPANET can be written.[17]

Another example linking micro-scale technology studies with macro-scale transitions is Paul Rosen's history of mountain bike development, which puts the 'social construction of technology' school (SCOT) in dialogue with Harvey's analysis of postmodernity and flexible accumulation.[18] Rosen analyses the mountain bike, a non-stable technological artefact undergoing constant revisions and rebranding, as a classic example of the flexibly-produced, highly-branded and aestheticized product of flexible accumulation. Rosen argues that social constructivist approaches, with their focus on relevant social groups of users, do not have a sufficiently detailed understanding of how society produces these group's social features, and thus the social features of technology; for example, Rosen argues that Pinch and Bijker's famous article on the development of the safety bicycle under-elaborates women and elderly men as relevant social groups, noting that 'we are told nothing about the social make-ups of these groups, how large a proportion of them were cyclists, from which social classes they came, and so on'.[19]

Rosen's point is not that SCOT is unable to explain why elderly men and women would support certain features of bicycle design – low wheels and air tyres met the safety concerns of both groups – but that SCOT does not situate these groups within broader societal contexts and so is unable to explain why these groups, from those classes, at that particular time, in that particular manner, articulated those pressures. Without this context, Pinch and Bijker are unable to link the technological features of the safety bicycle with broader features of late nineteenth century Britain. Rosen corrects this by situating the relevant social groups to mountain bike design – off-trail mountain bikers and urban users – within a vision of postmodernity; thus off-trail mountain bikers are located within

[17] Edwards, 'Infrastructure and Modernity: Force, Time, and Social Organisation in the History of Sociotechnical Systems', 213–20.
[18] P. Rosen, 'The Social Construction of Mountain Bikes: Technology and Postmodernity in the Cycle Industry', *Social Studies of Science* 23, no. 3 (1993): 479–513.
[19] Rosen, 483; Trevor Pinch and Wiebe E. Bijker, 'The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other', in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch (Cambridge, MA; London: MIT Press, 1987), 17–50.

the demodernising impulse of postmodernity, the desire to get away from the time-space compression of urban life, whilst urban users turned to the mountain bike as a way of dealing with potholed cities crumbling from state under-investment, and so Rosen casts the urban mountain biker as equally crucial to the postmodern urban landscape as architecture itself.[20]

Whilst Rosen and Edwards both show ways of integrating the macro-scale into technology studies, there remains the issue of writing the micro-scale into a history of the telephone system. I address this in several ways: throughout this thesis, I use detailed examination of low-level technical documents, meetings, and conferences to uncover critical moments where the micro and meso were mutually oriented; however, the ways I want to focus on here, for their important methodological dimensions, are oral history and local history, which I primarily use in Chapter Four. The Chandlerian and Hughesian approaches, in their attention to the meso, and as an unavoidable product of historical distance, neglect the voices of those who experienced the managerial strategies of the business corporation, or the increasing momentum of the technological system. Oral history is one way of giving a voice to those who are ignored or under-represented, particularly in the experiences of communities where unwritten rules and dynamics play important roles.[21]

An extension of this community focus is to combine oral history with local history: Valerie Yow points out that focussing on a particular group within a particular locality allows a glimpse of the local impacts of national or global pressures.[22] Combining these approaches – oral history as a voice for the under-represented, and local history as fresh insight into broader transitions – I undertake a local history of the telephone system's R&D labs. I explore its local history partly through the oral histories of two groups: those who worked in the laboratories, and those who lived around the research centre. Local history is here particularly important because the telephone system's research centre, as I expand on in the third chapter, is a significant spatial construct – a fixed place dedicated to collapsing space – and so is a place one would expect to be heavily implicated in broader information age or postmodern experiences of time-space. It is thus necessary not just to capture the stories of those who worked in the research centre, but also those who were exposed to it through their lived experience.

[20] Rosen, 'The Social Construction of Mountain Bikes', 497–501.

[21] Paul Thompson, '"The Voice of the Past" Extract', in *The Oral History Reader*, ed. Robert Perks and Alistair Thomson (Abingdon: Routledge, 2006); Valerie Raleigh Yow, *Recording Oral History: A Guide for the Humanities and Social Sciences*, 2nd ed. (Walnut Creek, California: AltaMira Press, 2005), 12.

[22] Yow, *Recording Oral History*, 188–89.

There are also ways to further flesh out the meso, and so I also use two approaches which provide neglected but useful perspectives for conceptualising the history of information and control: visual sources and environmental history.

In sections of this thesis, I explore how advertising and imagery, used to sell technologies and tie them into certain discourses, is an important part of understanding the construction of the information discourse. The visual culture of advertising is useful because of its ubiquity and because it taps into discourses in ways which purely textual evidence cannot.[23] Ludmilla Jordanova warns of the dangers in uncritically using advertising as a visual source: adverts can become associated with things to which they have no intrinsic connection, and can become over-familiar to the point that they are difficult to fully unpack.[24] Audience is also a problematic issue: seeing advertising as 'messaging' can be misleading, implying that adverts are always clearly transmitted, and so it is better to read adverts as revealing the culture and goals of those responsible for them, rather than those receiving them.[25]

That said, it is not necessarily crucial to handle advertising as a wholly different type of source. Mica Nava points out the dangers of treating advertising as a monolithic example of corporate hegemonic control over consumption, and in this sense I think Roland Marchand's history of corporate publicity and advertising is useful.[26] Marchand treats advertising probably more homogenously than Nava would like – Nava sees adverts as part of a broader heterogenous grouping of cultural visual forms[27] – but I think Marchand's approach, which treats advertising as a defensive, rather than offensive, strategy for early-twentieth-century US corporate giants, avoids the implication of corporate hegemony. These corporations, criticised as too large for the social good, underwent a crisis of moral and social legitimacy, and so Marchand situates advertising within a broad range of initiatives – fairs, factory visits, showcases, etc. – intended to create a 'corporate soul'. Marchand's wide use of different source types raises another issue with advertising: Malcolm Barnard points out the dangers in treating advertising as unique, arguing that all forms of information are intended to influence behaviour, and so

23 Ludmilla Jordanova, *The Look of the Past: Visual and Material Evidence in Historical Practice* (Cambridge: Cambridge University Press, 2012), 2.
24 Jordanova, 21–22.
25 Jordanova, 168.
26 Mica Nava, 'Framing Advertising: Cultural Analysis and the Incrimination of Visual Texts', in *Buy This Book: Studies in Advertising and Consumption*, ed. Mica Nava et al. (London; New York: Routledge, 1997), 35–36; Roland Marchand, *Creating the Corporate Soul: The Rise of Public Relations and Corporate Imagery in American Big Business* (Berkeley, CA: University of California Press, 1998).
27 Nava, 'Framing Advertising: Cultural Analysis and the Incrimination of Visual Texts', 45.

argues that adverts are not unique nor somehow inherently morally questionable.[28] So, whilst it is important to bear in mind the distinctive features of the visual culture of advertising which Jordanova points out, it is also important to not treat advertising as an exceptional manifestation of corporate culture, or control over consumption, just because it is 'advertising'.

A further approach, somewhat neglected in business history and history of technology, and far more neglected in accounts of the information age, is environmental history. Environmental history and history of technology have had substantial links built between them since Jeffrey Stine and Joel Tarr's landmark essay on technology and environment, but business history has neglected this area more.[29] Christine Meisner Rosen has repeatedly called for business history to pay more attention to the environmental dimensions of corporate activity, and there are now signs of change.[30] However, I think the more significant point is the place of the environment in accounts of the 'information age'. As I will explore in the next chapter, the information age is all too often presented as dematerialised and invisible and so, whilst environmental history is not this thesis' focus, I do address the environmental history of transatlantic communications in Chapter Seven and so signpost it here as another dimension in which I write this history of information and control in the British telephone system.

I wish to conclude this section by noting that it is by now apparent that I deploy a variety of methodologies through this thesis: archival research, oral history, cultural theory. An additional resource I draw on is science fiction literature, which, as I shall show in Chapters Seven and Nine, telecommunications management and politicians deployed to explicate the political and technological changes which Britain and the telephone system were going through. I focus on these uses because, as the science fiction theorist Darko Suvin argues, science fiction is a genre which is used to confront normative systems with new, unfamiliar rules: paying attention to how and when it is invoked thus

---

[28] Malcolm Barnard, 'Advertising: The Rhetorical Imperative', in *Visual Culture*, ed. Chris Jenks (London; New York: Routledge, 1995), 36.

[29] Jeffrey K. Stine and Joel A. Tarr, 'At the Intersection of Histories: Technology and the Environment', *Technology and Culture* 39, no. 4 (1998): 601–40.

[30] Christine Meisner Rosen, 'Industrial Ecology and the Greening of Business History', *Business and Economic History* 26, no. 1 (1997): 123–37; Christine Meisner Rosen and Christopher C. Sellers, 'The Nature of the Firm: Towards an Ecocultural History of Business', *The Business History Review* 73, no. 4 (1999): 577–600; Christine Meisner Rosen, 'The Business-Environment Connection', *Environmental History* 10, no. 1 (2005): 77–79; Hartmut Berghoff and Adam Rome, eds., *Green Capitalism?: Business and the Environment in the Twentieth Century* (Philadelphia: University of Pennsylvania Press, 2017).

provides rich insight into the motivations of those invoking it.[31] This variety of methods provides a complementary approach to the scalar organisation of this thesis: just as exploring information, control, and privatisation from the local to the international shows how these changes occurred in different ways at different levels, exploring these changes beyond archival research shows how these changes were effected and resonated in ways beyond the textual record of historical decisions. A particular concern of this thesis is how the idea of an 'information age' became entangled with the rise of neoliberal political economy in Britain: to do so, it is thus necessary to study how the aesthetic of the 'information age' has been constructed, why it was constructed, and how it differs from reality. This necessitates not only delving into the archival record, but also people's memories and, through science fiction and the visuals of advertising, cultural change.

A final point I would like to make is that, whilst the British telecommunications system, both as part of the Post Office and BT, is central to this thesis, there are certain key actors (such as Merriman) whom I focus on to avoid anthropomorphising the Post Office and BT as autonomous decision-making entities. Some of the methods I outline above, such as advertising studies, read source material as emblematic of broader organisational attitudes, and risk conflating attitude with agency. I will briefly outline these key actors and decision-makers here, before outlining the broader importance of keeping these actors in mind. The key politicians include: Ernest Marples, Postmaster-General from 1957-9, who pushed through the construction of the Post Office Tower and large-scale automation; Tony Benn, Postmaster-General from 1964-66 and Secretary of State for Industry from 1974-75, who was a strong advocate of both Post Office reorganisation in the 1960s and industrial democracy in the 1970s; Margaret Thatcher, who of course oversaw both the liberalisation and privatisation of BT, as well as championing information technology; Patrick Jenkin, Secretary of State for Industry from 1981-83, who first formally proposed privatising BT to the Cabinet, and tied BT's privatisation to the economic importance of information technology; and Kenneth Baker, Minister for Information Technology from 1981-85, who played a key role in embedding BT's privatisation within information technology policy and discourse.

The key managers and engineers are: Tommy Flowers, whose wartime work at Bletchley Park influenced early electronic switching development; Gordon Radley, Director of Research during World War II and later Director-General, who was a key supporter of Flowers' research and also initiated the relocation of the Post Office research

[31] Darko Suvin, *Metamorphoses of Science Fiction: On the Poetics and History of a Literary Genre*, ed. Gerry Canavan (Oxford: Peter Lang, 2016), 15–27.

station; James Merriman, who, as Engineer-in-Chief, established the core driving principles for development of the British telephone network; William Ryland, Chief Executive, and then Chairman, of the Post Office from 1969-77, who was a key advocate of further separation of the telephone service from the Post Office and the state, and also defended the Post Office's computer modelling activity in Whitehall; J.S. Whyte, Merriman's successor, who also oversaw the establishment of the Long Range Planning Department; Roy Harris, Flower's successor in overseeing telephone exchange development, who implemented many of Merriman's principles and was also one of the key figures introducing information theory into the Post Office; and David Probert, Director of Strategic Modelling in the Business Planning and Strategy Department, a key developer of modelling in the business in the late 1970s and early 1980s.

By focusing on these key managerial, engineering, and political figures, I will analyse and align their views and decisions, and so uncover the trends and philosophies guiding the telephone system, rather than read the system itself as an actor. In this sense, I follow Hughes' approach to the history of technological systems, where the system is the subject, but the historical decisions of key actors – managers, engineers, politicians – are crucial to showing the system as *socio*technical.

Subjects

Interrogating the construction of the 'information age' and the shifting forms of control – particularly those implicated in the change from public to private, and with the advent of computerisation – in the British telephone system is this thesis' goal, and, as mentioned above, I conduct this on various scales. In this section, I shall provide further detail on each chapter, including their evidential bases.

In Chapter Three, 'The Telephone Service: A History of Control', I deliver a historical overview of the British telephone service, starting with the telephone network's nineteenth century origination in competing private local and regional systems, addressing the state's 1912 monopolisation of the telephone network, and then more thoroughly exploring the service's history after World War II. I frame the history in terms of external and internal control, relating weakening external control of the telephone business, starting in 1955 with the separation of Post Office finances from the Treasury, to strengthening internal managerial control over labour, computerisation, and customers. I also situate the liberalisation of the state monopoly and eventual privatisation of BT in 1981 and 1984 in a longer history of weakening state control, complicating the traditional narrative of privatisation as a significant rupture. The evidential basis for this chapter primarily draws from board records and annual reports from the British Postal Museum and Archive and BT Archives, and Treasury records from the National Archives.

In Chapter Four, ‘The Door to Tomorrow? Research Centres, Science Parks, and New Villages’, I undertake an oral and local history of the Post Office’s research centre, which I use to interrogate information age and postmodern conceptions of spatiality and temporality. I look at the transformation of the Post Office and BT’s research centre into a science park and the construction of an ‘instant village’, built in a postmodern, historically evocative, traditional style, known as neo-Vernacular, around the research centre. I show that British Telecom publicity, land developers, and architects constructed Martlesham Heath, the location of this science park and village, as a place – a crystallisation of time and space – through active efforts to evoke the past: for the village, through its neo-Vernacular architecture, and for the science park, through repeated attempts to compare its activity to World War II military research and science ‘boffins’. I thus argue that to see Martlesham Heath as a place purely characterised by the compression of space, as a telecommunications research lab and in the clustering of high-tech firms in a science park, and time, in the rapid construction of an ‘instant village’, is to overlook the significance of permanence and historicity to the construction of these places. The evidential basis for this chapter primarily draws from research and development records from BT Archives and oral histories with BT research staff and Martlesham Heath residents.

In Chapter Five, ‘The Universal Machine: Integrating Computers and Communications’, I examine the computerisation and digitalisation of the telephone network. I situate the development of a failed 1950s electronic telephone exchange known as Highgate Wood within ‘defiant modernism’ and return to James Merriman’s philosophy of ‘information and control’. I argue that two approaches to computing influenced this philosophy: the British ‘government machine’, and cybernetics. I then outline how computer modelling negotiated industrial disputes in telephone exchange computerisation, before moving on to explore the incorporation of the government machine and cybernetics into two projects: System X, an ‘evolutionary’ telephone exchange, and the Integrated Services Digital Network, a new digital standard for transmitting telephone and data signals simultaneously. Overall, this chapter addresses how computerisation and digitalisation shaped and were shaped by information and mechanisation discourses in the telephone system, and influenced new techniques for machine control. The evidential basis for this chapter primarily draws from network planning records from BT Archives and Ministry of Post and Telecommunications records from the National Archives.

In Chapter Six, ‘The Information Highway: Metaphors and Vision in the Telecommunications Network’, I explore two dimensions of the history of transmission technologies, from the construction of London’s Post Office Tower to the roll-out of optical fibre. First, I explore the metaphors used for these technologies, from the Post Office Tower as a ‘lighthouse’ to the growing prominence of the ‘information highway’ in the development of the millimetric waveguide and optical fibre. Second, I follow on from the previous chapter by exploring how the Post Office’s continuing interest in an integrated network, capable of transmitting voice, data, and video, led to repeated attempts to secure a monopoly on cable TV provision in the UK. I also explore the influence that the finance industry had on the telephone system by examining the relationship between the Post Office and a Bank of England and City of London group, the City Telecommunications Committee, demonstrating the influence this had on the growing prioritisation of the City of London by the Post Office and BT at the end of the 1970s and into the 1980s. The evidential basis for this chapter primarily draws from network planning and telecommunications publicity records from BT Archives, the City Telecommunications Committee Records from the Bank of England Archives, and official government publications on cable television and optical fibre.

In Chapter Seven, ‘The Machine Starts: Invention, Prediction, and Surveillance in Telephone Futurology’, I explore the history of the Post Office’s Long Range Planning Department, a futurology department for the telephone system’s engineering and research functions. This chapter continues themes from the previous two by relating telecommunications futurology to various visions of computer control in the telephone system, and I argue that computer modelling of the future paved the way for various forms of computer surveillance in the telephone network. I show that the department’s early imaginative approach to the future was related to concerns about machine control and argue that, in response the financial and fuel crises of the early 1970s, the department developed more sophisticated approaches to the future, including corporate computer modelling, as a way of managing uncertainty. Computer modelling was interpreted as a form of future surveillance, and helped senior management in British Telecom negotiate liberalisation and privatisation by providing a model for how customers might be surveilled and predicted in a competitive telecommunications environment. The evidential basis for this chapter primarily draws from the records of the Long Range Planning Department from BT Archives.

In Chapter Eight, 'The Single World System: Transatlantic Communications from the Cold War to the Information Age', I undertake an environmental and cultural history of transatlantic telecommunications. I explore the development of transatlantic submarine telephone cables by the Post Office/BT in the UK and AT&T in the USA, and the creation of a global communications satellite system, INTELSAT, to answer two questions: first, what were the envirotechnical strategies taken to secure submarine cables and communication satellites in the hazardous environments of the sea-floor and outer space? Second, how did communication satellites come to be the primary symbol of an instantaneous, dematerialised, international communications for the information age? I show that a variety of protective strategies were taken to protect cables and satellites in their hazardous environments, and that these environments became a conquered territory as part of a 1950s and 1960s Cold War rhetoric; however, during the 1970s and 1980s, satellites were increasingly presented by INTELSAT and the USA, its majority stakeholder, as dematerialised and environmentally transcendent compared to European-supported submarine cables. I argue that this image subsequently became the basis for the communications satellite as one of the chief icons of the information age and supported the notion of international communications as global, instantaneous, and dematerialised. The evidential basis for this chapter primarily draws from AT&T advertising records from the National Museum of American History Archives Center, INTELSAT records from the National Air and Space Museum Archives Center and George Washington University Special Collections, and international telecommunications records from BT Archives.

In Chapter Nine, 'The London Ideology: Constructing the Information and Privatisation Movements', I explore the history of BT's privatisation as an episode of policy-making and organisational change. I draw together the approaches to privatisation and information technology by Margaret Thatcher's Conservative government with BT's negotiations of privatisation to argue that BT's privatisation was not only significant for neoliberalism, but also for the nascent information discourse. I show the ways in which privatisation shaped BT, but, more importantly, the ways in which BT shaped privatisation as a wider movement, and argue that privatisation came at a unique moment in which it could tap into both the information and neoliberal discourses, fusing the two and thus playing an important role in intertwining the information age and neoliberalism. The evidential basis for this chapter primarily draws from cabinet and Prime Ministerial records from the National Archives, and board and publicity records from BT Archives.

In Chapter Ten, my concluding chapter, I draw together these different scales and subjects to reflect on the micro, meso, and macro-histories of information and control in the British telephone system, drawing attention to historical trends. I also explore how this history, in different ways, might inform histories of the ‘information age’ and alternative histories of control, and identify areas of interest for further inquiry.

Conclusion

In this introductory chapter, I have outlined the subject of this thesis and the methods used to undertake this study. I have outlined the diverse methods used, and justified them as serving a broader historical goal of understanding how the telecommunication system’s role in the rise of an apparent ‘information age’ became entangled with the privatisation of BT. I have given an overview of the subject for each chapter, explained how these subjects intersect with ‘information and control’, and demonstrated the evidential basis for each chapter. However, before I move onto these historical studies, it is first necessary to review in more detail what is meant by ‘information’ and ‘control’, and how they became so important to both telecommunications management and many social theorists.

2 Critical Review of Literature

Information and Control

Information and control were fundamental to the British telecommunications system in 1967, according to its Engineer-in-Chief, and in the previous chapter I set out the methods and case-studies I will use to study the telephone system as a site of information and control. In the first chapter, I also alluded to the fact that 'information' and 'control' have both had broader resonances in the twentieth century beyond the Post Office and British Telecom, amongst engineers, managers, politicians, and social theorists. It is thus necessary, before undertaking histories of information and control in the British telephone system, to understand where these terms came from, what they have meant to different people, and how they have been theorised in relation to social, political, and technological change. In this chapter, I review the literatures of 'information' and 'control' to understand these histories, explore their relevance and limitations for this thesis' subjects, and explain their positive contributions to my analysis. I start first with 'Information', then move onto 'Control', before concluding.

Information

The first point to make is that the information discourse has been culturally constructed. Ronald Kline had explored its construction through a history of two inter-related fields – cybernetics and information theory – which were created in the wake of World War II.[1] In 1948, Norbert Wiener and Claude Shannon simultaneously published theories of information as the amount of order or disorder in messages, inspired by their wartime work on anti-aircraft control systems and cryptography respectively.[2] Wiener also linked information with control: the input-output feedback loops used to control automatic anti-

[1] Kline, *The Cybernetics Moment*.

[2] Kline, 9–36.

aircraft emplacements' target acquisition became the basis for cybernetics as the study of information, feedback, and control, and this novel science captured the public and scholarly imagination in the 1950s and 1960s.[3]

However, information theory overtook cybernetics, which declined for several reasons: its extensive use and ambiguous definitions led to its disciplinary fragmentation; the problematic connotations of its wide use in the Soviet Union; and its association with counter-culture figures such as Gregory Bateson and Stewart Brand.[4] Meanwhile, the 'information bandwagon' meant that 'information' was used broadly within academia, but also by management scientists and business groups as 'information technology', referring to managerial technologies and techniques, and by social theorists such as Marshall McLuhan and Daniel Bell, who popularised the 'information society' label.[5] By the 1980s, the notion of an 'information age' was firmly established, having completed its journey from its post-war origins in cybernetics and information theory.

Kline's work is especially useful in this thesis for two reasons: first, it shows how the idea of an 'information age' was constructed, and second, Kline also shows how cybernetics established an engineering definition of 'control' with roots in anti-aircraft communication loops. These insights are particularly relevant in Chapters Five, where I explore the influence of cybernetics and information theory on telecom engineers, and Seven, where I explore the influence of the growing information discourse of the 1970s on the Post Office's Long Range Planning Department. However, there are two areas which do not receive his full attention: first, its construction outside the USA; second, information's popularisation in the engineering imagination. Communication networks are the primary medium for transmitting information, and yet the processes which redefined these systems as information networks are not addressed. Here, I will begin to address the first issue, exploring the information discourse in Britain, but this thesis will address both issues.

There is unfortunately no history of a British information discourse, although Kline does not completely neglect the UK, highlighting the importance of English information theorists in popularising broader definitions of information theory, and drawing attention to Margaret Thatcher's promotion of information technologies as a globally significant moment for the information discourse.[6] However, there are several

---

[3] Kline, 68–102, 135–51.
[4] Kline, 179–201.
[5] Kline, 102–34, 202–28.
[6] Kline, 104–12, 203.

histories which address aspects of information technology's development and interpretation in Britain. Tom Lean, on the popularisation of home computing, highlights government efforts in the late 1970s to popularise microelectronics, which he suggests were in response to public fears about a 'microelectronic future', where clerical and manufacturing work would be lost to IT.[7]

James Sumner describes computing in post-war Britain as transitioning from 'defiance to compliance'.[8] Sumner draws on Robert Bud and the Science Museum's concept of 'defiant modernism', developed for the museum's *Making the Modern World* gallery, which describes British technological triumphalism in the 1950s and early 1960s, exemplified by projects such as Comet, the first civilian jet airliner, Bluebird, the speed record-setting land and water vehicles, and Calder Hall, the first commercial nuclear power station.[9] Sumner argues that the British computing industry and policy-making in the 1950s similarly had a national exceptionalist fixation on unique and distinctive hardware but, as the 1960s progressed, this was displaced by compliance with international computing systems, weakening national exceptionalist rhetoric. However, Sumner also points to the Thatcher government's IT rhetoric, which focussed on regenerating post-industrial regions with IT and microelectronic entrepreneurialism, as a potential revival of 'defiance'.

Jon Agar takes a different approach to Lean and Sumner, exploring computing within government, and within a longer history of governmental clerical mechanisation.[10] Agar uses 'discreet modernism' to describe government mechanisers' deliberate obscuring of mechanisation and computerisation, which avoided the problematic representation of government as automatable, rather than run by well-educated 'generalist' Civil Servants.[11] Like Lean and Sumner, Agar points to a transition in the 1970s and 1980s, interlinking the rise of the personal computer, growing public demands for transparent government, and the rise of Thatcherism and neoliberalism, as together responsible for the 'hollowing out' of the state: distributed, networked, individualist personal computing, combined with a public appetite for transparency, and a political

---

[7] Tom Lean, *Electronic Dreams: How 1980s Britain Learned to Love the Computer* (London: Bloomsbury Sigma, 2016), 91–94.
[8] James Sumner, 'Defiance to Compliance: Visions of the Computer in Postwar Britain', *History and Technology* 30, no. 4 (2014): 309–33.
[9] Robert Bud, 'Penicillin and the New Elizabethans', *The British Journal for the History of Science* 31, no. 3 (1998): 305–333.
[10] Jon Agar, *The Government Machine: A Revolutionary History of the Computer* (Cambridge, MA: MIT Press, 2003).
[11] Agar, 424–30.

ideology favouring small government, formed an ideal model for the small state.[12] Agar's work is particularly relevant because the British telephone system was, until 1969, a government department, and I argue in this thesis, particularly in Chapter Four, that the telephone system's philosophy of information and control was heavily influenced by British governmental computing culture. Indeed, James Merriman, the Engineer-in-Chief whose quotes open this thesis, also features in Agar's history, when Merriman lead the Treasury's Office Mechanisation Branch within their Organisation & Methods Division (O&M) in the 1950s.[13]

The work of Lean, Sumner and Agar on computerisation and information technologies is indispensable in understanding the changing cultures of computing in Britain: Lean's work on the popularity of microtechnology and computers in the late 1970s and early 1980s is important in Chapter Nine, where I explore the Conservative party's championing of information technology; Sumner's analysis of 'defiance' and 'compliance' is also relevant to my exploration of Thatcherist information technology policy, as well as providing useful insight into the Post Office's exploration of digitalisation and its crossover with international standard-setting, which I address in Chapter Five. Finally, as mentioned above, Agar's work on the 'government machine' is crucial to understanding the discourse of 'information and control', the origins of which I address in Chapter Five.

However, one area these scholars do not address, which Kline explores in the American context, is the popularisation of 'information age' theories in Britain. Here, I explore one of the earliest and most influential information age theories – Daniel Bell's post-industrial society – not because of its analytical value, but because of its popularity: I show in Chapter Seven that Bell's theory influenced telephone system engineers' visions of the future. Bell, in his 1973 book *The Coming of Post-Industrial Society*, argued that society was moving to a post-industrial form, characterised by technological rationalisation and maximisation of industrial output, a corresponding decline in industrial workforce, and the expansion of the services sector, which he characterised as informational.[14] Bell's work has been criticised as teleological, deterministic, and

[12] Agar, 367–90; for further evidence of this transition, also see Helen Margetts, *Information Technology in Government: Britain and America* (London: Routledge, 1999).
[13] Agar, *The Government Machine*, 309.
[14] Daniel Bell, *The Coming of Post-Industrial Society: A Venture in Social Forecasting* (New York: Basic Books, 1973).

misleading;[15] however, it was nevertheless influential, particularly on telephone system engineers and managers, and so Bell's insights are worth bearing in mind for one of the significant developments I outline in this thesis, particularly in Chapter Seven – the growing emphasis on information services in the telephone system.

Perhaps the most widely-read contemporary information age theory is Manuel Castells' *Information Age* trilogy, which outlines the rise of the 'network society'.[16] Castells argues that capitalism has been restructured to an informational mode of development, where information generates the surplus which capitalism distributes.[17] Castells argues that information has had far-reaching consequences for its own production and distribution, reshaping the global economy, business organisations and networks, work patterns, culture, and space and time. Castells rightly devotes a huge part of his work to how informational capitalism has been worked out not just in the West, but all over the world, as well as considering the consequences of the 'network society' for social and cultural identity.[18]

However, here I specifically want to explore Castells' conception of information and communication technologies.[19] Whilst Castells disavows technological determinism, it is clear that he locates informational capitalism's source in the 'information technology revolution' of the 1970s. Castells claims that technology only 'embodies the capacity for society to transform itself',[20] but his defence would be easier to believe if he did not spend only a single section of a single chapter of his trilogy outlining a superficial linear history of IT. For Castells, informational capitalism is defined by ICT's 'networking logic', which imparts a dangerous teleology: society is apparently transformed by the implacable drive of the networking logic, which itself seems to have spontaneously formed into existence.[21] As has been pointed out elsewhere, this conceptualisation of information and communication technologies – the prime movers for his networking logic – is seriously

[15] Frank Webster, *Theories of the Information Society* (London; New York: Routledge, 2014), 43, 50, 53; Jonathan Gershuny and Ian Miles, *The New Service Economy: The Transformation of Employment in Industrial Societies* (New York: Praeger, 1983).
[16] Manuel Castells, *The Rise of the Network Society*, 2nd ed., The Information Age: Economy, Society and Culture, Vol. 1 (Chichester: Wiley-Blackwell, 2010); Manuel Castells, *The Power of Identity*, 2nd ed., The Information Age: Economy, Society and Culture, Vol. 2 (Chichester: Wiley-Blackwell, 2009); Manuel Castells, *End of Millennium*, 2nd ed., The Information Age: Economy, Society and Culture, Vol. 3 (Chichester: Wiley-Blackwell, 2010).
[17] Castells, *The Rise of the Network Society*, 13–21.
[18] Castells, *The Power of Identity*; Castells, *End of Millennium*.
[19] This is primarily outlined in Castells, *The Rise of the Network Society*, 38–62.
[20] Castells, 7.
[21] Castells, 70, 500.

under-developed.[22] Castells' positive contributions should not be overlooked, however, and, in particular, his insights into the spatial dimensions of the 'information society': whilst I disagree with Castells' assertions of a novel information age, he is one of the leading scholars in recognising distinctive spatial configurations of information technology, such as science parks and IT parks. Castells' conceptualisation of spatiality in these places, which I address in more detail in Chapter Four, is particularly important to my analysis of the Post Office and BT's R&D centre in the same chapter.

The final information theorist I will address is Herbert Schiller, who Frank Webster calls the 'most helpful yet underrated scholar of the Information Age'.[23] Schiller, like Castells, has a huge corpus devoted to information and its effects, such as the projection of US power, increasing class inequality, and the growth of consumer capitalism.[24] However, here I will explore Schiller's analysis of ICT development and privatisation. Schiller attributes privatisation, which he broadly construes as the public sector's decline and the private sector's corresponding expansion, to information and communication technologies, which he argues rose to prominence due to the economic crises of the 1970s.[25] Schiller argues that Western nations turned to ICTs as a new market and industry to gain a competitive edge during economic crisis; this in turn aided the expansion of corporate power and subsequent privatisation movements: ICTs became both the layer through which international business flowed and the commodity which was traded. This doubled significance of information to business strengthened the private sector over the public, and so privatisation ensued.

Schiller's work is not flawless: as Webster points out, Schiller implicitly views capitalism and ICTs as inherently flawed, without due consideration to ICTs' potential benefits.[26] Furthermore, the role of government, as both ICT developer and user, is under-developed in relation to his attention to corporate capitalism; as Schiller's son, Dan Schiller, points out, the nation-state and government have played an important role here, even if private capital has subsequently dominated the sector.[27] This last point is

---

[22] Webster, *Theories of the Information Society*, 132; Jan Van Dijk, 'The One-Dimensional Network Society of Manuel Castells', *New Media & Society* 1, no. 1 (1999): 127–138.
[23] Webster, *Theories of the Information Society*, 195.
[24] Herbert I. Schiller, *Information and the Crisis Economy* (Norwood, NJ: Ablex, 1984); Herbert I. Schiller, *Culture, Inc.: The Corporate Takeover of Public Expression* (New York; Oxford: Oxford University Press, 1989); Herbert I. Schiller, *Mass Communications and American Empire*, 2nd ed. (Boulder, CO; Oxford: Westview Press, 1992); Herbert I. Schiller, *Information Inequality: The Deepening Social Crisis in America* (New York; London: Routledge, 1996).
[25] Schiller, *Information and the Crisis Economy*, 28–43.
[26] Schiller, 190.
[27] Dan Schiller, *Telematics and Government* (Norwood, NJ: Ablex, 1982).

particularly important given the major role that state ownership and government plays in the history of the British telephone system. However, overall, Schiller has been a particularly helpful analyst in developing my understanding of why, in the late 1970s and early 1980s, information technology became so important to Western governments, and why these governments saw deregulation and privatisation as policies aiding the development of information technology – in this respect, Schiller has greatly informed the historical context for this thesis, and particularly Chapter Nine, which deals with the privatisation of BT.

Many of my above analyses have been greatly aided by the insights of Frank Webster, whose critiques point to other helpful ways of theorising information.[28] Webster rejects information age theories, often on the grounds of technological determinism, and instead theorises ‘business civilisation’: the ascendancy of private over public supply and ownership, increasing commodification and market criteria, and competition prioritised over regulation.[29] Webster is explicitly influenced by Schiller’s interlinking of information and corporate capitalism, and exemplifies business civilisation by devoting a significant part of his *Theories of the Information Society* to the privatisation of BT, the liberalisation of the state monopoly, and the creation of BT’s competitor, Mercury.[30] Webster points out, like Schiller, the predominance of business interests in pressuring the government to liberalise BT’s monopoly, in the creation of Mercury (it was financed by Barclays, British Petroleum, and Cable & Wireless), and in BT and Mercury’s prioritisation of business telecommunication services over residential users. Webster also argues that informational developments must be more fully accounted for in terms of historical antecedents and continuities and so establishes a need, which this thesis addresses, for more rigorous historical research into the causes and effects of information and communication technologies.

Control

There is no history of the cultural significance of ‘control’, although it has not been entirely neglected: Kline sees wartime control systems and engineering as integral to cybernetics and information theory, and Thomas Hughes draws attention to ‘control’ as part of a growing ‘language of systems’ in the 1920s, rising from the electrical

[28] Webster, *Theories of the Information Society*.
[29] Webster, 345, 348.
[30] Webster, 168–75.

engineering of power networks.[31] As I will show, during the 1970s and 1980s there was also significant scholarly attention to the problem of 'control'. In this section, I will focus on various theories of control, how they relate to information, and how they might inform a history of information and control in the British telephone system. I will also address two other twentieth-century transitions which touch on control: neoliberalism and postmodernity.

Frank Webster, with Kevin Robins, points to planning and control as two forces more fundamental than information to contemporary society.[32] They define planning as social management and administration, and control as authoritative activities such as surveillance; but both are mutually reinforcing: social planning and administration requires surveillance, and, conversely, surveillance reinforces administrative power.[33] They view ICTs as important to planning and control, such as the ways satellites, cables, and computers are used to co-ordinate mass production, distribution and consumption, which they call the 'growth of the programmed market'.[34] However, Webster and Robins situate this in a longer history originating in the early-twentieth-century scientific management of Frederick Winslow Taylor, arguing that Taylorism's reliance on planning and control became a model for society itself, extending out from the factory and into distribution and consumption, culture and politics.[35] Webster and Robins' account is not wholly satisfying, implying that the development of information and communication technologies followed the Taylorist logic of planning and control, without detailing these developments. Nevertheless, their account is useful in demonstrating the non-revolutionary importance of information technologies, in drawing attention to a longer history of control, and in paying attention to organisational and bureaucratic context.[36] This intersection of managerial and technological interpretations of information and control is at the core of this thesis, and so their attention to Taylor has helped clarify how managerial forms of control have intersected with technological systems: this is particularly relevant to Chapter Five, where I explore the intersection of a British mode of civil administration (Agar's 'government machine') with Post Office engineers' understandings of cybernetics and information theory.

[31] Kline, *The Cybernetics Moment*, 18–26; Hughes, *Networks of Power*, 368.
[32] Frank Webster and Kevin Robins, 'Plan and Control', *Theory and Society* 18, no. 3 (1989): 323–51.
[33] Webster and Robins, 327.
[34] Webster and Robins, 338.
[35] Webster and Robins, 331–38.
[36] Webster and Robins, 345.

However, given their attention to managerial thought, it is odd that Webster and Robins mention Taylor but not Henri Fayol, the French management theorist who established 'control' as a keyword for management in business and industry in the early twentieth century. Fayol, who began his career as an intern in the Commentry coal mine in 1860, rising to managing director of the Commentry-Fourchambault Company by 1888 and trading the company back into profit, first publicly spoke of his theories of management in 1900 and 1908, and published his seminal work, *Adminstration Industrielle et Générale*, in 1916.[37] In it, Fayol outlined five elements of management: planning, the long-term forecasting of productive capacity; organising, the medium-term arranging of productive capacity; command, the generation of productive operations; coordination, the short-term synchronisation of productive resources; and finally, control, the verification that activities conform with defined plans and corresponding adjustment.[38] In this vision of control, then, is a process somewhat similar to the feedback loops of control present in cybernetics: the monitoring of outputs used as an information loop to feed back into and adjust inputs. Differences nevertheless remain – Fayol does not prioritise the feedback loops which are so central to cybernetics: for cybernetics, feedback-control is central, whereas for Fayol, it is only one of five central elements of management.

I raise Fayol because whilst cybernetics, with its engineering origins, appears of primary relevance to engineering conceptions of control within the telephone system, it is important to note the influence that management theory may have had: Merriman and other senior engineers were, after all, as much managers as they were engineers. The importance of management theory on influencing corporate ends and the dynamics of capitalism have been stressed by several scholars. Rakesh Khurana, in his history of American business schools, emphasises that not only does managerial education shape individuals who progress to significant positions within important institutions, but education and management shape one another, producing complex sets of interacting norms which ultimately define corporate goals.[39] More ambitiously, Luc Boltanski and Eve Chiapello have taken managerial discourse as central to the shifts in late twentieth century capitalism, arguing that managerial thought's normative and prescriptive tone

[37] Henri Fayol, 'Adminstration Industrielle et Générale', *Bulletin de La Société de l'Industrie Minérale*, no. 10 (1916): 5–164.
[38] Jean-Louis Peaucelle and Cameron Guthrie, 'Henri Fayol', in *The Oxford Handbook of Management Theorists*, ed. Morgen Witzel and Malcolm Warner (Oxford: Oxford University Press, 2013), 49–54.
[39] Rakesh Khurana, *From Higher Aims to Hired Hands: The Social Transformation of American Business Schools and the Unfulfilled Promise of Management as a Profession* (Princeton; Oxford: Princeton University Press, 2007), 5.

was important to systematising managerial practice and rules of behaviour in a way conducive to the expansion of capitalism.[40] Recognising the influence of managerial theory on telecom engineers is thus important to identifying not only how the telephone system's corporate goals were set, but also its role in Britain's political economy.

Taylorist management theory was not the only influence on Webster and Robins' concepts of planning and control: they also partially derive their conceptualisations from Anthony Giddens' attention to control and information in the modern state. Giddens identifies two types of control: allocative control, exerted through the asymmetric allocation of material resources, means of production and produced goods (and so analogous to Webster and Robbins' 'planning'), and authoritative control, exerted through informational and organisational activities, such as surveillance, which co-ordinate subjects (the basis for Webster and Robins' 'control').[41] Giddens argues that these forms of control have been fundamental to the emergence of the modern nation-state, which is defined by the increased organisation and mediation of control through four major institutions: surveillance, capitalist enterprise, industrial production, and the state's monopoly on violence through policing and the military.[42]

Information and communication, especially technologies thereof, are thus important as control and surveillance are not possible without information, and so Giddens notes that 'all states have been "information societies", since the generation of state power presumes reflexively monitored system reproduction, involving the regularized gathering, storage, and control of information applied to administrative ends'.[43] Telecommunication is an important demarcator for Giddens, as since the nineteenth-century invention of the telegraph, the state has had access to instant communication and control; Giddens thus argues that 'the state has been electronic longer than imagined'.[44] Giddens' insights serve valuable roles in this thesis: in addition to Kline's analysis of the cultural construction of the information age, Giddens shows the ways in which the state and society have been informational prior to the mid-twentieth century. Giddens also demonstrates the importance of information to the control functions

[40] Luc Boltanski and Eve Chiapello, *The New Spirit of Capitalism*, trans. Gregory Elliott (London; New York: Verso, 2007), 57–60.
[41] Anthony Giddens, *Power, Property and the State*, A Contemporary Critique of Historical Materialism, Vol. 1 (London: Macmillan, 1981), 51–52; Anthony Giddens, *The Nation-State and Violence*, A Contemporary Critique of Historical Materialism, Vol. 2 (Cambridge: Polity Press, 1985), 2.
[42] Giddens, *The Nation-State and Violence*, 3–5.
[43] Giddens, 178.
[44] Giddens, 178.

of the state, and so has motivated my attention to how the telephone system's surveillance apparatus was reinterpreted during privatisation, which I explore in Chapter Seven.

The micro-scale of workplace control is apparent for Webster and Robins and for Giddens, and so I now turn to Deleuze's 'society of control', which argues that control is being electronically built into society from the bottom up, and is displacing Foucault's disciplinary society.[45] Foucault's disciplinary society, of spaces of bodily self-control, such as barracks, hospitals, and prisons, is being displaced by the spatially extensive, continuous control and influence of subjects by information and communication technologies; where Foucault's society is full of rigid 'molds', the extensive, fluid, electronic control seen in, for example, electronic travel cards, creates a society of 'modulation'.[46] Foucault and Deleuze's perspectives are useful for their attention to the smaller scales: society here is not a product of macro-scale forces, such as capital, but instead produced through the micro-accumulations of power originating with personal bodily discipline, and, in the society of control, electronic monitoring and modulation.

However, both views are not without their issues: Foucault and Deleuze, the latter particularly, are empirically shallow, and as Giddens notes, Foucault's archetypal disciplinary spaces, the prison and the barracks, were closed, totalising, spaces, in contrast to the open schools and workplaces experienced by most people.[47] Giddens argues that Foucault's most compelling insight is the rise of new administrative, disciplinary techniques, such as the employer's file on its employee, an informational administrative mode of surveillance.[48] It is here where I think Foucault's insights (and Deleuze's) lend themselves to an analysis of control in Britain's telephone system: control should not just be conceived of as something exerted outwardly by managers and engineers, via the telephone system, on users and the nation at large, but also an internal micro-scale phenomenon which refers not just to the control of the system, but how the system and its organisation – the Post Office and British Telecom – sought to control its employees. These insights have been particularly helpful in drawing my attention to new, computerised forms of monitoring and influencing staff within the telephone business, which I address in terms of electronic databanks in Chapters Three and Nine, and in terms of computer modelling in Chapter Seven.

---

[45] Michel Foucault, *Discipline and Punish: The Birth of the Prison*, trans. Alan Sheridan (London: Penguin Books, 1991); Gilles Deleuze, 'Postscript on the Societies of Control', *October* 59 (1992): 3–7; Gilles Deleuze, *Negotiations, 1972-1990*, trans. Martin Joughin (Columbia University Press, 1997), 174–75.

[46] Deleuze, 'Postscript on the Societies of Control', 4.

[47] Giddens, *The Nation-State and Violence*, 185–86.

[48] Anthony Giddens, *Social Theory and Modern Sociology* (Cambridge: Polity Press, 1987), 156.

A theory of control with some similarities and stark differences to Deleuze is Seb Franklin's argument that control, mediated through digital technologies, forms the episteme of late capitalism.[49] Similarly to Deleuze, and drawing from cybernetics, which he argues has informed the current digital condition, Franklin argues that digital control technologies render individuals as programmable objects of inputs and outputs. However, Franklin differs from Deleuze in also addressing the macro-scales of control, and argues that digital technologies have materially and metaphorically produced this condition by providing the basis for control as a system of capitalism which purely exploits and dispossesses human life. Crucially, this system also obscures itself by emphasising information flows – the 'information economy' – and so de-emphasising capitalist control over the human inputs and outputs to these flows. Franklin is particularly insightful in two regards: first, in his attention to digitalisation over information, which is an angle I develop throughout this thesis; second, in drawing attention to the information economy's obfuscation of materiality, which is another subject I address, particularly in Chapter Eight's exploration of transatlantic communications networks and their environments.

However, there are two critiques I wish to make: the first applies to many of these theories of control, and that is Franklin's inattention to control's longer discursive history. As I raised in this section's introduction, Hughes points out that control was part of a growing language of systems since at least the 1920s, and so to name control as purely the episteme of late capitalism neglects this history. Second is Franklin's generalisation of digitality, which draws in a sweeping array of technologies. In doing so, Franklin misses out on the technical specificities of digitalisation and their socially-constructed, contradictory interplay with control. This thesis does not entirely oppose Franklin's arguments, which are insightful, but specifies, complicates, and historicises digitalisation in ways which Franklin does not.

A final theorisation of control I want to address, before I move onto control in neoliberalism and postmodernity, is James Beniger's 'control revolution'.[50] Beniger, like Webster and Robins, argues that, counter to a late-twentieth-century information revolution, the real revolution occurred in the late nineteenth century. Beniger argues that mass production of the nineteenth century's long industrial revolution generated crises in distribution and consumption, which in turn created pressures for the development of new technologies of control, defined as 'purposive influence toward a predetermined goal'.[51]

---

[49] Seb Franklin, *Control: Digitality as Cultural Logic* (Cambridge, MA: MIT Press, 2015).
[50] Beniger, *The Control Revolution*.
[51] Beniger, 6–7.

Technology here is broadly construed, ranging from new transportation and communication technologies to facilitate distribution, to new financial technologies to facilitate international trade, to advertising, broadcasting and market research as techniques for exerting 'weak' control over consumption.[52] In Beniger's view, Taylorism was part of a broader orientation to controlling commodity chains – production, distribution, retail, and consumption.[53] This is more convincing than Webster and Robin's account, in which Taylorism is cast as the model for modern society, but is seemingly also unique among the multiple solutions used to coordinate mass production.

However, Beniger's weakness, in contrast to Webster and Robins, is his technological determinism and the circular reasoning this leads him to. Beniger's control revolution is a technological response to crises in over-production which were themselves generated by technology; hence, technology begets technology and in doing so, reshapes society. Beniger's spectacular, flawed, defence is that this in fact reflects a biological drive towards control which has existed in life since its origins in the protein soup of prehistory, thus supplanting technological determinism with biological determinism.[54] A more charitable reading is that Beniger's industrial systems of control are sociotechnical, composed of both technological and human inputs and outputs. Whilst perhaps still overly reductive, this reads technological systems similarly to Thomas Hughes' 'sociotechnical systems', which I addressed in the previous chapter.[55] Beniger's account is also, of all the above, perhaps the most comprehensive historical account of techniques of control throughout the nineteenth and twentieth centuries, and his orientation towards the commodity chain of production, distribution, communication and consumption resembles Webster's attention to 'business civilisation' and the 'programmed market', and Giddens' attention to surveillance and capitalist enterprise. In terms of this thesis, Beniger's primary influence has been in highlighting how seemingly disparate industrial activities – such as marketing and telecommunications – can be aligned into single systems with guiding philosophies, which has helped me conceptualise how the marketing and development of telecommunications can be oriented to similar ends. However, I modify Beniger's decentred and somewhat actorless analysis by following Hughes' influence in recognising that such systems are composed by the actions and beliefs of key actors.

[52] Beniger, 17–18, 8.
[53] Beniger, 294–97.
[54] Beniger, 31–60.
[55] Hughes, 'The Evolution of Large Technological Systems'.

I will now turn to other analyses of twentieth century transitions which implicitly deal with control: neoliberalism and postmodernity. Neoliberalism is a novel political economy which took hold in the West in the 1970s and 1980s, variously defined as: a political economy prioritising individual entrepreneurial freedom using an institutional framework of free trade, free markets, and strong private property rights;[56] a free market political economy of taxation structures favouring capital accumulation over income redistribution, industrial policies minimising state presence (through deregulation or privatisation), and reduced welfare spending;[57] and the promotion of free markets, individual responsibility, and global homogeneity.[58] The simple summarisation is that the state prioritises the market as the most effective way of allocating resources and maximising the social good, in contrast to the strong state presence which preceded neoliberalism. Whilst interpretations of the exact causal mechanisms behind neoliberalism's rise also vary, the broad commonality is that various crises in the world financial system – the OPEC oil embargo and energy crisis, periods of inflation and stagflation, the end of the Bretton Woods international monetary agreement – created an opportunity for a new political economy to establish itself.[59] The point I want to make is that neoliberalism can also be framed as a new political economy of control, shifting allocative control of resources and social good from the state to the market.

Both Britain and information and communication technologies have been heavily implicated in the rise of neoliberalism, adding further interest to a history of the British telephone system. David Harvey has argued that information and communication technologies are privileged in neoliberalism because they facilitate increased speed and volume of market transactions, and have created new industries to capitalise on, both of which prioritise the market.[60] In Britain, the rise of neoliberalism has been situated within the transition from a 'post-war consensus', characterised by a strong welfare state, mixed economy, and trade union consultation, to the rise of Thatcherism, a British flavour of neoliberalism enacted through council house sales, monetarist fiscal policy, and the

---

[56] David Harvey, *A Brief History of Neoliberalism* (Oxford; New York: Oxford University Press, 2005), 2.
[57] Monica Prasad, *The Politics of Free Markets: The Rise of Neoliberal Economic Policies in Britain, France, Germany, and the United States* (Chicago: University of Chicago Press, 2006), 4–5.
[58] Kean Birch, 'Neoliberalism: The Whys and Wherefores … and Future Directions: Neoliberalism', *Sociology Compass* 9, no. 7 (2015): 571.
[59] Harvey, *A Brief History of Neoliberalism*, 12; Prasad, *The Politics of Free Markets*, 2–3.
[60] Harvey, *A Brief History of Neoliberalism*, 157–58.

privatisation of British Telecom.[61] This last act is thus a convergence of the importance of Britain and ICTs for the rise of neoliberalism, as the privatisation of BT has been cast as both the starter gun for a worldwide privatisation movement and a policy episode which refocussed Thatcherism and neoliberalism into a moral imperative.[62] The British telephone system, both as a landmark privatisation and in how ICTs are implicated in the neoliberal political economy, is thus clearly historically significant to neoliberalism as a new political economy of control.

The rise of neoliberalism has been situated within theories relating changing forms of capitalism to broader societal changes, conceptualised by some as modernity and others as postmodernity. As with many of the concepts covered thus far, there are varying definitions of modernity: Zygmunt Bauman calls modernity the 'production of order';[63] David Harvey defines it as human emancipation through rationality and rationalisation, particularly of time and space;[64] Giddens sees modernity as institutionally characterised by surveillance, capitalism, industrialism and militarism, and epistemologically founded upon the reflexivity of social thought and action.[65] As with neoliberalism, these varying formulations all touch on forms of control and so transitions in modernity can also be conceptualised in terms of control. For example, Giddens identifies modernity's increasing reflexivity, its accelerating, chronic revising of social practices, as responsible for late modernity's unstable and mutable character.[66] Bauman, in contrast, differentiates modernity as the search for order from 'liquid modernity', a condition of instability and insecurity.[67] Other accounts addressing transitions in capitalism and modernity in terms of organisation and control include Peter Wagner's 'organized modernity' and Scott Lash and John Urry's 'disorganized capitalism'.[68] However, here I wish to particularly focus on David Harvey's account of postmodernity and capitalism given the ways it touches on communication technologies.

---

[61] Arthur Marwick, *British Society Since 1945*, 3rd ed. (London: Penguin, 1996), 18, 107, 278, 307; Sean Glynn and Alan Booth, *Modern Britain: An Economic and Social History* (London; New York: Routledge, 1996), 186–87; Prasad, *The Politics of Free Markets*, 12.
[62] Prasad, *The Politics of Free Markets*, 11, 37; Harvey, *A Brief History of Neoliberalism*, 60–61.
[63] Zygmunt Bauman, *Modernity and Ambivalence* (Cambridge: Polity Press, 1991), 15.
[64] David Harvey, *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change* (Oxford: Blackwell, 1990), 249.
[65] Anthony Giddens, *The Consequences of Modernity* (Cambridge: Polity Press, 1990), 38, 59.
[66] Giddens, 40–45.
[67] Zygmunt Bauman, *Liquid Modernity* (Cambridge: Polity Press, 2000).
[68] Peter Wagner, *A Sociology of Modernity: Liberty and Discipline* (London; New York: Routledge, 1994); Scott Lash and John Urry, *The End of Organized Capitalism* (Cambridge: Polity Press, 1987).

Harvey argues that postmodernity is not a schism with modernity, but rather a shift in some practices – cultural, social, economic, political – in response to a change in the management of capitalism.[69] Harvey draws on the regulation school approach to capitalism, articulated by a broad collective of Marxian analysts such as Michel Aglietta, Robert Boyer, and Alain Lipietz, which conceptualises capital accumulation in terms of how it is stabilised, and identifies different 'regimes' of accumulation, which are associated with 'modes of social and political regulation'.[70] The transition from one regime to another thus means changes in the modes of social and political regulation, and the significant change for Harvey is the transition from a Fordist-Keynesian mode of accumulation, characterised by a power balance between organised labour, large corporate capital and mass production, and the nation-state, to flexible accumulation, characterised by flexible production and the increasing use of pliable credit and financial instruments to regulate capital.[71] It is important to recognise that this change is not as hegemonic as Harvey or the regulation school presents: Michael Piore, Charles Sabel, Jonathan Zeitlin and Philip Scranton have all argued for greater recognition of the historical importance of flexible, small units of production, such as the family firm, to the American economy.[72] However, where Harvey differs from these accounts is that, even if this transition is over-stated, his attention is on how flexible accumulation, even as an ideal, produces time-space compression. The condition of postmodernity is produced by the experiences of this compression.[73]

It is here that Harvey implicates information and communication technologies in the shift from Fordist-Keynesian to flexible accumulation and from modernity to postmodernity. ICTs like communication satellites are crucial for the time-space compression required to facilitate flexible co-ordination of production and capital flows,

---

[69] Harvey, *The Condition of Postmodernity*, vii.
[70] Harvey, 121; Michel Aglietta, *A Theory of Capitalist Regulation: The U.S. Experience* (London: Verso, 2000); Robert Boyer and Yves Saillard, eds., *Regulation Theory: The State of the Art*, trans. Carolyn Shread (London; New York: Routledge, 2002); Alain Lipietz, 'New Tendencies in the International Division of Labour: Regimes of Accumulation and Modes of Regulation', in *Production, Work, Territory: Geographical Anatomy of Industrial Capitalism*, ed. Allen J. Scott and Michael Storper (London: Allen & Unwin, 1986).
[71] Harvey, *The Condition of Postmodernity*, 121–97.
[72] Michael Piore and Charles Sabel, *The Second Industrial Divide: Possibilities For Prosperity* (New York: Basic Books, 1984); Charles Sabel and Jonathan Zeitlin, 'Historical Alternatives to Mass Production: Politics, Markets and Technology in Nineteenth-Century Industrialization', *Past & Present*, no. 108 (1985): 133–176; Philip Scranton, *Figured Tapestry: Production, Markets and Power in Philadelphia Textiles, 1855-1941* (Cambridge: Cambridge University Press, 1989); Charles F. Sabel and Jonathan Zeitlin, eds., *World of Possibilities: Flexibility and Mass Production in Western Industrialization* (Cambridge: Cambridge University Press, 1997).
[73] Harvey, *The Condition of Postmodernity*, 284–307.

as well as in cultural and social experiences of compressed time and space, such as the rise of the mass media and international TV broadcasting.[74] This results in the aesthetic condition of postmodernity – postmodernism – which connotes ephemerality, instantaneity, and volatility.[75] Harvey's point is that whilst postmodernity has the appearance of chaos, this is a surface manifestation of a transition in the control of capitalism and the new information and communication technologies which facilitate that transition in control.

Harvey is unabashedly Marxist in seeing capitalism as prime mover, and whilst he mostly manages to avoid the technological determinism of historical materialism, his role for technology is fairly simplistic. However, Harvey's account is still useful for further adding to the changing dimensions of control which draw on information and communication technologies, and because of its attention to cultural and aesthetic responses to technological time-space compression within modernity and postmodernity, which aids a historical study of these technologies not just as they were developed, but also as they were formulated aesthetically and culturally. Harvey here has been useful to understanding how technological change has been presented with respect to the Post Office and BT's own corporate identity, which I explore in detail in Chapter Four.

I have raised these theories of control not to choose a specific analytical framework, but to make two points about the importance of control in a history of the telephone system. The first is that communications systems are implicated in all these theories, but not entirely satisfactorily; technological change is subordinated to broader needs – co-ordinating commodity chains, flexible accumulation, state control – whilst not actually explored to identify how those needs informed technological development and use. The second is the theories which explicitly deal with control all overlook the rhetorical significance of 'control' as a concept; this thesis aims to understand why 'control' was so explicitly important to the telephone engineers and managers, and yet none of these theories provide tools for analysing that rhetorical significance, or, indeed, why these theorists themselves see 'control' as so fundamental. A history of the British telephone system is thus important for both fleshing out the role of information and communication technologies in shifting patterns of control, and for more fully understanding the importance of 'control' itself.

[74] Harvey, 161, 165, 232, 293.
[75] Harvey, 285–87.

Conclusion

What then can be said about 'information' and 'control'? In this chapter, I have reviewed literature on both subjects, and the key historical findings have been information and control's engineering and managerial lineages from cybernetics and Fayol. Information became a frame for describing how all forms of communication could be unified into one category, launched from the popularity of information theory, and in the 1970s and 1980s information technology in Britain entered the popular and policy-making lexicon, whilst also shifting from compliant standard-setting to a potentially defiant industrial policy regime. Control can be seen in both the cybernetic sense of input-output feedback loops, and the Fayolian sense of monitoring corporate and industrial outputs to feed into other managerial activities, including planning, organising, commanding, and so on.

However, I have also shown how a range of scholars have diversely interpreted information and control. For Bell, information comes as part of the transition to a service-based post-industrial society, whilst for Castells, information underpins a new, networked regime of capitalism, and for Schiller, information was the focal point for the neoliberal response of the 1980s to the crisis economies of the 1970s. Webster and Robins offer a Giddens-esque interpretation of Taylorist control, whilst for Giddens himself, control refers to both modes of allocating resources and exercising authority; Beniger goes further to view control as constitutive of society itself. Deleuze sees control as a networked, modulating, micro-scale phenomenon produced by electronics and information technologies, whilst Franklin views control as the cybernetisation of late capitalism through digital technologies. For Harvey, control is one way to describe the tensions between modernism and postmodernism as a reflection of transitions in capitalist control.

These accounts all inform my analysis, but they can range from teleological to inattentive when explaining the dynamics behind the development of modern telecommunications, which is near omnipresent in these theories. A deeper inspection of these developments is thus needed.

3 The Telephone Business

A History of Control

A history of information and control in Britain's telephone system cannot proceed without first addressing the historical organisation of that system. In this chapter, I outline the history of the telephone business from the first use of telephones in Britain, through the state's monopolisation of telephony, and the end of this monopoly in 1981 with the creation of BT and liberalisation of telecommunications. I do not address the history of BT's privatisation in this chapter: it is significant enough to merit its own chapter (Chapter Eight) and moreover, draws together threads from throughout this thesis. The history of BT's privatisation would thus be a poor introduction, but makes an excellent conclusion, and so is left for the end.

Instead, with this chapter, I focus on one of this thesis' core themes – control – and analyse the multiple types of control which surface in the history of the telephone business. Control in this chapter is broadly divided into two forms – external and internal – but some care is needed with this morphology. External control is taken as the organisational status and financial controls of the telephone business as set out by government, whilst internal control refers to the strategies operated by management within the telephone business and over the technological system. As I shall show, there are multiple registers within these forms as well: a history of external control ranges from smaller-scale policy initiatives, such as experiments in industrial democracy, to a more systemic loosening of external control, tied to crises and shifts in the management of nationalised industries. Likewise, a history of internal control shows differentiation in both target and technique: telephone managers and engineers devised strategies for controlling customers and employees, and the techniques deployed to do so ranged from managerial reorganisation and rationalisation to mechanical and computerised systems of monitoring and evaluation.

This chapter also builds from prior histories of the Post Office and telephone business. The most comprehensive history of the British telephone business is D.C. Pitt's *The Telecommunications Function of the British Post Office*, an application of organisational theory to a case study of the telephone business.[1] Pitt's work has been influential in highlighting the tensions between external political control of the telephone business and its internal structure, but it also has its limitations. Published in 1980, it only addresses the history of the telephone business up until its corporatisation in 1969, and so does not explore the consequences of corporatisation, the experiences of the 1970s, or liberalisation and privatisation in the 1980s. Moreover, Pitt's goal is to highlight the importance of key individuals – who were often ministers rather than managers – in organisational change, rather than broader technological and other contextual factors, which means he often overlooks the internal processes of technological and managerial change which influenced the history of the telephone business.

Other useful histories are the authorised history of the Post Office by Duncan Campbell-Smith, who, unlike his predecessor Martin Daunton, does include the telephone business up until its separation from the Post Office in 1981; Mark Thatcher's (no relation to the former Prime Minister) international comparison of the political management of the telephone businesses in Britain and France; and Kenneth Lipartito's analysis of Americanisation in the telephone business.[2] However, a common issue throughout these histories is externalist lines of argumentation, which focus on the controls exercised by government and quantitative measures of performance, and neglect the internal dynamics of structure and mechanisms of control operated by the telephone business. My primary purpose here is to establish an organisational history of control which the remainder of the thesis builds from, but in my attention to the business's internal dynamics of control, also flesh out a history neglected by these prior accounts.

Monopolisation and Incrementalism

The history of the telephone business up to 1955 shows a business that, once monopolised by the state, was subservient to external governmental control. I divide this into two broad

[1] Douglas C. Pitt, *The Telecommunications Function in the British Post Office: A Case Study of Bureaucratic Adaptation* (Farnborough: Saxon House, 1980).
[2] Campbell-Smith, *Masters of the Post*; M.J. Daunton, *Royal Mail: The Post Office since 1840* (London: Athlone Press, 1985); Thatcher, *The Politics of Telecommunications*; Kenneth Lipartito, 'Failure to Communicate: British Telecommunications and the American Model', in *Americanization and Its Limits: Reworking US Technology and Management in Post-War Europe and Japan*, ed. Jonathan Zeitlin and Gary Herrigel (Oxford; New York: Oxford University Press, 2000), 153–79.

periods: nineteenth and early twentieth-century debates about whether the state should own Britain's nascent telephone system, and the early to mid-twentieth century, characterised by tensions between the government's external control and the Post Office's internal control of the business.

The early history of the Post Office and telecommunications lies not with telephones, but with telegraphs. The first telegraph company in Britain was the Electric Telegraph Company, formed in 1845, and by 1861 it was head of a cartel of five telegraph companies. Public dissatisfaction with these companies' price-fixing agreements had swelled since the mid-1850s, which spurred calls for the nationalisation of the telegraph system, and an 1865 price hike by the cartel further incentivised nationalisation. Subsequently, the Telegraph Act of 1869 gave the Post Office an indefinite monopoly on all electrically-carried communications, which would have consequences down the line for the growth of telephony from the 1870s, and so the Post Office became the sole carrier of telegraphy in Britain, operating a nationwide infrastructure.[3]

In 1877, however, the Post Office declined to set up a telephone business after receiving a demonstration from Thomas Edison; the Post Office's Engineer-in-Chief, William Preece, believed that the telephone would only have limited use.[4] Several regional private telephone companies were set up, including the Telephone Company Limited, a subsidiary of the Bell system, and Edison's own Edison Telephone Company of London, which eventually repeated the patterns of telegraphy and cartelised under pressures to avoid duplication of network plant and satisfy the public demand for a nationwide network.[5] This threatened any future telephone business the Post Office might want to operate, and so in 1880 the High Court found in the Post Office's favour that the 1869 Telegraph Act extended to telephony.[6] However, the Treasury, which controlled Post Office spending, refused to authorise the Post Office's expansion into telephony, partly motivated by telegraph protectionism.[7] Campbell-Smith characterises this period as the 'restrictionists' in the Treasury set against the 'expansionists' in the Post Office.[8]

A middle way for telephone expansion operated for the remainder of the nineteenth century. Telephone companies were given licenses to operate by the Post Office, which also took over the construction of a publicly-owned telephone exchange

[3] Campbell-Smith, *Masters of the Post*, 176–79.
[4] Campbell-Smith, 193.
[5] Pitt, *The Telecommunications Function in the British Post Office*, 25.
[6] Pitt, 27.
[7] Pitt, 25–27.
[8] Campbell-Smith, *Masters of the Post*, 192–94.

system. The privately-owned networks had been, up to this point, local, and so in 1884 the Trunk Wire Agreement allowed the private development of trunk wires between main cities, forming the basis for a national telephone network.[9] In 1889, the various private telephone companies began to amalgamate, and by 1894 a private monopoly, the National Telephone Company, had been formed.[10] Alongside that, however, there had also been further moves, in response to public demand for inter-city trunk calling and the realisation that the telephone system may constitute a natural monopoly, to give the Post Office greater control over the telephone system, and so the 1892 Telegraph Act had required the NTC to sell all trunk wires in the UK to the Post Office in the public interest.[11]

In 1899, a fascinating and under-studied experiment with the British telephone system began: municipalisation. Under municipalisation, local authorities were permitted to apply for telephone licenses, and many did so. Most returned to the main Post Office-operated network with time, but one municipal network – Kingston upon Hull, operated by the Hull Corporation – did not. The Hull telephone system is the only telephone system outside of Britain's main network, and lasts to this day. Today, it is operated by KCOM Group, formerly known as Kingston Communications, and the company maintains a virtual monopoly over the Hull area as it is uneconomical for BT to build its own *de novo* infrastructure. The Hull telephone system is outside of the scope of my thesis, but as Britain's only successful experiment with municipal telephony, it surely deserves greater historical attention than that which has been given here or elsewhere.

Despite the Post Office's takeover of trunk lines in 1892, public dissatisfaction with NTC's private monopoly remained. In 1901, the Post Office agreed a deal with NTC to purchase its London assets in 1911, taking over the country's largest regional network, and in 1905, a Select Committee inquiry recommended that the state support the Post Office's purchase of the remainder of the British telephone system in 1912.[12] Thus, by 1912, the Post Office had an effective public monopoly on British telephone service, and it would shortly buy out the remaining municipal systems, with the exception of Hull.[13] For the remaining first half of the twentieth century, the administration of the telephone business would be characterised by friction between Post Office 'expansionist' advocates

[9] Pitt, *The Telecommunications Function in the British Post Office*, 29.
[10] Campbell-Smith, *Masters of the Post*, 194.
[11] Pitt, *The Telecommunications Function in the British Post Office*, 32–35.
[12] Campbell-Smith, *Masters of the Post*, 195; Pitt, *The Telecommunications Function in the British Post Office*, 37.
[13] Pitt, *The Telecommunications Function in the British Post Office*, 37; Campbell-Smith, *Masters of the Post*, 195.

of greater telephonic freedom and central government – particularly Treasury – ‘restrictionists’.

The mediocre performance of the telephone business in the early years of Post Office ownership stimulated review into both internal and external control mechanisms. This performance was not chiefly the Post Office’s fault, as it had inherited a system saddled with years of under-investment: the first ‘Strowger’ automatic telephone exchange (i.e. not requiring a human operator) was not installed until 1912, in Epsom, 24 years after its invention in the USA.[14] The losses of the telephone business, partly influenced by World War I, plunged the entire Post Office into the red in 1919-20, and despite the return of pre-war growth rates, incentivised further review into the Post Office.[15] In 1920, the Coates Committee, investigating pricing, focussed its attention internally, arguing that the Post Office needed a more commercial structure, whilst the Cecil Committee of 1921-22 focussed on the external status of the telephone business, recommending that it should be separated from the Post Office altogether.[16] Internally, the Engineer-in-Chief, A.J. O’Meara, had also called for internal restructuring, arguing that a high-level board overseeing two separate postal and telephone boards would be more effective. None of these recommendations were taken up, although separate directorships were created for posts and telephones, and so O’Meara resigned in 1921.[17]

Criticisms of the telephone business increased throughout the 1920s and into the 1930s. Treasury spending controls had a significant influence, slowing both the rural development of the telephone system and the total number of exchanges built across the 1920s.[18] The Liberal party’s campaign for the 1929 general election included liberating the telephone business from state control, whilst two ‘gamekeepers turned poacher’, as Pitt puts it, the former Postmaster-General Clement Attlee and Roundell Palmer, the Viscount Wolmer and former Assistant Postmaster-General, also added their voices to calls for the Post Office to become more business-like and less restrained by the Treasury – although neither, unlike the Liberals, advocated separating out the telephone service from government altogether, either as a public or private corporation.[19]

In 1932 the Bridgeman Inquiry into the Post Office was thus set up, and it focussed on both the internal and external dimensions of control over the telephone system.

[14] John Liffen, ‘Telegraphy and Telephones’, *Industrial Archaeology Review* 35, no. 1 (2013): 22–39.
[15] Campbell-Smith, *Masters of the Post*, 264.
[16] Pitt, *The Telecommunications Function in the British Post Office*, 46.
[17] Campbell-Smith, *Masters of the Post*, 267–69.
[18] Pitt, *The Telecommunications Function in the British Post Office*, 47–52.
[19] Pitt, 49–51.

Internally, Bridgeman recommended the replacement of the Post Office Secretariat by a board of senior men, including those with engineering expertise, to enhance the flexibility of internal control, whilst externally, it recommended the loosening of Treasury control over the GPO.[20] The exact nature of this new relationship was remitted to a joint Post Office/Treasury committee, which determined that the Post Office would make a fixed annual payment of £10.75m to the Treasury and the excess would be saved in the Post Office Net Surplus Fund for the Post Office to spend.[21] These reforms, as both Campbell-Smith and Pitt note, were gradualist rather than fundamental,[22] and as Pitt points out, they did little to halt debate about exogenous Treasury control: the £10.75m annual payment meant that it was very difficult for the Post Office to save up any surplus whatsoever and so the 'Gordian knot' of the Treasury-Post Office relationship remained intact.[23]

The next significant period for the telephone business, World War II and its aftermath, meant a tightening of external controls. For the war effort, the Treasury suspended the Bridgeman funding arrangement and, after the war was over, refused to revert to the Bridgeman arrangements. A Parliamentary Committee endorsed this position in 1950, concluding that Britain's strained economic conditions meant that a return to the surplus fund was not possible.[24] The post-war nationalisations undertaken by Labour had also excluded the Post Office: Clement Attlee, now the Prime Minister, had opposed transforming the Post Office into a public utility corporation before the war, favouring an 'administrative agency' run by a fixed-term manager instead, and, as both Pitt and Campbell-Smith note, was far more interested after the war in bringing industry closer to Whitehall, rather than distancing it.[25] Pitt also points out that the war had shown the strategic importance of telecommunications, and so added another incentive to keep the Post Office under tighter control. This was highlighted by the 1952 Post Office and Telegraph Money Bill, which prioritised trunk spending over local exchange and customer equipment to ensure resilient connections between strategically important urban centres.[26] However, this pattern of greater external control from 1939 would change – fractionally – in 1955, and establish a new trend in the dynamics of internal and external

[20] Pitt, 78–82.
[21] Pitt, 80–82; Campbell-Smith, *Masters of the Post*, 299–301.
[22] Pitt, *The Telecommunications Function in the British Post Office*, 71; Campbell-Smith, *Masters of the Post*, 299.
[23] Pitt, *The Telecommunications Function in the British Post Office*, 102.
[24] Pitt, 102–4.
[25] Campbell-Smith, *Masters of the Post*, 297, 373; Pitt, *The Telecommunications Function in the British Post Office*, 103.
[26] Pitt, *The Telecommunications Function in the British Post Office*, 152.

control in the Post Office which would imbricate commercialism, managerialism, and technology.

Mechanisation and Corporatisation

In the previous section, I gave a brief descriptive overview of the history of the telephone business from the 1870s to the mid-1950s. In the following sections, which cover the period directly addressed by this thesis, I make a more detailed analysis of the dynamics of external and internal control which shaped the business. In this section, which addresses the period from 1955 up to the Post Office's corporatisation in 1969, I particularly focus on mechanisation and managerialism. Here, I refer to mechanisation in two senses: the mechanisation of the telephone network, but also, through new technological and managerial techniques, the mechanisation of internal control, which, as I show in this section and throughout this thesis, were intimately connected.

In 1955, a new arrangement between the Post Office and Treasury was arranged, motivated by the feeble performance of the telephone business. By 1955, there was a waiting list of 380,000 people for telephone service, and 40,000 of those had been waiting for over three years; half a million new applications were expected in 1955-56 alone.[27] This motivated the first substantial post-war review of the Post Office's relationship with government, and led a Home Affairs subcommittee to conclude that a 'comprehensive overhaul of Post Office finance was necessary'.[28] The new arrangement, a five-year trial, would return to a setup similar to Bridgeman, where the Post Office would pay a fixed sum of £5m per year to the Treasury, excess profit would spill over into a General Reserve Fund, and the Post Office would manage its finances independently. This scheme was also motivated by the additional investment need for a new technique of mechanisation in the trunk telephone system: Subscriber Trunk Dialling (STD), a system which enabled telephone service subscribers to directly call people through the trunk network, rather than require an operator to connect them.[29]

I accord STD special significance not just because it motivated the telephone business's greater freedom in 1955, but also because of how it surfaced the Post Office's attitudes to machine control and control of its employees and customers. Queen Elizabeth II inaugurated STD on December 1st, 1958, by placing Britain's first automatic trunk call

[27] *Report on Post Office Development and Finance*, Cmd. 9576 (London: HMSO, 1955).
[28] 'Prime Minister: Post Office Finance (C.P.(55) 146)' 17 October 1955, PREM 11/2459, TNA.
[29] *Report on Post Office Development and Finance*.

to the Lord Provost of Edinburgh in a televised ceremony in Bristol. STD was made possible, as proclaimed in Movietone and Pathé newsreels, newspapers, and the Post Office's own automation reports, by GRACE, the 'robot telephone operator' and 'electronic brain'.[30] GRACE was in fact not a robot, but a register-translater: a device which registers the numbers dialled and translates them into a form recognisable by the mechanical switches in the telephone exchange.

GRACE surfaced both the broad popularity of 'robots' and the concurrent 'automation scares' which pervaded Britain at the time. Kline has drawn attention to the popularity of robots in the 1950s, and so it is unsurprising that the Post Office labelled GRACE the 'robot telephone operator' and the 'brain' of the telephone system, but I would like to draw further attention to GRACE's intersection with fears about automation.[31] The immediate post-war decades for Britain were a time of automation scares, primarily in the motor industry – the *Daily Herald* called a Standard Motors strike the 'men against robots strike', whilst *The Daily Telegraph* suggested the nefarious hand of Communist Party agitators.[32] There were competing narratives about automation – Leon Bagrit, Chairman of Elliot Automation, delivered the BBC Reith Lectures in 1964 on the possibilities of the 'Age of Automation' and Harold Wilson, in his famous 1963 'white heat' speech, promised to harness automation for the national good – but the broader tone was, as Alan Booth describes, that 'automation was synonymous with redundancy and worker resistance', whilst David Edgerton describes the 'visions of jobs disappearing into factories without humans'.[33] Automation was also a fear outside Britain – David Noble has described post-war American concerns about the 'Automatic Factory' and 'Machines Without Men' and Jacob Hamblin has shown how UNESCO perceived

---

[30] *'GRACE' in Action* (British Movietone, 1958), https://www.youtube.com/watch?v=YUy1f1eGNew; *Queen Dials Edinburgh* (British Pathé, 1958), https://www.youtube.com/watch?v=wfH0Xr1rIcY; D.A. Barron, 'Dialling for Trunk Calls: A Cheaper Telephone Service', *The Manchester Guardian*, 4 December 1958; *Full Automation of the Telephone System*, Cmnd. 303 (London: HMSO, 1957); *Telephone Policy: The Next Steps*, Cmnd. 436 (London: HMSO, 1958).

[31] Kline, *The Cybernetics Moment*, 70.

[32] 'Car Workers Vote to Stay Out Against Automation', *Daily Herald*, 1 May 1956; 'Automation Firm Sacks 2,600 Men', *Daily Herald,* 31 May 1956; 'Communist Link in Car Strike. Party Activity at Standards. Orders given to Fight Automation', *Daily Telegraph*, 2 May 1956.

[33] Leon Bagrit, 'The Age of Automation', *The Reith Lectures* (BBC Radio 4, 1964); Harold Wilson, 'Labour's Plan for Science' (Labour Party Annual Conference, Scarborough, 1 October 1963); Alan Booth, *The Management of Technical Change: Automation in the UK and USA since 1950* (Basingstoke; New York: Palgrave Macmillan, 2007), 8; David Edgerton, *Shock Of The Old: Technology and Global History since 1900* (London: Profile Books, 2006), 85.

even the problem of atomic energy through the lens of automation.[34] It is thus possible that the Post Office humanised GRACE, which would displace trunk telephone operators from their jobs, as a 'robot' and 'brain' to mitigate these fears; the Post Office acknowledged that exchange automation would decrease operator numbers by half by 1970.[35]

These concerns fed into a 1959 Post Office report, *Telephone Service and the Customer*, which interlinked mechanisation with control over customers and telephone operators. Ernest Marples, the Postmaster-General, announced the report, based on a study of customer service in AT&T's long-distance telephone service, in the House of Commons with the statement, 'In this age of mechanisation, we must never forget the importance of human personal service'.[36] The report addressed strategies used to provide customers with quality service in a system where contact with human operators was diminishing, and three key outputs came from the study: first, remaining operators were permitted to speak more informally, conveying a more pleasant and helpful tone; second, the telephone business embarked upon market research, undertaking methodical and regular surveys of public opinion; finally, the business trialled new facilities – premium telephones, such as the 'Trimphone', kiosks, and coin boxes – with customer-friendly aesthetics.[37] The report was also prefaced with eight maxims for the telephone business:

1. For any great enterprise objectives must be clearly stated and widely understood.
2. The aim and purpose of the telephone service is not only to serve but to please the customer. Everything must be subordinated and surrendered to that aim.
3. Scientific advances are making possible the most sweeping and radical changes in telephone history. These match the electronic age in which we live. Much will always remain to be done but technically our course is charted for years ahead.
4. Scientific progress by itself is not enough. What really counts is the spirit of the men and women behind the machines. Machines must be servants not masters.

[34] David F. Noble, *Forces of Production: A Social History of Industrial Automation* (New York: Knopf, 1984), 67–69; Jacob Darwin Hamblin, 'Exorcising Ghosts in the Age of Automation: United Nations Experts and Atoms for Peace', *Technology and Culture* 47, no. 4 (2006): 734–756.
[35] *Telephone Policy: The Next Steps*.
[36] 'HC Deb: Telephone Service' 11 March 1959, Vol 601 cc1260-63, Hansard.
[37] *Telephone Service and the Customer* (London: HMSO, 1959); 'Survey of Public Opinion on the Telephone Service' 1960, TCB 2/365, BTA; 'Survey of Opinion on Subscriber Trunk Dialling' 1961, TCB 2/303, BTA.

5. Our telephone service must be a personal service to meet the customers' wishes. We must study their wishes all the time; we must then satisfy them by a service which is courteous, pleasing and speedy.
6. To that and all our thinking, training, procedures, and organisations will be directed – in every department at every level. And we must act boldly. We must not be paralysed by precedent or inhibited by fear of error. If we try and fail, we shall be forgiven. If we do not try, we shall be condemned – and rightly so.
7. But success will elude us unless we are a united, determined and dedicated team with management and staff moving in harmony.
8. Finally, we must never forget we are a monopoly. We do not face the challenge of competition. We must not fail them. Let our purpose be to give the finest and most courteous service in the world. And let it be seen that we have this daily sense of purpose.[38]

This was a remarkably explicit formulation of the telephone business's self-definition, produced in the short-term as a response to increasing automation, but also against a backdrop of greater freedom from government control. These maxims thus juxtapose the Post Office's external status – the eighth maxim's comment on monopoly – with the new strategies of studying customers – maxims five and six – and with an affirmation of the telephone business's control over machines – the fourth maxim. One statement from the fourth maxim – 'Machines must be servants not masters' – is particularly revealing, as it implies that operators, then being displaced by the machines, were also servants, whilst also surfacing the automation fears of the period.

Telephone Service and the Customer is important because it shows, as machine control accelerated with the Post Office's greater freedom, the telephone business's twofold response: first, to counterbalance mechanisation by permitting operators to speak more informally, demonstrating greater human freedom to the public; second, to enhance its strategies of 'weak' control over customers through marketing surveys and premium, fashionable, apparatus such as the Trimphone. There is an apparent contradiction here between the Post Office's claim that it had 'subordinated and surrendered itself' to the customer and my assertion that these strategies constituted a form of 'weak' control. Here, I draw on Beniger's characterisation of 'weak' control as a form of influence over consumption, and argue that, whilst, there was undoubtedly a move to meet public desires for human service and consumer choice, it should not be forgotten that the Post Office

[38] *Telephone Service and the Customer*, ii.

still had a monopoly over these customers, and moved to capitalise on customer desires by embarking on market research.[39] These techniques were not a way of putting the customer in control, but rather served a dual purpose of mitigating public fears about machine control and increasing consumer investment – emotionally and financially – in the telephone system.

The adoption of new managerial techniques in the telephone business continued into the 1960s, and can be contextualised against a broader managerialist ethos in British government. A useful example here, deployed by Pitt also, is the 1961 Plowden Report, which addressed Britain's rising public expenditure by, in part, recommending the greater use of managerial techniques.[40] The report has since established a reputation for establishing a managerial revolution in government.[41] However, this has since been critiqued on grounds of novelty and success: Agar points out that computerised systems for management and expenditure planning were in place in the Treasury several years prior to the report (as, indeed, the report both noted and praised), whilst Rodney Lowe criticises Plowden's success by drawing attention to the rapid escalation of public expenditure in its wake and noting that the Fulton Committee, which reported on public expenditure seven years after Plowden, also aimed at stimulating managerialism in the Civil Service.[42] However, whilst Plowden may be neither especially novel nor successful, it nevertheless represents a managerial spirit of the time and interlinks this spirit with the government's loosening control over public spending, which proves relevant for the telephone business.

The telephone business was well-acquainted with the public expenditure concerns which had motivated Plowden: in 1957, Britain's balance of payments crisis and the government's stop-go economic policy cut public sector investment, reducing the telephone business's ability to finance investment and affecting the system's performance. As a result, the 1959 Conservative manifesto pledged to separate the Post Office's finances from the Treasury, and so in 1961, after re-election, the five-year trial period from 1955 was formalised with the 1961 Post Office Act, formally reviving a surplus trading fund for the Post Office and allowing the organisation to balance its own books. Alongside these changes to external control, a technocratic managerialism took

[39] Beniger, *The Control Revolution*, 386–89.

[40] Pitt, *The Telecommunications Function in the British Post Office*, 137–38.

[41] Trevor Smith, *The Politics of the Corporate Economy* (Oxford: Martin Robertson & Company, 1979), 147; G.K. Fry, *The Administrative 'Revolution' in Whitehall* (London: Croom Helm, 1981), 35.

[42] Agar, *The Government Machine*, 330–31; Rodney Lowe, 'Milestone or Millstone? The 1959–1961 Plowden Committee and Its Impact on British Welfare Policy', *The Historical Journal* 40, no. 2 (1997): 463–491.

hold internally. As Plowden had suggested, management techniques such as 'accountable management' and 'management by objectives' were imported from the private sector,[43] and computerisation was also strengthened: in 1957, the Post Office had opened its first computer centre, London Electronic Agency for Pay and Statistics, or LEAPS, with the promise that 'the drudgery and, by modern standards, inefficiency of many dull, repetitive clerical routes will be swept away by the "electronic office"' in the Post Office's pioneering computerisation of business efficiency.[44] In 1965, LEAPS was followed by a second London computer centre in Charles House, Kensington, which the *Post Office Magazine* heralded as 'The Post Office Enters the Computer Age', and computerised the preparation of customers' statements and bills.[45] Underscoring this, the Charles House Computer Centre featured in a Post Office publicity poster series entitled 'Progress' (Figure 3.1).[46] The new relationship with the Treasury was thus accompanied by new techniques of control featuring – as with STD – the deployment of computerisation.

However, continuing events and critiques throughout the 1960s highlighted that the 1961 Act had neither loosened external controls as much as promised, nor had the telephone business improved correspondingly. Successive Treasury capital restrictions in 1962 and 1963 had limited the Post Office's capital borrowing,[47] causing Campbell-Smith to characterise the 1961 Act as less a landmark and more a 'modest milestone' in the Post Office's quest for freedom from the Treasury.[48] The National Economic Development Council ('Neddy'), set up by the Conservatives in 1962 to reverse Britain's poor economic performance, attempted to rectify this by announcing in 1963 a near £900m five-year spending plan for the telephone service.[49] However, in 1966, Harold Wilson's 'July measures' followed, which, amongst other measures taken to avoid devaluation of the pound, cut government spending, reducing the telephone business's 1967-68 investment programme by £11.5m.[50] The sluggish demand for telephone service during these restrictions (see Figure 3.2) motivated critiques of the telephone business's performance from a range of sources. The 1968 report, *Britain's Economic Prospects*, by the American think tank the Brookings Institution was sharply critical of the 1961 Act,

---

[43] Pitt, *The Telecommunications Function in the British Post Office*, 140.
[44] 'Introducing You to LEAPS', *Post Office Magazine*, October 1957, 300.
[45] 'The Post Office Enters the Computer Age', *Post Office Telecommunications Journal* 17, no. 1 (1965): 2–4; 'The Computer Centre in Kensington', *Post Office Telecommunications Journal* 17, no. 1 (1965): 6–8.
[46] 'Progress: Kensington Computer Centre' 1965, TCB 420/IRP (PR) 4, BTA.
[47] Pitt, *The Telecommunications Function in the British Post Office*, 141.
[48] Campbell-Smith, *Masters of the Post*, 423.
[49] *The Inland Telephone Service in an Expanding Economy*, Cmnd. 2211 (London: HMSO, 1963).
[50] Pitt, *The Telecommunications Function in the British Post Office*, 145.

Figure 3.1 'Progress': the Kensington Computer Centre, 1965. Courtesy of BT Archives.

which, by enabling the Post Office to raise tariffs, had unintentionally reduced telephone service demand, whilst various newspaper op-eds demanded greater freedom and a more commercial attitude for the Post Office.[51]

Numerous committees and reports into the Post Office thus formed during the 1960s to review its external status and internal structure, and Tony Benn's arrival as Postmaster-General in October 1964, after Labour entered government, gave them further

[51] Richard Caves, ed., *Britain's Economic Prospects* (Washington: Allen & Unwin, 1968); Pitt, *The Telecommunications Function in the British Post Office*, 146; 'Freedom for the GPO', *The Guardian*, 4 August 1966; 'All Change At The Post Office', *The Times*, 4 August 1966; 'A Commercial Post Office', *The Financial Times*, 1 March 1967.

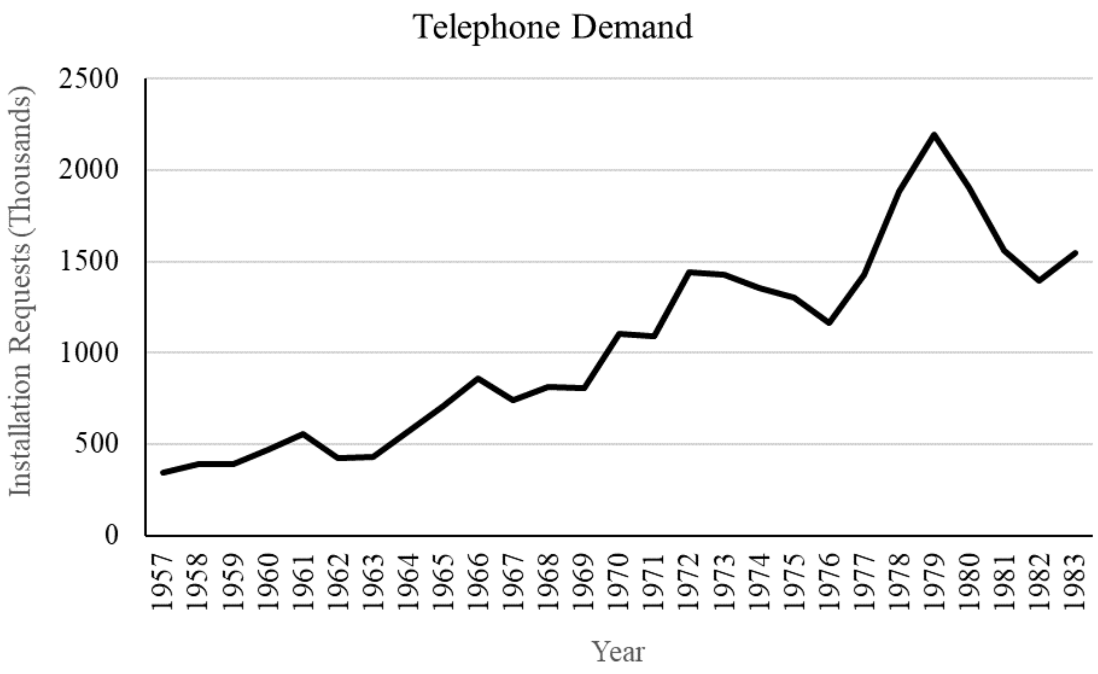

Figure 3.2. Slumps in telephone demand after the 1962-63 capital restrictions, the 1966 July Measures, the 1973-75 recession, and the early 1980s recession. Sources: 'Post Office/BT Annual Reports and Accounts', 1958-1984, TCB 10/TCC 11/TCD 12/TCE 13, BT Archives.

impetus. Benn's tenure as a young, modernising, Postmaster-General is well-covered by Campbell-Smith,[52] and here it will suffice to say that one of Benn's top priorities was transferring the Post Office out of the Civil Service and into a public corporation (the 'break') and extricating the telephone business out into a separate public corporation (the 'split'). In March 1965, Benn argued to Wilson that Post Office reform was 'a necessary act of modernisation' which would permit the telephone business to become more entrepreneurial, more dynamic, and collaborate with the private sector more effectively.[53] The performance of the Post Office and Benn's entry as Postmaster-General triggered a series of reports: two Joint Working Parties made up of Treasury, Post Office and Cabinet officials, an NEDC subcommittee ('Little Neddy'), an inquiry by the Select Committee for the Nationalised Industries, and a review of the Post Office undertaken by the American management consultants, McKinsey.

Due to Benn's advocacy, the first Joint Working Party was set up, chaired by the Treasury. The working party's report was ostensibly investigatory in nature, making no recommendations, and yet still surfaced friction between the Post Office and Treasury.

[52] Campbell-Smith, *Masters of the Post*, 438–69.
[53] 'Annex A: Copy of a Minute from the Postmaster General to the Prime Minister. Organisation of the Post Office' 2 March 1965, PREM 13/1063, TNA.

One Treasury official compared the Post Office's attitudes to that of 'a Colonial nationalist movement anxious to get rid of the shackles of imperialist rule!'.[54] The working party's final report arrived in late July 1965 and was inconclusive, but mainly – and perhaps unsurprisingly, given the Treasury's chairmanship – drew attention to the disadvantages of corporatisation and suggested that the Post Office was akin to a nationalised industry in all aspects except formal status already.[55] James Callaghan, then the Chancellor of the Exchequer, was more explicit with his distaste for the notion, expressing to Wilson his 'doubt whether there is much profit in pursuing the matter just now'.[56] However, Benn countered with a historical treatise to Wilson, covering much of the background outlined above, which Benn called 'a hundred years of argument for reform'.[57] Wilson thus agreed to set up a second committee to review the structure of the Post Office, effectively siding with Benn and agreeing that the Post Office would be reformed. The task of the second Joint Working Party was to frame the nature of reorganisation, and it concluded that the key question for the government was the 'split' – whether the Post Office would become one or two separate organisations.[58]

A 'Little Neddy', a National Economic Development Council subcommittee of cabinet ministers, also considered the 'split'. The committee studied Benn's arguments and the working parties' reports, and by February 1966 concluded that the Post Office should become a nationalised industry and public corporation, with one board supervising both the postal and telephone businesses; it was recommended that businesses should be separated at executive level, so that they would effectively function independently from one another.[59] The announcement of these conclusions was delayed by the general election in March 1966 and Benn's replacement as Postmaster-General by Edward Short in June 1966 (Benn moved to take over the Ministry of Technology), which effectively halted Benn's ambitions for the full separation of the postal and telephone businesses. Short moved to announce the corporatisation quickly, leaving the question of internal

[54] 'Mr Hunt: P.O. (W.P.)(65)4' 11 June 1965, T 319/167, TNA.
[55] 'Organisation of the Post Office: Report by a Working Party of Officials' July 1965, PREM 13/1063, TNA.
[56] 'Prime Minister: Post Office Organisation' 20 July 1965, PREM 13/1063, TNA.
[57] 'Post Office Re-Organisation: Memorandum by the Postmaster General' August 1965, PREM 13/1063, TNA.
[58] 'Steering Group on the Organisation of the Post Office: Report of the Steering Group' 18 January 1966, T 319/173, TNA.
[59] 'ED(PO)66 2nd Meeting. Cabinet Ministerial Committee on Economic Development. Sub-Committee on Status and Organisation of the Post Office' 10 February 1966, CAB 134/1761, TNA.

structure for later, and so it was announced on August 3rd, 1966, that the Post Office would become a nationalised industry.[60]

The internal organisation of the Post Office was thus a key subject for two further reviews of the Post Office which took place during the 1960s, both of which, in different ways, surface the role of technology and managerialism in the structure of the subsequent Post Office corporation. The first review, by the Select Committee on Nationalised Industries (SCNI), commenced after the announcement that the Post Office would be corporatized and so is particularly interesting for how the review focussed its attention on the Post Office's internal structure. The committee noted in February 1967, in its final report, that their position would guide the Post Office's future organisation, and so re-iterated the possible structures: first, a federal structure with semi-autonomous regional boards, comparable to gas and electricity in Britain and the Regional Bell Operating Companies of the USA's Bell System; second, a semi-split, with a top policy co-ordinating board with separate statutory executives for Posts and Telecoms, largely autonomous from one another; finally, and favoured by the committee, was a recreation of the Post Office in its then current form, but as a corporation, maintaining central support services.[61] Here, the telephone business's perceived capacity for technological progress undermined the opportunity for an internal split: the Post Office's Research Station at Dollis Hill, which the two services shared and forms the focus of the next chapter, was considered by the select committee as 'the greatest drawback' for an internal cleavage of the postal and telephone services.[62] The two ostensibly shared the research station, although nearly all staff were focussed on telecommunications research, with a small group working on postal mechanisation.[63] The committee, however, had 'serious doubts whether the postal service, by itself, could maintain an active and imaginative research organisation', and expressed its hope that a common research organisation would cross-fertilise technical thinking between the businesses.[64] The external status of the telephone business had thus been undermined by the perceived effectiveness of its internal structures for technological development.

---

[60] Campbell-Smith, *Masters of the Post*, 470.

[61] 'House of Commons. Minutes of Evidence Taken before the Select Committee on Nationalised Industries. Meeting at Post Office Research Station, Dollis Hill' 12 July 1966, 202–5, POST 122/10345, BPMA.

[62] 'First Report from the Select Committee on Nationalised Industries: The Post Office. Volume 1: Report and Proceedings of the Committee' (London: HMSO, 1967), 205.

[63] 'House of Commons. Minutes of Evidence Taken before the Select Committee on Nationalised Industries. Meeting at Post Office Research Station, Dollis Hill, 12 July 1966, POST 122/10345, BPMA'.

[64] 'First Report from the Select Committee on Nationalised Industries: The Post Office. Volume 1: Report and Proceedings of the Committee', 205.

The final report I address, the McKinsey review, was, like the SCNI review, internally oriented, and made a series of recommendations to increase the independence of the postal and telephone businesses, and to enhance the telephone business's control over Engineering and Research. Ronald German, the Post Office's Director-General, had initially hired McKinsey in 1965 to review the postal business's organisation and management, but, as Campbell-Smith notes, McKinsey was quickly embraced by Benn as a potential ally in the fight for the 'split'.[65] The presence of McKinsey is also indicative of this period's managerialist spirit: Christopher McKenna notes that McKinsey's reputation underwent rapid growth in Britain during the 1960s and 1970s, highlighting *The Times* journalist who wrote in 1969, 'Ask anyone to name a management consultant and chances are, if he is British, that the answer will be "McKinsey"'.[66] McKinsey made several significant recommendations geared at increasing the independence of the telephone and postal businesses, and enhancing the telephone business's technology machinery: first, McKinsey, once the split was abandoned, supported the semi-split – the maximal possible separation of the two businesses within the same corporation; second, it recommended that the Engineering Department, a shared service between the postal and telephone businesses, should be abolished, along with the position of Engineer-in-Chief, and instead engineering functions should be split; finally, it also recommended that the Research Department should be moved into the telephone business, rather than exist as a shared service.[67]

The formal plans for the Post Office's corporatisation were announced in March 1967 and blended the recommendations of these reviews.[68] The government approved the break, as proposed by the second Joint Working Party and 'Little Neddy', but rejected the split or semi-split, as had been advocated by Benn and McKinsey, after the SCNI's argument that central functions, like research, strengthened the case for keeping the postal and telephone businesses together. The board, however, followed McKinsey's recommendations in other ways: whilst the semi-split did not happen, separate Managing Directors were appointed for the postal and telephone businesses; the Engineering Department and position of Engineer-in-Chief was abolished; and the telephone business took over Research. Formal, separate headquarters were set up for the postal and

---

[65] Campbell-Smith, *Masters of the Post*, 461–64.

[66] Christopher D. McKenna, *The World's Newest Profession: Management Consulting in the Twentieth Century* (Cambridge: Cambridge University Press, 2006), 166; 'In This Concluding Article, Joe Roeber Analyzes the Attitudes of Top Management to Their Consultants', *The Times*, 7 July 1969.

[67] 'McKinsey and Company: Progress Review with Postmaster General' 23 February 1967, POST 72/906, BPMA.

[68] *Reorganisation of the Post Office*, Cmnd. 3233 (London: HMSO, 1967).

telephone businesses, whilst a Central Headquarters remained to house the businesses' central support functions. These structural changes, as shown in Figures 3.3 to 3.5, are perhaps also suggestive of McKinsey's further influence: pre-corporatisation, the Post Office had an extremely flat structure, whereas post-corporatisation, the organisational structure much more closely resembles the hierarchical organograms of the Chandlerian corporation. Chandler's point is that this structure developed as a way of controlling the market, and whilst the Post Office remained a monopoly, I would suggest that McKinsey, the archetypal American management consultants of the 1960s, perhaps acted as 'market-by-proxy', applying its experiences of the American managerial corporation to the Post Office, and so influencing the eventual structure of the new Post Office corporation. The Post Office Corporation, formally vested on October 1st, 1969, was thus a hybrid, where external influences had prevented the full independence and separation of the postal and telephone businesses, and yet maintained its monopoly, whilst its internal re-structuring enhanced and reflected the growing managerial control within the telephone business.

Corporatisation to Liberalisation

After the corporatisation of the Post Office, management introduced new managerial methods and rationalised existing techniques; however, whilst these internal control strategies developed, continuing problems for Britain and the telephone business throughout the 1970s show that the external performance and control of the state remained an issue. In this section I will first address the managerial tools developed during and after corporatisation, and then outline the external pressures and constraints on the telephone business through the 1970s, called a 'dismal decade' by Campbell-Smith,[69] and which culminated in the separation of the postal and telephone businesses and liberalisation of the telecommunications monopoly in 1981.

The corporatisation of the Post Office stimulated new departments, tools, and techniques for enhancing managerial control in the telephone business over both customers and employees. Market research was formally reorganised into the Telecommunications Marketing Department, and with this reorganisation came a renewed focus on market research which carried from corporatisation in the late 1960s throughout the 1970s.[70] Merriman set up a Management Services Department, which he described as harnessing 'technological opportunity' and 'scientific man-management' to

[69] Campbell-Smith, *Masters of the Post*, 488.
[70] 'Market Research Reports' 1969 1981, TCC 101, BTA.

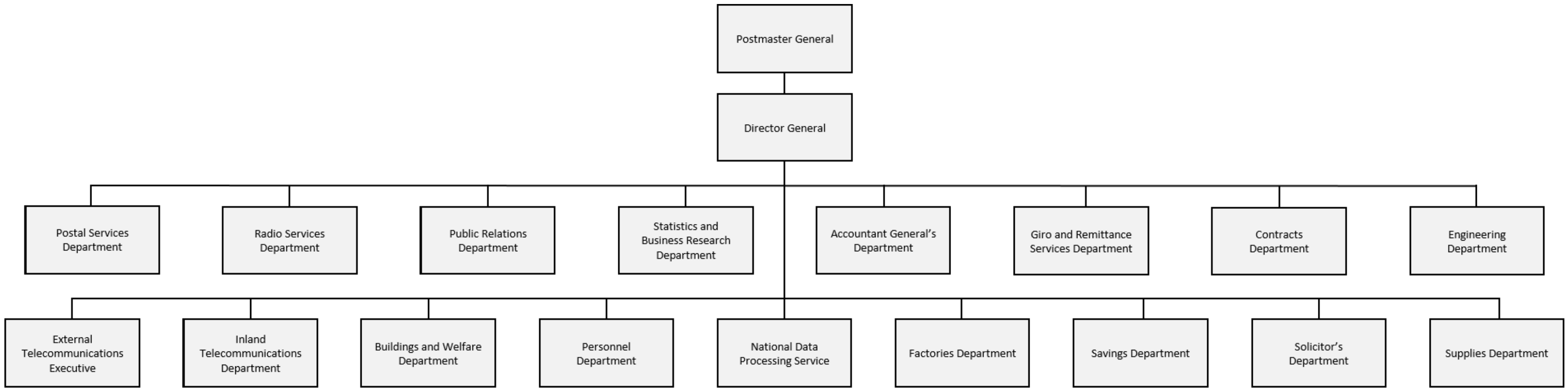

Figure 3.3 Post Office central structure pre-corporatisation. Source: The British Imperial Calendar and Civil Service List. London: HMSO, 1968

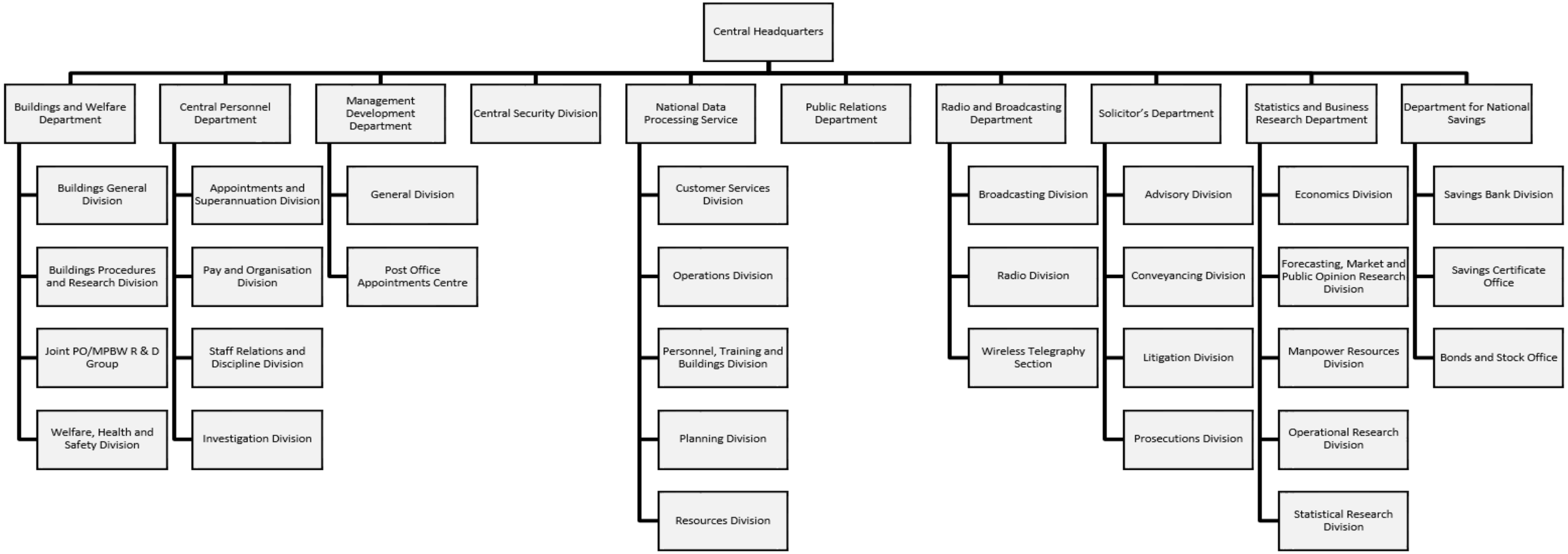

Figure 3.4. Post Office central headquarters structure post-corporatisation. Source: James Elder/BT Archives

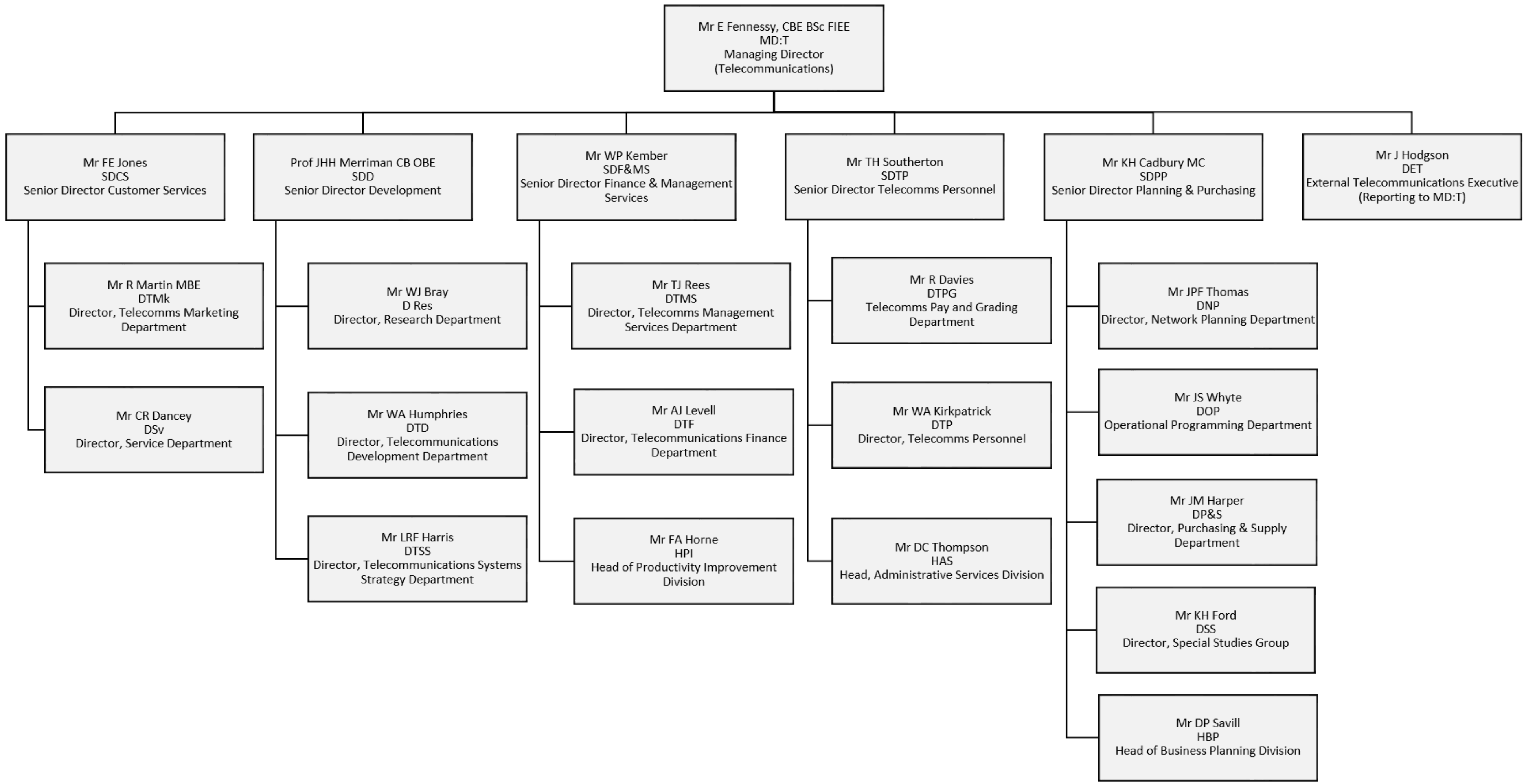

Figure 3.5. Post Office telecommunications headquarters structure, post-corporatisation. Source: James Elder/BT Archives.

increase productivity. For example, the department used work measurement studies and statistical and computer-aided analyses, such as Monte Carlo simulations, to produce work-flows of engineers' days to improve staffing arrangements.[71] I return to Merriman's Management Services Department in more detail in Chapter Five, where I relate management mechanisation to telephone switching development, but here it serves to show how the changing external status and reorganisation of the Post Office was an opportunity for strengthening internal managerial control. Indeed, Pitt points out that these techniques and others, such as management-by-objectives, caused the General Secretary of the Post Office Engineering Union, Charles Smith, to later lament the 'paradox of consequences' of corporatisation, in which the growing independence of the telephone business had resulted in the decreased independence of engineering staff, such as through the gradual abandonment of the Whitley Council joint management-staff side negotiation mechanism of the Civil Service.[72]

However, whilst corporatisation gave opportunities for managerial reform, it also did not prevent external regulation and critique. The press particularly criticised the telephone business for delays in replacing outdated telephone exchanges, which did fractionally slow in the wake of the July Measures (see Figure 3.6), but which was also a product of fraught relations with manufacturers, which I address in greater detail in Chapter Five.[73] This was exacerbated by financial objectives, restrictions on Post Office borrowing, and pricing policies: the government's financial objectives had necessitated increases in postal and telephone charges, but, as inflation spiralled in the early 1970s, the Post Office had to contend with high wages and voluntary price restraints set by the Confederation of British Industry.[74] This was formalised by the Heath government's Prices Commission, which caused the Post Office to enter the red for several years, and continued under the Wilson government after 1974. Furthermore, the terms of corporatisation meant that Post Office borrowing still required Ministerial and Treasury approval;[75] the inability of the Post Office to finance its expenditure internally, due to price restraints, meant that it either had to borrow more or reduce expenditure. As Mark Thatcher points out, this resulted in the Treasury using the Post Office as an instrument of macro-economic management, reducing its expenditure by £150m; there were further

[71] Merriman, 'Men, Circuits and Systems in Telecommunications', 241–42.
[72] Pitt, *The Telecommunications Function in the British Post Office*, 163.
[73] 'How the Post Office Got Its Lines Crossed', *The Observer*, 4 June 1972.
[74] 'Post Office Report and Accounts' 1971, TCC 11/2, BTA; 'Post Office Report and Accounts' 1972, TCC 11/3, BTA.
[75] *Reorganisation of the Post Office*.

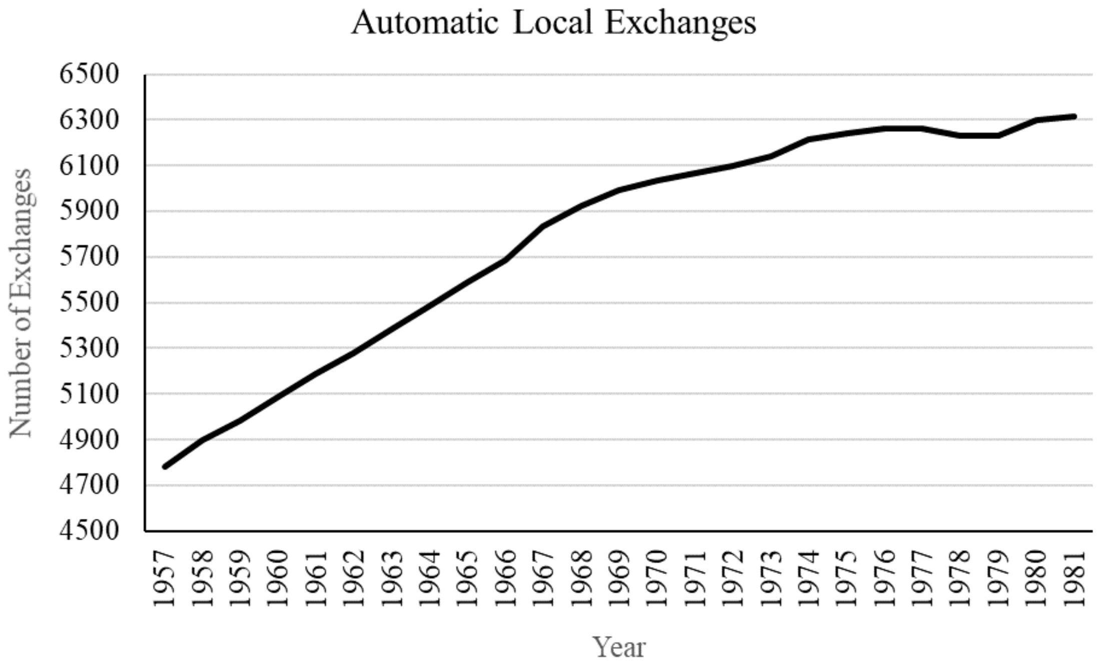

Figure 3.6. Automatic local exchanges in the UK, 1957-1981. The rates begins to slow after the July measures and continues into the 1970s recession. The dip at the end of the 1970s represents the decommissioning of old automatic exchanges faster than they could be replaced. Sources: 'Post Office/BT Annual Reports and Accounts', TCB 10/TCC 11/TCD 12/TCE 13, BT Archives.

expenditure reductions in 1975-76 as telephone demand decreased following the 1973-75 recession, and another decrease from 1979 to 1980 following the Winter of Discontent (see Figure 3.7 for the telephone business's expenditure, inflation adjusted, throughout the 1970s, and refer to Figure 3.2 for the influence of economic activity on telephone demand).[76] The postal side's issues also compounded problems for the telephone business: Peter Sutton has outlined the negative consequences of the 1971 anti-mechanisation postal strike, Britain's first national postal strike, on the public perception of the Post Office, although Sutton points out that in the aftermath of the strike, postal mechanisation was pursued more co-operatively than the reputation of trade union militancy would have most believe.[77]

Under these pressures, a new review into the Post Office was announced in 1975: the Carter Committee, chaired by Charles Carter, the founding Vice Chancellor of Lancaster University. The selection of Carter and the terms of the committee highlight the negotiations which affected the scope of the review: Wilson, assuaging the Union of

[76] Thatcher, *The Politics of Telecommunications*, 123–24.
[77] Peter Sutton, 'Technological Change and Industrial Relations in the British Postal Service, 1969-1975' (PhD diss., King's College London, 2013).

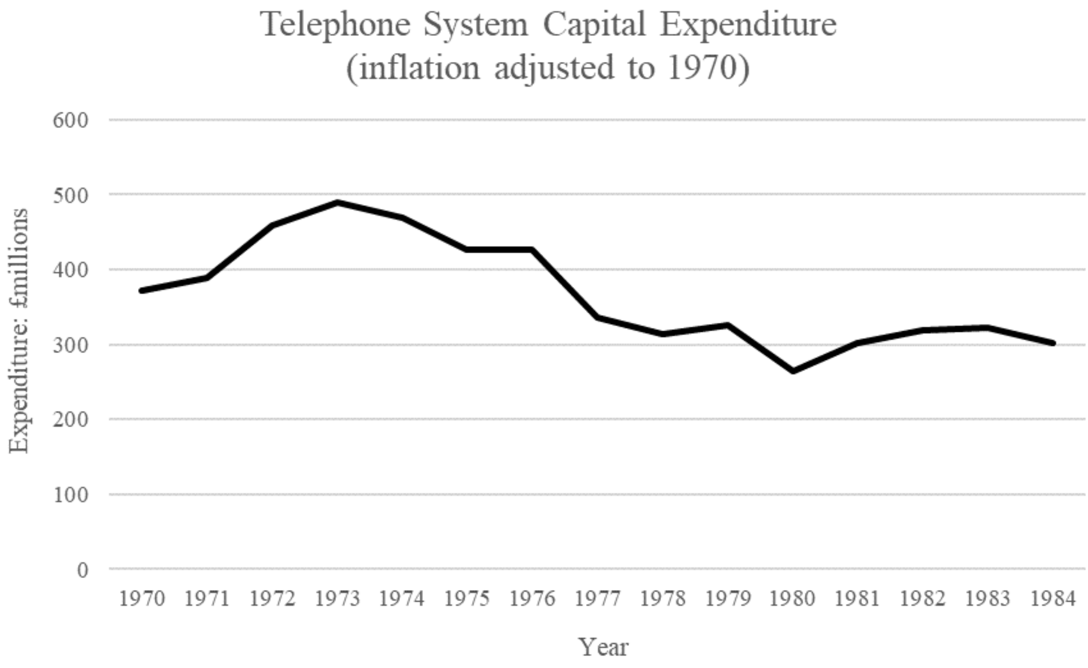

Figure 3.7. The effect of 1970s fiscal restraint on the telephone business's capital expenditure. Sources: 'Post Office/BT Annual Reports and Accounts', TCB 10/TCC 11/TCD 12/TCE 13, BT Archives.

Postal Workers after fraught mechanisation negotiations, had assured the union at its 1974 conference that there would be no chance of splitting the poorly-performing postal service from its subsidising partner, the telephone business.[78] On the other hand, William Ryland, the Post Office chairman, was openly calling for the split and lobbying the Post Office board for support.[79] The board agreed with Ryland, viewing the telephone business's development towards media and data transmission as sufficiently novel that it merited independent management. Carter, who had some previous experience working in the Post Office's regional administration, was chosen as an educated outsider, and Ryland negotiated terms of reference for the review that had scope to include the recommendation for a split.[80] A second SCNI report gave additional impetus to these terms in 1975, recommending that the split be given further consideration by another review committee.[81] The Carter Committee reported its conclusions two years later, in July 1977,

[78] Campbell-Smith, *Masters of the Post*, 529.
[79] Colin Chapman, 'The Torment of the Post Office', *The Observer*, 20 July 1975; 'Post Office Organisation' 1976, TCC 55/8/8, BTA.
[80] Campbell-Smith, *Masters of the Post*, 529.
[81] Campbell-Smith, 530.

and its core recommendation was that, given the poor performance of the corporation, the postal and telephone businesses should be split.[82]

However, despite Carter's recommendations, there was one last clash between external governmental and internal managerial control which delayed the split: the industrial democracy experiment. Parliament had approved this experiment whilst the Carter review was still underway, and involved increasing the size of the Post Office board from seven management members to nineteen, adding seven trade union members and five external members from industry.[83] Benn had advocated industrial democracy since he had taken over the Department for Trade and Industry in 1974, and successfully got Callaghan's and the Post Office's approval in 1977: the experiment started that year, and so in 1978 the Callaghan government vetoed the Post Office split to continue the industrial democracy experiment.[84] The experiment ended in 1979 when Margaret Thatcher's Conservatives replaced the Labour government. James Prior, the Employment Secretary, had initially been reluctant to end the experiment, wary of upsetting the Trades Union Congress, but under pressure and threat of resignation from the Post Office's Chairman, William Barlow, who had been appointed in 1977 under the assumption that he would be overseeing the split and taking over the telephone business, meant that in 1979, Keith Joseph, the Secretary of State for Industry, announced an end to the experiment.[85]

The opinions on industrial democracy are ambivalent. The press initially reported on it as a pioneering experiment, but soon suggested that Post Office management was behind the cancellation of the experiment, tired of industrial relations dominating the board's time.[86] Britain's interest in industrial democracy in the late 1970s – which was only ever notably implemented in the Post Office and British Steel – has been cast as a flirtation that only got as far as it did because of underlying economic issues, and the failure to find lasting solutions to those issues.[87] An academic report on the experiment, by the University of Warwick's Industrial Relations Research Unit, found that difficulties

---

[82] *Report of the Post Office Review Committee*, Cmnd. 6850 (London: HMSO, 1977), 120–35.
[83] Campbell-Smith, *Masters of the Post*, 539.
[84] *The Post Office*, Cmnd. 7292 (London: HMSO, 1978).
[85] 'HC Deb: Post Office Board (Industrial Democracy)' 12 December 1979, Vol 975 cc1303-12, Hansard; Campbell-Smith, *Masters of the Post*, 551–52.
[86] 'Industrial Democracy "Test Case"', *The Guardian*, 17 May 1977; 'Post Office Democratic Pioneers', *The Financial Times*, 5 January 1978; John Ardill, 'Worker-Directors Dropped by Post Office Management', *The Guardian*, 13 December 1979.
[87] Adrian Williamson, 'The Bullock Report on Industrial Democracy and the Post-War Consensus', *Contemporary British History* 30, no. 1 (2016): 119–49.

had arisen from the sheer size of the Post Office organisation, and had been exacerbated by conflicting expectations and interests of management and union members:

> Management members in particular claimed to take into account the interests of the various groups involved in and with the Corporation. The best means of doing so was often seen by managers to be to ensure that those interests had no direct representation at key management decision-making points.[88]

This quote is an explicit assessment of industrial democracy as an intrusion on internal strategies of managerial control, and echoes POEU General Secretary Charles Smith's 'paradox of consequences' mentioned above. The management board members discounted the Warwick report as overly academic and 'essentially anthropological', and there was a consensus across the board that it had lacked a unity of purpose during the experiment.[89] In terms of contemporary accounts, Campbell-Smith's is the only significant history, and mainly reports the views of management on the experiment; in doing so, Campbell-Smith's implicit conclusion is that industrial democracy was an unworkable waste of time which delayed the split. More historical attention is needed to fully assess industrial democracy as a success or failure, but it is nevertheless an episode in Post Office history which showcases the friction between external management of the Post Office as an instrument of economic and industrial policy and internal managerial ambitions to enhance control over the business.

The election of the Conservatives in May 1979 laid a foundation for the Post Offices' reorganisation: whilst the party's manifesto didn't mention the Post Office or the telephone business, it did make commitments to promoting competition and rolling back the nationalisation of industry. In September 1979, Keith Joseph announced that the postal and telephone businesses would be separated and in his announcement noted that the split would be part of a broader review of the telecommunications monopoly, setting the stage for liberalisation.[90] The split of the telephone business from the Post Office can thus not be addressed without also addressing the liberalisation of the telephone monopoly, which, as I will show, had a significant influence on the structure of British Telecom.

---

[88] Eric Batstone, Anthony Ferner, and Michael Terry, 'Interim Report on the Post Office Industrial Experiment: National Level' 1979, POST 65/178, BPMA.
[89] Campbell-Smith, *Masters of the Post*, 551; 'Post Office Board Meeting' 4 September 1979, TCC 15/24, BTA.
[90] Adrian Hamilton, 'Joseph to Split Post Office', *The Observer*, 9 September 1979.

In 1980, Joseph commissioned a report into telecommunications liberalisation by Michael Beesley, Professor of Economics at the London Graduate School of Business Studies. Beesley was one of the most influential economists on the Thatcher government's liberalisation and privatisation policies. Beesley's background was in transport, undertaking cost-benefit analyses of the M1 and the London Underground's Victoria Line, and he had served as Chief Economic Adviser to the Ministry of Transport in the 1960s.[91] However, it was in the 1980s and 1990s where he came to the fore, along with the economist Stephen Littlechild, as the two published together and separately on market reform, liberalisation and privatisation.[92] Beesley's report on telecommunications was initially targeted only at value-added network services (VANS): services where a third-party would lease lines from the telephone business to provide non-voice services, such as data transmission, between clients. Beesley expanded the report to look at leased lines, the process whereby competing telephone businesses could lease BT's lines and resale voice telephony to customers, thus fully competing with BT in the telephone business. Finally, Beesley also looked at the expansion of competition into transmission and switching networks, i.e. liberalising the construction of telephone systems themselves, so that businesses would be able to build their own telephone infrastructure to compete with BT.

Beesley's conclusions were unabashedly pro-competition, and proved too much, too soon, for the Thatcher government. Beesley concluded that there should be no restrictions on VANS provisions, that BT should lease circuits to competitors, and that competing telephone systems should be established.[93] As Mark Thatcher notes, these suggestions brought strong opposition from BT, the unions, and even some segments of business users, who preferred liberalisation to focus on VANS provision and private circuits rather than competing systems for residential customers.[94] The government chose a compromise: proposals were invited for a single alternative network, which was eventually formed in 1981 as Mercury Communications and funded by a consortium of Barclays Merchant Bank, BP, and Cable and Wireless. Mercury gained its initial license in 1982 to supply leased private circuits and then became a full alternative telephone

[91] Christopher Foster, 'Michael Beesley', *The Guardian*, 8 October 1999.
[92] M. Beesley and S. Littlechild, 'Privatisation: Principles, Problems and Priorities', *Lloyds Bank Review*, July 1983, 1–20; M.E. Beesley and S.C. Littlechild, 'The Regulation of Privatized Monopolies in the United Kingdom', *The RAND Journal of Economics* 20, no. 3 (1989): 454–72; M.E. Beesley, *Privatization, Regulation and Deregulation* (London: Routledge, 1992).
[93] Michael E. Beesley, *Liberalisation of the Use of British Telecommunications Network* (London: HMSO, 1981).
[94] Thatcher, *The Politics of Telecommunications*, 176.

system in 1984, gaining a license as a public telecommunications operator. However, as Frank Webster points out, these market-oriented liberalisation policies meant that Mercury was only ever a public telecommunications operator in name. Mercury, unlike BT, was not saddled with the responsibilities of a nationwide system, and so targeted lucrative business traffic; by 1990, Mercury was earning 30% of total nationwide revenue from bulk customers (those with 100 lines or more, i.e. businesses and other organisations). Whilst overall, Mercury had little market share – less than 10% – Webster argues that its importance lies in showing that liberalisation was less about full system competition, and more about the orientation of priorities in telecommunications towards business provision.[95]

The intertwining of business-centrism and liberalisation is also evident in the restructuring of the telephone business in preparation for the creation of BT, which formally took place on October 1st, 1981 (Figure 3.8). Despite Labour's rejection of the Carter Report's recommendation of the split, management had begun preparation for the split in 1979 in anticipation of a Conservative government, and soon after the split was announced in 1980, the government renamed the telephone business British Telecom, which re-organised itself into a market-oriented structure.[96] BT set up a subsidiary company, BT Enterprises, to market, supply, and distribute customer equipment such as telephones, the supply of which had also been liberalised. The board created a new director to oversee 'Organisation and Business Systems Development', combining the Management Services Department and the telephone business's futurology unit, the Long Range Planning Department, giving them a greater market orientation; MSD was subsumed to business systems and LRPD was combined with business planning and renamed the Business Planning and Strategy Department. I will show that similar changes happened across BT in subsequent chapters: BT created Martlesham Enterprises at its research centre to commercialise spin-off (Chapter Four); System X, BT's new telephone exchange, underpinned a new business data services strategy (Chapter Five); the first major rollouts of fibre-optic transmission technology prioritised finance in the City of London (Chapter Six); management oriented Long Range Planning towards the business environment (Chapter Seven); and BT founded BT International to market satellite business services (Chapter Eight). BT's new structure can be considered against Chandler's interpretation of modern corporate structure as a way of securing managerial

---

[95] Webster, *Theories of the Information Society*, 173.
[96] 'Future Structure of the Post Office' March 1979, TCC 55/11/14, BTA; 'Telecommunications Board Structure and Organisation' May 1981, TCC 62/2/42, BTA.

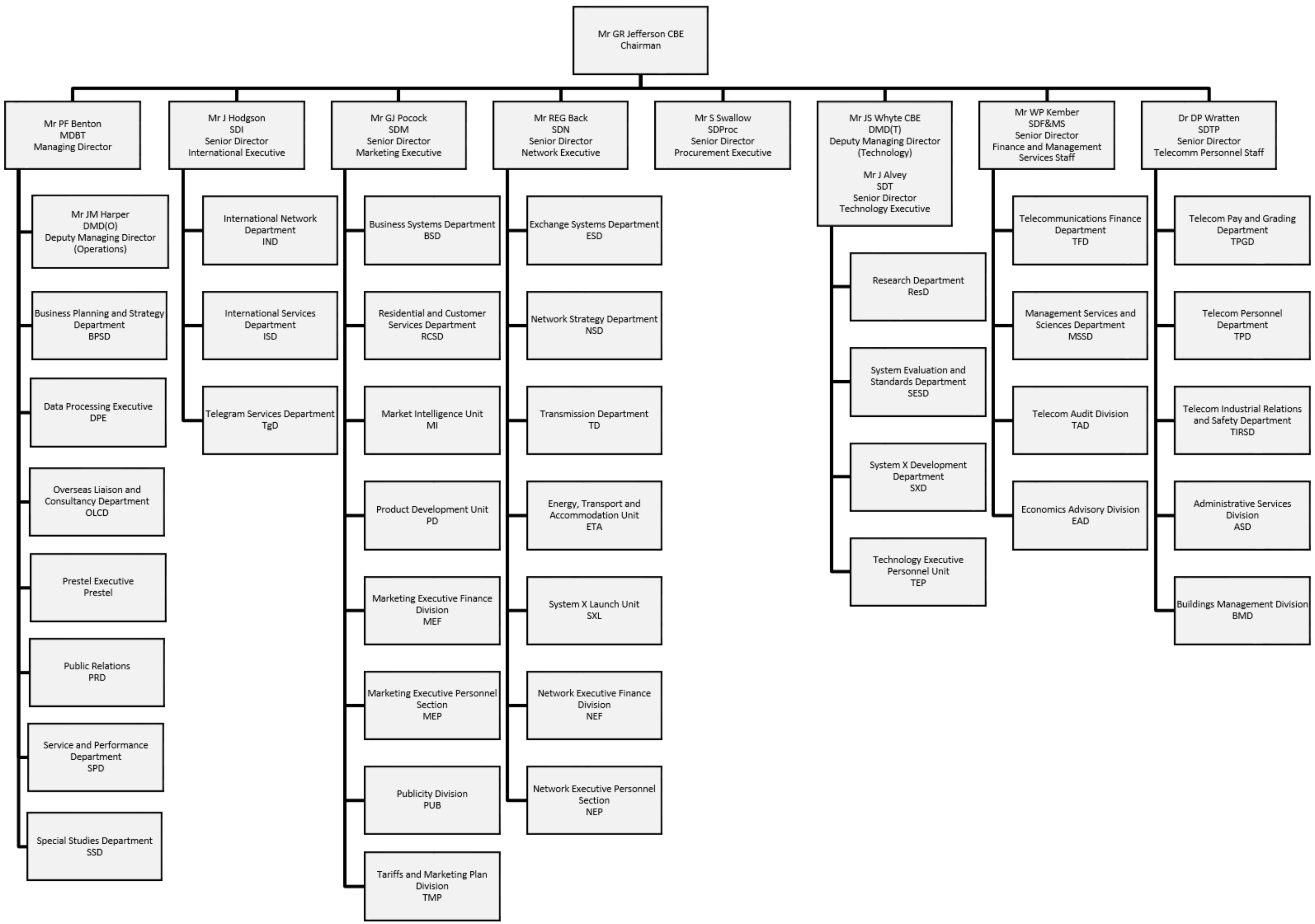

Figure 3.8. British Telecom central structure after the separation from the Post Office. Source: James Elder/BT Archives.

control over the market.[97] BT, formally created on October 1st 1981, was more than a publicly-owned telecommunications system: its structure is indicative, yet again, of how management used changes in external control to enhance its control over areas of uncertainty; where previously these areas had been residential customers and employees, they had instead become business customers and the market itself.

Conclusion

By pointing out the recurrent external controls placed on the telephone business, I do not mean to imply that the telephone business would necessarily have performed better with more independence. This chapter should not be read as an argument for liberalisation; it is intended as an inspection of the dynamic relationship between strategies of external and internal control. As I have noted throughout this chapter, the government often exercised these external controls in response to broader economic conditions which affected all British industries, regardless of nationalisation status. It is likely, for example, that telephone demand would have slumped following the July Measures and 1970s recession regardless, although it could be argued that these slow periods may have been an opportunity for the Post Office to 'catch up' with demand by maintaining its rates of automatic exchange and telephone service installations, had it not been for the government's economic measures restricting capital investment. Lipartito has suggested that higher investment in telephony may have alleviated the turbulence of the 1970s, arguing that such investment would have led to widespread accessible communications, which may have had direct economic benefits for the nation, or would have enhanced quality of life, which in turn may have had productivity benefits.[98] Speculative counterfactuals aside, it is clear that the performance of the telephone business was vulnerable to Britain's broader economic condition. As William Ashworth has shown, the telephone business was one of the better performers amongst the national industries, although he also argues that, overall, the nationalised industries received a bad rap, neither unprofitable nor particularly profitable, and often paying back more to government than they were subsidised, but also lacking the support, oversight and operations to structure themselves in ways which generated sufficient internal revenue.[99]

---

[97] Chandler Jr., *The Visible Hand*.
[98] Lipartito, 'Failure to Communicate: British Telecommunications and the American Model', 178–79.
[99] William Ashworth, *The State in Business: 1945 to the Mid-1980s* (Basingstoke; London: MacMillan, 1991), 144–63.

Extending this point, I believe this critical reading of external and internal control suggests that the changing status of the Post Office often had ambiguous consequences for the strategies of control – machine and managerial – oriented towards staff and customers. Earlier, I pointed out that previous histories of the telephone business have neglected its internal structural dynamics and control mechanisms, and so in this chapter I hope to have shown how attention to these features has produced a foundation for further analysis of the relationships between information and control. For example, in this chapter I have shown that the Post Office increasingly researched and surveyed telephone customers, with implications for computerised surveillance which I address more fully in Chapter Seven; and that automation rendered many employees unemployed – an outcome which recurs in Chapter Five – whilst management subjected those who remained to increasingly computerised forms of monitoring and control. This blending of managerial and computerised control is a theme which recurs throughout this thesis, and so I have aimed here to not only outline an organisational history of the telephone business, but to signpost this thesis' analytical orientation.

However, as I have pointed out in Chapter Two, information and control have not only been mediated through corporate structures, but also through changing experiences of time and space. As such, I now turn my attention to the telephone business's dedicated time-space-compression unit – its research laboratory – and explore its local and oral histories.

4 The Door to Tomorrow?

Research Centres, Science Parks, and New Villages

Above the entrance to BT Labs in Martlesham Heath, Suffolk, is a plaque engraved with 'Research is the Door to Tomorrow'. BT Labs is now the centre of a science park, Adastral Park but it was not always so: the plaque is a physical token from BT Labs' predecessor, the Post Office Research Station, in Dollis Hill, north-west London. BT Labs was formally opened by the Queen in 1975 as the Post Office Research Centre, after moving from Dollis Hill. Adastral Park, however, is not Martlesham Heath's only distinctive feature: from 1975, an 'instant village', built like 'an unspoiled traditional village', was also constructed on the heath, in part to provide housing for Post Office research staff.[1] Martlesham Heath, both in the research centre and the village, thus has multiple, contradictory expressions of temporality: the future-facing plaque paying tribute to the past, and the 'traditional' village built in an instant. These temporal contradictions are also caught up with shifting spatial forms: the relocation of the Research Department, the construction of a new village, and the development of the science park, a quintessential 'information age' development. In 1964, Martlesham Heath was not a place; now, it is a place with its own sense of space and time.

The construction of Martlesham Heath raises important questions: how did the Research Department transform from a research station in north-west London to a science park in Suffolk? How were the new research centre and new village interlinked and implicated in the construction of Martlesham Heath as a 'place'? How were these novel spatial forms related to changing temporal expressions? I address this history in several sections and develop two intertwined arguments: first, the spatiality of Martlesham Heath underwent informatisation, commercialisation, and post-modernisation; second, bound

[1] Peter Vallis, 'Martlesham Heath Village', *ERA*, no. 45 (August 1977): 64–68; 'Redevelopment of Martlesham Heath, East Suffolk' February 1965, TCB 391/1/3/9/1, BTA.

up with these spatial transformations, was a contradictory approach to temporality, where the historicisation of Martlesham Heath was crucial to its establishment as a new space and place.

In the first section, I explore the relocation of the Research Department from Dollis Hill to Martlesham Heath, showing how the Research Department was used by central government as instrument of spatial re-ordering, and how this was experienced by staff. Next, I analyse the construction of the research centre at Martlesham Heath, linking visions for the new site to two contemporaneous spaces – new universities in 1960s Britain, and corporate research campuses in post-war USA – and documenting the strategies of spatial control used to regulate the laboratory's environment. I then move on to the history of Martlesham Heath new village, and, through the history of its inception, development, and experiences of its residents, I show how the village and the research centre shaped one another, whilst also showing how its novelty and instantaneity was deeply embedded with references to English 'tradition'. Finally, I address the recent history of Martlesham Heath by exploring the creation of Adastral Park, which showcases a new spatial strategy for research in the wake of BT's privatisation, but which has also been rooted in novel representations of the place and history of Martlesham Heath.

These changes can be situated within broader theories of late-twentieth-century time-space transitions, and speak to this thesis' goal of exploring 'information' and 'control' in the telephone system. The transformation of the Post Office Research Centre into a science park could easily fit into broader narratives of science parks as novel sites of innovation, intimately entwined with the sunrise IT sector of the 1980s and 1990s and the information age, whilst the construction of an 'instant village' in the 1970s could form a perfect case study for the rise of postmodern architecture and town planning. The most comprehensive theories in this respect, which also speak to information and control, are Giddens' exploration of time-space and organisation, Castells' information age theorisations of space and time, and Harvey's analysis of postmodern time-space.

Giddens argues that organisations control time-space to reproduce themselves. The locale is a particularly important place for the organisation because it is the site in which the organisation can control its self-reproduction across time and space, by defining when and where individuals should be, and through the ends it orients those individuals towards. Giddens superimposes historicity as another temporal layer upon this: as the locale and organisation accumulates information, in the form of inventories, organisational data, life histories, and so on, it is able to use this historical information to generate its own history and articulate its own historical discourse, which in turn generates an organisational culture supporting the organisation's self-reproduction.[2] This interlinkage of organisational historicity and time-space control within a defined locale is a key focus of this chapter, but I also turn to Castells' and Harvey's theories of time and space, as accounts of information age and postmodern transitions in spatiality and temporality respectively.

Castells differentiates 'spaces of flows' from 'spaces of places', and 'timeless time' from 'fragmented time'.[3] Spaces of flows are the growing structuration of space by networking logic and electronic communication – flexible industrial spaces like science parks, the networked global economy, and mega-cities – which, as new communication technologies and spatial-economic structures enable flexible, instantaneous commerce on one hand and more diverse, anachronistic cultural expressions on the other, induces timeless time: a binary composition of instantaneity and eternity.[4] Castells contrasts this new order, where space dominates time, to a prior order, where spaces of places – locales with self-contained form, function and meaning – are formed because of the fragmentations of time that existed before the network society – for example, the clock-time of industrial capitalism makes the factory a 'place'.[5]

Castells owes much here to Harvey, whose analysis of time and space under postmodernity I turn to now. Harvey argues that postmodernism is an aesthetic response to the time-space compression produced by capitalism, characterised by spatial and temporal emphases on disruption and instantaneity respectively. Harvey argues that disruption and instantaneity are contradictorily coped with through the construction of place-identity through retrogressive temporal expressions, such as historical evocation in architecture and the growing prominence of heritage organisations.[6] There are similarities and differences between Castells and Harvey's theorisations: both point to the compression of time and space, and the acceleration of flows (Castells emphasises electronic flows, and Harvey capital flows); however, they differ on the subject of place. Castells sees 'place' as self-contained locales, which he implies are in decline relative to the space of flows, whereas Harvey instead sees the new aestheticisation of place – spaces of Being – as a response to the growing ephemerality and fragmentation of time made possible by capitalism.

---

[2] Giddens, *Social Theory and Modern Sociology*, 153–65.
[3] Castells, *The Rise of the Network Society*, 407–99.
[4] Castells, 440–48, 464–65, 493.
[5] Castells, 494–99.
[6] Harvey, *The Condition of Postmodernity*, 217, 85–87.

Giddens', Castells' and Harvey's theorisations will be useful in understanding the history of Martlesham Heath as a place, although as I will show, they also have their limitations. I now explore the beginning of that history: the relocation of the Post Office's Research Department from Dollis Hill to Martlesham Heath.

Relocation and Dispersal

The motivations for relocating Dollis Hill were twofold: by the close of the 1950s, more space was needed for the overpopulated research station, and the suburbanisation of London had brought issues of electrical interference. By 1958, 1,200 staff were located on a site built for 800, and studies projected that, by 1974, numbers would increase to almost 2,000.[7] Staff who worked at Dollis Hill remember the site's congestion: Chris Wheddon, who joined Dollis Hill as an apprentice in 1959, and went on to become Deputy Director of Research, remembers that 'it was fairly evident to most people at Dollis Hill that it was getting more and more cramped',[8] and Ray Hooper, who started at the Post Office as an apprentice in 1964, recalled that 'the Dollis Hill site was quite limited in many ways and it was in London, it was limited because they were trying to expand'.[9] Allen Snow, who worked in submarine cable testing, contrasted the limitations of space at Dollis Hill with the benefits of space at Martlesham Heath: 'We went from a little 30-tonne testing machine at Dollis Hill to a 100-tonne test machine with a 500 metre pull capability … moving to Martlesham really expanded out what the research labs could do, we ran out of space at Dollis Hill'.[10]

Dollis Hill was also no longer free from electrical and vibratory interference.[11] Since its founding, north-west London had suburbanised and railways had expanded. Dollis Hill had been founded in largely rural environs, and although it was sited close to the Metropolitan railway, it was apparently distant enough to avoid interference.[12] However, by the 1950s, the population of the surrounding area reached around 316,000, from c. 140,000 in 1906, and from the mid-1930s the Bakerloo line began to run more services through the area, taking over for the Metropolitan line's congested Stanmore

[7] 'Feasibility of Existing Site' 1963, TH/FB/528, BTA; 'Dollis Hill: Estimated Growth R. Branch 1964-74' 1964, TH/FB/362, BTA.
[8] Chris Wheddon, Oral Histories of Martlesham Heath, interview by Jacob Ward, 4 August 2016.
[9] Ray Hooper, Oral Histories of Martlesham Heath, interview by Jacob Ward, 15 July 2016.
[10] Allen Snow, Oral Histories of Martlesham Heath, interview by Jacob Ward, 14 July 2016.
[11] 'Dispersal of Post Office Research Station' 30 April 1964, TH/FB/528, BTA.
[12] A thesis on Dollis Hill's early years is currently underway: Alice Haigh, 'The Origins and Early Years of the P.O. Research Station at Dollis Hill, 1908-38' (PhD diss., University of Leeds, in progress).

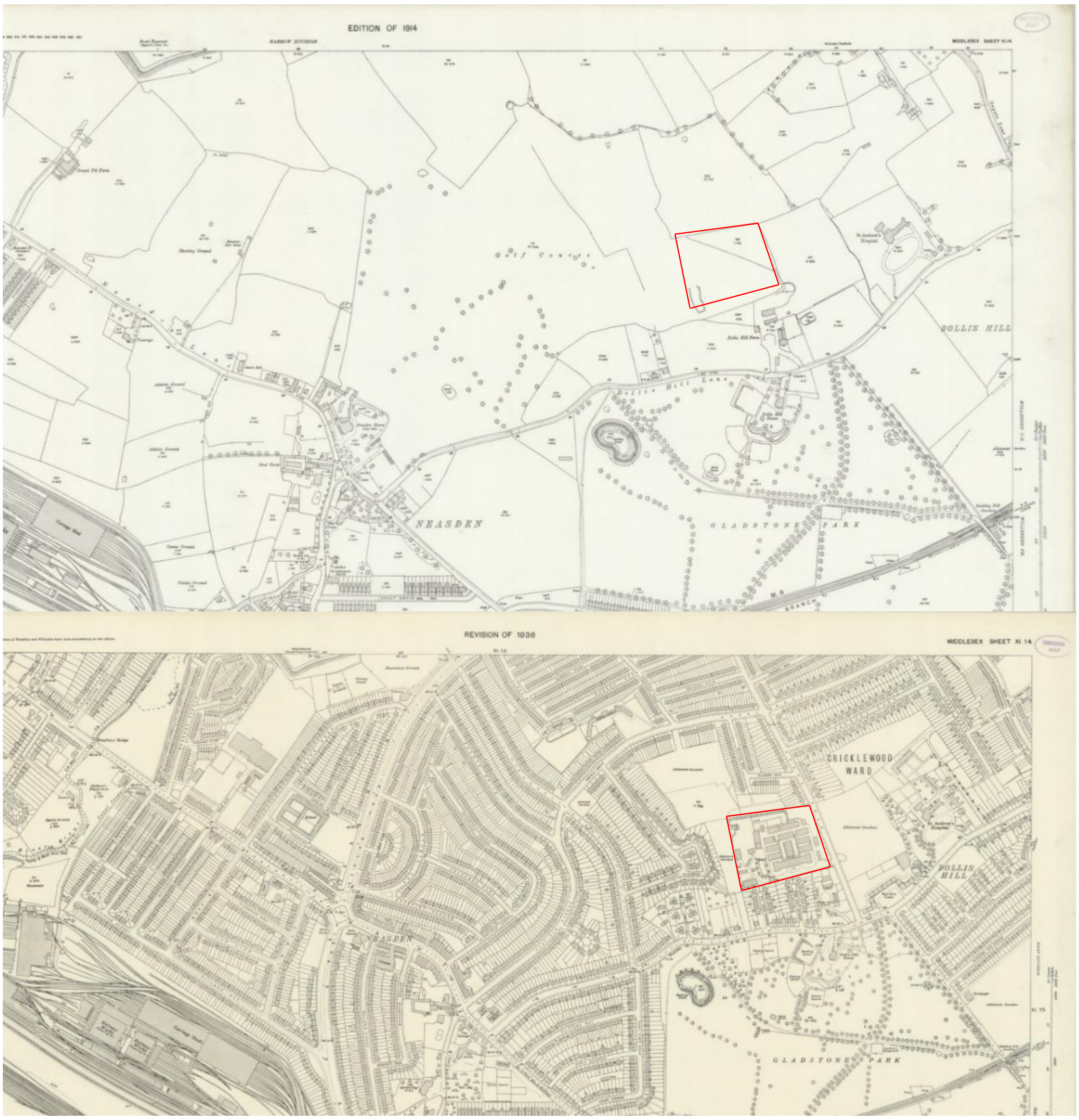

Figure 4.1. Dollis Hill in 1914 and 1936. The red box shows, in the top map, the planned site for the research station in 1914 – the same year its purchase was originally authorised – and, in the bottom map, its actual site, surrounded by suburban London, in 1936. Reproduced with the permission of the National Library of Scotland.

---

branch.[13] As Figure 4.1 shows, between 1914 and 1936, Dollis Hill turned from rural farmland into suburban London.[14] Gordon Radley, the Post Office's Director-General, decided to relocate the station in 1958, and set three requirements for a new location: first, that it should be close enough to maintain good contact with the rest of the Engineering

[13] M.C. Barres-Baker, 'A Brief History of the London Borough of Brent', *Brent Museum and Archive Occasional Publications*, no. 5 (2007).

[14] *Middlesex XI.14 (Includes: Willesden)*, 1:2500 (Southampton: Ordnance Survey, 1914), http://maps.nls.uk/view/103657949; *Middlesex XI.14 (Includes: Willesden)*, 1:2500 (Southampton: Ordnance Survey, 1938), http://maps.nls.uk/view/103657946.

Department, especially Development, in London; second, that it should be within easy access of towns with residential facilities and good day-schools; third, that there should be a technical college nearby for further education for staff.[15] Each of these requirements – the boundaries between research and development, the relationship with housing developments, and the links between research and higher education – all play important roles in understanding the place that Martlesham Heath became.

The Post Office General Directorate's first choice was the Harlow new town.[16] Harlow did not pan out, but its selection is suggestive of the Post Office's search philosophy. Harlow was one of the first wave of new towns approved after World War II, which became vehicles for visions of a modern, reconstructed Britain. As was noted at the time in the *Architects' Journal*, Harlow was one of the foremost examples of novel town design concepts, which included the 'neighbourhood unit', a concept popularised by the American planner Clarence Perry in the 1920s and 1930s, and later used at Martlesham Heath, where residential neighbourhood units were isolated from arterial traffic routes to engender community spirit.[17] Other electronics companies also relocated to Harlow: A.C. Cossor, later acquired in 1961 by the American defence contractor Raytheon, in 1958, and Standard Telecommunication Laboratories (STL), the UK-based research centre for the Standard Telephone & Cable (STC) and its parent company, International Telephone & Telegraph (IT&T), in 1959. Harlow clearly held some appeal for industrial R&D, and so it may have been on the Post Office's radar as a potential cluster of electronics and telecommunications expertise, for this reason. However, Dollis Hill staff rejected Harlow, claiming that it lacked adequate housing and education, and that alternatives had not been explored.[18] From this latter complaint, I would suggest that the staff objected to a lack of consultation, which is supported by the creation of a joint management-staff relocation working party in 1962. However, I raise Harlow to point out that, from the beginning, the relocation and construction of a new research centre was, for the Post Office, bound up with the co-location of corporate research and contemporaneous visions for a 'new' Britain.

The search for a new site became further entangled with central government initiatives to more evenly develop employment opportunities around Britain. In 1963, the

[15] 'Dispersal: Post Office Research Station, Dollis Hill' 16 March 1964, TH/FB/528, BTA.
[16] 'Conclusions (60) 11: General Directorate Meeting' 27 June 1960, POST 72/1083, BPMA.
[17] Mark Llewellyn, 'Producing and Experiencing Harlow: Neighbourhood Units and Narratives of New Town Life 1947–53', *Planning Perspectives* 19, no. 2 (2004): 155–74; D.R. Childs, 'Harlow', *Architects' Journal*, no. 116 (1952): 196.
[18] 'Dispersal: Post Office Research Station, Dollis Hill, 16 March 1964, TH/FB/528, BTA'.

Flemming Report on ‘Dispersal of Government Work’ was produced to identify Civil Service departments suitable for relocation to outside London.[19] Dollis Hill’s relocation was identified as a prime candidate, forcing the Post Office to commit to a site outside London; a relocation memorandum produced after the report noted that dispersal’s goal of relieving regional unemployment ‘was a secondary consideration which has recently assumed perhaps more importance’.[20] Relocation could thus be summarised as inadequate space and electrical interference drove the move away from Dollis Hill, whilst dispersal drove the move away from London.

By July 1963 the Joint Working Party had come up with a shortlist; Hastings, Sussex, was at the top, using the same criteria as established in 1958: towns with a good supply of housing, a good number of schools, and a technical college for further education. However, where previously there had been a requirement to remain close to Engineering and Development, this had now been relaxed to regions up to two hours’ commute from London, bringing the move more closely in line with dispersal.[21] Hastings Council proved very welcoming, informally confirming to the Post Office that they would cancel a planned aerodrome development to provide space for the station and prevent disturbances from aircraft – although, in a display of faith in the British aerospace industry, one council member asked if there would still be scope for vertical take-off craft to have a small section of land.[22]

However, the Hastings plan was stalled by the leaked plans for the Ministry of Public Buildings and Works (MPBW) to disperse some of its offices there. This caused irritation at the Post Office as the MPBW had been aware of the Post Office’s plans, but Post Office management were still keen to secure Hastings so as not to lose face with the staff.[23] However, this attitude changed once the MPBW officially announced its move in January 1964 and were subsequently, in the words of Postmaster-General Reginald Bevins, ‘roasted’ in the House of Commons by MPs from Scotland, the North-East and the South-West.[24] Dispersal, as a programme designed to alleviate unemployment, had not been created for the affluent South-East, and so relocating the Research Department

---

[19] ‘Dispersal of Government Work’ 1963, MAF 229/22, TNA.

[20] ‘Postmaster General: Dispersal: Dollis Hill Research Station’ 1 May 1964, TH/FB/528, BTA.

[21] Reginald Bevins to John Boyd-Carpenter, ‘Draft: Dispersal of Post Office Research Station’, April 1964, TH/FB/528, BTA.

[22] D.J. Kinder to C.H. Coates, ‘Dollis Hill Research Station’, 5 February 1964, TH/FB/528, BTA; N.P. Lester to G.H. Metson, ‘Post Office Research Department’, 12 February 1964, TH/FB/528, BTA.

[23] ‘Postmaster General: Dispersal: Dollis Hill Research Station’ 6 March 1964, TH/FB/528, BTA.

[24] ‘HC Deb: Ministry (Staff)’ 28 January 1964, Vol 688 c34W, Hansard; ‘HC Deb: Government Offices (Dispersal)’ 29 January 1964, Vol 677 cc486-506, Hansard; ‘Note by J.R. Bevins, Postmaster General’ 1964, TH/FB/528, BTA.

to Hastings appeared politically untenable. This was particularly worrying for the Post Office as other shortlisted sites were losing viability: the Christchurch and Poole sites were on difficult terrain, Ipswich was becoming 'restive' as the landowners, Bradford Property Trust, were keen to start a residential development (the soon-to-be Martlesham Heath new village), and Folkestone looked uncertain after the somewhat premature announcement that it would be the site for the British end of the Channel Tunnel.[25]

The Post Office was also courted by MPs from the North and Scotland. Jeremy Bray, MP for Middlesbrough West, advocated Middlesbrough to the Post Office, whilst a delegation of Scottish MPs made an impassioned case for Scotland, pointing out that the Department for Scientific and Industrial Research had a site in East Kilbride, Ferranti a site in Edinburgh and National Cash Register a site in Dundee.[26] Tam Dalyell, MP for West Lothian, even formulated research agendas, suggesting that Scotland would be an ideal location to research masers. The Scottish delegation and Bray were largely given the same answers: that the Research Station needed to be closer to the Engineering Department; tactfully, neither Bray nor the Scots were told what was confessed in private: that the Post Office could not keep staff if research moved northwards, nor did it believe new staff could be recruited if research was in the 'less attractive' North-East.[27]

Instead, the Joint Working Party turned its attention to Ipswich, third on the list, after discarding Christchurch because of the site's terrain issues, mentioned above, and because there were already two government research establishments there – the Military Engineering Experimental Establishment and the Signals Research and Development Establishment – and so again dispersal over-rode any other considerations.[28] Ipswich was suitable because a large site had been found on Martlesham Heath, four miles east of Ipswich, which had previously been used by the RAF and USAF during World War II, and as an experimental aviation site before and after the war. Furthermore, Ipswich had been earmarked as part of a South-East development study for major expansion, thus alleviating staff concerns about housing availability.[29] Finally, the new University of Essex, established in Colchester in 1963 as part of seven 'plateglass' new universities – East Anglia, Essex, Kent, Lancaster, Sussex, Warwick and York – fulfilled far and above

[25] G.H. Metson to D.J. Kinder, 'East Suffolk County Council', 7 February 1964, TH/FB/528, BTA; T.B. Oxenbury to G.H. Metson, 'Projected Move from London', 4 February 1964, TH/FB/528, BTA.
[26] 'Deputy Director General: Dispersal: Dollis Hill Research Station' 16 March 1964, TH/FB/528, BTA; 'Notes of a Meeting Held at the House of Commons' 19 December 1962, TH/FB/528, BTA.
[27] 'Dispersal of Dollis Hill Research Station' 18 March 1964, TH/FB/528, BTA.
[28] 'Dispersal of Dollis Hill Research Station, 18 March 1964, TH/FB/528, BTA'.
[29] 'The South-East Study' 1964, TH/FB/528, BTA.

the Post Office's hopes to forge links with a local technical college.[30] Staff approval was secured in June 1964 and the move formally announced to the House of Commons in July.[31] Two of these motivations – the development of the Ipswich area and the new University of Essex – were particularly influential on the research station's subsequent development, but before that, I will explore the memories of staff on the relocation decision.

These memories speak to two different subjects: first, the apparently collaborative nature of the selection process, and second, the experiences of life at Dollis Hill in contrast to Martlesham Heath. Despite the adoption of a more collaborative process for selecting the new site, many former staff recall a more hierarchical presentation of the move. Ray Hooper says that 'I wouldn't say it was particularly presented, I don't remember it being presented in any form to us, it was mentioned in various things',[32] whilst Dennis Wheeler, who started at Dollis Hill in 1967, recalls the move remaining opaque even after its formal announcement: 'There were rumours, there was talk about a possible move to Martlesham, I don't think it was anything more than that'.[33] Colin Whitlum, who started at Dollis Hill as an apprentice in the 1960s, remembers that 'it wasn't really talked about very much, it was just a case of this, well this is where we were going, and you can get on the coach and go and have a look around, other than that, find a house!'.[34] Chris Wheddon remembers that 'it was felt that Martlesham was the choice made by the powers that be before we actually went through the process of choosing, you know, there was discussion amongst the troops that, "It was a done deal, wasn't it?"'.[35]

The hierarchy at Dollis Hill features in many recollections of the research station. One recurring story was of the Dollis Hill car park, where Major Staff had red parking passes and Minor Staff had green. Jeanette Higgins, who worked in the Research Department's clerical division, and was thus 'Major Staff', remembers that 'you had to stick to your own [car parking spaces]',[36] but Dennis Wheeler, on the other hand, recalls with frustration that Major Staff would often take Minor Staff's spaces: 'greens could only park in greens, but reds could park in reds or greens, so we would arrive on the dot of quarter to eight, ten to eight, drive into the research station, all the green places had

[30] 'Dispersal of Dollis Hill Research Station, 18 March 1964, TH/FB/528, BTA'.
[31] 'Note to Director General from A.H. Mumford' 22 June 1964, TH/FB/528, BTA; 'HC Deb: Research Centre, Dollis Hill' 28 July 1964, Vol 699 cc234-5W, Hansard.
[32] Hooper, Oral Histories of Martlesham Heath.
[33] Dennis Wheeler, Oral Histories of Martlesham Heath, interview by Jacob Ward, 15 June 2016.
[34] Colin Whitlum, Oral Histories of Martlesham Heath, interview by Jacob Ward, 15 July 2016.
[35] Wheddon, Oral Histories of Martlesham Heath.
[36] Jeanette Higgins, Oral Histories of Martlesham Heath, interview by Jacob Ward, 14 July 2016.

gone 'cause there were a lot of red car park tickets in there' and that 'prompted me to want to get promoted more than anything else, that was such a frustration. I wanted a red park pass!'.[37] Chris Wheddon also recalled Dollis Hill's hierarchy: 'it was very interesting in those days because there was a, sort of, hierarchy … almost like army structure … when I became … senior staff … my now new colleagues that used to be my bosses had great difficulty in calling me Chris! They still called me Wheddon'.[38]

Despite this, staff also have fond memories of Dollis Hill and some believe that Martlesham Heath was never able to recapture Dollis Hill's community spirit. Allen Snow remembers that 'we had a lot of social clubs in at Dollis Hill … they were transferred and that was a great social thing, for all these clubs and sports, but alas membership dropped',[39] and Colin Whitlum remembers similarly: 'they tried very hard to regain the social side because that was the key to Dollis Hill, fantastic social side, pantomimes at Christmas, dances, you know, people would always be eating or drinking … it was a really nice atmosphere. When we moved to Martlesham we had nothing like that, you know, the social club hardly existed'.[40] I will cover staff memories of life at Martlesham Heath in more detail in the next section, but I specifically raise these comparisons to Dollis Hill here because they highlight issues of community and identity which were core issues for the development of Martlesham Heath as a place.

Industrial Versailles Meets the New Universities

The envisioning and construction of the new research centre were influenced by two different types of post-war research site: the new universities in Britain and corporate research laboratories from the USA. In planning the new site, the Post Office forged explicit links with the new University of Essex whilst also making implicit references to the new universities programme. Press releases announced the Post Office's hopes for a 'university character', which was 'of a clean and quiet nature and in appearance might resemble a university area with mainly low buildings set in landscaped areas'.[41] This vision can be contextualised against the high-profile new universities programme, which established several universities (Sussex, Warwick, Kent, York, Essex, Bath, and

[37] Wheeler, Oral Histories of Martlesham Heath.
[38] Wheddon, Oral Histories of Martlesham Heath.
[39] Snow, Oral Histories of Martlesham Heath.
[40] Whitlum, Oral Histories of Martlesham Heath.
[41] 'Draft Press Statement by County Planning Officer: Development at Martlesham for the Post Office Engineering Research Station' 22 July 1964, TH/FB/528, BTA.

Lancaster) during the 1960s, which became known as the 'plateglass universities'.[42] Stefan Muthesius' history of the plateglass universities outlines how they were designed as a defence of modernism, another welfare state public project in step with the social architecture of public housing and new towns like Harlow.[43] Bearing striking similarity to the Post Office's vision for Martlesham Heath, many of the early new universities – Sussex, Warwick, Kent, and York – were built on landscaped park-like campuses, composed of low-profile buildings of metal, glass, and concrete. These universities were launched amidst a fervour which Muthesius describes as, 'the country as a whole was told to appreciate the general social importance of that institution'.[44] The Post Office's invocations of 'university character' and aesthetic visions of low-profile buildings on a landscaped campus suggest an imitation of these new, socially important institutions; this echoes the Post Office's earlier selection of Harlow, an extension of a desire to align with the state's centralised, modern, utopian projects for a 'new' Britain.

The University of Essex and later plateglass universities took on a more 'integrated urban' form compared to their predecessors,[45] but it was with Essex, the closest new university to Martlesham Heath (and closest university in general), that strong ties were forged. The University of Essex was perhaps the most high-profile of all the new universities – according to Muthesius, 'none of Britain's postwar universities was launched with such enthusiasm'[46] – and the Post Office was quick to establish links. In 1967 a Chair in Telecommunications Systems was set up with a grant from the Post Office, as was a Lecturer in Telecommunications Systems.[47] Research grants followed – £30,000 was donated in 1971 to research video telephony – as did collaborative MScs and PhDs.[48] An MSc in Telecommunications was set up by the Research Department, and senior engineers were employed as lecturers, which more junior engineers on the Post Office were given time to attend. Chris Wheddon, one such student, remembers that 'I went to university to do a Master's course at Essex, an MSc, because the technology was about lasers, it was about advanced digital techniques … the lecturers then in the Faculty

42 Michael Beloff, *The Plateglass Universities* (London: Secker and Warburg, 1968).
43 Stefan Muthesius, *The Post-War University: Utopianist Campus and College* (New Haven; London: Yale University Press, 2001), 104–5.
44 Muthesius, 107.
45 Muthesius, 138.
46 Muthesius, 149.
47 'University of Essex: Chair in Telecommunication Systems', *The Observer*, 15 January 1967; 'University of Essex: Electronic Engineering', *The Guardian*, 22 December 1967.
48 'Phone Foresight', *The Guardian*, 7 October 1971; 'University of Essex/Post Office Research Centre. SRC Case Studentship: Optical Communications', *The Guardian*, 29 May 1979.

of Electronic, or Digital Engineering, were very good. J.J. O'Reilly was one of those that was, excellent lecturer and very well-known'.[49]

The new universities were not the only influence; the Post Office also took cues from American corporate laboratory design. In 1964, representatives from the Post Office and the MPBW (who would provide architectural services for the new research centre) visited laboratories across the USA, including Bell Labs, the Radio Corporation of America's laboratory, Hughes Research Lab, Fairchild Semiconductor's R&D Labs, and the Stanford Research Institute.[50] Some features which the British delegation found most noteworthy – artificial lighting and air conditioning – were also those which later surfaced tensions between management and staff in the construction and working conditions of the research centre. The other significant American feature which the Post Office would emulate was flexible portioning, so that rooms could be reconfigured as needed. Air conditioning was seen as essential for controlling atmospheric conditions for delicate electronics work, whilst artificial lighting would allow more compact building design, as rooms could be housed within the inner structure without windows. The Post Office report on the trip amusingly described this as 'Americans have no objection to working in rooms without natural light'.[51]

Of all the visits made, the most influential were the laboratories designed for Bell Labs and IBM by the Finnish neo-futurist architect Eero Saarinen. Scott Knowles and Stuart Leslie's history of Saarinen's work on IBM, Bell Labs and for General Motors shows that, paralleling the Post Office's references to new universities, Saarinen's research centres for GM – which was called a 'Versailles of Industry' by *Life* magazine due to its palatial grandeur – IBM, and Bell also emulated the isolated campuses of post-war universities.[52] Knowles and Leslie argue that, in doing so, these corporate laboratories, as with post-war US university campuses, embodied the linear model of research, where vast centres of basic research were put to work generating scientific knowledge, which would later be used for technological development. It is easy therefore to see why the Post Office identified with Saarinen's Bell and IBM sites, given its similar infatuation with the university campus. This insight is particularly important to bear in mind as I consider below how relocation became entangled with the shifting organisation of research and development within the Post Office.

---

[49] Wheddon, Oral Histories of Martlesham Heath.
[50] 'Laboratories Visited in USA' November 1964, TCB 391/2/4, BTA.
[51] 'Laboratories Visited in USA, November 1962, TCB 391/2/4, BTA'.
[52] Scott G. Knowles and Stuart W. Leslie, '"Industrial Versailles": Eero Saarinen's Corporate Campuses for GM, IBM, and AT&T', *Isis* 92, no. 1 (2001): 1–33.

The construction of the Martlesham Heath research centre implemented these influences; the exterior and landscaping was conceptually similar to the new universities and the interior design prioritised US-style flexibility, air conditioning, and lighting. The main design features were established in 1967 with the MPBW, who provided architectural and design services to meet the Post Office's schedule of requirements.[53] The main decisions which shaped the building were the extensive use of air conditioning and staff resistance to plans for low lighting, which resulted in more natural light being used in exterior rooms with windows. In a reminder of Cold War concerns – and the cost-benefit analysis thereof – it was also agreed that a fall-out shelter would not be needed on site. The research centre's eventual form was three main buildings: a seven-floor lab block, a three-floor administration building, and a single-storey building to accommodate mechanical engineering, a drawing office, a workshop, and storage; two towers – a radio tower and water tower – were also constructed.[54] The towers, which served as the primary lift shafts, were sited on diagonally opposite sides of the main lab block to encourage circulation in between. A similar priority can be seen with the installation of movable partitions to encourage 'flexibility' in research.[55] There was a separate acoustics complex for the research centre, which contained two anechoic chambers, a reverberant room, and a microphone calibration room. Acoustic isolation was achieved throughout the complex by using double-walled construction and mounting the inner rooms on acoustic mountings.[56]

There were plans to create a campus atmosphere through landscaping: a lagoon was pursued, partly as a landscape feature and partly as a resource for fire engines, but was eventually discarded as not cost-effective.[57] The lagoon is suggestive again of both the landscaped campuses of the plateglass universities and the US corporate campuses: York and Essex had pools and lakes, and all the new universities campuses were landscaped to varying extents to create 'park' atmospheres, whilst Saarinen's Bell Labs campus in Holmdel, New Jersey, also had a large lagoon.[58] Unfortunately, there is no

---

[53] 'GPO/MPBW Meeting: Move of the Research Station' 7 August 1967, TCB 391/2/2, BTA.

[54] C.F. Floyd, 'The Design of Martlesham Research Centre: Part 1 - Basic Design Requirements and Design of Buildings', *The Post Office Electrical Engineers' Journal* 69, no. 3 (1976): 146–53; C.F. Floyd, 'The Design of Martlesham Research Centre: Part 2 - Services Provided', *The Post Office Electrical Engineers' Journal* 69, no. 4 (1977): 258–64.

[55] Floyd, 'The Design of Martlesham Research Centre: Part 1 - Basic Design Requirements and Design of Buildings', 147.

[56] Floyd, 'The Design of Martlesham Research Centre: Part 2 - Services Provided', 263–64.

[57] 'Buildings and Welfare Department Meeting: Martlesham Heath Research Centre' 1966, TCB 391/2/6, BTA.

[58] Muthesius, *The Post-War University*, 107–74; Knowles and Leslie, 'Industrial Versailles', 26.

remaining evidence of the aesthetic decisions taken in the exterior design and shape of the research centre buildings; the impression given therefore is that form followed function. The broad conclusion that I take from the research centre's construction is that, internally, it recreated US corporate labs through air conditioning and flexible partitioning, whilst the goal with the landscaped, low-profile exterior appearance was to evoke the new university campus atmosphere. This latter point could be read as merely another imitation of the Saarinen design archetype but I would argue that, given the Post Office's explicit references to a 'university atmosphere' and the links it forged with the University of Essex, it was rather an evocation of the modernist welfare state's programmes of social architecture and institution-building.

The first staff arrived on Martlesham Heath in 1968: a small project team were housed in temporary huts and worked on waveguides (see Chapter Six for more on the waveguide project); the research centre finally opened in 1975 after construction delays because the contractor, Mitchell Construction, went bankrupt, but was completed after it was bought out by Tarmac. Nevertheless, the protracted move and the use of various alternative sites – temporary huts and rented offices in nearby towns – featured in many staff's memories of Martlesham Heath's early years. Allen Snow remembers the difficulties of the back-and-forth between Dollis Hill and Martlesham Heath:

> I moved up here as one of the third or fourth person at Martlesham … then I got a promotion and went back to Dollis Hill … I stayed down there for a few years but travelled up because my wife was up here … so I used to travel up at least once during the week and I wore the car out.[59]

Allen also remembered being housed in a temporary 'igloo' on the site, followed by a 'huge wooden shed' which was nicknamed 'Fort Apache' because it resembled an 'old western type fort'.[60] Allen and Colin Whitlum both had to work at various temporary offices in the East Suffolk region as the research centre was built up; Allen worked at 'a drawing office, as a satellite out of Martlesham, although Martlesham was being occupied were down here still, so yeah, it wasn't too much of an issue',[61] whilst Colin remembers that these 'outstations in Ipswich' continued after construction and some staff 'didn't move back onto the Heath'.[62] The back-and-forth between Dollis Hill and Martlesham Heath also featured in Ray Hooper and Chris Wheddon's memories. Chris remembered

---

[59] Snow, Oral Histories of Martlesham Heath.
[60] Snow.
[61] Snow.
[62] Whitlum, Oral Histories of Martlesham Heath.

going back-and-forth to London as 'the biggest problem … but that was a novelty going on the train, the train wasn't too bad'.[63] Ray remembers the distance causing difficulties for his research, which had suffered from 'a coordination problem' when his team were split across Dollis Hill and Martlesham Heath:

> Worst memory? … I think it was the period when we were separated at Dollis Hill and the group at Martlesham, because I think it did actually create some divisions between people.[64]

Similarly, the completed building also drew ambivalent recollections. Sheila O'Brien, who moved to Martlesham Heath in 1979 from the National Physical Laboratory, recalls:

> I didn't like it to start with … the ceilings were really high and then you had a false floor where we would run things, so that made, I never liked any of the rooms in the main lab block. … I was lucky enough to get moved over to B10 … a prefabricated building that was built before the main lab block … it's interesting that a scruffy old timber framed building should be cosy, but it was. I still preferred it to the new building.[65]

Sheila also mentioned the air conditioning's influence on the main lab block's unpleasantness, remembering that 'I was always cold, even in the summer, so I just didn't like the working environment in the main block'.[66] Colin also disliked the main building, particularly its uniformity:

> …most people were in this massive building four or five floors high, very long, very big, all the same, when you walked in it was absolutely the same, in every part of it was the same, so if you didn't know which floor you were on, the only way you could tell by the colour of the carpet.[67]

However, not all memories were negative. Allen Snow, also mentioning the air-conditioning, appreciated the purpose-built labs at Martlesham Heath, which he viewed as enhancing control over research:

> …they moved out on a grander scale, purpose-built air-conditioned labs, everything was purpose-built and designed, which was great … the workshops were fully manned and

[63] Wheddon, Oral Histories of Martlesham Heath.
[64] Hooper, Oral Histories of Martlesham Heath.
[65] Sheila O'Brien, Oral Histories of Martlesham Heath, interview by Jacob Ward, 11 August 2016.
[66] O'Brien.
[67] Whitlum, Oral Histories of Martlesham Heath.

> equipped, a lot of the labs were set up as things really moved on there, and it gave, not only did it give the Post Office a great opportunity to develop with an open site and control everything.[68]

Ray Hooper concurred, finding that as his research program on optical fibre expanded, the additional space at Martlesham Heath proved valuable:

> …suddenly the whole program, because it just grew and grew and expanded and expanded, and I think being at the Martlesham site was a real boost because I couldn't imagine that at Dollis Hill that expansion you would have had to had, it wouldn't have been able to take it.[69]

The Research Department was also implicated in changing formulations of R&D in the Post Office during this period. I drew comparisons earlier between the design of Martlesham Heath and American corporate laboratories, which Knowles and Leslie cast as embodiments of the linear model, focussing on basic research and feeding into advanced research and development. Paradoxically, however, the move to Martlesham Heath was accompanied by a new emphasis on 'development', which was bound up with the Post Office's corporatisation in 1969. Prior to corporatisation, research and development were separate branches within the Engineering Department. They were on the same tier of the organisational hierarchy, but an implicit stratification could perhaps be seen: in 1946, a combined Research and Development Subcommittee was set up, but was chaired by the Controller of Research.[70] However, after corporatisation, the Engineering Department was dissolved, and the telecommunications side of the Post Office set up the Development Division, of which the Research Department and Development Departments became sub-units.

These changes in status can be contextualised against Benoît Godin's conceptual histories of 'research' and 'development'. Godin, with Désirée Schauz, argues that 'research' has gone through several identity shifts in the twentieth century: first, 'basic' research thrived in the interwar period, when research was an organised, holistic activity across academia, industry and government, organised by institutions into a systematic laboratory-based practice; second, 'research and development' gained prominence after World War II, popularised by the US Office of Scientific Research and Development,

[68] Snow, Oral Histories of Martlesham Heath.
[69] Hooper, Oral Histories of Martlesham Heath.
[70] W. West, 'Facilities for Experimental Work in the Engineering Department', *The Post Office Electrical Engineers' Journal* 47, no. 1 (1954): 10–14.

founded in 1941 for the war effort, and followed by further integration of research into industrial 'development', which referred to the application of research as a means of evolving industry; third, 'technological innovation' was popularised in the 1960s and after, whilst 'research' was marginalised, and instead emphasis was placed upon the application of the results of research, rather than research itself.[71] Godin has also analysed the addition of 'development' to form 'R&D', arguing that three factors contributed to this combination: organisational, analytical, and political.[72] First, there was a greater organisational differentiation of research from development from the mid-twentieth century; second, R&D became a useful category for statistical analyses and study of the innovation process; finally, prestige was derived from combining research and development to show off gross R&D expenditure, whilst, contradictorily, these sums were also used as evidence to demonstrate the meagre funding research got in comparison to development by post-war advocates of basic research.

It would be simplistic to view the belated popularity of 'development' in the Post Office, coming decades after its mid-century vogue in the USA, through a stereotyped declinist view of British science playing catch-up to American trends. Instead, I would argue that the new emphasis on development and R&D was tied to two changes: first, the corporatisation of the Post Office in 1969; second, the relocation of the research centre to Martlesham Heath. First, as mentioned, Development Division was set up after corporatisation, with the Research Department and Telecommunications Development Department as its two main sub-units; giving 'Development' greater status was thus a way of reflecting the new organisational structure. Second, I would suggest that 'R&D' allowed greater collectivisation of geographically dispersed departments. Previously, Research Branch and Development Branch had both been located in London; after corporatisation, relocation was in full swing, and by the mid-1970s, various departments of Development Division were split across London and the 'East Anglia Complex', composed of Ipswich and Cambridge, which partly housed the Long Range Planning Department, a department I explore in Chapter Six.[73] As some staff raised in their oral histories, dispersal brought problems, and so 'R&D' might not just have been an

[71] Benoît Godin and Désirée Schauz, 'The Changing Identity of Research: A Cultural and Conceptual History', *History of Science* 54, no. 3 (2016): 276–306.
[72] Benoît Godin, 'Research and Development: How the "D" Got into R&D', *Science and Public Policy* 33, no. 1 (2006): 59–76.
[73] 'R&D: New Horizons in Telecommunications' 1975, HIC W04/06 Business Ops/R&D/Dollis Hill - Martlesham Heath - The Circuit Laboratory, BTA.

opportunity for a new corporate organisational definition of research, but also a way of collectivising spatially dispersed departments.

Spatial dislocation of research created the need and opportunity for identity formation; hence the articulations of university atmosphere, the use of US corporate laboratory design, and the growing prominence of development. This complicates narratives of large corporate research campuses' emphasis on basic research and as reifications of the linear model. Whilst I think corporate campuses' influence was important for Martlesham Heath, so were the new universities, as was the broader context of corporate reorganisation. However, the research centre's identity was not only the important part of Martlesham Heath's place-identity: in 1975, construction of a new village began adjacent to the Post Office Research Centre.

The Instant Traditional Village

The relocation of the Research Department to Martlesham Heath created a need for housing. In 1964, Ipswich had been identified as a potential major development area by a government study of the South-East. The owners of the Martlesham Heath site, Bradford Property Trust, which had sold a section of their land to the Post Office for the new research centre, also had its own plans for a residential development. These plans became intertwined with the Post Office Research Centre, and, as I showed the importance of architecture, design and landscape to the identity of the research centre in the above section, so I will too for the new village in this section.

The initial development plans for Martlesham Heath were produced in 1965 for the Bradford Property Trust by the architectural firm Clifford Culpin.[74] The proposed development was for 10,000 people and the relocation of the Research Department took a prominent place in the report as it created an immediate need for housing; the proposed town was planned around the research site, which 'would allow the GPO to be related to the heart of the town'.[75] The report also pointed to the Post Office's emphasis on university character as a 'splendid basis on which to build a new community' and suggested leaving room for the development of light industries in keeping with the 'university background'.[76] The role of technology in developing the Suffolk region also featured: the layout of the proposed development had been designed with the

[74] 'Redevelopment of Martlesham Heath, East Suffolk, February 1965, TCB 391/1/3/9/1, BTA'.
[75] 'Redevelopment of Martlesham Heath, East Suffolk, February 1965, TCB 391/1/3/9/1, BTA', 13.
[76] 'Redevelopment of Martlesham Heath, East Suffolk, February 1965, TCB 391/1/3/9/1, BTA', 4.

incorporation of future transport systems in mind – a monorail station in Martlesham Heath was specifically touted as a potential development.[77] An exclusive, communal atmosphere was also envisioned: as the land was entirely owned by Bradford Property Trust, the opportunity existed to use 'the best forms of social and architectural planning in order to relate the needs of the individuals to those of the community', which would be achieved through the formation of a community trust to safeguard the development.[78] Landscaping, as with the research centre, was also planned to create and preserve this unique atmosphere: tree planting and earth mounding, whilst used to 'maintain and enhance existing views', would also be used to 'screen certain development' around the village.[79] There was thus an emerging contradiction, where the research centre and proposed industrial development formed major components to the plan, and yet the community vision was best served by screening those spaces.

However, central government did not pursue the South-East expansion proposals for Ipswich, delaying the new village as East Suffolk County Council had to decide between approving the *de novo* Martlesham Heath development or expanding Kesgrave, an existing village slightly further east.[80] This exacerbated research staff's concerns about housing, and indeed housing searches feature heavily in staff memories. Colin Whitlum remembers that 'house prices were shooting up, the interest rates were something like fifteen percent, half a percent today, fifteen percent then, I mean it was phenomenal', whilst Jeanette Higgins and her husband had to go to extreme lengths to secure a property during a period of intense gazumping:

> There was a lot of gazumping going on, there were so few houses, that as soon as they went on the market they were sold, so it caused huge problems for everyone … then we noticed that actually outside the estate agents' office there was a queue forming already because there was so many houses … so having decided that, yes, we like it … we went back home to Kirton and he packed up everything he needed to camp for a week or more until they actually went on sale, he went back … and he went and camped for however long it took.[81]

[77] 'Martlesham Heath Township Proposals for about 10,000 People', *The Surveyor and Municipal Engineer*, 20 March 1965, 31–35.
[78] 'Redevelopment of Martlesham Heath, East Suffolk, February 1965, TCB 391/1/3/9/1, BTA', i.
[79] 'Redevelopment of Martlesham Heath, East Suffolk, February 1965, TCB 391/1/3/9/1, BTA', 20.
[80] 'Martlesham Move Committee, Progress Report 6' July 1969, TCB 391/1/4/1, BTA; 'Martlesham Move Committee, Progress Report 11' October 1971, TCB 391/1/4/1, BTA.
[81] Higgins, Oral Histories of Martlesham Heath.

The absence of amenities in Suffolk had already put some research staff off. Allen recalled how some colleagues complained that 'There's no theatres, there's no cinemas', whilst Chris also remembered similar questions asked at the time: 'Oh yeah, well how often do you go to the pictures? … How often do you go to the theatre and so on?'.[82] Colin noted that the move was too much for some of his colleagues and their families:

> Some didn't like it because they moved into the country and they were stuck out, they thought it was a wonderful life, but they were stuck out in the wilds and found that difficult. Families split up and people went back, others didn't like the working environment at Martlesham and they went back, and of course as I explained to you before a lot of people didn't come up, didn't move up, so we split and we lost a lot of people.[83]

However, there were also positive memories as staff remembered the support offered by the Post Office in terms of temporary accommodation and assistance for the move, as well as the opportunities for upsizing by moving out of London. Chris Wheddon remembers that the 'terms for moving were very generous', 'in terms of financial support and other support mechanisms',[84] whilst Colin Whitlum recalled that the Post Office 'had houses that they put people up in and rented'.[85] Allen Snow and Thomas O'Brien both recalled how the move had enabled them to buy larger houses that 'you would never have done that in the outskirts of London'[86] and that 'I never dreamed that I would ever own a house like that'.[87]

The delays to the Martlesham Heath village development also meant that the Research Department's Move Committee made visits to East Suffolk County Council to lobby the County Planning Officer to choose Martlesham Heath over the Kesgrave expansion and to accelerate the decision-making process.[88] The new village was thus finally approved in December 1972 and construction started in 1974. However, between the initial development plan and the construction of Martlesham Heath, the vision had changed substantially.

The new village embodied new design ideals which had not been mentioned in the 1964 plan: Martlesham Heath was, on the one hand, a 'traditional village', and on the

[82] Snow, Oral Histories of Martlesham Heath; Wheddon, Oral Histories of Martlesham Heath.
[83] Whitlum, Oral Histories of Martlesham Heath.
[84] Wheddon, Oral Histories of Martlesham Heath.
[85] Whitlum, Oral Histories of Martlesham Heath.
[86] Snow, Oral Histories of Martlesham Heath.
[87] O'Brien, Oral Histories of Martlesham Heath, 11 August 2016.
[88] 'Martlesham Move Committee, Progress Report 10' May 1971, TCB 391/1/4/1, BTA.

other hand, an 'instant village' or a 'new village'.[89] The new aim was to create a 'twentieth century village' which reflected the design traditions of the region by using Suffolk vernacular, whilst also appearing to have developed organically over time:

> A variety of materials have been employed, both traditional and modern, and deliberate changes in scale, street pattern and rooflines have been featured to try to create the appearance of organic growth that is so evident in many villages in the county.[90]

The lead architect for Martlesham Heath, Christopher Parker, described the village as a 'revolt against convention' – specifically, the highly planned post-war housing of new towns which he argued had failed 'through its insistence on control and careful avoidance of any design function'.[91] Parker chose the village concept instead, using an 'incoherent' architecture that would also emulate actual villages. The 'instant village' concept spoke to the goal of putting 'as much village character into the design as possible', whilst also using contemporary building techniques to accelerate construction.[92] Parker also achieved the traditional village concept through broader planning and landscaping: there was a central village green and a cluster of commercial units on the green for a village store, pub, and so on.[93] However, there were also some continuities with the earlier plans: the neighbourhood unit concept, with its origins in interwar US town planning, was kept. Parker organised the new village into various 'hamlets', which were all built off the village's arterial loop road; however, despite this conceptual lineage from American interwar planning and post-war new towns like Harlow, the 'hamlets' also served the village's chaotic aesthetic choices, as each hamlet was built along distinctive and varied design concepts, whilst still broadly adhering to the traditional English aesthetic and using the Suffolk vernacular.[94]

This aesthetic was also achieved through what might be termed 'technological detailing': the contradictory application of various techniques to limit the intrusion of technology into the traditional village aesthetic. Bidwells, the site developer, used earth mounding and tree planting to exclude road noise and screen the research centre, which

---

[89] Vallis, 'Martlesham Heath Village'; Christopher Parker and Gillian Darley, 'Martlesham Heath Village', *Architects' Journal* 170, no. 36 (1979): 492; Tony Aldous, 'Controlled Chaos Proves a Winner', *Chartered Surveyor Weekly* 4, no. 13 (1983): 662–63.
[90] 'Twentieth Century Village', *Building Design*, no. 406 (1978): 8.
[91] Parker and Darley, 'Martlesham Heath Village', 485.
[92] Vallis, 'Martlesham Heath Village'.
[93] Aldous, 'Controlled Chaos Proves a Winner'.
[94] 'Building Dossier: Martlesham Heath', *Building* 253, no. 7575 (1988): 43–54; David Prichard, 'Village Values', *RIBA Journal* 95, no. 8 (1988): 42–45.

was described in various features on Martlesham Heath as a ‘huge concrete toadstool of a research centre’ giving a ‘totally unbalanced impact’ to the new village.[95] Residents, through a householders’ association set up by Bradford Property Trust, had to sign covenants banning them from putting up TV aerials and parking caravans in the village; TV reception was instead received through an underground cable carrying a television signal from an aerial atop the research centre’s radio tower.[96] A block of flats in the village centre had ‘their parking courts discreetly positioned to avoid the visual intrusion of the car’.[97]

These design choices can be situated within the postmodernist movement. The emphasis on vernacular and regional style is a feature of postmodern architecture; Charles Jencks describes the neo-Vernacular movement of 1970s postmodernism as ‘*the* style to fall back on when there were no other clear directions’ in Britain.[98] Martlesham Heath can also be compared to other developments which have aimed to capture the traditional English aesthetic: it was compared favourably to a similar development in Essex, Woodham Ferrers, which had been criticised as a ‘pastiche’,[99] and there are undoubtedly similarities with the eminent postmodern architect Leon Krier’s development, Poundbury, built under the influence of Prince Charles in Dorset, which also has a revivalist aesthetic, and has alternately been called ‘radical’ and a ‘cottagey slum’.[100] These attempts to engineer a sense of history and tradition in brand-new developments fits in with a distinctive feature of postmodernism which Harvey identifies, in the turn to the stability of past as a response to the acceleration of time. A review of Martlesham Heath in the *Royal Institute of British Architects’ Journal* articulated that ‘the perceived stability of the vernacular idiom in housing design is an understandable reaction to a rapidly changing world’.[101] This contradictory combination of ‘incoherence’ and ‘stability’ in Martlesham Heath captures the essential tensions of postmodernism, well-put by a 1983 *Chartered Surveyor Weekly* feature on Martlesham Heath titled ‘Controlled

---

[95] Tony Aldous, ‘Suffolk Sensibilities’, *Building Design*, no. 680 (1984): 15; ‘Building Dossier: Martlesham Heath’, 48.

[96] Andrew Sellon, Oral Histories of Martlesham Heath, interview by Jacob Ward, 17 June 2016.

[97] ‘Building Dossier: Martlesham Heath’, 49.

[98] Charles Jencks, *The New Paradigm in Architecture: The Language of Post-Modernism* (New Haven; London: Yale University Press, 2002), 67.

[99] Prichard, ‘Village Values’.

[100] Witold Rybczynski, ‘Behind the Façade of Prince Charles’s Poundbury’, Architect, 3 December 2013, http://www.architectmagazine.com/Design/behind-the-facade-of-prince-charless-poundbury_o; Jonathan Meades, *Museum Without Walls* (Unbound, 2012), 367.

[101] Prichard, ‘Village Values’, 43.

chaos proves a winner'.[102] Herein lies a crucial point that can be made about the new village and its relationship with the research centre. Superficially, the village represented incoherence, but this aesthetic required various strategies of control, some of which drew on the research centre, to effect the appearance of organic evolution and natural integration into the Suffolk region: organisational, in the formation of a householders' association; spatial, in the neighbourhood units/hamlets concept; architectural, in the controlled production of incoherence; environmental, in the landscaped screening of the research centre; and technological, in the use of the research centre for TV reception.

Residents often raised the village's aesthetic values. Andrew Sellon, a retired Police Officer who claimed to be the village's 'oldest living resident', remembered liking the staged development of the hamlets:

> …the two or three different clumps that they had started on, and each one was different, and I thought yes this had something to it, I liked it.[103]

Andrew Johnson, a retired road planner for East Suffolk County Council, highlighted the regional style and contrasted the village with the planned town of Milton Keynes:

> …the architects to their credit and indeed the planning authority to their credit, I think have driven a good variety of properties rather than having picked up a house and put it at Milton Keynes or wherever you want sort of thing! … it shows a real willingness to experiment … the use of local architects as well which I think was nice as well you, get a Suffolk-feel if you like, the various designs, different pitches on the roof, different colours everywhere.[104]

Beverley Johnson, married to Andrew, who worked for various firms involved in the development, also praised the 'mix of houses' and 'wonderful village green' compared to 'your typical new housing estate, built pretty uniformly'.[105] Jeanette Higgins, who lived on Martlesham Heath as well as working at the research centre, recalls that she 'did like this idea of it being a village', naming the village green, church, pub, community hall and Scouts' Nissen hut as some of the 'so many things I would associate with a village'.[106] Thomas O'Brien, married to Sheila O'Brien, who also worked at the research centre and lived in the village, thought the village ideal 'was a good concept, a good idea', but noted

[102] Aldous, 'Controlled Chaos Proves a Winner'.
[103] Sellon, Oral Histories of Martlesham Heath.
[104] Andrew Johnson, Oral Histories of Martlesham Heath, interview by Jacob Ward, 14 July 2016.
[105] Beverley Johnson, Oral Histories of Martlesham Heath, interview by Jacob Ward, 14 July 2016.
[106] Higgins, Oral Histories of Martlesham Heath.

that it had died off recently, ‘I’m a bit disappointed they don’t still use the word, I think they should still use the word Martlesham Heath village’.[107]

However, several residents recognised the deeply artificial nature of the ‘village’. Andrew Sellon believes that ‘one has to call it an estate, such as it is, other people try and pretend it’s not’,[108] and Andrew Johnson takes a similar view:

> I’ve never really seen it as a new village I must admit … if you consider it to be a village in the true Suffolk style then no, it isn’t, and it never will be, because it’s not been developed along traditional lines.[109]

Beverley agrees, although also recalls having to defend the village from comparisons with ‘Legoland’:

> If I’m honest, it’s a housing estate, but it’s more than a housing estate … it definitely is a community, but it’s not one’s idea of a traditional rural village … people would ask where you lived and you would say Martlesham Heath, “…Oh, *Legoland*”.[110]

Another aspect of the village’s identity which appeared in oral histories was the relationship between the village and the research centre, as well as Suffolk Police Headquarters, also sited near the village. Andrew and Beverley Johnson both expressed irritation with how it was perceived as an extension of the research centre:

> …once people heard you’d moved onto the estate, onto the village … people who you got into conversation with in various places, “Oh, you work for BT or the police do you?”, “Well no, actually, I don’t”, … it rankled a bit to think that just because you lived on Martlesham Heath, to think that you worked for BT.[111]

> …it was kind of like, “Oh you live on Martlesham Heath, you must be very well off and you must work for BT”, which wasn’t actually the case … it was kind of thought that it was all BT and police officers that were living up here, which wasn’t the case at all.[112]

Martlesham Heath’s place-identity as a dialogue between the new village and the research centre would continue with the transformation of the research centre into a science park after BT’s privatisation.

---

[107] Thomas O’Brien, Oral Histories of Martlesham Heath, interview by Jacob Ward, 11 August 2016.
[108] Sellon, Oral Histories of Martlesham Heath.
[109] Johnson, Oral Histories of Martlesham Heath, 14 July 2016.
[110] Johnson, Oral Histories of Martlesham Heath, 14 July 2016.
[111] Johnson, Oral Histories of Martlesham Heath, 14 July 2016.
[112] Johnson, Oral Histories of Martlesham Heath, 14 July 2016.

Science Parks and History in the Making

The liberalisation of the telephone monopoly and the privatisation of British Telecom affected both the research centre and the new village and, as I will show, were also implicated in new historicisations of Martlesham Heath's place-identity.

Liberalisation and privatisation meant that the research centre, renamed BT Research Laboratory in 1981, became more oriented towards business markets and commercialising research. In 1981, Lazard Bros, the financial advisers, proposed a subsidiary called 'Martlesham Enterprises' to BT's board.[113] Martlesham Enterprises, which was founded in 1982, was set up to sponsor and secure financing for spin-off projects emerging from research which were peripheral or irrelevant to the telephone network, but still commercially viable.[114] The Thatcher government's emphasis on 'sunrise' IT industries, small enterprise, and innovation, particularly influenced the proposal, which was a common strategy in the 1980s and 1990s: BP and ICI founded similar subsidiaries called BP Ventures and Marlborough Technical Development respectively.[115] Another 1980s industrial strategy, interlinked with the IT booster-ism of the Thatcher government, was the 'science park': special-purpose clusters of industrial and academic research centres. Indeed, their early 1980s popularity was significant enough that the *Financial Times* ran a special section on science parks in 1983, and referred to Silicon Valley as a prime example, noting that it had evolved from Stanford University's research campus.[116] Again, the links between post-war universities and research sites inspired new spatial forms, but it would not be until the late 1990s that BT drew on the science park concept.

Throughout the 1980s and early 1990s, Martlesham Heath became a site for collaborative commercialisation of research. BT started open days, called 'Innovations at Martlesham', to showcase research to bankers and financiers from the City in order to garner investors, which Chris Wheddon recalls:

> We wanted to get investment analysts up from London … I enjoyed the look of wonderment that came over their faces and confusion, and some of them were sharp lads,

---

[113] 'British Telecommunications Board Meeting' 22 December 1981, TCD 16/1, BTA.
[114] 'BT Enterprise in Venture to Exploit R&D Spin-Off', *Electronics and Power* 28, no. 2 (1982): 141.
[115] 'Martlesham Enterprises' 1981, TCD 69/1/35, BTA; Kevin McNally, *Corporate Venture Capital: Bridging the Equity Gap in the Small Business Sector* (London: Routledge, 1997), 61.
[116] Anthony Moreton, 'Survey: Science Parks', *The Financial Times*, 21 January 1983.

very, very sharp, they asked very penetrating questions which we could answer … we were showing the people that were, if you like, going to buy BT.[117]

BT Labs also began to offer consultancy services where research staff would consult for other companies on research and development, which Allen Snow participated in during the 1980s:

…people would ask for expertise, for experts to come out and offer a consultancy service and I was on that list, and we would go and go through what they required, or bring them in to our facilities and show them what we've done … what we had developed over the years, could save them months of evaluation or trial and error so we could go straight in and help them.[118]

BT also embarked on various collaborative ventures and contractor arrangements with companies from across the world, including DuPont, Corning, Mahindra, and AT&T, which were a recurring proud memory for those who worked at BT Labs. BT's collaborative venture with DuPont, BT&D, which Ray Hooper worked for, was set up in 1986 to manufacture optoelectronic components for fibre-optic communications.[119] Ray Hooper attributed its formation to privatisation, suggesting that collaboration improved R&D commercialisation:

One of the big problems I think with R&D there was, there had been no way to commercialise other than go through Plessey or STC or the other guys, there was no direct route, it was a bit indirect, so what privatisation made possible was the idea of joint ventures, and BT did this a lot back then.[120]

BT also set up a joint venture, Tech Mahindra, in 1986 with the Indian conglomerate Mahindra & Mahindra to provide technology outsourcing, and this was co-located at BT Labs.[121] Chris Wheddon, during his time as Director of Systems Engineering at BT in the 1990s recalls:

In the end, I had nearly six thousand BT staff, I had a thousand contractors that we had, that we, contractors mostly from India, they were from a company called Mahindra, so

[117] Wheddon, Oral Histories of Martlesham Heath.
[118] Snow, Oral Histories of Martlesham Heath.
[119] Alan Cane, 'Hewlett-Packard Purchase', *The Financial Times*, 17 May 1993.
[120] Hooper, Oral Histories of Martlesham Heath.
[121] 'BT Exits Tech Mahindra', *The Hindu*, 12 December 2012, http://www.thehindu.com/business/companies/bt-exits-tech-mahindra/article4191751.ece.

> they were called Mahindrans, and I had staff in, I had about three thousand at Martlesham.[122]

In 1998, BT formed a $10b joint venture, Concert, with AT&T to provide network management services, which Colin Whitlum worked for, remembering that 'we managed networks from across the globe from this one console, it was an amazing feat' and that 'in some cases we pulled some tigers out of hats, really amazing things'.[123] In 2000, BT also formed a collaborative research partnership with Corning, the American glass manufacturer, which acquired BT's photonics lab as part of the deal.[124]

This spatial co-location of BT's various partners in and around Martlesham Heath was, in 1999, distilled into a new spatial form: Adastral Park, a science park. The renaming of BT Labs as Adastral Park was part of BT's broader aim to turn the site into a high-tech hub.[125] Adastral sited BT's technology and research partnerships, mentioned above, but also housed subsidiaries and spin-offs, such as Ignite, an e-business and communications solutions subsidiary; Napoleon, a joint venture with the private equity firm 3i to provide network management software; and Quip!, a web-based international phone call provider.[126] In 2000, BT set up a technology incubator, Brightstar, extending the Martlesham Enterprises concept by taking minority stakes in companies and in turn providing on-site accommodation, management services and advice.[127] BT also set up the East Anglia High Tech Corridor in partnership with Vision Park, Cambridge, and based a subsidiary, Internet Designers, which provided internet, IP, and multimedia support services to BT, at Vision Park.[128] At present, Adastral Park houses a large number of companies, including 3M, Cisco, Intel, and Huawei.[129] This last company is particularly interesting given the criticisms, made in 2013 by Parliament's Intelligence and Security

---

[122] Wheddon, Oral Histories of Martlesham Heath.
[123] 'AT&T, British Telecom Set $10B Venture', CNN, 27 July 1998, http://money.cnn.com/1998/07/27/deals/bt/; Whitlum, Oral Histories of Martlesham Heath.
[124] 'Corning in Deal With NetOptix, 2 Other Firms', *Los Angeles Times*, 15 February 2000, http://articles.latimes.com/2000/feb/15/business/fi-64359.
[125] 'First Chapter: Celebrating 30 Years of BT Laboratories' August 1999, HIC W04/06 Business Ops/R&D/Dollis Hill - Martlesham Heath - The Circuit Laboratory, BTA.
[126] 'Venturing to a Higher Plane: BT R&D Innovation Report' 2000, HIC W04/06 Business Ops/R&D/Dollis Hill - Martlesham Heath - The Circuit Laboratory, BTA.
[127] 'BT R&D Innovation Report, 2000, HIC W04/06 Business Ops/R&D/Dollis Hill - Martlesham Heath - The Circuit Laboratory, BTA'; Richard Fletcher and Mary Fagan, 'BT Sets up £2bn Venture Arm', *The Telegraph*, 19 November 2000, http://www.telegraph.co.uk/finance/4472832/BT-sets-up-2bn-venture-arm.html.
[128] 'BT R&D Innovation Report, 2000, HIC W04/06 Business Ops/R&D/Dollis Hill - Martlesham Heath - The Circuit Laboratory, BTA'.
[129] 'Companies | Innovation Martlesham', accessed 21 July 2017, http://www.innovationmartlesham.com/companies/.

Committee, of BT's decision to award critical infrastructure contracts to Huawei, who are seen as a possible security risk given rumoured associations with the Chinese government; elsewhere, Huawei has been excluded from involvement in Australia's National Broadband Network and is banned from bidding for US government contracts.[130]

Whilst Adastral Park is a new spatial form for Martlesham Heath, it also clearly has historical roots. Adastral Park is often described as a 'science campus',[131] echoing the 'university atmosphere' of the original Post Office Research Centre. This raises the question: how have these new spatial constructs on Martlesham Heath been tied to changing temporal expressions?

The formation of Adastral Park surfaced a temporalisation process which had begun with the Research Department's relocation and continues to the present: the historicisation of Martlesham Heath as an innovative place, and the convergence of place-identity between the research centre and the new village. In 1967, a Post Office report on relocation entitled 'Martlesham Heath: Home of Experimental Units' covered the heath's prior history as an aviation experimental unit from World War I.[132] In January 1917, the Experimental Flying Section of the Royal Flying Corps' Central Flying School moved to Martlesham Heath, and the site remained an experimental aviation site until World War II, at which point the RAF used it as a forward base until 1943, when it was loaned to the USAF. After World War II, it housed the Bomb Ballistic and Blind Landings Unit until 1961, when it was put onto care and maintenance status, finally closing in 1964, and the land reverted to the Bradford Property Trust. BT reiterated this experimental history in 1999 when it created Adastral Park: in a loose chronology of the relocation from Dollis Hill, BT celebrated 1999 as '30 years of BT research' at Martlesham Heath to inaugurate the creation of Adastral Park, but this was positioned within a longer lineage of research.[133] An internal BT magazine described how RAF pilots had flown 'research missions' from Martlesham Heath, narrating that 'in those days, pilots like Sir Douglas

---

[130] 'UK Ministers Defend Chinese Deals after Security Risk Warning', *BBC News*, 6 June 2013, http://www.bbc.co.uk/news/uk-politics-22795226; Linda Yueh, 'Huawei Boss Says US Ban "Not Very Important"', *BBC News*, 16 October 2014, http://www.bbc.co.uk/news/business-29620442.
[131] Becky Barrow, 'BT's Bunker Is a Brave New World in the Making', *The Daily Telegraph*, 15 March 2001; Dave Wilby, 'Inside Adastral: BT's Belgium-Sized Broadband Boffinry Base', 26 March 2013, https://www.theregister.co.uk/2013/03/26/geeks_guide_adastral_park/; 'Adastral Park', *Wikipedia*, 26 June 2017, https://en.wikipedia.org/w/index.php?title=Adastral_Park&oldid=787639388.
[132] 'Martlesham Heath: Home of Experimental Units' January 1967, TCB 391/1/3/9/1, BTA.
[133] 'First Chapter: Celebrating 30 Years of BT Laboratories, August 1999, HIC W04/06 Business Ops/R&D/Dollis Hill - Martlesham Heath - The Circuit Laboratory, BTA'.

Bader could be seen testing the latest Spitfires to destruction'.[134] The relocation of the Post Office, readers were told, meant that Martlesham Heath 'once again became a focus for leading-edge technologies, with Spitfires being replaced by circular waveguides and optical fibres'.[135] Tellingly, this publicity celebrated the establishment of Adastral Park as 'history in the making'.[136]

This WWII heritage has become prominent in the historicisation of Martlesham Heath. The initial move to Martlesham Heath was, in the thirty-year 'anniversary', described as an 'expeditionary force', and Martlesham Heath's role in allied bombing raids was played up.[137] The name 'Adastral Park' is itself a deliberate reference to the RAF, referencing the force's motto 'Per Ardua Ad Astra', which translates as 'through adversity to the stars'.[138] Adastral Park has subsequently become the locus for further invocations of WWII heritage as it now also houses the Tommy Flowers Institute, a reference to the Research Department's role in WWII codebreaking at Bletchley Park.[139] I cover this subject in more detail in the next chapter, but for now a brief sketch will suffice: in WWII, Post Office Research engineer Tommy Flowers, along with other Dollis Hill engineers, played a significant role at the Government Code & Cypher School at Bletchley Park, building the codebreaking machine Colossus and working with Alan Turing. The opening of the Tommy Flowers Institute at Adastral thus ties the site to Bletchley Park's codebreaking efforts. The institute aims to foster collaboration between the ICT industry and academia in the UK; there is an irony here in that, as I argue in the next chapter, Flowers, as a working-class engineer with no higher education, felt marginalised by his academic Bletchley Park colleagues Alan Turing and Max Newman. The Tommy Flowers Institute, with its emphasis on academia, is thus a highly selective invocation of the past.

The historicisation of innovation at Martlesham Heath continues to the present and has converged with the place-identity of the new village. Martlesham Heath village

[134] 'First Chapter: Celebrating 30 Years of BT Laboratories, August 1999, HIC W04/06 Business Ops/R&D/Dollis Hill - Martlesham Heath - The Circuit Laboratory, BTA'.
[135] 'First Chapter: Celebrating 30 Years of BT Laboratories, August 1999, HIC W04/06 Business Ops/R&D/Dollis Hill - Martlesham Heath - The Circuit Laboratory, BTA'.
[136] 'First Chapter: Celebrating 30 Years of BT Laboratories, August 1999, HIC W04/06 Business Ops/R&D/Dollis Hill - Martlesham Heath - The Circuit Laboratory, BTA'.
[137] 'First Chapter: Celebrating 30 Years of BT Laboratories, August 1999, HIC W04/06 Business Ops/R&D/Dollis Hill - Martlesham Heath - The Circuit Laboratory, BTA'.
[138] 'First Chapter: Celebrating 30 Years of BT Laboratories, August 1999, HIC W04/06 Business Ops/R&D/Dollis Hill - Martlesham Heath - The Circuit Laboratory, BTA'.
[139] 'Tommy Flowers Institute | BT Adastral Park', accessed 21 July 2017, http://atadastral.co.uk/about/tommy-flowers-institute/.

has celebrated 2017 as ‘MH100’, an anniversary of 100 years of innovation on the heath, sponsored by, amongst others, BT.[140] MH100 was celebrated through a weekend fete from 8th-9th July on the village green, by which is a pub called *The Douglas Bader*, and attractions included full-size Hurricane and Spitfire aircraft; vintage military vehicles; historical re-enactments, including a Winston Churchill actor and impersonator; representatives from the RAF and USAF; WWII songs and jive dancers; and a Battle of Britain memorial fly-by.[141] The event’s website summarises that ‘The story of Martlesham Heath is one of innovation, research and development, initially for aviation and more recently for telecommunications and IT. The Martlesham Heath “new village” itself was an innovative approach to building new housing’.[142]

The telephone business’s research activity, which itself drew on a prior history of aviation research to cement its own innovative research identity, has thus hugely shaped Martlesham Heath, as a ‘place’, a crystallisation of time and space. Here, the construction of *place* has required the construction of *history*. This might also be seen in the origination of this PhD, along with two others, from a joint Science Museum/BT Archives research proposal to investigate Post Office/BT R&D; this proposal took a decidedly place-oriented approach to the subject, conceiving of R&D as a place – Dollis Hill first, then Martlesham Heath – rather than, as I show in this chapter and through this thesis, in multiple sites, including Dollis Hill, Martlesham Heath, London, Cambridge, Goonhilly Satellite Earth Station, and the Castleton, Backwell, and Banbury Radio Research Outstations. The plaque above Dollis Hill and Martlesham Heath’s entrances read ‘Research is the Door to Tomorrow’, but research at the Post Office and BT has, in many ways, also served as a ‘door to yesterday’.

The place of history, heritage and tradition in twentieth-century Britain has been extensively addressed. Patrick Wright and Raphael Samuel both explore articulations of the past in everyday life, and so are helpful in identifying how Martlesham Heath village has contributed to the historicisation of place-identity.[143] Samuel highlights architecture as a feature of everyday experience which can reinforce senses of temporality; thus, he casts neo-vernacular architecture, as found at Martlesham Heath, as a ‘dreamscape’ for

[140] ‘Martlesham Heath • 100 Groundbreaking Years’, accessed 20 July 2017, https://mh100.org.uk/.
[141] ‘The Main Event – Martlesham Heath • 100 Groundbreaking Years’, accessed 21 July 2017, https://mh100.org.uk/the-main-event/.
[142] ‘Martlesham Heath • 100 Groundbreaking Years’.
[143] Patrick Wright, *On Living in an Old Country: The National Past in Contemporary Britain* (London: Verso, 1985); Raphael Samuel, *Theatres of Memory: Past and Present in Contemporary Culture* (London: Verso, 1994).

an old English palette.[144] Samuel also draws attention to manifestations of the historicist turn in communal everyday life, such as village green revivals, traditional pubs, historical performance and re-enactment, all of which featured at Martlesham Heath and MH100.[145] Just because MH100 was a once-off festival does not marginalise it as an example of everyday historicisation: as Wright points out, everyday life is not just about the mundane, repeated experience of every day, but is also marked by the special occasions which feature in everyday life, and these occasions can be particularly powerful enforcers of the past.[146] David Lowenthal and Robert Hewison have both addressed the historicist turn as well, in somewhat more critical terms, but in ways which I think are helpful for understanding Martlesham Heath. Both argue that the past is invoked as a response to severe change, but if I frame this as 'upheaval', it helps to highlight that the gradual turn to the past in Martlesham Heath has accompanied various forms of spatial upheaval: the research centre's relocation, the new village's creation, BT's privatisation, industrial, high-tech co-location, and, as I shall soon show, new, part-time workers as well.[147] All these upheavals became entangled with invocations of the past.

However, it is also clear from staff's and resident's experiences that these changing time-space expressions were not universal. In 1991, research staff experienced BT's Project Sovereign, a restructuring and cost-cutting effort which also brought new flexible working practices to Martlesham Heath.[148] Sovereign's intention was to cut 10,000 jobs a year through redundancy drives and early release schemes, which featured heavily in staff's memories. Allen Snow remembers it as 'not a very nice time' and recalls a colleague whose 'division were told that they had to lose twenty-two people, so that head of division went down, found a group with twenty-two people in, went, "Right, I'll close that", with no regard to business operational needs, so Sovereign did cause a few upsets'.[149] This story was repeated by Colin Whitlum, who also recalled that Sovereign was sold by BT as the 'kind release package':

[144] Samuel, *Theatres of Memory: Past and Present in Contemporary Culture*, 59–63.
[145] Samuel, 65, 146–74.
[146] Wright, *On Living in an Old Country: The National Past in Contemporary Britain*, 6.
[147] Robert Hewison, *The Heritage Industry: Britain in a Climate of Decline* (London: Methuen, 1987), 47; David Lowenthal, *The Past Is a Foreign Country* (Cambridge: Cambridge University Press, 1985).
[148] Roger Cowe, 'BT's Operation Sovereign Will Cost Nearly 400m: Outlook', *The Guardian*, 25 May 1990; Richard L. Hudson, 'British Phone Firm Sets Job Cuts' Cost At $660.7 Million', *Wall Street Journal*, 25 May 1990.
[149] Snow, Oral Histories of Martlesham Heath.

> …well that "kind release package" turned out to be a Level Five walking in and saying, "We've got to lose thirty-two people, this section has thirty-two people in it, goodbye". So we had a month to, I had to find another job or leave.[150]

Jeanette Higgins remembers that 'it made me think well, perhaps I haven't got a job for life here',[151] whilst Sheila O'Brien recalls the scheme as a lengthy process: 'I didn't know much about it except that I was on the receiving end … they offered their early release schemes, which went on for years, probably still doing them'.[152] Thomas O'Brien also took an early release package, which brought its own difficulties:

> …when I was 48, I could see that these offers were coming to an end, retirement at 50, so I took it, took it two years early because they were coming to an end, so I always expected to just follow on and be a telecoms engineer, but nothing ever came up, you know, I reached this age barrier and couldn't seem to find anywhere, and I ended up working for, doing jobs like working in Argos at Christmas and Marks & Spencers at Christmas, and I got a job for a while at Nationwide which I wasn't really being paid a lot, I was behind the counter and then I got a job back at BT testing some internet sites, that lasted six months, and then later on I managed to get a job at Bayer, testing urine analysis machines, and then that was the last, which I won an award, I was pleased about so for that, but then nothing ever came up that, and decided, since Sheila was working, just to be a house husband really, so been doing bird watching and going out and about, looking after the home, looking after the family, helping my son do his degree, I think that was my biggest achievement since I left BT, my son was really struggling with his software degree, but he got through that, so I was pleased about that.[153]

Many staff, like Thomas, also found themselves back at BT at various points as the flexible working practices which Sovereign introduced meant that they were re-hired as contractors and consultants. Allen Snow went back as a consultant, as did Colin Whitlum, who, after retiring and going on holiday with his wife, returned to 'a letter asking me if I'd go back for 8 weeks' but then 'I stayed for 11 and half years in various roles in the company'.[154] Colin remembered how working as a contractor was characterised by other flexible working practices:

---

[150] Whitlum, Oral Histories of Martlesham Heath.
[151] Higgins, Oral Histories of Martlesham Heath.
[152] O'Brien, Oral Histories of Martlesham Heath, 11 August 2016.
[153] O'Brien, Oral Histories of Martlesham Heath, 11 August 2016.
[154] Snow, Oral Histories of Martlesham Heath; Whitlum, Oral Histories of Martlesham Heath.

> …what they said to me was, as long as you keep your contract going, wherever you're working, you keep that contract, your name on that contract, you'll get back every time. Soon as you drop off, you won't get back … so what they did for me, when I wanted to on a sabbatical for three months was they gave me a three-month zero hours contract, alright? So I love 'em![155]

Sheila O'Brien, Jeanette Higgins, and Ray Hooper all worked as contractors too: Sheila at BT&D, Corning, and Huawei;[156] Jeanette at a joint venture between Accenture and BT, which she remembers as 'a lovely way to finish off my working life';[157] and Ray opened his own consultancy after contracting for BT:

> So in 1999 … I decided to take voluntary redundancy … I did actually work back at BT for a period in various other, much of it was to do with fibre and particularly the challenge of fibre to the home, and then more recently then I expanded my kind of work into other companies which I did some consultancy, various consultancy jobs, again a lot of it around optical fibre communications, particularly in the local network.[158]

The flexible working practices at Adastral Park also influenced Martlesham Heath new village. A block of flats was built in the village centre during the 1990s, which Beverley Johnson attributes to the contractor culture at BT:

> There were, by then BT were employing a lot of guys and ladies on short term contracts, and people were looking for six-month rentals or whatever, and how easy was it just to rent a flat across the road and you're on the doorstep for work … I thought, "Oh I kind of wish they hadn't done that", but I get why and once they were built I thought, "Well, the design is not that bad actually".[159]

Andrew Johnson similarly believes that 'these days, of course it's not quite the same, because they employ a lot of contract labour and short term contracts'.[160] Further significant changes may be coming to Martlesham Heath as well; in 2008 and 2009, BT submitted planning applications to build 2,000 homes south-east of Adastral Park.[161] Suffolk Council rejected these plans, but another project proposal for 450 homes is underway and a group, 'No Adastral New Town', with ties to the Martlesham Heath

---

[155] Whitlum, Oral Histories of Martlesham Heath.
[156] O'Brien, Oral Histories of Martlesham Heath, 11 August 2016.
[157] Higgins, Oral Histories of Martlesham Heath.
[158] Hooper, Oral Histories of Martlesham Heath.
[159] Johnson, Oral Histories of Martlesham Heath, 14 July 2016.
[160] Johnson, Oral Histories of Martlesham Heath, 14 July 2016.
[161] 'No Adastral New Town', accessed 20 July 2017, http://noadastralnewtown.com/.

householders' association, has formed to resist the development.[162] Martlesham Heath may by now be an established place, but its spatial and temporal transformations are evidently still ongoing.

Conclusion

I think it is no surprise that a laboratory has been at the centre of so many diverse transitions. The mutual significance of laboratory and place has already been thoroughly explored: as Cahan and Agar show respectively, the history of the Physikalische-Technische-Reichsanstalt cannot be told without the history of urbanising early-twentieth-century Charlottenburg, and the history of Jodrell Bank cannot be told apart from the history of suburbanising post-war Manchester.[163] However, as I have shown in the history of Martlesham Heath's relationship with governmental strategies of spatial restructuring, private postmodern residential developments, and new spatial strategies for innovation and enterprise, it is also clear that these histories of laboratories and place speak to broader scales of change. The changes in post-war Britain – the Flemming Report, the new universities, 1980s 'sunrise' IT and enterprise – were crucial in shaping the Post Office and BT's goals and strategies. There is another useful way to consider Martlesham Heath's spatiality here: Harvey points out that, contradictorily, many fixed spaces – airports, railways, motorways – result from the societal drive to reduce spatial barriers.[164] Crucially, these places, as fixings of time and space, can be poorly suited to macro-contextual transitions, and hence the forms of spatial restructuring and aesthetic movements which accompany these places are particularly valuable in surfacing new shapes of society. This chapter adds laboratories to Harvey's list, and, in showing how Martlesham Heath leveraged various trends and transitions, also speaks well to this thesis' organising concepts of information and control.

Information as a concept was not explicitly visible in Martlesham Heath, but science parks have often been subordinated to broader information age theories, such as Peter Hall and Manuel Castells' account of 21st century 'technopoles', or, indeed,

[162] 'No Adastral New Town'.
[163] David Cahan, 'The Geopolitics and Architectural Design of a Metrological Laboratory: The Physikalische-Technische Reichsanstalt in Imperial Germany', in *The Development of the Laboratory: Essays on the Place of Experiments in Industrial Civilization*, ed. Frank A.J.L. James (Basingstoke: Macmillan, 1989), 137–54; Jon Agar, *Science and Spectacle: The Work of Jodrell Bank in Postwar British Culture* (Amsterdam: Routledge, 1998).
[164] Harvey, *The Condition of Postmodernity*, 232, 258.

Castells' 'space of flows' and 'timeless time'.[165] Castells' analysis clearly resonates with phenomena experienced at Martlesham Heath: the contradictory spatial co-location of strategic alliances and joint ventures to manage global networks, and the disruptive temporality of coercive early retirement packages and instant villages, combined with deepening historicity, are classic features of Castells' space of flows and timeless time. However, I think the history of Martlesham Heath also shows how Castells overstates the differences between spaces of places and spaces of flows, and between timeless time and fragmented time. These spaces and times are much blurrier and less revolutionary than Castells suggests: Martlesham Heath is undoubtedly a place, in that clear visions of its space, as a new village and science park, and time, as an historically innovative site, have become crystallised, and so 'place' cannot be so easily disentangled from 'flow'. Moreover, the temporality of 'timeless time' seems no less fragmented, between the contrasting experiences of traditional Englishness in the new village and the experiences of Project Sovereign by research centre staff.

The question therefore remains that, if no information revolution occurred in time-space expressions and experiences at Martlesham Heath, is there any value in the 'information' concept? Following Frank Webster's call to analyse the 'informatisation' of historical continuities, I think there has been informatisation on Martlesham Heath.[166] This has taken place both on the research site, in the establishment of ICT-based ventures, spin-offs, and incubators to provide consultancy, management, and network services, and in the village, from the early visions of a modern, monorailed village and the physical lobbying of county planners, to a postmodern new village built on invisible television circuits and web-based linkages like MH100.org and noadastralnewtown.com. However, it is also apparent that these have been bound up in broader transitions from public ownership – of the telephone business and housing developments – to private enterprise, and so these linkages have not just been informatised, but commercialised also.

Control is far more visible on Martlesham Heath, despite the attempts of Christopher Parker's incoherent instant village. Giddens' conception of time-space and the organisation are helpful here: through the systems of time-space control in the research centre, from parking spaces to part-time contractors and zero-hours contracts, and through the growing generation of historicity since the relocation, the Post Office and BT used their research centre to support organisational reproduction. However, Giddens'

[165] Manuel Castells and Peter Hall, *Technopoles of the World: Making of 21st-Century Industrial Complexes* (London; New York: Routledge, 1994); Castells, *The Rise of the Network Society*, 407–99.
[166] Webster, *Theories of the Information Society*, 357.

attention to the organisational locale also insufficiently captures the spatial extensiveness of Martlesham Heath, from the co-location of other organisations in the science park, to the 'controlled chaos' of Martlesham Heath village. Parker, Clifford Culpin, and the Bradford Property Trust extensively planned and controlled this village, and the Post Office similarly embedded the research centre within systems of environmental control. Both sites also deployed organisational frameworks for control: in the new village, the householders' association and covenants preserved aesthetic control; on the research site, Project Sovereign introduced new ways to control working practices. This may explain the recurrence of control – although not always explicitly – in oral histories with staff and residents. Staff's and residents' experiences and memories speak to the shifting identities and practices at the research centre, the new village, and Martlesham Heath, and how these practices impacted on their own lives. Some residents rankled at the imposition of the 'village' name on the new development, but many also appreciated the householders' association and covenants. Staff differentiated hierarchical working practices at Dollis Hill from Martlesham Heath, but also brought up Project Sovereign, highlighting that, whilst relations may have been informatised, and some novel forms of control appeared, there are nevertheless important continuities of control which remain.

Another significant aspect of control which this chapter has addressed is the changing strategies of control over R&D and innovation. The corporate laboratory, which Michael Aaron Dennis has cast as an expression of the vertical integration of research, and which Graeme Gooday has interpreted as a reification of broader industrial attitudes to the relationship between research and engineering, is no longer the distinguishing feature of Martlesham Heath.[167] Adastral Park replaced the corporate lab, and BT began to advance R&D strategy through collaborative ventures which are spatially bipolar: in one instance, these take place on a 'science campus' in Suffolk, and yet in another they virtually span the globe. Innovation in this model is not about the linear flow of basic research into new technologies, but instead horizontal collaboration on advanced development and commercial products.

Of course, R&D was not the only important object of control for the Post Office and British Telecom, and, whilst Martlesham Heath was an important passage-point for exerting control over a diverse array of targets, it was not the only register of control which the telephone business deployed during this period. As I addressed in the previous

[167] Michael Aaron Dennis, 'Accounting for Research: New Histories of Corporate Laboratories and the Social History of American Science', *Social Studies of Science* 17, no. 3 (1987): 479–518; Graeme Gooday, 'Placing or Replacing the Laboratory in the History of Science?', *Isis* 99, no. 4 (2008): 783–95.

chapter, machine control in the telephone network was a pressing issue during the 1950s and, as I will address in my next chapter, computerisation in the telephone network continued to be an important subject into the 1980s.

5 The Universal Machine

Integrating Computers and Communications

I opened this thesis with James Merriman's, the Post Office's Engineer-in-Chief, argument that 'the concepts of information and control are fundamental to any telecommunications system'.[1] In this chapter, I return to that quote to explore why Merriman articulated this vision in that specific manner at that particular time, and situate it within the telephone system's computerisation and digitalisation. This chapter explores both the concept of system 'control', via computerisation, and the origins of a holistic plan for an 'information' network.

Computer control in telecommunications is heavily entangled with telephone exchanges, which became computerised in the post-war period; a brief history of telephone exchanges is thus necessary. Telephone exchanges route, or 'switch', telephone calls from caller to recipient. At first, this traffic was switched by human operators, who received a call at the exchange, identified the caller's destination, and physically connected the appropriate telephone circuits using a switchboard. Telephone operators were eventually phased out by mechanical exchanges which could automatically switch traffic, and then, after World War II, electronic switches entered development. Electronic switches were followed by the development of computer-controlled exchanges, where a computer would interpret the dialled number and switch the call along the appropriate telephone circuits. Two of the Post Office's biggest post-war projects were electronic and computerised exchanges: the first, Highgate Wood, was planned as Britain's first all-electronic telephone exchange, but failed, whilst the second, System X, became Britain's first all-digital, fully-computerised telephone exchange, but only after protracted and problematic development.

[1] Merriman, 'Men, Circuits and Systems in Telecommunications', 250.

However, it would be misleading to see this as evidence of British technological failure. As Michael Kay points out on the early history of British exchange development, there has persisted a narrative that early British telephony was underdeveloped, but Kay shows that this was a complex period that did not involve simple engineering 'failures', but the interests of multiple stakeholders.[2] Likewise, in this chapter, I show that delays to exchange development and implementation were not solely due to technical failures (although these did occur), but rather due to competing ideas about the future of the British telephone system and the interests of various parties within and outside the Post Office. Another argument I develop in this chapter is that, beyond exchange computerisation, computer modelling was also important in shaping the development of British telephone exchanges: one way in which the telephone system exerted computer control was by using modelling to identify which exchanges it wanted to rollout across the network. Modelling as a form of control is a recurring theme in this thesis, appearing in this chapter, the next, and in Chapter Six.

I explore these subjects through several sections. In the first section, 'Tommy Flowers, Colossus, and Highgate Wood', I explore the development of Highgate Wood and relate its troubled history to the notion of 'prestige', which was a key motivator for many of the parties involved in its development. In the second section, 'Integrating Cybernetics and the Government Machine', I relate Merriman's philosophy of 'information and control' to two influences: information theory and cybernetics on one hand, and Merriman's background as an influential expert mechaniser in Treasury O&M on the other. I argue that these influences, which produced the 'information and control' discourse, resulted in the belief that the telephone system should not only be fully computerised, but fully *integrated*, by transmitting video and data alongside telephony. This was the origin of the telephone network as an integrated information network controlled by computers, and I trace these ideas through the remainder of this chapter and through following chapters. In the third section, 'A Model of Discretion', I explore the use of computer modelling to plan network modernisation in the 1970s, and relate the Post Office's model to a government tradition of 'discreet' computing. Finally, in the fourth section, 'System X and Integrated Digital Networks', I explore the reification of 'information and control' in two different systems: System X, an 'evolutionary' computerised telephone exchange system, and the integrated services digital network, a

[2] Michael Kay, 'Troublesome Telephony: How Users and Non-Users Shaped the Development of Early British Exchange Telephony', *Science Museum Group Journal* 3, no. 3 (9 April 2015), http://journal.sciencemuseum.org.uk/browse/issue-03/troublesome-telephony/.

standard for providing multiple signals – telephony and data – over the telecommunications system. I relate these systems, with the creation of BT and liberalisation of the monopoly, to changing attitudes to automation, unemployment, and BT's customers.

Tommy Flowers, Colossus, and the Prestige of Highgate Wood

The Post Office's first electronic exchange, located at Highgate Wood in North London, started formal development in 1956 with the formation of the Joint Electronic Research Committee (JERC), set up to coordinate research between the GPO and its suppliers – Siemens, ATE, Ericsson, GEC, and STC.[3] However, to understand Highgate Wood and its failure, it is necessary to first explore switching development in the aftermath of World War II.

The predominant form of switching used in the United Kingdom during the first half of the twentieth century was the mechanical Strowger telephone exchange, first patented in the USA by Almon Strowger in 1889.[4] Strowger applied to patent his system in the UK in 1892 and 20 years later, in 1912 – the same year the Post Office absorbed the NTC – Strowger entered service in the Epsom telephone exchange, becoming a mainstay of Post Office automatic switching.[5]

However, by the end of WWII, there was a clear need to upgrade Strowger, which was large and unreliable. After World War II, a delegation including Tommy Flowers, Post Office switching engineer and creator of the World War II codebreaking machine Colossus, visited the United States to report on a new version of the Crossbar exchange, an electromechanical alternative to Strowger.[6] The report found that Crossbar had higher accommodation and power requirements, but provided superior service, whilst costing fractionally more and having similar maintenance costs; the main disadvantages found were its high cost and much higher number of relays compared to Strowger. However, the report concluded that Crossbar provided superior service, was more adaptable, and could flexibly serve many locations, from small rural switching to metropolitan and trunk

[3] Gordon Radley to Ernest Marples, 'Electronic Switching', 12 April 1957, TCB 2/113, BTA.
[4] Anton A. Huurdeman, *The Worldwide History of Telecommunications* (Hoboken, NJ: John Wiley & Sons, 2003), 193–94.
[5] Liffen, 'Telegraphy and Telephones'.
[6] L. Roy F. Harris, *Automatic Switching in the UK* (Sunbury, Middlesex: The Communications Network, 2005), 52.

switching.[7] The mixed conclusions on Crossbar are perhaps indicative of the reported conflict between the two lead engineers on the trip – Flowers, who supported moving straight to fully electronic development, and Donovan Barron, later an Engineer-in-Chief of the Post Office, who advocated Crossbar switching with elements of electronic control.[8] Flowers won out, persuading the Controller of Research, Gordon Radley, that all development should be focussed on designing a fully electronic telephone exchange.

Flowers' position on electronic switching, and his success in convincing Radley, originates in Flowers' pre-war switching research and his wartime work on Colossus, the codebreaking machine developed for use at Bletchley Park, the Government Code and Cypher School. Rachel Boon has pointed out that Flowers had developed an experimental electronic installation by 1934, which was accepted and used on a highly limited basis by the Post Office from 1939.[9] However, the war interrupted and Flowers was approached in 1941 by Radley to undertake work for Bletchley Park, at which point Radley and Flowers became the first Dollis Hill engineers initiated into Bletchley Park.[10] Flowers' initial work was on a special-purpose electromechanical device for Alan Turing's codebreaking team, but after that project was scrapped, Flowers proposed Colossus, a large, electronic machine to process intercepted German messages, which, upon completion, was an immediate success, doubling the codebreakers' output.

Colossus has been the subject of attempts to cast it as the first electronic computer;[11] however, I will argue that Colossus is best understood as the product of Flowers' background and interest in electronic telephone exchanges, rather than electronic computing. This requires making three arguments: first, that Colossus, a digital electronic codebreaking 'computer', was seen by Flowers and his staff as more akin to an electronic switching device; second, that support for the Highgate Wood electronic exchange project was secured through invocations of Flowers' and Dollis Hill's wartime work with Bletchley Park; third, that Flowers' feelings about Colossus' secrecy, and his inability to capitalise professionally on Colossus compared to his Bletchley Park colleagues Alan Turing and Max Newman, was fundamental to his post-war research. I

[7] 'Report of an Official Visit to the United States of America to Study Developments in Telephone Switching Practice' 1947, TCB 371/39, BTA.
[8] Harris, *Automatic Switching in the UK*, 53.
[9] Rachel Boon, 'The Post Office Research Station, Dollis Hill, 1933-1965' (PhD diss., University of Manchester, in progress).
[10] Brian Randell, 'Of Men and Machines', in *Colossus: The Secrets of Bletchley Park's Codebreaking Computers*, ed. B. Jack Copeland (Oxford: Oxford University Press, 2006), 141–49.
[11] B. Jack Copeland, ed., *Colossus: The Secrets of Bletchley Park's Codebreaking Computers* (Oxford: Oxford University Press, 2006).

will suggest that Flowers' pursuit of electronic switching after the war was an attempt to recapture his technical and professional breakthroughs which had remained secret with Colossus.

Flowers and others at Dollis Hill thought of Colossus as more akin to a switching system rather than a modern computer. Flowers, in his retrospective explanations of Colossus, generally describes the machine in switching terms, rather than computing, such as an 'automatic number processor', and making direct comparisons between Colossus and early electronic switching systems based on their uses of thermionic valves.[12] Harry Fensom, a Post Office engineer who worked on Flowers' Colossus team, describes that many of the principles informing Colossus came from automatic telephone exchanges and switching, such as the use of 'routiners', which ran overnight 'programs' of electrical and logical tests on telephone switches; counters, to record the number of telephone dial pulses; logic functions, to detect when calls had been answered; and directors, which detected exchange codes in dialled phone numbers and translated them into a sequence of exchanges through which to route the call.[13] Colossus drew on all these principles: it used electronic switches in the form of thermionic valves; its master control, which included a counter to identify unique messages, was analogous to a director, and, of course, the machine could be configured to run though different routines, or programs, based on logical tests.

Flowers' pursuit of electronic switching after World War II was strongly backed by Radley, who later became Engineer-in-Chief and Director-General of the Post Office, and this support can be traced to their Bletchley Park history. When Flowers first proposed Colossus to Bletchley Park, it was not received especially well. It was thought that it would be too unreliable and that the war would be over before it was ready. However, Flowers was granted license to pursue the project independently at Dollis Hill, based on, according to Harry Fensom and Jack Copeland, Flowers and Colossus' historian, the 'complete backing' of Gordon Radley.[14] These accounts are perhaps exaggerated, appearing in a volume on Colossus as the world's first electronic computer, but they show that Radley's support of Highgate Wood has a longer history from his support of Flowers and Colossus. This support continued after the war: in justifying

---

[12] Thomas H. Flowers, 'Colossus', in *Colossus: The Secrets of Bletchley Park's Codebreaking Computers*, ed. B. Jack Copeland (Oxford: Oxford University Press, 2006), 91–100.

[13] Harry Fensom, 'How Colossus Was Built and Operated - One of Its Engineers Reveals Its Secrets', in *Colossus: The Secrets of Bletchley Park's Codebreaking Computers*, ed. B. Jack Copeland (Oxford: Oxford University Press, 2006), 300.

[14] Fensom, 301; B. Jack Copeland, 'Machine against Machine', in *Colossus: The Secrets of Bletchley Park's Codebreaking Computers*, ed. B. Jack Copeland (Oxford: Oxford University Press, 2006), 76.

Highgate Wood to Ernest Marples, the Postmaster-General, in 1957, Radley linked the new electronic exchange to Dollis Hill's wartime work, also invoking similar research on computers to support its viability.[15] According to Roy Harris, a member of Flowers' post-war switching team, and later the designer of System X, Radley always came down on Flowers' side in decisions on electronic exchange development.[16] Radley's support shows how Colossus' later significance lay not in computing, but in supporting electronic exchange development.

Flowers was particularly bitter about Colossus' secrecy and his inability to use the prestige gained from its creation. Flowers watched on as his Bletchley Park colleagues, Alan Turing and Max Newman, built off the principles of electronic code-breaking to develop computers, whilst he had 'no power or opportunity to use the knowledge effectively. With no administrative or executive powers, I had to convince others, and they would not be convinced. I was one-eyed in the kingdom of the blind'.[17] Flowers attributed delays on Highgate Wood to his lack of 'prestige, which knowledge of Colossus would amply have provided'.[18] Flowers is disingenuous here: as I have already shown, his prestige with Gordon Radley was instrumental in earning Radley's support post-war and furthermore, there were many factors contributing to Highgate Wood's delays, which I address below.

However, it is telling that Flowers highlights prestige as 'the one thing' he lacked, and which Turing and Newman could build on.[19] This had consequences for Flowers' and Turing's relations after the war, when Turing worked on a computer project, ACE, for the National Physical Laboratory (NPL), and commissioned Flowers to undertake development work for ACE. ACE, Automatic Computing Engine, would be a stored-program control (SPC) general-purpose computer used for laboratory calculations, but suffered numerous problems in its development, including Turing's departure from the NPL, and lost out as the first SPC digital electronic computer to the 'Manchester Baby', built at the University of Manchester. Flowers' sluggish attention had delayed ACE: Flowers had told Turing that an early version of ACE would be ready by August or September 1946, but in fact neglected the project, saying that his section was 'too busy to do other people's work', and instead focussed on updating the oversubscribed post-war

[15] Radley to Marples, 'Electronic Switching'.
[16] Harris, *Automatic Switching in the UK*, 53.
[17] Thomas H. Flowers, 'D-Day at Bletchley Park', in *Colossus: The Secrets of Bletchley Park's Codebreaking Computers*, ed. B. Jack Copeland (Oxford: Oxford University Press, 2006), 83.
[18] Flowers, 83.
[19] Flowers, 83.

telephone network.[20] In effect, Flowers neglected Turing's work on electronic computing for his own work on electronic switching; he was not interested in developing a SPC general-purpose computer, but instead fixated on repeating a previous feat: developing an electronic special-purpose switching machine.

From 1947, a small team under Flowers worked on developing Highgate Wood's basic principles: pulse amplitude modulation (PAM), which encoded telephone signals as pulsed samples, and time-division multiplexing (TDM), which transmitted signals by rapidly cycling through pulsed samples; combined, these electronic techniques meant that a single telephone circuit could simultaneously carry multiple signals and an electronic exchange could switch multiple signals without mechanically moving the circuit.[21]

However, development on the Highgate Wood exchange was slow. Assistance was solicited from the Post Office's suppliers, but their concerns about patent exploitation meant that in 1952, they turned down a proposal which had been the outcome of lengthy discussions with the National Research and Development Corporation, the Board of Trade, the Ministry of Supply and the Treasury.[22] Protracted discussions continued until 1956, at which point Gordon Radley, by this point Director-General, told the suppliers that unless they agreed, the Post Office would choose one of them as its main development and manufacturing partner. The suppliers quickly fell into line and on 15th May 1956 the Joint Electronic Research Agreement (JERA) was signed by the Post Office and its five suppliers, laying out the terms for pooling research, staff, and development tasks.[23] These protracted negotiations require reappraisal of Flowers' belief that his lack of prestige delayed switching development. In fact, Flowers and his team worked mainly undisturbed on switching principles, and it was only during the 1950s that delays, initially caused by manufacturer negotiations, began to occur. These tensions between collaborative research and competitive procurement were not unique to this period, and would continue to shape electronic exchange development in the 1970s and 1980s.

The motivation of 'national prestige' drove the development of Highgate Wood in the face of significant issues, which had raised concerns for the Postmaster-General, Ernest Marples.[24] Since Flowers and Barron's 1947 visit, Bell Labs had announced

---

[20] B. Jack Copeland, 'Colossus and the Rise of the Modern Computer', in *Colossus: The Secrets of Bletchley Park's Codebreaking Computers*, ed. B. Jack Copeland (Oxford: Oxford University Press, 2006), 109.
[21] L.R.F. Harris, 'Highgate Wood: General System Description' December 1960, HIC W04/01 Switching/Public Automatic Exchanges/Experimental and Prototype Systems, BTA.
[22] Radley to Marples, 'Electronic Switching'.
[23] Radley to Marples.
[24] Radley to Marples.

development of its own all-electronic exchange. The export prospects of British manufacturers also played a role, as exports in the 1950s had suffered under 'a resurgence of national competition and nationalistic considerations [which] have tended to restrict the market … The real chance for British manufacturers is to be able to offer electronic equipment that is a stage ahead'.[25] Radley thus defended Highgate Wood's development to Marples as both an extension of Dollis Hill's wartime work as a matter of 'national prestige'.[26]

The main problem was power. Two months after Radley's defence of electronic switching, power provision estimates had to be adjusted: more power was needed, with greater reliability and stability in the current provided, and at higher cost. Lionel Harris, the Engineer-in-Chief, and Roy Harris' father, raised concerns at a 1957 JERC meeting and so Don Barron, by this point the Assistant Engineer-in-Chief, suggested that Highgate Wood – always intended as an experimental proof-of-concept, and already un-economic – should be postponed until a small, economically competitive, practical exchange, could be built. Harris dismissed this idea and 'stressed the prestige value of the installation of a complete working system in view of similar projects now being developed abroad'.[27] The motivation to beat out foreign competitors such as Bell Labs was clear and apparent.

The urgency of Highgate Wood as a prestige project also fed into additional construction work needed for the exchange's burgeoning power requirements. The existing exchange building had to undergo structural alterations, and an additional room was needed to accommodate extra batteries. In turn, this meant that greater ventilation was required: a fan room of at least 1,600 square foot. The existing exchange building had no space for such a room, and so the Post Office requested that the Ministry of Works build an entire additional floor on the exchange building to create space for the fan room. In order to justify this additional expenditure and hurry the Ministry of Works, a letter from the Post Office explained that, 'It is a matter of national prestige for us to be the first to introduce such an exchange … it will be of inestimable value to our export trade to be able to be first on the scene with this new development'.[28] Despite the earlier acknowledgement by the Engineer-in-Chief and his deputy that Highgate Wood was an

[25] Radley to Marples.
[26] Radley to Marples.
[27] 'Minutes of a Meeting of the Joint Electronic Research Committee.' 2 September 1957, TCB 2/113, BTA.
[28] J Bellew to O.H. Lawn, 'Tudor T.E. 2nd Unit (Highgate Wood Exchange)', 2 August 1957, POST 122/894, BTA.

uneconomic experimental exchange, the Post Office still invoked a relationship between research prestige and export prospects.

‘Prestige’ was a significant and flexible rhetorical device in Highgate Wood’s continuing development. Agar’s history of the post-war construction of Jodrell Bank’s Mark I Telescope, completed in 1957, highlights the power of ‘prestige’ in mobilising various actors in support of construction, including the Royal Astronomical Society (RAS), the Department of Scientific and Industrial Research (DSIR), and the astronomers themselves.[29] Prestige meant different things to these different groups: for the RAS, it meant the standing of British science; for the DSIR, it meant a display of British prominence; for astronomers, it could be used as a funding invocation. Prestige’s interpretative flexibility meant that by invoking it, one had a term which could draw together different groups, even if for different reasons. For Highgate Wood, ‘prestige’ displays this flexibility in coordinating different groups with different goals: for Flowers, ‘prestige’ meant recognition for his work on Colossus; for the Engineering Department, it meant international recognition; and for the Postmaster-General and other government departments, it meant increasing export prospects. This rhetorical use of prestige in conjunction with big scientific and technological projects also fits in with the ‘defiant modernism’ trend which I introduced in Chapter Two: the Post Office’s aspiration to the world’s first electronic telephone exchange fits in well alongside the defiant modernist projects of Comet, Bluebird, and Calder Hall.[30]

Highgate Wood’s problems meant the project was substantially delayed. The exchange entered service in 1962, four years late, and was an abject failure.[31] Its component failure rate was quite low, but Roy Harris has catalogued how the system suffered several intractable faults.[32] It carried progressively less traffic over time as pulses were not always cleared from connection stores after calls, and so channels continued to look busy. The variety of pulsing systems used – subscribers’ lines were pulsed five times per second, whilst junctions were pulsed forty times per second – led to interference. In 1963, research on PAM/TDM exchanges was thus abandoned: economically, the equipment required was too expensive, whilst technically, it was clear that PAM would continue to produce interference and incompatibility between different pulsed frequencies.[33] Flowers reportedly could not endure this decision and so resigned from the

---

29 Agar, *Science and Spectacle*, 226.
30 Bud, ‘Penicillin and the New Elizabethans’, 312.
31 Harris, *Automatic Switching in the UK*, 10.
32 Harris, 10.
33 Harris, 10–11.

Post Office in 1964.[34] Highgate Wood, however, remained open. National prestige meant that it could not simply be closed: 'Highgate Wood has prestige value … it will be the only electronic exchange really connected to the public system in Britain … and has been an important feature of the visits of parties from abroad. Arrangements are in hand for a visit of continental technical journalists in March [1964]'.[35] The experimental Highgate Wood, disconnected from the telephone network, thus remained in place as a symbol of British prestige. It was eventually removed in 1965.

Integrating Cybernetics and the Government Machine

After PAM/TDM was abandoned, there was only one exchange left under development through the JERC agreement: REX, Reed-relay Electronic eXchange, which used small metallic 'reeds' as cross-points for routing calls, rather than Highgate Wood's electronic logic circuits, and used discrete connecting paths for each call, in contrast to Highgate Wood's shared TDM paths.[36] REX entered service in 1966 in Leighton Buzzard, providing service for 3,000 subscribers.[37] REX became known as TXE1 – Telephone eXchange Electronic 1 – and became the basis for the TXE exchange series developed and rolled out through the 1960s and 1970s, which was the subject of an onerous industrial dispute between the Post Office, STC, GEC, and Plessey revolving around the use of computer modelling to plan the modernisation of Britain's switching network.

However, before I move onto the TXE dispute, there was another important prototype exchange developed during the 1960s: Empress. Highgate Wood's PAM/TDM approach was dropped, but time-division multiplexing was not, and was instead allied to digital pulse code modulation (PCM), a way of encoding signals as digital, rather than analogue, pulses. PCM had been developed in the 1930s by the British radio engineer Alec Reeves whilst employed at IT&T's Paris research centre, Les Laboratoires Standard. Reeves is a fascinating but under-studied figure in British engineering history: alongside his development of PCM, he also contributed to radar development before and during World War II. Reeves was also a practicing spiritualist, and claimed to maintain contact with his 'friend and adviser' Michael Faraday, the nineteenth-century electrical scientist,

---

[34] Harris, 11.

[35] 'Consultative Group on Electronic Exchange Developments: The Future of Highgate Wood' January 1964, TCB 2/113, BTA.

[36] Harris, *Automatic Switching in the UK*, 10–11.

[37] S.H. Sheppard, 'The Leighton Buzzard Electronic Telephone Exchange', *The Post Office Electrical Engineers' Journal* 59, no. 4 (1967): 255–61.

who had died thirty-five years before Reeves' birth.[38] Whilst not my subject here, a history of Reeves which reconciles these two worlds would be fascinating.

For now, however, I continue with Empress. The Empress exchange utilised PCM and various forms of multiplexing, including TDM, and was installed near Earl's Court in 1968, making it the world's first digital electronic exchange.[39] However, my focus here is not Empress' technical development, but its role in stimulating Merriman's 'information and control' speech.

In 1967, Merriman delivered the speech which opens this thesis and this chapter, a speech entitled 'Men, Circuits and Systems in Telecommunications', in his inaugural address as Chairman of the Electronics Division of the IEE.[40] Merriman's speech addressed two developments in the Post Office – the use of computers as management tools, and the development of digital telecommunications, proven by Empress – and outlined a vision for the future telecommunications network which would inform the development of System X, and the re-cast the telephone network as an information network. Merriman's vision was of an evolutionary, autonomous, general-purpose, information network, which synthesised ideas from cybernetics, information theory, and his background in Treasury O&M. I will demonstrate this through Merriman's juxtaposition of three different subjects: in the first half of his paper, he addresses the use of computers and O&M in the Post Office, whilst his second half deals with two distinct but related concepts: 'general-purpose' networks and 'evolutionary, self-healing, self-governing' networks.

Merriman opened his address by talking about the interplay between 'circuits and men', stating that his aim was 'to show that telecommunications is not only a dialogue between sender and receiver; it is a dialogue between user and provider. It is not only circuitry; it is man management', explaining that the Post Office's 'greatest problem' was the 'deployment, use, and, in one sense, control, of manpower'.[41] Merriman outlined how the Post Office had increased productivity by harnessing 'technological opportunity' and 'scientific man-management' to found an O&M department which had undertaken studies on work measurement, queuing theory, and statistical control.[42] He showed a diagram demonstrating how the Post Office's works service organisation had been conceived of

38 Huurdeman, *The Worldwide History of Telecommunications*, 327–31.
39 'The World's First PCM Exchange', *Post Office Telecommunications Journal* 20, no. 2 (1968): 7–11; B.R. Kerswell and W.G.T. Jones, 'Conclusions from the Empress Digital Tandem Exchange Field Trial', *The Post Office Electrical Engineers' Journal* 72, no. 1 (1979): 9–14.
40 Merriman, 'Men, Circuits and Systems in Telecommunications'.
41 Merriman, 241.
42 Merriman, 242.

Copyright Material Removed

Figure 5.1. The Post Office works service organisation as inputs and outputs of information.

in terms of inputs and outputs of information (Figure 5.1). He also outlined the Post Office's use of computer-aided management techniques, such as Monte Carlo simulations to improve work-flows for fault engineers.

This approach to organisation and management was not novel for Merriman, who had undertaken similar work as Head of Office Machines in Treasury O&M from 1956-60, before returning to the Post Office.[43] Agar has outlined how Merriman ran an extended program of 'indoctrination and implementation' of clerical mechanisation by teaching sceptical executive civil servants to see the Civil Service itself as a modern machine.[44] Important projects undertaken by Treasury O&M included the mechanisation of Civil Service payroll and statistics production, and the computerisation of the Ministry of Pensions and National Insurance office. Agar argues that Merriman's success resulted from the line drawn between specialist, mechanisable clerical work and generalist, executive work. Merriman cast machines as capable replacements for clerical work, and

[43] 'Appointment of Mr. J.H.H. Merriman as Senior Director of Engineering', *The Post Office Electrical Engineers' Journal* 60, no. 2 (1967): 139.
[44] Agar, *The Government Machine*, 330.

computer aids to management as supplementary aids for generalists' control over government.

Agar argues that this hierarchical division between mechanical specialists and executive generalists formed the template for Turing's universal machine.[45] Turing's imaginary device could undertake different types of computation according to instructions written within the machine, so the machine could move from function to function and, by storing the progress of functions in memory, return to an earlier function; this is the basic principle of general-purpose computers with stored-program control, where a computer can store the instructions for a program within its own memory, rather than having to be programmed by an external operator. Crucially for Agar's argument, Turing describes this in terms of human computers; 'computer' had, before its current usage, referred to humans who would undertake calculations. Agar argues that in this description is inscribed a model of the Civil Service, composed of mechanical clerical workers, devoted to specialist functions, and generalists, who could move from office to office, satisfied that clerks would know how to undertake their special functions in the generalist's absence. Agar's argument is important for considering how Turing's ideas played out within the Post Office: Turing's interest in a general-purpose computer was eschewed by Flowers in favour of designing Highgate Wood, a special-purpose electronic exchange. However, by Empress, Flowers had left the Post Office and Merriman, the Civil Service mechaniser, was Engineer-in-Chief.

In his speech, Merriman moved seamlessly from discussing Post Office O&M to the Post Office's vision for a general-purpose communication network which would carry all forms of information. Superficially, Merriman's speech had moved between two unrelated subjects, and yet for Merriman it made complete sense to talk about these subjects together; his Treasury O&M background in the 'government machine' framed his thinking in terms of specialists and generalists, and so underpinned his vision of a general-purpose network. Empress had proved the viability of digital networks, and this concerned Merriman: he warned of digital transmission being used as a short-term solution in specialist networks, rather than 'the realisation of … a general-purpose digital network', which would have 'versatility and open-endedness built in to permit becoming a better system in the future'.[46] This, he argued, was the opportunity presented by doing 'all-digital' – all forms of information could be digitised, and so a 'single yet versatile

[45] Agar, 69–74.
[46] Merriman, 'Men, Circuits and Systems in Telecommunications', 248.

network can freely handle all forms of communication'.[47] Merriman portrayed the problems of a digital network as special-purpose versus general-purpose, which makes sense when juxtaposed with his speech's first topic of O&M, where problems were also framed through the Civil Service hierarchy of specialist and generalist. However, a key difference here is Merriman's plan to mechanise the generalist, which he and other expert mechanisers in government had previously been so keen to avoid. Why was Merriman, of the O&M tradition, so receptive to the computerised generalist network? The answer lies with information theory and cybernetics.

Information theory and cybernetics, as addressed in Chapter One, were developed by Claude Shannon and Norbert Wiener. Claude Shannon, at Bell Telephone Laboratories, and Nobert Wiener, at MIT, independently developed information theory: Shannon published 'A Mathematical Theory of Communication' in 1948 and Wiener his book, *Cybernetics*, which included his information theory, that same year.[48] Both Wiener and Shannon's theories of information were remarkably similar, construing information as the amount of order or disorder in a selection of messages.[49] However, they differed in how they defined information: Shannon took a tighter, non-semantic approach, rooted in his wartime cryptographic studies of language's statistical properties;[50] Wiener took a broader definition, addressing information's semantic and pragmatic dimensions, i.e. its meanings and effect upon recipients. Wiener's definition was a corollary of cybernetics, his theory of communication and control which explained the behaviour of organisms and machines in terms of information inputs and outputs, inspired by his wartime work on anti-aircraft predictors.[51] Wiener made various analogies between animals and machines, for example, comparing computers to nervous systems and so cybernetics, in its expansive applications to both animals and machines, and in information's subservience to control, had implications for Merriman's general-purpose philosophy.

Post Office engineers paid careful attention to Wiener and Shannon's ideas. In 1951, Roy Harris and D.L. Overheu, another Dollis Hill engineer, attended a series of lectures at Imperial College to learn about information theory from Colin Cherry and Denis Gabor, who, along with Donald MacKay at King's College London, made up the

---

[47] Merriman, 247.
[48] Norbert Wiener, *Cybernetics: Or Control and Communication in the Animal and the Machine* (New York: John Wiley & Sons, 1948); Claude E. Shannon, 'A Mathematical Theory of Communication, Part 1', *Bell System Technical Journal* 27 (1948): 379–423; Claude E. Shannon, 'A Mathematical Theory of Communication, Part 2', *Bell System Technical Journal* 27 (1948): 623–56.
[49] Kline, *The Cybernetics Moment*, 11–17.
[50] Kline, 26–35.
[51] Kline, 12–26.

'English School' of information theory.[52] Harris and Overheu reported on information theory to Flowers and subsequently lectured on information theory to Post Office engineers; at the end of their lectures, they thanked Colin Cherry for his correspondence on 'information theory and cybernetics'.[53] Harris and Overheu ostensibly addressed Shannon's 'communication theory', but also referenced Wiener's *Cybernetics* and took his expansive definition of information, explaining how information theory could be used to integrate subjects as diverse as digital computing and neurobiology and treated all forms of communications as essentially the same.[54] They also applied information theory to modulation showed how PCM was less error-prone and delivered higher bandwidth than PAM, foreshadowing PAM's failure with the Highgate Wood project.

These reports expanded beyond Shannon's communication theory to reflect on the communications, biological, and industrial applications of information theory and cybernetics and on an impending 'second industrial revolution'. Harris and Overheu pointed out how the versatility of information theory meant it could be used to assess not just the efficiency of transmission systems, but also the efficiency of switching systems and even control organisations themselves.[55] This was further extended to consider that analogies between machines and organisms could be made when feedback loops were used:

> Such machines are self-controlling and are given only a general instruction. Self-guiding projectiles, anti-aircraft predictors, etc., are examples of such machines. The human body is full of such mechanisms which control our temperature, balance, heart rate, etc., and there is evidence that conditioned reflexes operate in a similar way with a memory incorporated in the mechanism. Similarly the faculty of learning must depend considerably on past experience and must use some form of feedback.[56]

Inscribed in this quote are two classic examples of information theory applied to cybernetics: Wiener's research on anti-aircraft predictors and the British cybernetician W. Ross Ashby's 'homeostat', a device which modelled learning in the human brain by representing environmental adaptation through electrical feedback.[57] Harris and Overheu

[52] 'An Introduction to Information Theory' August 1951, TCB 422/13450, BTA; Kline, *The Cybernetics Moment*, 104.
[53] 'A General Introduction to Communication Theory' 1951, IPOEE Unpublished Papers 1950-52, Part 3, HIC 001/001/0015, BTA.
[54] 'An Introduction to Information Theory, August 1951, TCB 422/14350, BTA'.
[55] 'An Introduction to Information Theory, August 1951, TCB 422/14350, BTA'.
[56] 'An Introduction to Information Theory, August 1951, TCB 422/14350, BTA'.
[57] Kline, *The Cybernetics Moment*, 52–55.

concluded by reflecting on Wiener's prediction of a 'Second Industrial Revolution' from *Cybernetics* to hypothesise that 'human beings, used as sources of judgement, may also be replaced by machines'.[58]

These interpretations of information theory, which borrowed heavily from Wiener and cybernetics, can be considered against information theory's other definitions. Kline, drawing on the observations of information theorist Peter Elias, notes that by the end of the 1950s, there were three different definitions of 'information theory': the narrowest, associated with Shannon, referred purely to his communication theory; the second was a broader collation of Shannon and Wiener's work on analysing communication problems; finally, the third, which was particularly associated with the Imperial College information theory symposia and the journal *Information and Control*, was a synonym for 'cybernetics'.[59]

These broad interpretations can be seen in another Post Office application of information theory. In September 1952, Post Office engineers again attended an information theory symposium at Imperial, joined by the English School and information theorists from the USA, such as Stanford Goldman, Robert Fano and Yehoshua Bar-Hillel.[60] One Post Office engineer, D.L. Richards, presented a paper on the effects of the physical properties of a circuit on telephone users' behaviour, which aligns with Wiener's pragmatic definition of information theory, viewing the communication system as composed of human and electrical components. A report on the symposium, delivered to Merriman, amongst others, concluded that little of the work described at the symposium had 'direct application to bread-and-butter communications practice', but suggested that information theory's main benefits may be 'a fertilizing and catalytic action on the ideas of designers and development engineers, plus an understanding of ultimate possibilities that will act as a goal'.[61]

By the time Merriman was Engineer-in-Chief, cybernetics and information theory had indeed had a catalytic effect on the Post Office's ultimate goal for the telephone network: a digital network carrying voice, video and data signals as 'information'. Both features – digitalisation and informatisation – derived from the insights of information theory: the former in communication theory proof of digital encoding as more efficient

[58] 'An Introduction to Information Theory, August 1951, TCB 422/14350, BTA'.
[59] Kline, *The Cybernetics Moment*, 117.
[60] 'Notes on a Symposium on Communication Theory Arranged by Imperial College' December 1952, TCB 226/2227, BTA.
[61] 'Notes on a Symposium on Communication Theory Arranged by Imperial College, December 1952, TCB 226/2227, BTA'.

than analogue modulation;[62] the latter naturally followed from the former in that, if digital transmission was more informationally efficient, and if all forms of communication counted as information, then a digital telephone network could be used for much more than telephony. This was the ‘general-purpose’ network.

Another cybernetic characteristic of the general-purpose network was that it should be ‘evolutionary’, ‘self-governing’ and ‘self-healing’.[63] For Merriman, electronic computer control was central to realising this autonomous organic network, cybernetically blending organic and mechanical. Computers in the network would receive information about traffic flow, determine the optimal route for calls, and control switching centres; in doing so the Post Office would create a general-purpose, evolutionary, ‘self-governing, self-healing’ system, echoing the earlier 1950s reports on information theory and cybernetics, which predicted that the ‘mechanised thinking of electronic brains together with self-stabilising servomechanisms’ would allow machines ‘as sources of judgement’ to automatically manage industrial systems.[64] It was in these ways, Merriman argued, that ‘information and control’, were ‘fundamental to any telecommunication system’.[65]

The influence of Henri Fayol can perhaps also be detected on Merriman’s outline of a telecommunications system of information and control. As I discussed in Chapter Two, Fayol, the turn-of-the-century management theorist, had coined a managerial definition of ‘control’, predating cybernetics, as the monitoring of industrial and administrative outputs, and using that information to correct industrial processes. There are thus certainly similarities between Fayol’s definition of control and Merriman’s use of computers for work measurement and plans for computerised monitoring and feedback within the telephone network. Whilst there is no evidence of any direct influence of Fayol on Merriman or any other managers and engineers in the Post Office, there is a possible avenue via Merriman’s background in Treasury O&M and another, British, management theorist: Lyndall Urwick.

Lyndall Urwick was a prominent British management consultant theorist from the early-mid twentieth century. Urwick was the first secretary of the Management Research Groups established by Seebohm Rowntree in 1926 as a national forum for business managers. From 1928, Urwick was Director of the International Management Institute in

[62] ‘An Introduction to Information Theory, August 1951, TCB 422/14350, BTA’.
[63] Merriman, ‘Men, Circuits and Systems in Telecommunications’, 248–50.
[64] ‘An Introduction to Information Theory, August 1951, TCB 422/14350, BTA’; ‘A General Introduction to Communication Theory, 1951, IPOEE Unpublished Papers 1950-52, Part 3, HIC 001/001/015, BTA’.
[65] Merriman, ‘Men, Circuits and Systems in Telecommunications’, 250.

Geneva, and then in 1934, he founded one of the first management consultancies in Britain, Urwick Orr.[66] Urwick and Urwick Orr have been cast as leading proponents of Taylorism in British management in McKenna's history of management consultancy, in which McKenna describes them as dominating the market for organisational advice in Britain with Taylorist views, whilst in the USA, management consultants' primary influence had instead been accounting and engineering practice since the 1930s.[67] However, this overlooks the significant influence Fayol had on Urwick since his early career: Urwick's first publication, 'Principles of Direction and Control', which appeared in 1928 in the landmark *Dictionary of Industrial Administration*, was heavily influenced by Fayol; Urwick was also responsible for the first English translation of *Adminstration Industrielle et Générale*, and has been described as 'the main figure responsible for bringing Fayol to the attention of the Anglo-Saxon world'.[68]

Urwick intersects with this history in the world of Treasury O&M: Urwick joined the Treasury in 1940 as an advisor and, from 1941, O&M began contracting in private consultancies, including Urwick Orr.[69] Merriman was at the Post Office at this time, and did not join Treasury O&M until 1956, but it is possible that Urwick's influence, and his advocacy of Fayol, remained; moreover, Urwick, as mentioned by McKenna, was one of the most influential management consultants in Britain in the 1950s, and so it is possible that his influence came via another avenue, particularly as the most popular translation of Fayol, *General and Industrial Management*, was published in Britain in 1949. Boltanski and Chiapello also note Fayol as a lasting influence on managerial thought in the 1960s, noting that one of the key managerial dilemmas at this time was how to reconcile the Fayolian tenet of centralised command and control whilst also rendering bureaucracies more flexible:[70] here, there are parallels with Merriman's ambition of preserving information and control in centralised, computerised systems of the Post Office telecom monopoly, whilst also using those computers to render the system more flexible.

However, these influences are speculative and indirect, and it should be noted that one direct managerial influence has already been identified: Treasury O&M. As I noted in Chapter Two, referring to the work of Boltanski and Chiapello, along with Khurana, on the history of management, it is important to identify the influence of managerial

---

[66] Andrew Thomson and John Wilson, 'Lyndall Urwick', in *The Oxford Handbook of Management Theorists*, ed. Morgen Witzel and Malcolm Warner (Oxford: Oxford University Press, 2013), 113–14.
[67] McKenna, *The World's Newest Profession*, 49–50, 169.
[68] Thomson and Wilson, 'Lyndall Urwick', 116.
[69] Agar, *The Government Machine*, 256.
[70] Boltanski and Chiapello, *The New Spirit of Capitalism*, 71.

theory on Merriman and the Post Office engineers. Treasury O&M, whilst advanced by specialist mechanisers within government, was as much a theory of administration and bureaucracy as it was a programme of mechanisation; Agar thus argues that Treasury O&M was a distinctive British administrative science which, given its significant prominence in the large-scale bureaucracy of government, was an expert movement comparable to the management sciences of early twentieth century America.[71] My point here is that, whilst I have done much to show the influence of cybernetics and information theory on the Post Office, I am not claiming that an engineering vision of cybernetic control became hegemonic, but rather it fused with an administrative mode of thought from British government: the bureaucratic theory of the government machine is just as important here as the engineering theory of cybernetics.

This fusion of the government machine and cybernetics, and, more specifically, its re-interpretation as a general-purpose, or 'integrated' digital network, was also possibly tied to Flowers' departure. In 1963, amidst the failure of Highgate Wood, a research report exploring an 'integrated' digital telecommunications system, capable of transmitting voice and data, was prepared for Flowers.[72] The report suggested that a specialist data network might be possible or preferable to a general-purpose integrated network, which suggests that, under Flowers, the concept of a general-purpose network had yet to gain favour. The next year, another exploratory study was undertaken shortly before Flowers resigned, and again, the integrated digital network concept received a muted reception.[73] However, three years later, in 1967, with Flowers gone and Roy Harris in charge of switching development, Merriman, now Engineer-in-Chief, ordered a follow-up study, and this time integration and digitalisation for a general-purpose network received a much warmer reception.[74] The study's evidence was primarily economic, and doubtless there was a financial basis for this conclusion, but I would suggest that Flowers' commitment to analogue exchange development was perhaps also responsible for these rejections of digitalisation, in contrast to the endorsement of digitalisation by the report produced under Harris and Merriman.

Merriman's vision for a general-purpose, self-governing, self-healing network represents the convergence of Treasury O&M, information theory, and cybernetics.

[71] Agar, *The Government Machine*, 258.

[72] 'An Appraisement of an Integrated P.C.M. System' July 1963, TCB 422/20854, BTA.

[73] 'The Possibility of Progressive Conversion of a Telephone Area from an Analogue to an Integrated P.C.M. System, Part 1' April 1964, 1, TCB 422/20953, BTA.

[74] 'The Possibility of Progressive Conversion of a Telephone Area from an Analogue to an Integrated P.C.M. System, Part 2' August 1967, TCB 422/20953, BTA.

Merriman deployed Treasury O&M within the Post Office as a form of management, and as a way of framing the problems of digital networks as separate, specialised networks versus general-purpose networks. He envisioned a network comparable to Turing's universal machine, and in doing so endorsed a generalist computer-controlled network, which breached the Civil Service hierarchy of mechanisable specialist and executive generalist. I argue that the influence of information theory and cybernetics resolved this tension. Information theory paralleled the general-purpose executives of the government machine, showing how information, like generalists, was capable of moving between systems and performing many functions, whilst cybernetics interpreted the network as an entity that, like a human, was evolutionary, self-healing, and self-governing, explaining why Merriman concluded his paper with the assertion that 'both men and systems become self-optimizing'.[75] This view – men and systems as together self-optimising – possibly represents a step towards resolving automation tensions, which I explored in Chapter Three with GRACE, by presenting men and machines as optimising one another. This is a thread I will return to at the end of this chapter, as I explore automation, unemployment, and System X.

So far, I have spoken of the general-purpose network solely through Merriman's vision, but I will argue in my final section that System X and the 'integrated digital services network' were both implementations of the general-purpose evolutionary network. However, I will first address the next step of telephone exchange development: an industrial dispute over computer modelling of the TXE4 reed-relay exchange, which further highlights O&M traditions within the Post Office, particularly the 'discreet modernism' of computerisation in government.

A Model of Discretion

In 1971, the Post Office published plans to update the telecommunications network with the TXE4 reed-relay telephone exchange, jointly developed with STC, which had developed from the successful 1966 reed-relay trial at Leighton Buzzard.[76] The plan aimed to replace all Strowger exchanges by 1990, was subject to final approval by the Post Office Board in December 1972, and had been developed through computer modelling by the Post Office's Operational Programming Department, which became the subject of a fierce dispute between the Post Office and their manufacturers. The

[75] Merriman, 'Men, Circuits and Systems in Telecommunications', 251.
[76] 'Telephone Exchange Switching: Modernization Strategy' 1971, TCC 387/THQ ICU 45(a), BTA.

Operational Programming Department was headed by J.S. Whyte, who had previously headed the Post Office's Long Range Planning Department, and so will feature in Chapter Seven, and before that had, like Merriman, worked on government computing in Treasury O&M. He would go on to replace Merriman as Engineer-in-Chief (known at that point as Senior Director, Development, but still colloquially known as the 'E-in-C') after Merriman's retirement in 1976.[77]

The Post Office's use of the model, and Whyte's management of its availability for external review, fits in with a pattern of government computerisation and mechanisation which Agar labels 'discreet modernism'.[78] As I covered in Chapter Two, Agar argues that, up until the late twentieth century, government mechanisation and computerisation was characterised by an opaqueness which allowed the computer to thrive within government; the discreet invisibility of the computer meant that expert mechaniser movements, like Treasury O&M, were able to negotiate the potentially problematic idea of equating Civil Service work with computers by casting government, and not the computer, as their object of action. The invisible computer was thus allowed to thrive in a supposedly incidental role. However, the Post Office's confession that it had used computer modelling to plan its modernisation strategy breached this discreet modernism, and in doing so, modelling became the subject of an industrial dispute where questioning the model's authority became synonymous with questioning the Post Office's authority.

On 12th January 1972 a meeting was held between the Post Office, GEC and Plessey, regarding GEC and Plessey's concerns about the Post Office's modernization strategy.[79] GEC and Plessey's concerns were that their jointly-developed electronically-controlled Crossbar system, known as 5005, was cheaper than TXE4 and more reliable, and yet had been rejected for TXE4, a system which had undergone limited experimental trials and had mainly been tested by an experimental computer simulation, different from the model used for the Post Office's modernization strategy.[80] At the meeting, Arnold Weinstock, GEC's Chairman, argued that 'computer simulation alone should not be a

[77] 'Professor Merriman Retires... and so Does Dollis Hill', *Post Office Telecommunications Journal* 28, no. 4 (1976): 30.
[78] Agar, *The Government Machine*, 424.
[79] 'Post Office Switching Policy: Meeting between the Post Office, GEC and Plessey' 12 January 1972, FV 87/1, TNA.
[80] A.C. Cole, 'The Computer Exchange', *Post Office Telecommunications Journal* 22, no. 1 (1970): 22–23.

basis for major investment decisions'.[81] Merriman provided the Post Office rebuttal, arguing that the TXE4 had been supported by a high degree of computer modelling, and that 'It was not sensible to attempt to produce replicas of the exchange at every stage of design development, and computer simulations had therefore been employed instead'.[82]

The Ministry of Posts and Telecommunications (MPT), formed in 1969 as the Post Office's regulatory government department after the Post Office left the Civil Service, soon became involved. The Post Office informed the MPT that 'it is becoming more and more common in advanced technology to move straight from computer simulation to hardware'.[83] It is by no means clear that this was the case: whilst, as this chapter and later chapters show, the Post Office extensively used simulation, experimental hardware was also used, particularly, as I show in the next chapter, in waveguide and optical fibre trials. The Post Office also pointed out that Crossbar 5005 had its own flaws: its physical design meant that maintenance access involved high wear to cables and wires, whilst its limited flexibility meant that, beyond a certain point, extra lines could only be added by changing customers' numbers.[84] The row between the Post Office, GEC, and Plessey soon gathered national attention in *The Economist*, *The Financial Times*, and *The Daily Telegraph*.[85] Interestingly, and underscoring the discreet – up until this point – use of computers, only *The Financial Times* mentioned modelling, identifying the Post Office's 'giant computer model of the U.K. telecommunications network', from which Plessey and GEC 'claim to have been excluded' as the central point of contention.[86]

This 'giant computer model', used to plan TXE4's rollout, was the 'main area of doubt' for both GEC and Plessey.[87] GEC questioned the model's validity and influence over decision-making, whilst Dr Willets, Plessey's Director of Research, announced to the Treasury, who had been brought in to review the model, that he considered it a 'load of junk'.[88] STC, TXE4's manufacturer, mobilised in support of the Post Office and its

[81] 'Post Office Switching Policy: Meeting between the Post Office, GEC and Plessey, 12 January 1972, FV 87/1, TNA'.
[82] 'Post Office Switching Policy: Meeting between the Post Office, GEC and Plessey' 23 February 1972, FV 87/2, TNA.
[83] 'MPT Report on Discussions between the Post Office and GEC/Plessey' 16 May 1972, FV 87/1, TNA.
[84] 'MPT Report on Discussions between the Post Office and GEC/Plessey, 16 May 1972, FV 87/1, TNA'.
[85] 'Ryland's Row', *The Economist*, 5 February 1972; 'The Fight for the New Telephone System', *The Financial Times*, 28 January 1972; 'Post Office at Grips with Suppliers', *Daily Telegraph*, 10 February 1972.
[86] 'Post Office Equipment Row Brought into the Open', *The Financial Times*, 2 February 1972.
[87] 'Meeting at Post Office Central Headquarters' 22 September 1972, FV 87/2, TNA.
[88] 'Post Office Telephone Exchange Equipment: Meeting in the Treasury with Plessey' 29 November 1972, FV 87/2, TNA.

model, internally briefing its directors to respond to press interest with the statement, 'The Post Office have computer capacity and expertise unrivalled either in the Industry or perhaps in any private sector of British industry. They have programmed all the factors which affect the cost to the British public of its telephone system'.[89]

The model itself was known as ALEM 6: 'A Local Exchange Model 6'.[90] The model made year-on-year cost calculations by progressively simulating the changing mix and cost of switching equipment in the telephone network, according to the strategy it had been programmed with. The model had three priorities during simulations: first, that exchanges already using modern equipment must be allocated enough equipment of the same type to meet forecasted growth; second, that worn-out Strowger was replaced; finally, that serviceable Strowger was replaced. Whyte, who had overseen the model's development whilst Head of the Long Range Planning Department, emphasised that it was a 'powerful tool which enables a wide range of exchange replacement strategies to be explored on behalf of the decision maker … The model cannot of itself come to conclusions or take decisions. It does, however, expose the direct financial consequences of any strategy under consideration'.[91] I explore Whyte's tenure and the model's development in Long Range Planning in Chapter Seven, where I further analyse various discourses of computer control within the Post Office.

The controversy over the model was stimulated by the involvement of Ted Heath, the Prime Minister, who had met W.D. Morton, a senior GEC engineer, at an event for senior managers from the British manufacturing industry.[92] Morton complained to Heath that the Post Office's plans were harming GEC's export prospects, and so Heath wrote to John Eden, the Minister of Posts and Telecommunications, asking him to investigate further. Eden reassured Heath that he would have to approve the Post Office's proposals even after the Post Office Board made its decision at the end of 1972 and that the MPT, along with the Treasury, the Department of Trade and Industry (DTI), and the Cabinet's Central Policy Review Staff (CPRS), would investigate fully.[93] The Post Office's management of these investigations ensured that the judgement of the Post Office became a judgement of its model, and vice versa. The result was that the authority of the Post Office and the authority of its model become one and the same.

[89] Ken Corfield to Frank Wood, 'Questions about TXE4', 17 February 1972, FV 87/1, TNA.
[90] 'Economic Appraisal of Exchange Equipment Strategies by Computer Model' 1972, FV 87/2, TNA.
[91] 'Economic Appraisal of Exchange Equipment Strategies by Computer Model, 1972, FV 87/2, TNA'.
[92] 'Meeting between the Prime Minister and Senior Manufacturing Industry Managers' 25 May 1972, FV 87/2, TNA.
[93] John Eden to Edward Heath, 'Report on Morton's Complaint', 14 June 1972, FV 87/2, TNA.

Plessey also ordered its own report into the model, commissioning T.S. Barker, Senior Research Officer at the Department of Applied Economics at Cambridge, to investigate the model. However, as Barker could not access the model, he instead provided a commentary on the Post Office's report of the model. His conclusion was that it was 'suitable, but could be substantially improved'.[94] Barker highlighted the model's treatment of technical progress as 'almost non-existent' and recommended that it should be given 'urgent consideration'. He also regarded the model's treatment of uncertainty as 'inadequate'. The Post Office, however, relied on Barker's lack of access to the model as a counter-argumentative strategy: 'This report is interesting because the author broadly endorses what has been done, although on many items he would not have realised this when preparing the Report … by and large it gives strong support to what we have in fact done, albeit in some cases unknown to the author'.[95] Here, the Post Office relied on the model's discretion as a counter to Barker's criticisms. The Post Office's use of modelling had been controversial because it breached the governmental tradition of 'discreet modernism', and so to ensure closure of the controversy, the Post Office fell back on an old tradition of discretion, suggesting that Barker's criticism of *the model* was in fact an unknowing endorsement of *the Post Office*. Returning the model to an opaque state enabled criticism of the model to be reconfigured as trust in the Post Office.

The Treasury also reviewed the model and, like Plessey, had to do so by analysing the Post Office's report but, unlike Plessey, gave its tacit approval. Steve Littlechild, an economist who had joined the Treasury as a part-time consultant, was commissioned to review the model. An expert in mathematical programming, Littlechild had previously applied linear programming to analyse telephone services in the USA. He thus framed his opinion as an analysis of the Post Office's decision to choose simulation over linear programming, and advised the Treasury that simulation was 'at best a crude technique for finding an optimum' using 'hit and miss' repetition to find the best strategy.[96] However, his overall conclusion was 'that the Post Office has developed a powerful approach for dealing with their investment analysis' and had 'no comments'.[97] The Treasury passed

[94] 'Long-Term Investment in Exchange Equipment: A Report to Plessey on the Post Office Investment by T.S. Barker, Senior Research Officer, Department of Applied Economics, University of Cambridge' December 1972, FV 87/6, TNA.
[95] 'Commentary by P.O. on Report to Plessey by T. S. Barker, Department of Applied Economics, University of Cambridge' 6 February 1973, FV 87/6, TNA.
[96] H Christie to A.G. Manzie, 'Treasury Comments on the Post Office's Model.', 27 December 1972, FV 87/6, TNA.
[97] E.E. Baker to A.G. Manzie, 'Post Office's Economic Appraisal of Exchange Equipment', 8 November 1972, FV 87/6, TNA.

their report over to the MPT, who interpreted Littlechild's conclusions as an endorsement of the model: 'Unless we have been seriously misled it seems as if the simulation model has achieved what was required of it and that therefore there would be no substantial advantage in reformulating the model in programming terms'.[98] The interesting point here is that the Treasury did not bemoan its lack of access to the model, in contrast to Plessey's report. The Post Office's discretion thus received tacit approval from the Treasury, as it did from the MPT, where the language – 'unless we have been misled' – highlights the trusted opacity of Post Office computing.

The newly-formed CPRS analysed the dispute with a broader remit, addressing both the modernisation model and the Post Office's relationship with its suppliers. The CPRS, formed in 1970 by Ted Heath, was a government 'think-tank' established to help the cabinet take a long-term policy view.[99] The CPRS thus considered the longer relationship between the Post Office and its suppliers, which had been reorganised in 1968 by the Industrial Reorganisation Corporation (IRC) after the Highgate Wood failure. The IRC recommended that the cooperative arrangements of JERC be replaced by an 'arm's length' arrangement instead, and encouraged greater competition between the manufacturers.[100] The CPRS thus set out to answer three questions: first, would TXE4 be ready by 1975, as the modernisation plan had promised? Second, was the Post Office's economic evaluation correct? Third, was the Post Office's strategy best for the nation as well as best for the Post Office?[101]

The CPRS reported that everything appeared on schedule, whilst also agreeing with GEC and Plessey that the Post Office's plan was 'wildly optimistic'; on the first question, it thus hedged its bets by endorsing the Post Office's computer simulation, whilst also recommending that contingency orders of 5005 be prepared. The CPRS's answer to the second question, about the Post Office's economic evaluation, similarly concluded with an endorsement of the Post Office's model, saying that it seemed 'basically sound', and attributed GEC and Plessey's recalcitrance to the Post Office's previous secrecy about the model, followed by its sudden publicity.[102] Finally, on the structure of the telecommunications industry, the CPRS took the view that the 'pendulum has swung too far' towards competition, and was undermining collaborative research. The

98 Christie to Manzie, 'Treasury Comments on the Post Office's Model.'
99 Peter Hennessy, Susan Morrison, and Richard Townsend, 'Routine Punctuated by Orgies: The Central Policy Review Staff, 1970-83', *Strathclyde Papers on Government and Politics*, no. 31 (1985): 5.
100 'IRC: Enquiry into the Telecommunications Industry' 1967, TCB 712/35, BTA.
101 'CPRS Summary of the Post Office's Modernisation Plan' August 1972, FV 87/5, TNA.
102 'CPRS Summary of the Post Office's Modernisation Plan, August 1972, FV 87/5, TNA'.

CPRS thus recommended that a joint development company be formed by the Post Office and its manufacturers, with guaranteed funding from all parties, and guaranteed market share for manufacturers at the end of exchange development.

The CPRS concluded that the Post Office's modelling approach had been broadly correct, and so also recommended that the Post Office should have ultimate design authority over new exchanges.[103] As with the Plessey Report and the Treasury's investigation, the CPRS, in the absence of the model itself, had to equate the authority of the model with the authority of the Post Office. By centralising decision-making with the model, and by limiting access to it, the Post Office had created a situation where the CPRS could not decide whether it approved of the model, but instead whether it approved of the Post Office, and in doing so implicitly supported the centralisation of network decision making, such as design authority and purchasing, with the Post Office as well.

Finally, the MPT, as the Post Office's Whitehall counterpart also needed convincing. William Ryland thus invoked various expertise in support of the model: Sir James Lighthill, the renowned physicist and part-time Post Office board member, reviewed the model, twice, and gave his support both times. The Post Office also referred to similar approaches by Bell of Canada, who had used a similar model, and by AT&T, 'who are using a less elaborate model, have acknowledged the greater depth of our approach'.[104] These comparisons were intended to show the Post Office's modelling was not particularly unique, and this is broadly supported by history. The first industrial uses of modelling came before the digital computer, as companies used 'analogue models' – physical or electrical devices; for example, Vannevar Bush built an 'AC Network Analyzer', a model of power networks, using resistors, capacitors and inductors, at MIT for General Electric in 1930.[105] With digital computing, computer modelling and simulation was taken up by industry; the oil industry was a widespread adopter, using computer modelling throughout the 1960s and 1970s to model geological conditions, determine well placement, and cost mineral rights.[106]

In the 1960s, modelling also became more reflexive, as organisations sought to model not only their environments, but themselves. Various types of models were devised to simulate the organisation (I address the Post Office and BT's use of these corporate

[103] 'CPRS Summary of the Post Office's Modernisation Plan, August 1972, FV 87/5, TNA'.
[104] William Ryland to John Eden, 'Exchange Equipment Strategy', February 1973, FV 87/3, TNA.
[105] Martin Campbell-Kelly et al., *Computer: A History of the Information Machine,* 3rd ed. (Boulder, CO: Westview Press, 2014), 48.
[106] James W. Cortada, *The Digital Hand: How Computers Changed the Work of American Manufacturing, Transportation, and Retail Industries* (Oxford: Oxford University Press, 2004), 169.

models in more detail in Chapter Six), and again, the most spectacular example came from the oil industry. Sun Oil's Corporate Financial Model, developed between 1965-68, was touted as the first large-scale model of a corporation, and whilst the model was abandoned in 1969 (its lengthy development meant that it become obsolete, especially after Sun Oil amalgamed with Sunray DX Oil in 1968), Clarke and Tobias have pointed to it as indicative of the growing expansiveness of corporate modelling in the late 1960s.[107] Corporate modelling, as the Post Office argued to the MPT with its examples of Bell Canada and AT&T, was thus not extraordinary by the early 1970s, although, as the North American examples used above suggest, it remains an open question how common this practice was within British industry, and so further historical research is needed.

The MPT review got something which no other group had: access. Two MPT economists, H. Christie and D.C. Young, were permitted to visit J.S. Whyte at the Post Office.[108] Even then, the meeting was carefully screened: Christie and Young were shown MICES, Model for Investigating Competing Equipment Strategies, a pared-down version, rather than the full model, ALEM 6. The meeting highlighted some of the model's limitations and assumptions. Christie and Young criticised the model's conception of supply and demand, as the model did not simulate any interaction between the two, and instead assessed the cost of meeting a given demand set by the Post Office. There was also no parameter for capital rationing, so the Post Office had assumed that capital would be provided as needed for modernisation, precluding the idea of economic difficulty.

The absence of capital rationing seems unusual: as I addressed in Chapter Three, the Post Office had suffered investment restrictions after the 1966 July measures, and from 1973 would also suffer pricing restrictions to counter stagflation; furthermore, there were widely-known difficulties with capital rationing on two other British-supported projects, Concorde and the Advanced Gas-Cooled Reactor, during the 1970s.[109] However, the model's development had come between the July Measures and the Heath government's 1973 Prices Commission, rather than during these financial downturns and, furthermore, it had been developed in the wake of the Post Office's corporatisation. As I have argued in Chapter Three, the Post Office's corporatisation came amidst a managerial

[107] S. Clarke and A.M. Tobias, 'Complexity in Corporate Modelling: A Review', *Business History* 37, no. 1 (1995): 20.
[108] 'PO Model for Evaluating Alternative Equipment Strategies', 7 November 1972, FV 87/6, TNA.
[109] For a contemporaneous assessment of Concorde and the reactor's financial difficulties, see P. D. Henderson, 'Two British Errors: Their Probable Size and Some Possible Lessons', *Oxford Economic Papers* 29, no. 2 (1977): 159–205.

enthusiasm in Whitehall, and given the technocratic enthusiasm of Merriman and Whyte's O&M background, the model's optimism perhaps reflected the managerialist spirit and freedom which corporatisation had afforded the Post Office.

After the visit, Whyte wrote to Christie emphasising the computer's lack of decision-making ability:

> The model does not in any sense make decisions, it merely calculates the consequences of different strategies … ALEM is no more than a calculating machine; the quality of its output depends directly on the quality of the inputs and of the assumptions stored in the computer and of the logic of the programme itself.[110]

Whyte's emphasis on the model's mechanical role, contrasted to his implied executive decision-making, again demonstrates his O&M background. John Eden was convinced, and his full appraisal for the Cabinet Committee on Economic Policy gave support to the Post Office, citing the numerous other governmental reviews which had also endorsed the Post Office.[111]

The use of modelling could be seen here as an early example of the 'self-governing, self-healing' organisation, using computerisation to optimise management as well as the network. However, the Post Office made an error by breaching the discreet modernist tradition, resulting in a conflict with manufacturers which were not prepared to accept computerisation. In this sense then, this use of modelling was a premature, realisation of the self-governing, self-healing network. However, through the late 1970s and early 1980s, the Post Office would begin to enact its self-governing, self-healing, general-purpose network with the development of System X and an integrated digital network.

System X and Integrated Digital Networks

System X and the integrated digital network were two very different technologies pursued by the Post Office: the first was a new modular, digital telephone exchange, and the latter was a technical standard used to transmit voice and data over the telephone network. However, both have a common origin from Merriman's 1967 speech: System X, through its use of computer control, realised the 'self-healing, self-governing' network, whilst the

---

[110] 'Economic Appraisal of Exchange Equipment Strategies by Computer Model', 1972, FV 87/2, TNA.

[111] 'Modernisation of Telephone Exchanges: Memorandum by the Minister of Posts and Telecommunications for the Cabinet Ministerial Committee on Economic Policy', 9 April 1973, FV 87/4, TNA.

integrated digital network, which enabled multiple forms of transmission across the network, realised the 'general-purpose' network. In this section I will explore the development and roll-out of both System X and the integrated digital network. However, the integrated digital network was not the only way the Post Office pursued the general-purpose network, and so part of the next chapter also explores the Post Office and BT's attempts to build general-purpose infrastructures through national cable television and optical fibre networks.

The 'integrated services digital network', or ISDN, is a technical standard for simultaneously transmitting voice and data as digital signals from the local exchange to the subscribers' equipment across a single network. ISDN originated within the International Telecommunications Union (ITU) in the mid-1970s, which formalised ISDN research through its Consultative Committee on International Telephony and Telegraphy (CCITT) in 1980. Nippon Telephone and Telegraph (NTT) subsequently developed an ISDN technical concept 1982, and implemented it in Tokyo in 1984. CCITT drafted their first technical recommendations for ISDN that year, based on NTT's trial, and in 1986, technical specifications were finally agreed.[112] However, this history overlooks the longer interest in integrated digital networks within domestic telephone administrations, and how this was related to other data services and networks developed by these administrations.

As I discussed above, engineers' interest in 'integrated digital networks' dates to the early 1960s. In 1965, after Flowers' departure, Merriman, as Deputy Engineer-in-Chief, set up a 'Rationalisation of the Distribution Network Working Party', which concluded in January 1966 that a fully integrated digital network was possible.[113] The board thus approved a trial for Washington New Town in 1967 as the first step towards a 'single all-purpose cable to each home – an integrated network'.[114] The Washington trial proved highly profitable, and so further experiments were approved, occurring in Irvine, Craigavon, and Milton Keynes.[115]

---

[112] Anthony Rutkowski, *Integrated Services Digital Networks* (Dedham, MA: Artech, 1985); Eli Noam, *Telecommunications in Europe* (New York; Oxford: Oxford University Press, 1992), 360; Huurdeman, *The Worldwide History of Telecommunications*, 505.

[113] 'Rationalisation of the Distribution Network: First Meeting of the Working Party' 16 November 1965, TCB 807/751, BTA; 'Report of the Working Party on the Rationalisation of the Distribution Network' 31 January 1966, TCB 807/751, BTA.

[114] 'Post Office Board Meeting' 24 April 1967, TCB 14/5, BTA; 'Post Office Board Meeting' 5 July 1967, TCB 14/7, BTA.

[115] 'Post Office Board Meeting' 22 July 1968, TCB 14/14, BTA; 'Rationalisation of the Local Distribution Network' October 1968, TCB 54/2/45, BTA.

Meanwhile, early research into concepts for System X also started at this time with 'Project ADMITS'. ADMITS – an 'Adaptable Dispersed Modular Integrated Telecommunications System that *admits* change' – was proposed by Roy Harris to establish the technical basis for Merriman's evolutionary network.[116] ADMITS' basic principles were stored-program control exchanges, integrated digital transmission, switching, and signalling, and the use of micro-electronics, rather than reed-relays, for switching.[117] The project would proceed in tandem with industry, and the main priority would be developing a modular digital telephone exchange composed of general functional subsystems. This modularity, Harris argued, would enable the evolutionary network, as functional components could be competitively developed and procured independently over time.[118]

The success of these early integrated digital networks, and the approval of Project ADMITS, meant that both were formalised: the UK Trunk Task Force (UKTTF) was set up within the Post Office's Long Range Planning Department in 1968 to investigate the feasibility of digitalising the trunk telephone network, whilst the Advisory Group on Systems Definition (AGSD), headed by Roy Harris, was set up with industry, also in 1968, to establish the technical specifications for System X and digitalisation.[119] Whilst these groups were independent, the UKTTF fed into the AGSD's reports on digitalisation.

The UKTTF's mission was to recommend a strategy for trunk network development until 1985, with looser recommendations until 2000. Given its institutional location in the Long Range Planning Department, where ALEM 6 had been developed, it is perhaps unsurprising that the UKTTF also used computer modelling.[120] The UKTTF modelled traffic across the entire network for three services which the Post Office planned to offer: telephony, data, and Viewphone (a prototype video telephone which I explore in more detail in Chapter Six). The model simulated the cost, quantity and quality of this traffic based on whether transmission, signalling, and switching were analogue or digital; the model also simulated different network layouts to find the optimal arrangement of principal switching centres for the network's 'backbone'.[121] The model found that

---

[116] Harris, *Automatic Switching in the UK*, 18.
[117] W.J. Bray to J.H.H. Merriman, 'Project "ADMITS"', 3 November 1967, TCB 712/27/2, BTA.
[118] 'Proposals for a Research and Development Program Leading to an Evolutionary Telecommunications System: Project "ADMITS"' November 1967, TCB 712/27/2, BTA.
[119] 'A Presentation of the Work of the United Kingdom Trunk Task Force' 1969, TCC 145/1, BTA; 'AGSD Report No. 1: Costs Arising from Variations in the Design of Telephone Exchange Equipment' September 1970, TCC 55/3/45, BTA.
[120] 'A Presentation of the Work of the United Kingdom Trunk Task Force, 1969, TCC 145/1, BTA'; 'UK Trunk Task Force Final Report, Volume 1: Guide and Summary Chapters' 1971, TCC 145/7, BTA.
[121] 'A Presentation of the Work of the United Kingdom Trunk Task Force, 1969, TCC 145/1, BTA'.

digitalisation would halve equipment costs, and predicted that telephone connections would double by the decade's end, nearly quadruple by 2000, and that total traffic would almost quintuple.[122] The UKTTF's report, completed in 1971, thus recommended the digitalisation of the entire network.[123]

Given the similarities with ALEM 6 – both were used for major network decisions, and both were developed in the Long Range Planning Department – it is possible to read this as indicative of computer modelling's power within the Post Office. However, the UKTTF model made several assumptions which show its human inputs: it assumed a future of widespread videophone use, meaning that the network would need to carry video, in addition to voice and data, and assumed this would culminate with Viewphone's transformation into a 'concept that included facsimile and visual access to data banks'.[124] The UKTTF's head, Denis Breary, admitted that 'a certain amount of forecasting of a sociological nature was necessary to establish a likely pattern of demand in the latter decades of this century',[125] but this is precisely what is historically interesting: the model had to work from the UKTTF's assumptions, and these included optimistic expectations that, by 1980, Viewphone and teleconferencing systems would be in place, and that by 2001, digital transmission between all local street-side telephone cabinets and local telephone exchanges would have to carry both telephony and Viewphone signals.[126]

These assumptions echo Merriman's vision that the future network would carry video. I explore Viewphone's role in supporting these visions in Chapter Seven, but the important point here is that these visions were inputs, rather than outputs, for the UKTTF's model. The UKTTF report was not accepted because of modelling's strength, but because the model and the report reinforced existing Post Office expectations for the future. The UKTTF's report was accepted without objection by the Managing Director's Committee for Telecommunications in November 1972 because it supported the vision for an integrated, universal information network.[127]

---

[122] D Breary, 'A Long-Term Study of the United Kingdom Trunk Network, Part 1 - General Methodology: Forecasts: Plant Study', *The Post Office Electrical Engineers' Journal* 66, no. 4 (1974): 214; D Breary, 'A Long-Term Study of the United Kingdom Trunk Network, Part 2 - Network-Layout Studies and General Conclusions', *The Post Office Electrical Engineers' Journal* 67, no. 1 (1974): 2.
[123] 'UK Trunk Task Force Final Report, Volume 1, 1971, TCC 145/7, BTA'; Breary, 'A Long-Term Study of the United Kingdom Trunk Network, Part 1 - General Methodology: Forecasts: Plant Study'.
[124] Breary, 'A Long-Term Study of the United Kingdom Trunk Network, Part 1 - General Methodology: Forecasts: Plant Study', 212.
[125] Breary, 212.
[126] 'UK Trunk Task Force Final Report, Volume 1, 1971, TCC 145/7, BTA'.
[127] 'Managing Director's Committee: Telecommunications' 17 November 1972, TCC 55/4/194, BTA; Breary, 'A Long-Term Study of the United Kingdom Trunk Network, Part 1 - General Methodology: Forecasts: Plant Study'.

Meanwhile, the AGSD had also been proceeding with its goals, set by Merriman, to define and specify a framework with industry for the evolutionary network and System X's modular components.[128] However, it took almost five years for AGSD to submit its final report due to difficulties in co-ordinating manufacturers, caused by two events: first, the TXE4 dispute had delayed AGSD negotiations by almost a year; second, the Post Office's attempts to admit another manufacturer, TMC, as a System X supplier. In 1972, as the TXE4 dispute was winding down, the Post Office moved to bring in Pye/TMC, owned by the Dutch electronics manufacturer Philips; the Post Office board believed that by establishing a foothold for Philips in Britain, competitive pressures might bear more on its domestic partners.[129] This exacerbated relations with GEC, STC, and Plessey, all of whom refused to admit TMC and to undertake AGSD discussions.[130] This resulted in delays for over a year, which were resolved by the Post Office's bringing GEC on board by awarding them the contract for System X's central processor; this broke the deadlock and the Post Office were able to insert terms and conditions into the System X contracts for the admission of Pye/TMC, subject to Pye/TMC negotiating its contribution with the other three firms.[131]

AGSD finally submitted its report in 1972, which laid the framework for a modular family of exchanges collectively named 'System X'.[132] These exchanges could serve a range of functions within the network, from local to trunk switching, would be based on PCM/TDM, and would be composed of various configurations of modular subsystems. This concept of System X as a modular family of exchanges for local, trunk, and international switching was possibly inspired by IBM's 'compatible-family' concept for computers. In the early 1960s, IBM had developed System/360, built on a 'compatible-family' concept, to maintain software compatibility between different computers; five computer models were developed for System/360, which was aggressively marketed and announced in 1963 in simultaneous press conferences in sixty-three cities across fourteen countries. System/360 was an enormous success and became IBM's 'engine of growth' for the next thirty years.[133] The AGSD's report makes no direct mention of IBM or System/360, although given System/360's popularity and the

[128] Harris, *Automatic Switching in the UK*, 18.
[129] 'Post Office Board Meeting' 25 September 1972, TCC 15/6, BTA; J.M. Harper, *Monopoly and Competition in British Telecommunications: The Past, the Present and the Future* (London; Washington: Pinter, 1997), 110.
[130] 'System X' September 1975, TCC 55/7/150, BTA.
[131] 'System X, September 1975, TCC 55/7/150, BTA'.
[132] Harris, *Automatic Switching in the UK*, 23.
[133] Campbell-Kelly et al., *Computer*, 127–30.

similarity in both systems' names, it is possible that System/360 inspired System X; indeed, it was the same issue of software compatibility across multiple machines that drove the formulation of System X as a modular family.

By July 1973, a clear, technically detailed, direction for the development of the British telephone network had been established. The combined recommendations of the UKTTF and AGSD meant that the network would become an 'all-purpose digital transmission environment', echoing Merriman's call for a 'general-purpose network', and System X would serve as the network's digital switching system.[134] A digital overlay network, superimposed on the existing telephone network, would be constructed to avoid disrupting existing telephone service, and System X would be organised into 'Group Switching Centres'. The UKTTF's model planned the overlay network and location of these centres, which would centralise traffic, reducing the number of large regional exchanges from 370 to 200.[135] However, one detail had changed: by 1973, the ITU's CCITT had accepted that future telecommunications networks would be national integrated digital networks for telephony and data, and so international discussions began on setting ISDN standards.[136] This had two consequences: first, that development of standards for a combined telephony/data digital network had extended beyond the Post Office's control; second, the CCITT's research did not encompass using digital networks for video transmission. I shall explore the first of these consequences in the remainder of this chapter, alongside System X development, whilst I will explore the second in the next chapter, where I analyse, amongst other transmission technologies, the Post Office's aborted attempts to set up a national broadband network for cable television, telephony, and data.

System X development continued to experience disruption during the 1970s. After the AGSD was wound up, a new department, the Telecommunications System Strategy Department (TSSD), headed by Harris, was created to oversee allocation of System X development contracts; this contrasted with the CPRS's recommendation, discussed in the previous section, for a joint System X development company with industry, which had been rejected based on the AGSD delays.[137]

However, in 1975, as the Post Office finally prepared to place System X contracts, it emerged that subsidiaries of STC and GEC (STC Cables and TCL respectively), which

---

[134] 'Post Office Management Board Meeting' 2 July 1973, TCC 15/8, BTA.
[135] 'Development of the Trunk Network' June 1973, TCC 55/5/96, BTA.
[136] 'Development of the Trunk Network, June 1973, TCC 55/5/96, BTA'.
[137] 'Post Office/Industry Relationships in Telecommunications System Design' September 1973, TCC 55/5/131, BTA; Harris, *Automatic Switching in the UK*, 26–27.

supplied cables to the Post Office, had engaged in a price-fixing cartel.[138] The Post Office board reacted by ordering an immediate review into the System X contracts and attempted to rewrite the contracts, demanding access to all firms' costs to guard against further price-fixing. Plessey and Pye/TMC, having not engaged in any illicit activity, protested, and moreover, the development contracts were already cost-investigated; the suppliers would not accept further investigation. Fennessy, the Managing Director of Telecommunications, persuaded the Board to drop this proviso, by arguing that, because System X was modular, and so components were easily interchangeable, contracts could be easily interchanged to. If the Post Office wanted to change supplier for a subsystem, there already existed 'accurate yardsticks', in the form of the previous subsystem, by which to measure a contract's legitimacy.[139] System X thus became a model for tendering new contracts: just as a new modular subsystem had to be standardised so it could replace an old subsystem, so the costs of the new contract would have to be similar enough to the old contract for the Post Office board to trust it.[140]

System X contracts were placed by 1976, but by this point, its protracted development had attracted political attention. The Carter Committee, previously addressed in Chapter Three, was critical of System X's delays, and recommended that a separate department, responsible for liaising with suppliers, should be set up from the TSSD, which would continue to specify System X's technical details.[141] A new department, the System X Development Department, was created, headed by John Martin, who had previously supervised Systems Planning under Harris in TSSD.[142] System X entered the final stretch, and in 1979 it debuted at the International Switching Symposium in Geneva. System X debuted domestically in 1980 at the National Exhibition Centre, and that year the first System X exchange was installed at Baynard House in the City of London, followed by a local exchange in Woodbridge, Suffolk. In 1981, two more exchanges were installed, and by 1983 a further twenty were planned.[143] Installations picked up after privatisation, and by 1988, nearly 1,300 new exchanges had been installed.[144]

System X was launched as 'the complete approach' to telecommunications, and it was in this and other ways in which it embodied Merriman's general-purpose

[138] 'Cable Procurement' April 1975, TCC 55/7/50, BTA.
[139] 'System X, September 1975, TCC 55/7/150, BTA'.
[140] 'System X, September 1975, TCC 55/7/150, BTA'.
[141] *Report of the Post Office Review Committee*, 120.
[142] Harris, *Automatic Switching in the UK*, 26–27.
[143] 'System X Arrives Early', *Telecom Today*, May 1980, 16, BTA.
[144] '£100m Boost for Network', *Telecom Today*, May 1988, 4, BTA.

evolutionary network.[145] System X was a ‘total telecommunications system’ with ‘high evolutionary potential’, described as a ‘family’ of telephone exchanges which ‘share support systems by living together and learning together’.[146] This echoes Harris’ and AGSD’s ‘family’ concept, but also again cybernetically blurs the machine-organism boundary.[147] System X was not just one machine, but many, and BT marketed it as part of a future, all-digital ‘common network for speech, data, and other services’. The network evolution of the 1980s and beyond would create an ‘integrated services digital network’ which would provide all telecommunications services.[148] However, by the time System X had been launched, the ISDN was still some time off, and the Post Office and BT had turned their attention to other ways of meeting the growing domestic demand for data.

This domestic demand did not discriminate between data over integrated networks or from alternative, specialised, ‘packet-switched’ data networks. Packet-switching, first conceptualised by Donald Davies at the NPL in 1965, in contrast to circuit-switched voice telephony, does not require a continuous call between subscriber and destination, instead dividing data up into discrete ‘packets’ which can be independently routed.[149] Circuit-switching was necessary for telephone calls, and thus also necessary for an integrated network, but packet-switching was purpose-built for data transmission, and so was used for specialised data networks. In 1971, Merriman thus warned the Post Office board of the threat from closed packet-switched data networks as a potential obstruction for the Post Office’s goal of ‘universal integrated networks’.[150]

However, by 1975 it was increasingly clear that, between the time it would take to develop an international ISDN standard, and the growing demand for data services, the Post Office would have to develop a specialised packet-switched data network. In December 1975, the Post Office opened the Experimental Packet Switched Service, ‘XPSS’, in London and Manchester.[151] Within three months, XPSS was massively oversubscribed and so further development of packet-switching proceeded.[152] The Post Office’s pre-existing commitment to the idea of a circuit-switched integrated digital

---

[145] ‘System X: The Complete Approach’ 1978, TCB 318/PH 2380, BTA.
[146] ‘System X: The Complete Approach, 1978, TCB 318/PH 2380, BTA’; ‘System X: The Modernisation of British Telecom’ 1984, TCB 325/EHA 2770, BTA.
[147] ‘System X: The Key to Our Future’ 1981, TCB 325/EHA 2753, BTA.
[148] ‘System X: The Complete Approach, 1978, TCB 318/PH 2380, BTA’.
[149] David M. Yates, *Turing’s Legacy: A History of Computing at the National Physical Laboratory 1945-1995* (London: Science Museum, 1997), 128–29.
[150] ‘Interactions Between Data Processing and Telecommunications’ June 1971, TCC 55/3/76, BTA.
[151] ‘Post Office Management Board Meeting’ 15 March 1976, TCC 15/17, BTA.
[152] ‘Managing Directors’ Committee: Telecommunications’ 2 December 1977, TCC 55/9/179, BTA.

network meant that there was some desire to wait for both System X and ISDN; however, it was also recognised that huge demand meant that there were both economic and political pressures to set up a full packet-switched special-purpose data network. The Managing Director's Committee for Telecommunications was particularly concerned that the business sector might lobby government to liberalise the monopoly if it didn't extend packet-switched data services, and so began development of a separate packet-switched data network.[153]

In 1981, after significant lobbying from business users in the City of London, which I explore in more detail in the next chapter, BT (as it had become) finally launched its full packet-switched data network, PSS.[154] Alongside PSS, BT also launched a range of data services called 'X-Stream Services'. BT explained that that the 'X', clearly connoting System X, was to signify '*digital* services', whilst 'stream' indicated 'the flow of digital information through the network'.[155] X-Stream was initially made up of KiloStream and MegaStream, which were low-capacity and high-capacity data services provided using rented private networks. Another service, SatStream, which I explore in more detail in Chapter Eight, opened in 1984 using satellites.[156] PSS was also rebranded 'SwitchStream One' to align with X-Stream marketing, and in 1984, BT finally launched an ISDN trial, marketed alternately as 'Integrated Digital Access' (IDA) and 'SwitchStream Two', which at long last achieved the business's goal of providing telephony and data over the main circuit-switched telephone network, using System X.[157]

The X-Stream services surfaced BT's increasing orientation to business customers, particularly those in the City of London, after its liberalisation. I explore BT's motivations in more detail in the next chapter through a brief history of the City Telecommunications Committee, a technical liaison and lobbying committee organised by the Bank of England, but here I will address X-Stream and liberalisation. As I addressed in Chapter Three, a key component of the creation of BT was the liberalisation of leased line services, whereby third parties could rent lines from BT and provide a range of services. X-Stream was BT's home-grown competitor in this market, and targeted business customers, launching with a brochure which depicted a fictitious conversation

[153] 'Managing Directors' Committee: Telecommunications, 2 December 1977, TCC 55/9/179, BTA'.
[154] 'X-Stream' 1981, TCB 318/PH 3096, BTA.
[155] 'X-Stream: A New Range of Digital Services from British Telecom' 1981, Folder 4, Box 80, MS2137: Joseph V. Charyk Papers, GWSC.
[156] 'X-Stream' 1984, TCB 318/PH 3350, BTA.
[157] 'The Digital World of British Telecom' 1982, Folder 4, Box 80, MS2137, Joseph V. Charyk Papers, GWSC; 'X-Stream, 1984, TCB 318/PH 3350, BTA'; 'ISDN: Martlesham '84 Stand Guide' 1984, TCB 318/PH 3625, BTA.

between BT and a 'leading edge-business customer', who was informed that services like MegaStream 'recognises the unique character and needs of the City business community'.[158]

BT's most interesting presentation of digital services came with a 1984 exhibit to market IDA, BT's ISDN trial.[159] The exhibit showcased three 'typical situations' for ISDN: a secretary's office, an executive's office, and security surveillance. The secretary's office showcased a telephone, a fax machine, a teletex terminal, and a CCTV camera, used in conjunction with the surveillance system. The executive's office had a single terminal and telephone to use for simultaneously accessing a database and placing calls. Finally, the security surveillance exhibit showed how a single surveillance officer could surveille widespread locations. The hierarchy established by this exhibit is important: the executive can access databases and a telephone to communicate with customers and employees. The secretary has various networked clerical machines and, most significantly, is also watched by a CCTV camera, monitored by the surveillance officer. The ISDN, in this exhibit, clearly achieved Merriman's vision of a general-purpose network, transmitting voice, data, and video, but also re-inscribed the division between generalist executive and mechanical clerical staff, and added a new method, CCTV, for the executive to maintain control over their employees.

System X also reified visions of computerised, networked control, and had been identified early in its development as a way of changing societal attitudes towards automation. In 1972, a report from the Long Range Planning Department outlined the scope for further automation of operator services, highlighting how an electronic SPC exchange, such as System X, could use computerised inputs to transfer work from the operator to the customer.[160] This would be achieved through an interactive process where the caller, in response to computerised verbal commands, would undertake a 'series of simple acts' – keying or dialling a number, usually a single digit. The sequence of numbers, keyed according to the verbal commands of the exchange, would allow the caller to use services like directory enquiries. Explicitly highlighting the relations between man and machine envisaged in this system, the report emphasised that 'the initiative [is] always firmly with the processor'. However, the report warned that increasing automation may 'precipitate a response of rejection and neo-ludditism … such

[158] 'X-Stream, 1981, TCB 318/PH 3096, BTA'.
[159] 'ISDN: Martlesham '84 Stand Guide, 1984, TCB 318/PH 3625, BTA'.
[160] 'Long Range Studies Report 31: Operator Services: The Scope for Further Automation in the 1980s and Later' 1972, TCC 252/31, BTA.

an attitude by society would severely restrict the managerial freedom of the Business'. Such an attitude did not come to pass, and System X were incorporated these functions with 'New Star Services' – so called because they used the '*' button on the keypad – and it was explained to customers that 'simple codes' would be used to operate these new services, which included call diversion and three-way calling, and that 'an automatic voice guidance system' would provide 'step-by-step advice and verification'.[161]

This approach adds another way in which the computer-controlled network resembled the government machine of Treasury O&M. Merriman, whilst at the Treasury, supported computerisation by comparing the mechanical work 'programs' of clerical staff to computer programs: both worked along discrete, step-by-step lines, and by drawing this parallel, Merriman argued for the replacement of clerical work 'programs' with computer programs.[162] Inversely, with automated operator services, work was passed from the processor to the user by directing the user to follow a series of commands; in O&M, the clerical program was replaced by the computer program, whilst in the telephone network, the computer programmed the user. However, this still demonstrates a continuous thread of thinking about both machines and humans as programmable: in both Merriman's championing of office machinery and in System X's operator services, a metaphor was drawn between the work of machines and of people.

Senior management, across various internal communications and information pamphlets, used System X to persuade engineering staff of the benefits of the deskilling, reskilling, and job losses associated with automation and BT's new competitive environment. I previously drew attention to GRACE, the 'robot telephone operator', and the Post Office's assertion that 'machines must be servants not masters'.[163] Similar fears accompanied the rollout of System X, and management issued a similar statement: 'Computers are still the servants of people, as they have always been'.[164] However, this was followed with: 'Increasingly, however, machines will take over the more mundane occupations and release the talents of British Telecom staff for more creative and interesting work'. The implication here is clear: jobs were available, for those talented and creative enough. Staff were encouraged to acclimate themselves to this new environment:

[161] 'New Services from System X' 1982, TCB 318/PH 3210, BTA.
[162] Agar, *The Government Machine*, 298.
[163] *Telephone Service and the Customer*.
[164] 'System X: The Key to Our Future, 1981, TCB 325/EHA 2753, BTA'.

> A modern system will, of course, require a modern attitude from the people who operate it. This will inevitably mean changes in skills and outlook on the part of British Telecom staff, but the system offers fair exchange. The up-to-date equipment is more compact, lighter and healthier to work with and the new "user-friendly" environment it creates will contribute to greater job satisfaction.[165]

Again, the implication was clear: if one could change skills and attitude, then the outlook was good. This was the 'fair exchange' for subjecting oneself to the new 'modern system', whilst also reaffirming that staff now relied on System X for their job security. System X was even cast as a job creator, as internal BT communications claimed that it was 'usually the out-of-date who face unemployment'.[166] Liberalisation was also deployed, as System X was portrayed as crucial to the company's competitiveness. Job security, staff were informed, would depend on BT's ability to attract and retain new business, and System X was the 'strongest weapon in our armory as we meet tough commercial competition'.[167] However, it was privately admitted that System X would result in net job losses, with a significant decline in manpower forecasted from 1986 onwards.[168]

The language of competition was reinforced by tying it to the 'great evolutionary potential' of System X, which meant it would be an adaptable total telecommunications network, would have 'in-built economies', and could provide new services to attract customers.[169] System X's flexibility and adaptability, conferred upon it by its evolutionary potential, were crucial to its competitiveness. System X's rollout, at a time when BT was advancing the general-purpose ISDN, and was undergoing liberalisation and privatisation, was a natural peak for the usage of 'evolutionary' language: a term which encapsulated both the adaptability of System X, the flexibility of the general-purpose ISDN, and the competition of liberalisation.

Conclusion

In this chapter, I have shown how 'information and control' influenced exchange development and network digitalisation. I started by exploring the Post Office's pursuit of analogue electronic switching, and showed that 'prestige', in numerous ways, played

---

165 'System X: The Key to Our Future, 1981, TCB 325/EHA 2753, BTA'.
166 'System X: The Way Ahead' 1982, TCB 325/EHA 2772, BTA.
167 'System X: The Key to Our Future, 1981, TCB 325/EHA 2753, BTA'.
168 'Telecommunications Board: Network Modernisation and System X' 1980, TCC 62/1/64, BTA.
169 'System X: The Modernisation of British Telecom, 1984, TCB 325/EHA 2770, BTA'.

a role in Highgate Wood's protracted development, which I contextualised against the 'defiant modernism' of 1950s and 1960s Britain.

With Highgate Wood's failure and Tommy Flowers' resignation, a philosophical vacuum for network development was created, which was filled by Merriman and Harris' interest in a general-purpose, evolutionary digital network oriented towards the problems of 'information and control'. I showed how these ideas were informed by Harris' encounters with information theory and cybernetics, and Merriman's history in Treasury O&M, and contributed to the pursuit of an integrated digital network and the development of an evolutionary, adaptable digital exchange, which combined would create a 'self-governing, self-healing' system where men and machines became 'self-optimising'.

I also explored the influence of the 'government machine' on computer modelling, which exemplified the 'discreet modernism' deployed by Treasury O&M and other loci of government mechanisation to obscure the decision-making relationships formed by men and machines. I also suggested that, viewed in this light, computer modelling can be construed as an instance of the 'self-governing, self-healing' network. One of the key influences of Treasury O&M on the Post Office was to view the system as a broader organisation of man-management and technology. Merriman's philosophy for a 'self-optimising' network thus applied not just to computerisation within the telephone network, but computerisation around the network.

Finally, I investigated System X and ISDN through the 1970s and 1980s, showing how both suffered protracted developments. System X was completed by the end of the 1970s, but the growing demand for data meant that ISDN was pre-empted by special-purpose packet-switched data networks. These networks, along with ISDN's eventual implementation, also show the growing pressures of business customers on the Post Office and BT, which were particularly visible in X-Stream and ISDN marketing.

Two instances of System X and computer control – new operator services, and engineering labour – provide an opportunity to reflect on recurring themes through this chapter. Automated operator services can be seen as another example of the Post Office's self-optimising system, programming customers to become more accustomed to automation. This also applies to engineering automation: engineers were informed that they would have to reskill for System X, but also that System X would improve their working environment and create jobs. These are all further instances of self-optimisation: engineers would have to optimise themselves to retain employment (even though unemployment was forecasted as inevitable, and, as I showed in the previous chapter, Project Sovereign followed), System X would optimise their working conditions, and would even optimise the organisation to create jobs. ALEM 6, as I have suggested, is another example of the self-optimising system which controversially and ambiguously infringed upon human decision-making. These all stand in stark contrast to the ‘machines must be servants not masters’ of GRACE in Chapter Two, but the important point I wish to make is that ‘machines must be servants’ was neither ignored nor inverted. Instead, a new settlement was found through a cybernetic, government machine philosophy. Both provided resources for viewing the telephone system as heterogenous system of humans and machines working together to ‘self-optimise’, rather than a hierarchical system of executive humans dominating machines (or vice versa).

However, this does not mean that hierarchies disappeared altogether. The privileging of computer control had negative consequences, as I have mentioned for engineering labour. The ISDN also showcases this, in the way its exhibits inscribed executive-clerical hierarchies and reinforced them through new modes of surveillance. In Chapter Seven, I will further explore, through a case study of the Long Range Planning Department, how computerisation in the Post Office, particularly computer modelling, had transformative effects on telecommunications surveillance. The ISDN’s stop-start development also provides a segue into the next chapter. As ISDN development faltered, the Post Office explored alternative modes of achieving the general-purpose information network, attempting to secure a national cable television and a national fibre-optic network. In the next chapter, I explore this history of transmission technologies, investigating how they were used to conjure various visions of the future through different metaphors and discourses. Earlier in this chapter, I suggested that the UKTTF study was successful because it reinforced a pre-existing vision of the future. In the next, I will explore how the Post Office used various future visions to guide the development of transmission developments and contributed to a nascent information discourse in Britain.

6 The Information Highway

Metaphor and Vision in the Telecommunications Network

According to *Wired Style: Principles of English Usage in the Digital Age*, a dictionary created by the digital utopian magazine *Wired*, the term ‘information superhighway’ refers to a range of high-bandwidth digital communication technologies, and was coined by the US Senator Al Gore, Jr in 1978 and later popularised by Gore during the 1990s, when he was Vice-President for President Bill Clinton.[1] The term, as used by Gore, referred to a high-speed digital communications infrastructure, and peaked at the 1994 Superhighway Summit at the University of California, Los Angeles, where Gore outlined his and Clinton’s ambition for a national information infrastructure built on the principles of competition and private investment, whilst also ensuring open access and avoiding ‘a society of information “Haves” and “Have Nots”’. Gore also lamented the unexpected usages of the ‘information superhighway’: a high-tech start-up had complained to him about the danger of ending up as ‘road kill on the information superhighway’, whilst other companies had petitioned him to support their entry into the communications infrastructure market, concerned that they would end up ‘parked at the curb on the information superhighway’.[2]

Gore’s speech highlights the power of metaphor, and how the choice and usage of a particular metaphor can be used to mobilise various approaches to a specific technology. The significance of metaphor has not gone unappreciated in the history of technology: studies have been undertaken into the nervous system as a metaphor for

[1] Constance Hale, ed., *Wired Style: Principles of English Usage in the Digital Age* (San Francisco: Wired Books, 1997), 71.
[2] Al Gore, Jr, ‘Remarks at Superhighway Summit’ (The Superhighway Summit, Royce Hall, UCLA, Los Angeles, 11 January 1994), https://clinton1.nara.gov/White_House/EOP/OVP/other/superhig.html.

Victorian telegraph, and into clockwork and the computer as metaphors for government.[3] Historians and analysts of metaphor have taken different positions on metaphor's function as descriptive or performative. [4] In this chapter, I particularly bear in mind Thomas and Wyatt's view that metaphors are normative, 'used to help the imaginary become true', as I explore how different metaphors were used by the Post Office to articulate its idealised roles for various transmission technologies.[5]

In this chapter, I will explore the technological and metaphorical development of transmission technologies in the British telephone network. Elizabeth Bruton has shown how, since the late nineteenth century, the development of new wireless technologies has been an important part of the Post Office's role as an institution of the state, projecting the state as an institutional innovator.[6] As I shall show, this resonates with one of the Post Office's early post-war wireless developments: the construction of BT Tower, previously known as the Post Office Tower, in central London, which was positioned by the Post Office as part of a high-tech, democratic vision of British post-war modernity through the metaphor of the tower as a 'lighthouse'.

After the Post Office Tower, the 'highway' metaphor came to the fore, and I will relate it to the Post Office's vision for an integrated, universal network for information, which I explored with the ISDN in the previous chapter. Related to this history, I explore the Post Office and BT's interest in developing a nationwide cable television network, and then a national optical fibre network, as ways of achieving a 'national grid' of integrated voice, video, and data transmission. The 'national grid' and 'highway' metaphors here supported development of millimetric waveguides and optical fibre as high-capacity integrated transmission lines, but, with the privatisation of BT, I shall show how the highway metaphor was repositioned to reflect BT's business interests. I thus also explore the Post Office and BT's relationship with its large business customers in this chapter and how that relationship influenced transmission technologies in the UK; I do

---

[3] Iwan Rhys Morus, '"The Nervous System of Britain": Space, Time and the Electric Telegraph in the Victorian Age', *The British Journal for the History of Science* 33, no. 4 (2000): 455–75; Otto Mayr, *Authority, Liberty, and Automatic Machinery in Early Modern Europe* (Baltimore: Johns Hopkins University Press, 1986); Agar, *The Government Machine*.

[4] Arthur I. Miller, *Insights of Genius: Imagery and Creativity in Science and Art* (Cambridge, MA; London: MIT Press, 2000), 218; Mayr, *Authority, Liberty, and Automatic Machinery in Early Modern Europe*, 1; Agar, *The Government Machine*, 16; George Lakoff and Mark Johnson, *Metaphors We Live By* (Chicago: University of Chicago Press, 1980), 157.

[5] Graham Thomas and Sally Wyatt, 'Shaping Cyberspace—Interpreting and Transforming the Internet', *Research Policy* 28, no. 7 (1999): 695.

[6] Elizabeth Bruton, 'Beyond Marconi: The Roles of the Admiralty, the Post Office, and the Institution of Electrical Engineers in the Invention and Development of Wireless Communication up to 1908' (PhD diss., University of Leeds, 2012).

this through a case study of one of the most influential business customers: the City Telecommunications Group, representing the Bank of England and large financial institutions from the City of London.

Pillar of Progress

Microwave transmission started with the exploration of centimetre-wavelength radio waves, ranging from 300 MHz to 100 GHz frequencies, as a potential medium in the 1930s. These short waves – 'micro waves' – were also known as quasi-optical waves because of their similarity to light: both travelled in straight lines, lost intensity over distance travelled, and required direct line-of-sight. The key technology enabling microwave transmission was velocity-modulated tubes, which are used to generate microwaves. The first of these, the klystron, was developed around 1930 and, in 1931, experiment radio-relay terminals transmitted telephone and telegraph messages across the English Channel, during trials conducted by IT&T's Paris laboratory, met in the previous chapter for Alec Reeves' PCM work. By 1934, the first Anglo-French radio-relay service was open, and in the UK, a second commercial link was opened by the GPO in 1937 between Stranraer, Scotland, and Belfast, Northern Ireland.[7] World War II, however, interrupted, and it was not until the 1950s that Britain's microwave network would begin to take shape.

The first microwave links to open after World War II in the UK were for television: in 1949, a London-Birmingham link opened, followed by a link between Manchester and Kirk O'Shotts, Scotland, in 1952. However, full-scale microwave telephony development only started in 1956, as it was more difficult to multiplex large numbers of telephone calls than it was to transmit a single television signal.[8] Two new types of microwave generators were used here, rather than the klystron, to build the microwave relay network: the cavity magnetron and quartz crystal microwave oscillators.[9] By 1964, microwave telephone links had opened between Manchester and Newcastle, Elgin and Kirkwall in Scotland, and from Carlisle to Belfast. However, two key nodes – Birmingham and London – had not been served as, owing to their built environments and natural geography, it was difficult to provide line-of-sight links to the

[7] Huurdeman, *The Worldwide History of Telecommunications*, 337–43.
[8] D.G. Jones and P.J. Edwards, 'The Post Office Network of Radio-Relay Stations. Part 1 - Radio-Relay Links and Network Planning', *The Post Office Electrical Engineers' Journal* 57, no. 3 (1964): 147.
[9] R.J.D. Scarborough, K.H. Ferguson, and A.W. Searls, 'The Generation of Stable Carrier Frequencies in the Range 3,800-4,200 Mc/S', *The Post Office Electrical Engineers' Journal* 52, no. 2 (1959): 125–28.

Copyright Material Removed

Figure 6.1. The British microwave radio-relay network in 1964, showing links already constructed and those in development.

city centres (Figure 6.1).[10] For this reason, two towers were constructed at the centre of London and Birmingham. Construction of the Post Office Tower in London began in 1961, however, it was not a smooth road from ideation to construction. Dame Evelyn Sharp, Permanent Secretary for the Ministry for Housing and Local Government from 1955-1966, wrote to Ernest Marples in 1959 to express her and her ministry's 'horror' at the plans for such a 'particularly conspicuous' tower.[11] Marples' reply defended the tower

[10] Jones and Edwards, 'The Post Office Network of Radio-Relay Stations. Part 1 - Radio-Relay Links and Network Planning'.

[11] Evelyn Sharp to Ernest Marples, 'Post Office Tower', 24 July 1959, POST 122/1172, BTA.

as a 'bold and imaginative solution' to London's line of sight problems, which had been endorsed by the Royal Fine Arts Commission, and would also offer public amenities in the form of a revolving restaurant and observation gallery.[12] Construction went ahead, and the tower was completed by 1964, opening to the public in 1966.

The Post Office used the tower's amenities and visibility to present itself as a highly scientific and technological public service. A visitors' information booklet explained how the tower was 'a symbol of the modern Post Office, a science based industry using the most refined techniques in the telephone, teleprinter, television and computer communications so necessary for modern society'.[13] The presentation of the tower as a high-tech symbol also occurred outside the Post Office: the tower appeared in *Eagle and Swift* boys' comic in 1964. Peter Bowler has noted *Eagle and Swift*, which ran from 1950 to 1969, as part of the growing importance of visual impact in popularising science and technology in Britain at this time, in particular through two recurring features: the adventures of Dan Dare, 'Pilot of the Future', and its cut-away illustrations of technological wonders.[14] The Post Office Tower featured in both, with *Eagle and Swift*'s May 31st, 1964, front page showing Dan Dare locked in battle with Xel, a dangerous alien, at the Post Office Tower, whilst the cut-away illustration showed off the tower's interior and exterior (Figures 6.2 and 6.3).[15]

The Post Office Tower was evidently presented as a symbol of scientific, technological modernity, but contextualising it within the history of 1950s and 1960s Britain reveals nuances to that modernity. More recently, the Post Office Tower has been associated with the 'white heat' of Harold Wilson's Britain, and yet such an association is problematic for two reasons: first, as Christopher Goldie notes, the Post Office Tower started construction well before Wilson's 1963 'white heat' speech; second, as David Edgerton rightly points out, the post-war period is better characterised by a bipartisan, rather than uniquely left-wing, technological enthusiasm.[16] In the previous chapter, I used 'defiant modernism' to describe Highgate Wood. 'Defiant modernism' correctly pays attention to British technological enthusiasm throughout the Conservative 1950s, and so

---

[12] Ernest Marples to Evelyn Sharp, 'Post Office Tower', 1959, POST 122/1172, BTA.

[13] 'The Post Office Tower London' 1967, HIC W04/06 Buildings/BT Tower/Press cuttings and images, BTA.

[14] Peter J. Bowler, *Science for All: The Popularization of Science in Early Twentieth-Century Britain* (Chicago: University of Chicago Press, 2009), 272.

[15] 'Dan Dare, Pilot of the Future, in The Big City Caper', *Eagle and Swift*, 23 May 1964; 'London's New Landmark', *Eagle and Swift*, 23 May 1964.

[16] C.T. Goldie, '"Radio Campanile": Sixties Modernity, the Post Office Tower and Public Space', *Journal of Design History* 24, no. 3 (2011): 207–22; David Edgerton, 'The "White Heat" Revisited: The British Government and Technology in the 1960s', *Twentieth Century British History* 7, no. 1 (1996): 53–82.

Copyright Material Removed

Figure 6.2. The Post Office Tower features on the front cover of *Eagle and Swift* in a sci-fi adventure, 1964.

the Post Office Tower could adequately be positioned within this trend. However, ‘defiant modernism’ is not a perfect frame. It describes projects in which Britain sought world firsts: Comet, the first civilian jet airliner; Calder Hall, the first commercial nuclear power plant, and so on. The Post Office Tower, however, was neither the world’s first city-centre microwave tower, nor was it the tallest, built both later and smaller than similar radio towers in Stuttgart and Dortmund in Germany.

Most crucially ‘defiant modernism’ fails to capture the Post Office Tower’s public amenities, which play an important role in revealing the contested modernity of late 1950s and early 1960s Britain. Goldie highlights how the publicly-accessible revolving restaurant and observation galleries situate the tower within a longer post-war imbrication

Copyright Material Removed

Figure 6.3. The cut-away illustration of the Post Office Tower inside *Eagle and Swift*, 1964.

of modernity and democratic participatory citizenship. Goldie compares the tower to other social democratic projects such as London's Royal Festival Hall, built in 1951, where publicly accessible spaces could generate new patterns of social relations for a democratic, modern Britain. However, Goldie also points out that, whilst the tower's public amenities situate it in a social democratic modernity, the barriers created between the expensive, reservation-only, restaurant and the observation gallery perpetuated class differences. Goldie's reading is problematic in that, whilst it recognises the important social aspect of the tower's modernity, it takes the technology out, ignoring the tower's role in the microwave network altogether.

The Post Office's metaphor of the tower as a 'lighthouse', overlooked by Goldie, combined the technological and social functions of the tower into a broader, nuanced modernity, interlinking technological progress with public service. The brochure for the tower's opening ceremony described the tower as a 'lighthouse-looking structure', whilst an information booklet for visitors described the tower as a 'giant lighthouse'.[17] A 1962 press release also described the tower as a 'modern, slender lighthouse'. In this press release, the metaphor was used to describe two aspects of the tower: first, the revolving restaurant – both the restaurant and lighthouses revolve; second, an historic linkage was made to a Victorian telephone exchange, which, built upon the roof of a courthouse, was also described as a 'lighthouse'.[18] So, as lighthouses illuminate paths of progress for ships, the 'lighthouse' metaphor here, interlinking the tower as an amenity and a technological successor to Victorian exchanges, highlighted the Post Office's public service in societal and technological progress. The 'lighthouse' metaphor is also suggestive of the quasi-optical features of microwaves, and, when combined with the connotations of the lighthouse as a navigational instrument of public service progress, indicates an extensive entanglement of the tower's threefold functions: a node in the microwave relay network, a symbol of technological progress, and a site of democratic modernity. The metaphor used here was thus more than descriptive: it shows how the tower was deployed normatively to present the Post Office as a modern organisation.

However, this focus on the Post Office Tower obscures other important parts of the microwave network: the 'heart' of the tower, the Birmingham Radio Tower, and the nationwide radio mast network. The base of Post Office Tower was home to the 'heart that makes the tower tick', as it was called in the *Post Office Telecommunications Journal*: three telephone exchanges (Mercury, switching incoming traffic; Tower, switching outgoing traffic; and Museum, a tandem exchange linking two hub exchanges) and the London Television Switching Centre.[19] These exchanges, obscured by the tower rising above them, were as important to the microwave network as the aerials at the top of the tower, and yet were much less visible. The Post Office Tower was also not the only city centre tower constructed: Birmingham Radio Tower was also built as a node in the microwave network, and further underscores how these urban constructions were used to illustrate the Post Office's modernity. Birmingham Radio Tower featured in the 'Progress' series of publicity posters previously mentioned in Chapter Two (Figure 6.4)

[17] 'Post Office Tower Opening Ceremony Brochure' 1962, HIC W04/06 Buildings/BT Tower/Press cuttings and images, BTA; 'The Post Office Tower Information Booklet' 1965, HIC W04/06 Buildings/BT Tower/Press cuttings and images, BTA.
[18] 'GPO Press Release: Full Circle' 1962, HIC W04/06 Buildings/BT Tower/Construction, BTA.
[19] K.E. Ward, 'The Heart That Makes The Tower Tick', *Post Office Telecommunications Journal* 20, no. 2 (1968): 22–27.

Figure 6.4. Birmingham Radio Tower also featured in the 'Progress' poster series, previously seen in Chapter Two with the Post Office's Computer Centre. Courtesy of BT Archives.

and, like the Post Office Tower, was labelled 'like a giant lighthouse but instead of sending out a beam of light it transmits microwave radio signals', further embedding microwaves' quasi-optical nature into the lighthouse metaphor.[20] Finally, attention should also be given to the nationwide infrastructure of smaller microwave relay towers which

[20] 'Birmingham Radio Tower' 1981, HIC W04/06 Buildings/BT Tower/Construction, BTA; 'Progress: Birmingham Radio Tower' 1965, TCB 420/IRP (PR) 6, BTA.

linked cities together. By 1966, there were 120 relay towers, situated at intervals of about thirty miles, with an aggregate route length of 2,000 miles.[21]

The Post Office Tower's fate illustrates the passing of the Post Office's moment of high modernity. On October 31st, 1971, a bomb exploded in the tower's restaurant toilets; initially attributed to the Provisional IRA, the bomb has since also been linked to the Angry Brigade, a British anarchist collective active from 1970 to 1972. The tower was subsequently closed to the public and, after the restaurant's lease expired in 1980, the restaurant remained closed.[22] Whilst the tower continued to be used for microwave transmission, its closure signalled the beginning of the end for the modern Post Office Tower. By the 1990s, the tower had been renamed BT Tower, and BT experienced growing criticism for its continuing closure of the tower to the public, whilst using it for corporate functions. A 1994 editorial in *The Independent* criticised 'the ephemeral fizz of public relations receptions' which excluded the public, whilst a 1995 article in *The Scotsman*, 'Tower to the People', laid in heavily, asking 'how come, 30 years on, nobody except corporate fat-cats can get inside it?'.[23] Whilst the tower would continue to transmit into the 2000s, giving it a healthy forty-year lifespan, by the 1990s, it was clear that the Post Office Tower's original era of democratic modernity was over.

The Super Communications Highway

Even as Britain's skies were filling with microwaves in the 1960s, the Post Office's attention had already turned terrestrially to a new subterranean transmission medium: the millimetric waveguide. However, despite its earthly bounds, the millimetric waveguide can also be seen as a direct descendant of microwave transmission. Millimetric waveguides are metallic tubes used to direct waves; 'millimetric' refers to the waves' wavelength, so extending the development of the centimetre wavelength for aerial microwave transmission. The smaller wavelength accentuated the quasi-optical nature of the microwaves, and so, where centimetric microwaves could be transmitted through the air, millimetric microwaves suffered too much degradation during rainstorms and other adverse conditions. The trade-off, however, was that as wavelength decreased, frequency

[21] D.G. Jones and P.J. Edwards, 'Post Office Tower, London, and the United Kingdom Network of Microwave Links', *The Post Office Electrical Engineers' Journal* 58, no. 3 (1965): 149–59.
[22] 'British Telecom News Release: London Telecom Tower' 3 August 1982, HIC W04/06 Buildings/BT Tower/Press cuttings and images, BTA.
[23] 'It's Lonely up There at the Top', *The Independent*, 16 November 1994; Pete Clark, 'Tower to the People', *The Scotsman*, 30 June 1995.

increased, which meant higher bandwidth and greater transmission capacity; metallic tubes – waveguides – were thus proposed as a housing and guidance system for millimetric microwaves. In the UK, the IEE held the first conference on millimetric waveguides in 1959, and a conference report in *The Post Office Electrical Engineers' Journal* suggested that further research and development work was needed.[24]

The Post Office was not the only organisation to explore waveguide development. Bell Labs also undertook a lengthy research and development programme on waveguides, which was abandoned by 1973, and STL also conducted some early research into waveguides.[25] Alec Reeves was the chief figure at STL assessing waveguides, and was unconvinced, particularly regarding limitations in waveguide geometry: to avoid signal degradation, waveguides needed to avoid significant kinks and tight turns. The significant distances between urban centres in the USA meant that waveguides, requiring gentle, sweeping curves, were potentially suited for AT&T's needs; Reeves, however, was sceptical that waveguides would be suited to the densely built-up British landscape, and so, in 1963, STL abandoned their waveguide project and pursued optical fibre transmission instead.[26] However, the Post Office continued to pursue waveguide research, tempted by the high-capacity millimetric waveguides potential role in the future integrated digital information network.

Before that, however, I will first explore how the waveguide project intersected with the relocation from Dollis Hill. As mentioned in Chapter Four, the need for more space, both for manpower and research trials, was the primary motivation for the move. The earliest research trial at Martlesham Heath was a 1-mile circular waveguide test, undertaken in 1967 by a team of Post Office research staff, working with Professor Harold Barlow, a UCL Professor of Electrical Engineering.[27] The Martlesham area was also used for 14km trial between Martlesham Heath and Wickham Market in 1975. The trial was broadly successful, but had required a significant degree of auxiliary infrastructure: a special bridge to navigate a river, a purpose-made tunnel for a stream and marsh, and 'mirror corners', using reflective surfaces to bounce the beams at tight angles, were tested in segments with unavoidable sharp bends. The waveguide also required mechanical tensioning using tensioning equipment installed at both ends: the waveguide had to be

[24] 'Long-Distance Transmission by Waveguide', *The Post Office Electrical Engineers' Journal* 52, no. 3 (1959): 213–14.
[25] Jeff Hecht, *City of Light: The Story of Fiber Optics* (Oxford; New York: Oxford University Press, 1999), 87, 172.
[26] Hecht, 87.
[27] 'A Year of Challenge and Change', *Post Office Telecommunications Journal* 19, no. 4 (1967): 10–14.

held taut to mitigate soil subsidence and overcome the problems of expansion and contraction due to temperature changes.[28]

The mixed successes of the waveguide trials, combined with the Post Office's pursuit of waveguide transmission well after STL and AT&T had abandoned it, invites the question of why the Post Office continued with the waveguide. The answer is complex, and can be explained by three inter-related factors: first, the Post Office's vision for an integrated high-speed digital network, explored in the previous chapter; second, and related to the first, is a broader vision of an impending information revolution with high bandwidth needs; and third, the Post Office's views on the time optical fibre development would take and the eventual position that optical fibre would occupy in the network. The Post Office's use of a 'highway' metaphor for the waveguide is particularly revealing of these three factors' entanglement.

The waveguide was highly influenced by the UKTTF study on the integrated digital network, which I outlined in the previous chapter. The UKTTF's conclusion that the entire telephone network should be digitalised was used to reinforce the privileged status of the waveguide as the natural next step for transmission. Digitalisation suited Post Office expectations of the future in two ways – first, in the expanding number of connections the network would need to provide, and second, in the forms of transmission the Post Office expected to carry – and the waveguide was highlighted as a key technology for meeting both expectations. The UKTTF report had found that the benefits of digitalization would be so strong that it would be economical regardless of transmission medium: coaxial copper cable, microwave, or waveguide. However, waveguide was specifically highlighted in the study as the most cost-effective and high-bandwidth transmission medium available, and the UKTTF's final report included a recommended waveguide layout for 1986, stretching from London to Bristol, and to Carlisle via Manchester and Leeds, with onward connections to Cardiff and Glasgow if there was enough demand for Viewphone in those cities.[29] Viewphone again appears as a symbol of the future needs of the integrated digital network, but I will postpone its discussion to the next chapter on the Long Range Planning Department, given that department's central role in sustaining the Viewphone future. The UKTTF report also addressed optical fibre,

---

[28] D. Merlo, 'The Millimetric Waveguide System: The Current Situation', *The Post Office Electrical Engineers' Journal* 69, no. 1 (1976): 34–37; Hecht, *City of Light*, 174.

[29] Breary, 'A Long-Term Study of the United Kingdom Trunk Network, Part 1 - General Methodology: Forecasts: Plant Study'; 'UK Trunk Task Force Final Report, Volume 1, 1971, TCC 145/7, BTA'.

but only as an experimental technology, and did not included it in any forecasts.[30] Millimetric waveguides, already identified as a high-capacity successor to centimetric microwaves, were thus seen as an important technology for the integrated digital network.

The relationship and relative status of optical fibre and waveguides continued to influence appraisals of both mediums through the 1970s. In 1972, a meeting of the Managing Director's Committee for Telecommunications, including Fennessy and Merriman, noted that optical fibre research was demonstrating greater potential than expected, but predicted that waveguides would still be used in the main trunk network, whilst optical fibres were more suitable for the local network.[31] In the mid-1970s, Post Office publicity and information brochures described waveguides as the 'big brother' of optical fibres, carrying heavy communications traffic, whereas optical fibres would provide lower-capacity transmission for local networks.[32] This complementary attitude was particularly prominent at a 1976 IEE conference on the millimetric waveguide, where Merriman, in the opening address, argued that waveguides 'will have to be judged – against their timeliness and their relevance – or irrelevance – to the spectrum of competing or complementary technologies'.[33] Merriman gave an overview of potential alternatives to the waveguide: coaxial, low-bandwidth but already in extensive use; microwave, already exhausting the available frequency spectrum and vulnerable to degradation during heavy weather; satellites, only economically viable for international transmission; and optical fibre, 'not yet in a position to compete' in the trunk network, but a promising option for high-capacity local transmission. Merriman concluded that waveguides were the clear victor, referencing 'their extraordinary capability for information/bandwidth'.[34]

However, complementary relationships between trunk waveguides and local optical fibre did not extend to the Research Department, where various research groups competed to make transmission breakthroughs. Chris Wheddon recalls significant competition:

---

[30] Breary, 'A Long-Term Study of the United Kingdom Trunk Network, Part 1 - General Methodology: Forecasts: Plant Study', 213.

[31] 'Managing Director's Committee: Telecommunications, 17 November 1972, TCC 55/4/194, BTA'.

[32] 'Post Office Develops New Ways of Keeping in Touch' 1975, HIC W04/01 Network/Transmission Systems/Waveguides, BTA; 'British Waveguide Plan - With Export Potential' 8 November 1976, HIC W04/01 Network/Transmission Systems/Waveguides, BTA.

[33] 'Millimetric Waveguide System Conference: Opening Address, J.H.H. Merriman' 9 November 1976, TCC 711/31, BTA.

[34] 'Millimetric Waveguide System Conference: Opening Address, J.H.H. Merriman'.

> There was then three competing transmission technologies, well four if you include satellite, there was coax, there was waveguide, there was optical and there was satellite and they were all vying to be top dog … the early days of optical fibres, using the lasers, they lasted about five minutes you know, and we were saying "Oh you guys, they can't get it to work for more than a couple of days and it all buggers off!". So we thought they were well, had got their heads in the clouds.[35]

Ray Hooper remembered that, at the 1976 IEE waveguide conference, one Post Office engineer breached the complementary view of waveguides and optical fibre:

> One of the funniest things I remember, a guy called Dick Dyott, he died a couple of years ago but he was something of a character, as they say, and Dick was very good and he got up in the meeting and they were talking about comparison between the circular waveguide and optical fibre; he got up and said "Well, carry on laying your circular waveguides – we can use that as duct for the optical fibres!". That didn't go down very well but I thought that was hugely funny.[36]

Ironically, the vision of complementary transmission methods would later be BT's downfall, as BT attempted to secure a national optical fibre network to fulfil their general-purpose information network ambition; I will address this in the next section on optical fibre and the deregulation of the British telephone network.

The waveguide philosophy peaked in 1977 with the Post Office board's approval of the first trunk transmission system designed specifically for digital use: a link built between Reading and Bristol, linking the South Wales and the West with London. Bristol was also an important node for routing international traffic to London from submarine cable stations in Cornwall and the Post Office's two satellite earth stations in Cornwall and Herefordshire. Two variants for the link were proposed: first, a waveguide, ready by the end of the decade; second, an optical fibre link, which would not be available until 1983. The Managing Director's Committee for Telecommunications recommended the waveguide variant to the board due to the uncertainty of optical fibre research, which had not yet entered development stages, and also because the Post Office, as one of the few remaining waveguide pioneers, had the opportunity to showcase its world-leading position and create an export market for Britain. The waveguide decision also further highlights the high expectations for future transmission needs, especially in video transmission: forecasts suggested that only 20% of the waveguide's capacity would be

---

[35] Chris Wheddon, Oral History with Chris Wheddon, interview by Jacob Ward, 4 August 2016.

[36] Ray Hooper, Oral History with Ray Hooper, interview by Jacob Ward, 15 July 2016 ; This incident is also recalled in an interview with Dick Dyott himself in Hecht, *City of Light*, 142.

required over 20 years, but presented this as an opportunity to use excess capacity for other transmission types, including video-conferencing.[37] The Post Office Management Board's selection of the waveguide link also shows a new perspective on the waveguide-optical fibre relationship: the Bristol-Reading waveguide was seen as an 'insurance' against delays in the development of optical fibre.[38]

The Bristol-Reading waveguide project failed, signalling the death of the waveguide. The Post Office board, as part of the project's 'insurance policy' status, had also decided in advance that Bristol-Reading would be the only waveguide link, expecting that optical fibre would come good before other trunk routes required their own waveguides. This attitude filtered down to the Post Office's manufacturing partners on the project, Marconi and BICC. Marconi, now uncertain of whether there would be a British waveguide market, decided to recoup all waveguide R&D expenditure from the Bristol-Reading project, significantly raising the costs for the Post Office. However, it was not just the influence of manufacturing which affected the project's prospects, but also the broader downturn in Britain in the 1970s. This had slowed telephone growth relative to the UKTTF's earlier forecasts: the Post Office's optimistic projections of a high-capacity integrated digital network, serving telephony, data, and video over waveguides had become excessive after the effects of economic slumps on telephone use.[39] The combinations of slow telephone growth, faster-than-anticipated optical fibre development, and higher manufacturing costs, meant that the Post Office cancelled the Bristol-Reading waveguide project in 1978.

The waveguide, whilst not a technical success, was, however, a metaphorical success. The waveguide had surfaced the Post Office's first uses of the 'highway' metaphor, before Al Gore's 1978 coining of the 'information superhighway', and well before the metaphor's 1990s digital utopian popularity. The Post Office, however, was not the first user of the 'highway' metaphor in relation to communication networks: in the 1920s, AT&T used the phrase 'a highway of communication' to compare its telephone network – a government-sanctioned private monopoly – to the public highways system, attempting to persuade its customers, as Marchand capably expresses, of 'the logic and beneficence of a unified system'.[40]

---

[37] 'Post Office Board: Bristol-Reading Waveguide System' 1977, TCC 55/9/24, BTA.
[38] 'Post Office Management Board' 21 February 1977, TCC 711/31, BTA.
[39] 'Bristol-Reading Waveguide System: Paper by Director of Network Planning' 1977, TCC 711/31, BTA.
[40] Marchand, *Creating the Corporate Soul*, 60–61.

The Post Office used the 'highway' metaphor to communicate the waveguide's high bandwidth and the telephone business's plans for a general-purpose digital information network. The highway metaphor first appeared in the *Post Office Telecommunications Journal* in 1970, where waveguides were described as 'highways of communication' and 'super-highways for telecommunications traffic'.[41] This continued throughout the 1970s: the waveguide, as a 'high capacity communication highway', was also called optical fibre's 'big brother'.[42] Publicity for the 1975 Martlesham-Wickham Market trial described waveguides as a 'super-highway' solution which the Post Office had prepared for 'major telecommunication highways', and various press notices for the Bristol-Reading link called it a 'super communications highway', explaining that it would carry data, television, videophone, and video-conferencing services for the integrated digital network.[43]

The highway metaphor took hold in the 1970s because of the Post Office's plans for a high-capacity general purpose information network for voice, video, and data. This demonstrates two points: first, the waveguide may have failed, but the Post Office only pursued it for so long because of its need for a ready solution to the integrated information network. The waveguide may therefore occupy the same position in the Post Office as Picturephone did for AT&T. Picturephone was a prototype videophone launched by AT&T at the 1964 New York World Fair in its $500 million Picturephone Center. Despite this fanfare, Picturephone had a lukewarm reception; AT&T installed booths that year in New York, Chicago and Washington, D.C., but had only seventy-one patrons in the first six months, and by 1970 nobody was using them. In 1970, the first customer sets debuted in Pittsburgh, but over two years only thirty-two sets were sold. By 1978, service had ceased. Picturephone was, conventionally, a failure, but Lipartito argues that it was also 'a rather successful piece of the technological imagination that guided innovators by helping to establish a basic paradigm for information services and technology'.[44] Picturephone successfully embedded visions of an information revolution in AT&T, and I would suggest that the waveguide superhighway did the same for the Post Office.

[41] R.W. White, 'Waveguides - Highways of Communication', *Post Office Telecommunications Journal* 22, no. 3 (1970): 5.
[42] 'Post Office Develops New Ways of Keeping in Touch, 1975, HIC W04/01 Network/Transmission Systems/Waveguides, BTA'.
[43] 'British Waveguide On Show To World: A Successful Field Trial by Post Office' 8 November 1976, HIC W04/01 Network/Transmission Systems/Waveguides, BTA; 'British Waveguide Plan - With Export Potential, 8 November 1976, HIC W04/01 Network/Transmission Systems/Waveguides, BTA'; 'British Waveguide Will Be World's First' 1977, TCC 711/31, BTA.
[44] Kenneth Lipartito, 'Picturephone and the Information Age: The Social Meaning of Failure', *Technology and Culture* 44, no. 1 (2003): 77.

Second, the waveguide also shows how the 'highway' metaphor was an information metaphor before its apparent invention by Al Gore. The Post Office's view that 'communications highways' would be used in the future for all types of information – telephony, video services, television, and data – predates the 'information superhighway' metaphor, which is itself arguably even narrower in scope, referring to data alone. AT&T had used the highway metaphor earlier, but the Post Office was involved in the early years of its most popular variant: the highway as an *information* highway.

Visions for Cable and Optical Fibre

A recurring theme in the previous section was the faster-than-anticipated development of optical fibre. In this section, I shall explore the Post Office's development of optical fibre and its intersection with two other developments: the liberalisation and privatisation of the telephone system, and the Post Office and BT's ongoing interest in developing a national cable television network as an alternative path to the general-purpose information network. I also explore the pressures exerted by the City of London on the Post Office and BT's transmission network, which resulted in BT ending its policy of region-neutrality in the transmission network and concentrating resources on London. Alongside these histories, I also explore the evolution of the 'highway' metaphor within BT and its transition from a metaphor for waveguides, then optical fibre, and then the ISDN.

Optical fibre transmission uses light waves, generated by lasers, to transmit communication signals down optical fibres, made of ultra-transparent glass, which guide light waves through internal reflections from their interior surface. This means that, just as the millimetric waveguide succeeded centimetric microwaves by using increasingly higher frequency, shorter wavelength, regions of the electromagnetic spectrum, so optical fibre succeeded the waveguide, by using even the higher frequencies of near-visible light, and in applying the same principle of using tubes to guide waves. Whilst superficially the three transmission methods discussed in this chapter look very different, transmitting through the air, metal tubes, and glass fibres, they are all in fact neighbours on the electromagnetic spectrum.

Optical fibre was pioneered at STL in the 1960s; the key figure at STL was Charles Kao, a Chinese-born engineer who, in 1969, proving that ultra-transparent glass could be synthesised and used for low-loss laser communications, and later won a Nobel

Prize in Physics in 2009 for his pioneering breakthrough. Jeff Hecht has shown that the Post Office had a significant influence on Kao's research: Kao worked for STC, a manufacturer and not a network provider, and so needed partners and customers. The Post Office, as both a domestic telephone carrier and research organisation, was an ideal partner. Its requirements for a local transmission system to complement waveguides set the standards which Kao targeted with his research – a degradation of at most 20 decibels per kilometre.[45] Post Office research staff collaborated with STL, working on new ways to synthesise glass fibres, as well as setting benchmarks for optical fibre's credibility: they were crucial for verifying the purity and credibility of glass fibres synthesised by Corning Glass in 1970, another breakthrough following Kao's proof of ultra-transparent glass.[46]

These breakthroughs triggered the start of a race through the 1970s and 1980s to create practical optical fibres. Important developments at laboratories around the world followed, including new fabrication techniques for optical fibre and the creation of small, reliable lasers, by 1977 the Post Office had two working trials: a 13km low-bandwidth 8.448 Mbit/s link and a high-bandwidth 7.25km 140 Mbit/s link.[47] These trials were the first fibre-optic installations in the British telephone network, and also represent Post Office research staff's pursuit of fibre optic world firsts into the 1980s. In 1979, orders were placed with STC, GEC, and Plessey to begin optical fibre installation in fifteen routes across Britain.[48] Several of these tested experimental low-bandwidth links in different environments, such as lakebeds, but three links were high-bandwidth 140 Mbit/s cables, including a Reading-London link. Only a year after the cancellation of the Bristol-Reading waveguide, preliminary tests were taking place to standardise optical fibre systems. In the 1980s, the Post Office broke several optical fibre world records: in 1982, research staff tested a 140 Mbit/s link over 102km, the longest in the world; the following year, the Post Office placed the first order in the world for a commercial optical fibre link, running between Milton Keynes and Luton.[49] This culminated in 1985 with another record – the fastest transmission rate ever achieved over optical fibre, 2.4 Gbit/s over 32km of cable – and a prize for the research staff – a Queen's Award for Technological

---

[45] Hecht, *City of Light*, 111.
[46] Hecht, 142–43.
[47] J.E. Midwinter, 'Optical-Fibre Transmission Systems: Overview of Present Work', *The Post Office Electrical Engineers' Journal* 70, no. 3 (1977): 146–53.
[48] 'Optical Fibre Systems', *BT Technical News,* July 1979.
[49] 'Telecom's Optical Triumph', *BT Management News*, March 1982; 'World's First Commercial 140 Mbit/s Optical Link Fibre Tested', *BT Technical News,* Winter 1983.

Achievement.[50] Hecht labels this period the 'Fiber-Optic Performance Olympics', with records set and broken around the world on a frequent basis.[51] In the British case, highlighting these breakthroughs also lends additional context to the Bristol-Reading waveguide's cancellation, illustrating the surprising pace of fibre-optic development. It took a decade from Charles Kao's breakthrough at STL in 1969 to the installation of the first trunk network fibre-optic trials in 1979, but less than four years later, BT was ordering and installing commercial systems.

One of the earliest areas prioritised by BT for fibre-optic rollout was the City of London financial district. An October 1983 press release from BT proudly announced that London would be one of the world's first cities to get 'communication highways of glass'.[52] The press release highlighted the business services provided by optical fibre, and described how optical fibre would hook up the City of London and London Docklands. Docklands seems incongruous here, but in fact corresponds to another example of City prioritisation which I explore in Chapter Eight: from 1984, Docklands was home to London 'Teleport', a new satellite earth station installed in London specifically to provide the City financial district with better international communication links.

This prioritisation came after many years of dialogue and lobbying between the City of London and the Post Office/BT. In 1968, the Bank of England organised the City Telecommunications Subcommittee (CTC), a sub-committee of the Committee on Invisible Exports, which had been created in 1968 by the Bank of England and the British National Export Council in order to promote the City's 'invisible' exports – financial services and associated activities – abroad.[53] Initially, the CTC acted as a technical liaison and reporting service on behalf of the City to the Post Office, requesting updates on the roll-out of various services such as telex and data services, and reporting various technical issues.[54] However, this changed in 1974: the Subcommittee was enlarged into an independent Committee, and gained more representatives from City financial institutions in response to 'the increasing inadequacies of international and domestic services'.[55] The committee embraced more of a political lobbying mindset, although its focus was still

---

[50] 'New Optical Fibre Record Set To Cut Costs' 21 November 1985, HIC W04/03 Network/Cable/Fibre-Optic, BTA; 'Queen's Award for Telecom Research' 17 April 1985, HIC W04/03 Network/Cable/Fibre-Optic, BTA.
[51] Hecht, *City of Light*, 232.
[52] 'Lightlines for the Heart of London' 24 October 1983, HIC W04/03 Network/Cable/Fibre-Optic, BTA.
[53] 'Committee on Invisible Exports: Arrangements for Meetings' 1968, 7A6/1, BOE; 'City Telecommunications Committee: General Papers' 1968, 6A403/1, BOE.
[54] W.M. Clarke to P. Vermeulen, 'GPO Telex', 23 December 1968, 6A403/1, BOE; 'Second Meeting of the Telecommunications Sub-Committee' 17 February 1970, 6A403/1, BOE.
[55] W.M. Clarke, 'City Telecommunications Committee' 1974, 6A403/2, BOE.

ostensibly on the City's present and future telecommunications requirements. This change had been in the works since 1973, when some subcommittee members began lobbying for organisational reform of the Post Office, including privatisation, and the sub-committee eventually agreed it needed a more formal framework for lobbying the Post Office in order to cement London as an international financial centre.[56]

The CTC became more aggressive in its complaints to the Post Office, particularly during engineering strikes, although this also formed part of a tacit alliance against organised labour: the Post Office had informally let the CTC know that, during strikes, it welcomed complaints from the City, as it gave leverage against the Post Office Engineering Union.[57] However, once the Conservatives came to power in 1979 and preparations began for liberalisation, the CTC became much more overt in lobbying for organisational change in telecommunications. A paper authored by the Foreign Exchange and Currency Deposit Brokers' Association in August 1979, and used by the CTC, shows how the City was already planning on lobbying the government for several changes, including: liberalisation of the telephone network, allowing competing networks to be set up; liberalisation of customer premises equipment, so terminals such as telephones and other machines could be bought from third-party suppliers; a new regulatory authority to oversee the Post Office and its successor, BT; and finally, an argument against the 'integrated network', which the City felt was inherently monopolistic.[58]

BT responded to City lobbying with the London 'TeleCity' concept, proposed by Alex Reid, BT's Director of Business Systems, which fused together several projects mentioned throughout this thesis: the ISDN and X-Stream services mentioned in the previous chapter, the City optical fibre grid addressed in this chapter, and the London Teleport, which I explore in Chapter Seven.[59] The London 'TeleCity', which Reid fully acknowledged had been stimulated by pressure from the City, was announced as a break away from the 'uniformity' principle which had guided the telephone system previously, where geographical regions were treated equally by the Post Office and BT, and would instead be replaced by a system where the City was prioritised above all. The London TeleCity meant that the City would be the first to receive ISDN, X-Stream services, local

[56] 'Present Shortcomings in International Telecommunications' 26 June 1973, 6A403/1, BOE; 'London as a World Financial Centre' 22 March 1974, 6A403/1, BOE.
[57] W.M. Clarke to Francis Sandilands, 'Post Office Dispute', 17 May 1978, 6A403/2, BOE.
[58] 'Communications Services in the United Kingdom for Business Users' August 1979, 6A403/3, BOE.
[59] 'Telecommunications in the City of London: A Note on the Telecity Studies' 23 October 1980, 6A403/3, BOE.

optical fibre networks, and would get its own satellite earth station. Such a policy, Reid posited, would benefit the City, BT, and 'the National Economy'.[60]

This policy stands in contrast to planning for the microwave network, where the most visible users were the BBC and ITA television networks. London was of course the most important node in the trunk system, but neither the City's financial institutions, nor specific regions of London, such as the City, featured in any of the planning documents mentioned above, such as the UKTTF report. Instead, the BBC and ITA, the new independent television agency created in 1954, were the only significant user highlighted in plans for microwave network. Waveguide planning never reached the stage where specific users were mentioned but, given the first route was planned from Bristol to London, and given City users' dissatisfaction with international telecommunications during the 1970s, the Bristol-Reading waveguide, which would carry international traffic to and from the Post Office's submarine cable stations and satellite earth stations, could possibly be read as a sign of City prioritisation by the telephone business.

The rapid pace of fibre-optic development continued through the 1980s, and, even with the shift to prioritising data services and optical fibre in the City, video transmission still featured in other ways. By 1989, BT had installed 600,000 kilometres of optical fibre in the trunk network, and so turned its attention to the local network.[61] BT started a fibre-to-the-home trial, or 'FttH', in 1989 in Bishop's Stortford, a market town approximately thirty miles north of London, and one of the trial's novel features was the provision of broadcast TV and a 'video library', which meant that, alongside telephony and data, customers could also receive up to thirty TV channels and access a 'video library', which would allow them to play TV shows and movies stored on a remote data-bank on demand.[62] This was an advanced trial, but also not out-of-step with the ambitions of the time: similar trials were undertaken in Japan, Canada, France, and the USA from the late 1970s to the early 1990s.[63]

The Post Office's interest in providing television, along with data and telephony, over cable networks stretches back to its early integrated digital network trials in the 1960s. During these trials, telecom engineers identified that, with more advanced cables, it would be possible to provide up to nine television channels, along with voice and data,

---

[60] 'Telecommunications in the City of London: A Note on the Telecity Studies, 23 October 1980, 6A403/3, BoE'.

[61] T.R. Rowbotham, 'Plans for a British Trial of Fibre to the Home', *British Telecommunications Engineering* 8, no. 2 (1989): 78.

[62] Rowbotham, 'Plans for a British Trial of Fibre to the Home'.

[63] Hecht, *City of Light*, 219–24.

over the network; the economics at that point were unfavourable and so a lower bandwidth system had been used instead for the trials in Washington, Irvine, Craigavon, and Milton Keynes.[64] However, in the mid-1970s a review of broadcasting in the UK, the Annan Committee, reignited the Post Office's interest in providing cable TV.

Cable TV first appeared in 1951, but had been limited to a supplementary role, extending television coverage to areas with limited or no reception.[65] In 1974, Wilson's Labour government convened the Annan Committee to make a recommendation on the allocation of the fourth and final terrestrial channel with complete coverage across the UK; by this point, the rest of the available bandwidth had been allocated to BBC 1, BBC 2, and the ITA. The Managing Director's Committee for Telecommunications saw the Annan Committee, which only had one technical expert on the panel – Professor Geoffrey Sims, Head of the Electronics Department at Southampton University – as an opportunity, under the guise of technical advice, to lobby for a Post Office cable television network.[66] The Annan Committee's remit to investigate the expansion of broadcasting was interpreted within the Post Office as an opportunity to expand cable television, and it believed that, both technically and politically, it had the right to develop and administer a national cable network for television, telephony and data. The Post Office only viewed itself as the network provider, leaving 'operation' – i.e. broadcasting and programming – to actual broadcasting corporations like the BBC and ITA.[67] Merriman's evidence for the Annan Committee, submitted on behalf of the Post Office, outlined the Post Office's previous experience in cable provision in its early integrated digital network trials, and argued that 'the transmission of information was PO business', viewing a national cable television network as a means for the 'integration of a wide range of service options in the PO telecomms network'.[68] It summarised its evidence with the argument that 'present and future telecoms services, together with TV broadcasts, could most economically and conveniently be carried on a single wideband network provided by a single administration', which aligned with its existing philosophy for developing an integrated digital network. The Annan Committee, however, elected not to review cable television, but, apart from its main recommendation to set up an independent fourth broadcast

---

[64] 'Post Office Board Meeting, 24 April 1967, TCB 14/5, BTA'; 'Rationalisation of the Local Distribution Network, October 1968, TCB 54/2/45, BTA'.

[65] Ralph Negrine, 'Cable Television in Great Britain', in *Cable Television and the Future of Broadcasting*, ed. Ralph Negrine (London; Sydney: Croom Helm, 1985), 104–7.

[66] 'Managing Director's Committee: Telecommunications' 1 November 1974, TCC 55/6/178, BTA.

[67] 'Managing Director's Committee: Telecommunications, 1 November 1974, TCC 55/6/178, BTA'.

[68] 'Managing Director's Committee: Telecommunications, 1 November 1974, TCC 55/6/178, BTA'.

channel (which became Channel 4 in 1980), also recommended that, if a national cable television network was to be created, it should be provided by the Post Office.[69]

This remained the case until a flurry of cable TV reports were produced by the Thatcher government in 1982 and 1983. The first report was undertaken by Cabinet Office's Information Technology Advisory Panel (ITAP), and the BT board again lobbied the panel, keen to establish a broadband cable network for television, telephony, and interactive information services for entertainment, banking, and advertising.[70] In the short-term, BT envisioned using coaxial cable, but in the medium-term planned to use optical fibre, showing BT's nascent visions for FttH. The BT board was aware that the Thatcher government's liberalising stance meant it was incredibly unlikely that the report would recommend the creation of a publicly-owned national cable infrastructure, and so BT's board also accepted that, in the very least, a private venture partnership would be necessary, but also suggested that it would be amenable to privatisation – which was still not set in stone – if it meant that it would be able to develop a national cable network in return.[71]

The ITAP report, released in 1982, was not favourable to BT, recommending the expansion and liberalisation of cable TV so customers could receive multiple channels and interactive services from private, regional cable TV operators, and only awarded BT a limited role in setting technical standards, explicitly rejecting a publicly-funded national network operated by BT.[72] The ITAP report was, however, only advisory, and so BT lobbied the government again as a second official review into cable television, the Hunt Review, started. BT board members were particularly critical of the ITAP report's indiscrimination between cable providers and cable operators, arguing that the government needed to consider cable TV in the broader context of a national information infrastructure:

> Broadband links provided initially for entertainment TV should be seen in the context of a national strategy for developing information technology infrastructure; network configuration and technologies should be adopted which were capable of carrying broadcast TV distribution, TV narrow casting, a wide range of interactive services, two-

[69] Annan Committee, *Report of the Committee on the Future of Broadcasting*, Cmnd. 6753 (London: HMSO, 1977); 'British Telecommunications Board Meeting' 15 January 1982, TCD 16/2, BTA.
[70] 'British Telecommunications Board Meeting, 15 January 1982, TCD 16/2, BTA'.
[71] 'British Telecommunications Board Meeting, 15 January 1982, TCD 16/2, BTA'.
[72] Information Technology Advisory Panel, 'Report on Cable Systems' (London: HMSO, 1982).

way video switched services and interconnection with national and international telecommunication networks.[73]

However, again BT were ignored. The Hunt Review decided against distinguishing between cable provision and operation which mean, to the BT Board's lament, that 'the concept of a totally integrated system would not be achievable'.[74] The review also neglected BT's point that a national cable network could be used for telecommunications as well as television, and instead recommended that the government franchise out regional cable TV systems. In a compensatory gesture, the report also recommended that cable TV franchises should not provide telephony, but left the door open for data provision. However, as BT had tried to point out to the government, this latter recommendation was nonsensical as digital encoding meant it was impossible to differentiate between the transmission of voice and data.[75] The Hunt Review's recommendations, which effectively repeated the ITAP report, were formalised in a 1983 government white paper, *The Development of Cable Systems and Services*.[76] Cable networks were rolled out as regional franchises, but BT and Mercury's duopoly over voice and data was preserved, restricting the cable networks to television. The government permitted BT to participate in consortia bids for cable franchises, and successful participated in five: Aberdeen, Coventry, Ulster, Merseyside, and Westminster.[77]

These reports had not addressed optical fibre networks, and so as BT rolled out optical fibre throughout the 1980s, hope still remained to create an optical fibre 'national grid', serving every household with telephony, data, and video. Several government reports in the mid and late 1980s addressed this idea: in 1986, the Peacock Committee, ostensibly reviewing the financing of the BBC, recommended that BT ought to be permitted to construct a fibre-optic national grid for TV and telecommunications, and in 1988, two further reports – one advisory, and one representing official government policy – were released. The first, 'Optoelectronics: Building on our Investment', by the Advisory Committee on Science and Technology (ACOST) argued in favour of state funding of a national grid, whilst the second, 'The Infrastructure for Tomorrow', produced by the

[73] 'British Telecommunications Board Meeting' 27 April 1982, TCD 16/2, BTA.
[74] 'British Telecommunications Board Meeting' 26 October 1982, TCD 16/2, BTA; Hunt Report, *Report of the Inquiry into Cable Expansion and Broadcasting Policy*, Cmnd. 8679 (London: HMSO, 1982).
[75] 'British Telecommunications Board Meeting' 23 November 1982, TCD 16/2, BTA.
[76] *The Development of Cable Systems and Services*, Cmnd. 8866 (London: HMSO, 1983).
[77] Negrine, 'Cable Television in Great Britain', 117.

Department for Trade and Industry (DTI) concluded that the government should not fund a national grid.[78]

The DTI's primary reason was that to do so would promote BT over Mercury, but the report is also interesting for how it played the fibre-optic national grid against BT's commitment to the ISDN. The report argued that infrastructure policy should not only take competition between firms – such as BT and Mercury – into account, but that it should also take competition between technologies into account. The government should thus not 'pin its colours' on a particular technology.[79] The report, turning BT's own ambition for an integrated digital network against itself, drew attention to how the ISDN meant that:

> The barriers between services are crumbling (voice, vision and data are indistinguishable in digital form; films made for the cinema may receive their first showing on TV or on video-cassette). The barriers between delivery mechanisms should also crumble. The screen and telephone are oblivious to the technology that lie behind them – as are their users! Thus a call to a mobile telephone in the field of a farm might come by a satellite from Hong Kong to a Mercury dish, through a BT line onto a cellular radio system.[80]

Rendering its view of a competitive marketplace for technologies completely explicit, the report argued that by increasing the technologies available to the end user, a wide range of business opportunities would arise, allowing the market-place to determine which would succeed and which would fail.[81]

The government's rejection of FttH, amongst other influences, became entangled with the BT's metaphors for optical fibre. The 'highway' metaphor did not transition smoothly from waveguides to optical fibre – instead, a new term arose: 'Lightlines', BT's brand for optical fibre.[82] 'Lightlines' was launched in 1982 with the completion of the London-Birmingham fibre-optic link, and was used frequently over the next few years, before 'highways' began to mount a come-back in the mid-1980s, with the Nottingham-Sheffield fibre-optic link announced as a 'high-capacity, long-distance highway'. The two metaphors were eventually fused in 1988 when Lightlines were described as 'a network

[78] 'Optoelectronics: Building on Our Investment' (Advisory Council on Science and Technology, 1988); Communications Steering Group, 'The Infrastructure for Tomorrow' (Department for Trade and Enterprise, 1988), HIC 017/003/014, BTA.
[79] Communications Steering Group, 'The Infrastructure for Tomorrow', 5.
[80] Communications Steering Group, 5.
[81] Communications Steering Group, 6.
[82] 'Recent Major Events in the Evolution of British Telecom's Optical-Fibre Network', *British Telecommunications Engineering* 1, no. 3 (1982): 178–79.

of super highways of glass fibres for visual communications'.[83] There are several factors which I suggest influenced the rise and fall of 'Lightlines': the association of the highway metaphor with the failed waveguide may still have been problematic in the early 1980s, whilst the 'lightline' metaphor, conveying how optical fibres work on a more physical level than the abstract, information-oriented 'highway', may have been seen as more informative and educational. 'Lightline', as a constructed term, would also have been better suited as a brand name for the competitive marketplace, and so the DTI's rejection of a national fibre optic grid may have also contributed to Lightline's demise. Regardless, as the 1980s progressed, the re-appearance of the 'highway', used again to convey the optical fibre's high bandwidth, demonstrates that 'Lightline' was not connoting the desired meanings.

There was another, short-lived, metaphor at play in the late 1980s, already mentioned above: the fibre-optic network as a 'national grid', used in the ACOST and DTI reports, and also in press coverage of FttH. The 'national grid' was an evocative analogy with the United Kingdom's power network, known as the national grid for much of the twentieth century, and clearly attempted to draw parallels with the near-universal connectivity of the power network, as well as connoting its public ownership (the electricity market was not liberalised and privatised in the UK until 1990). However, with the government's rejection of FttH and the deregulation of the electricity market, the 'national grid' metaphor faded away, and by the early 1990s, when a spate of opinion pieces advocating government-funded FttH appeared in *The Guardian*, it was the 'highway' metaphor which took centre-stage again – this time, ironically referring to Al Gore's free market usage at the 1994 Superhighway Summit.[84]

However, by this point, BT had already transitioned the 'highway' metaphor away from FttH and applied it to ISDN, which had rolled out nationally, finally achieving the decades-long vision of a general-purpose network. BT launched its nationwide ISDN service in 1998 under the brand name 'Highway', a broadband service which enabled customers to surf the internet and use their phone line simultaneously. Highway, providing simultaneous voice and data services to its customers, was thus the culmination of Merriman's 1967 vision for a nationwide general-purpose network.

[83] 'Longest Lightlines for UK Cities', *BT Technical Review*, Autumn 1982; 'On the Lightlines...', *British Telecom Journal* 3, no. 3 (Autumn 1982): 15; '"Super" Link Installed', *British Telecom Journal* 6, no. 4 (Winter 1985): 41; 'Lightlines' 1988, TCC 474/HF 83E, BTA.
[84] Victor Keegan, 'Through a Glass Fibre Darkly', *The Guardian*, 22 May 1993; Will Hutton, 'Why Britain Is So Slow In Getting A Fibre Optic Network', *The Guardian*, 28 July 1994.

However, Highway also showed the influences of liberalisation and business markets on BT since both Merriman's speech and the participatory, democratic Post Office Tower. Highway adverts told audiences to 'find out how the business highway can help you work faster' and to 'get on the BT highway'.[85] A TV advert started with a car speeding down a road at night, before it suddenly stops, its headlights illuminating a man sitting at his desk, using both his phone and computer simultaneously. The car reverses its journey until it returns to its starting point, illuminating the word 'Drive'.[86] The advert's implication was clear: the physical, road-based journey was interrupted and reversed by a vision of a businessman making two simultaneous virtual journeys – telephonic and computerised. These adverts divorced the highway metaphor from optical fibre – and, indeed, all transmission media – altogether, and instead pitted metaphor directly against its real-life counterpart, with the message that the virtual, metaphorical, highway was superior to the material, physical highway, and that BT, in its new competitive condition, was the toll road operator. This highway was not just a highway: it was a turnpike, and it could only have been in this new political and economic environment that such a metaphor, positioning private telecommunications above public roads, would be permissible. This in turn highlights the profound changes in telecommunications which had occurred since the Post Office Tower, when the 'lighthouse' metaphor had connoted norms of democratic participatory citizenship.

Conclusion

In this chapter, I have explored the development of the transmission technologies used in the British telephone network since World War II, and related the metaphors used for these technologies to the Post Office and BT's political and economic context, as well as the telephone system's goal create a high-capacity integrated digital network.

The Post Office Tower, in Post Office publicity and sci-fi comics, was part of a 1960s scientific and technological enthusiasm, but the tower's public amenities and the 'lighthouse' metaphor show how this enthusiasm, characterised elsewhere as 'defiant modernism', was interlinked with ideals of democratic participatory citizenship. These ideals were replaced within the Post Office by expectations for a high-capacity integrated digital network, and the millimetric waveguide, an information 'highway', was presented

[85] 'Find out How the Business Highway Can Help You Work Faster.' 1998, TCE 306/PHME 33098, BTA; 'Get on the BT Highway' 1998, TCE 306/PHME 32863, BTA.
[86] 'Highway 1' 1998, TCE 305/V 99576, BTA.

as the technology to turn those expectations into reality. Whilst the waveguide failed, it embedded new ways of talking about communications technologies in the Post Office: the high modern visibility of technology in artefacts like the Post Office Tower and Highgate Wood had been replaced by a nascent information discourse, articulated in the vision of an integrated digital network, and reinforced – but ultimately not reified – by the failed waveguide.

In the 1970s, as the waveguide failed and political opportunity presented itself, attention turned to optical fibre and cable television. The former represented an alternative means to realise the integrated digital network of voice, data, and video services – 'the transmission of information was PO business' – and so cable television was added as another form of information for the integrated digital network. The telephone business's attempts to secure a nationwide cable network failed, and so optical fibre, which the Post Office and BT had taken a worldwide lead in developing, took up the mantle for a nationwide information network. After a brief flirtation with the 'Lightlines' metaphor/brand, the highway metaphor returned to again connote high bandwidth for all types of information. However, another metaphor, the 'national grid', connoting universal access, appeared when a national optical fibre network seemed viable. The 'national grid' might be considered the 'lighthouse' of the 1980s: both referred to long-established infrastructures constructed for the public good and available to all. However, where 'lighthouse' enjoyed some success in the 1960s, the 'national grid' was clearly not suited to its political environment, as the national fibre-optic grid was rejected and the metaphor's real-life counterpart, the electricity network, liberalised and deregulated not long after.

The 'highway' metaphor, in contrast, adapted to its environment. As the national fibre-optic network was rejected, ironically in favour of BT's other general-purpose network, the ISDN, 'highway' instead came to refer to BT's 1990s nationwide ISDN network, marketed to business customers and implicitly positioning privately-owned virtual networks over publicly-owned physical networks. This business orientation came after growing pressure, from the late 1970s, from financial institutions in the City of London, which organised to lobby the Post Office and BT for greater prioritisation, and Westminster for the liberalisation of the telecommunications monopoly. This resulted in BT ending its 'uniformity' policy, and using the City of London, or 'London TeleCity', as its exclusive region for rolling out new technologies: ISDN, X-Stream services, optical fibre, and Britain's first urban satellite earth station.

A recurring feature of this chapter, and the last, is the intersection of transmission technologies and the integrated digital network with monopoly and liberalisation. Eli Noam has argued that European telephone carriers' focus on ISDN from 1980 was, in part, a defensive effort to preserve control over their networks in the face of deregulatory politics, and I would argue that the longer history of integrated digital networks in Britain supports this idea of ISDN as a technology of monopoly.[87] The general-purpose integrated digital network monopolised all types of transmission in order to, as Merriman put it, counter the danger of special-purpose networks arising in the future. Merriman did not mention monopoly in his speech on 'information and control', but the threat of special-purpose networks implies competition. Competition was, however, explicitly raised, as I referred to in the last chapter, when packet-switching began development in the 1970s; Merriman argued to the Post Office's board that competition from packet-switched networks potentially obstructed the integrated digital network, and, as the domestic demand for data increased, the Post Office felt forced to provide packet-switching under the threat of deregulation lobbying from its business users. As I showed in this chapter, that was also very much the viewpoint of the City Telecommunications Committee, in which some members specifically argued that ISDN was anti-competition, reinforcing the Post Office's monopoly over all telecommunications services, and lobbied the government to liberalise packet-switched data networks and other services. Integration, in the eyes of the City's financial institutions, meant monopoly. The Post Office also appeared aware of as much when lobbying for cable television networks, viewing the transmission of all information as 'PO business'. This resurfaced with lobbying for a national fibre-optic network, where 'national grid', a metaphor of monopoly, was invoked. This metaphor was used to help BT's imagined network become reality, but ultimately failed, although BT finally achieved the general-purpose vision in the 1990s with the ISDN, when 'highway' connoted new norms of private ownership.

Imagination is also the subject of my next chapter, a history of the telephone business's Long Range Planning Department, where I explore the contrast between imaginative, inventive approaches to the future and computerised, simulated approaches. The next chapter returns to the subject of computer control which recurred through the last chapter and so, along with this chapter's greater focus on 'information', continues the history of 'information and control' in the British telephone network.

[87] Noam, *Telecommunications in Europe*, 360–61.

7 The Machine Starts

Inventions and Predictions of Computer Control and Surveillance

> Imagine, if you can, a small room, hexagonal in shape, like the cell of a bee … There were buttons and switches everywhere – buttons to call for food, for music, for clothing. There was the hot-bath button, by pressure of which a basin of (imitation) marble rose out of the floor, filled to the brim with a warm deodorized liquid. There was the cold-bath button. There was the button that produced literature, and there were of course the buttons by which she communicated with her friends. The room, though it contained nothing, was in touch with all that she cared for in the world.[1]

> We created the Machine, to do our will, but we cannot make it do our will now. It has robbed us of the sense of space and of the sense of touch, it has blurred every human relation and narrowed down love to a carnal act, it has paralysed our bodies and our wills, and now it compels us to worship it. The Machine develops – but not on our lines. The Machine proceeds – but not to our goal. We only exist as the blood corpuscles that course through its arteries, and if it could work without us, it would let us die.[2]

The above passages are from E.M. Forster's *The Machine Stops*, published in 1909.[3] *The Machine Stops* describes the story of Vashti and her son, Kuno, who live in isolation on opposite sides of the world, in rooms where their every need is provided for by a world-spanning Machine. The Machine is worshipped as omnipotent, but it eventually fails – 'the Machine stops' – and so does their underground society, although a mythical race of

[1] E.M. Forster, *The Machine Stops* (London: Penguin Classics, 2011), 1–6.
[2] Forster, 33–34.
[3] E.M. Forster, 'The Machine Stops', *The Oxford and Cambridge Review*, 1909.

surface-dwelling humans survives. *The Machine Stops* originates from Forster's concern about a modernist, mechanistic philosophy which would erode the human capacity for imagination, and is intended as an instrument of prophylaxis: note that the opening line is 'Imagine, if you can'.[4] In this chapter, I will explore both imagined and mechanical methods for inspecting the future within the Post Office's Long Range Planning Department (LRPD) and suggest that *The Machine Stops* is helpful in two regards: first, in highlighting how modes of exploring the future can performatively beget those futures. *The Machine Stops* intended audiences to use human imagination to beget a humanistic future, and I will argue that computer simulation modelled – both literally and figuratively – futures of computer control. Second, I will also suggest that *The Machine Stops* was a direct cultural influence on imagined futures narrated J.S. Whyte, the LRPD's head, to counterbalance fears of computer-controlled futures.

The LRPD has recurred through the last two chapters. The LRPD developed ALEM 6, the model used by J.S. Whyte's Operational Programming Department to oversee the modernisation of the telephone network with TXE4 exchanges. The LRPD was also the parent department for the UKTTF, which also used modelling to simulate the digitalisation of the telephone network. In this chapter, I trace the history of the LRPD from its founding in 1966 and involvement in Roy Harris' Project ADMITS, its stewardship under J.S. Whyte until 1972, through its expansion in the 1970s to address global futures, and then its re-orientation to free market futures with the creation of BT.

This chapter particularly focusses on the intersection of attitudes towards computer control with computer modelling. In the LRPD's earlier years, despite its involvement in computer modelling for UKTTF and TXE4 modernisation, both Harris and Whyte articulated inventive, imaginative futures of human control, in opposition to computerised, technological futures. However, in the 1970s, modelling within the LRPD expanded, and was reflexively applied to simulate the future of the whole telephone business: computers had thus been placed in charge of the future. Management deployed modelling to negotiate the creation of BT and liberalisation of the telecommunications monopoly, but it also formed a template for new applications of computer control and simulation to electronic surveillance.

I undertake this history in three sections: in the first, I explore the origins of the Long Range Planning Department, situating it in post-war histories of planning and

[4] Paul March-Russell, '"IMAGINE, IF YOU CAN": Love, Time and the Impossibility of Utopia in EM Forster's' The Machine Stops'', *Critical Survey* 17, no. 1 (2005): 56–71; Silvana Caporaletti, 'Science as Nightmare: "The Machine Stops" by E.M. Forster', *Utopian Studies* 8, no. 2 (1997): 32–47.

futurology, and the department's development of computer modelling for the UKTTF and TXE4 modernisation project. I also explore the attitudes to the future and computer control articulated by two senior figures from the department's early years – Roy Harris and J.S. Whyte – and relate these attitudes to debates about automation and computerisation. In the second section, I analyse the department's outward-facing turn, as it engaged with global futures of economic and energy crises, and predictions of a post-industrial revolution. I explore the growing sophistication of the department's methods, particularly as it reflexively applied computer modelling to the telephone business itself. In the final section, I explore how computer simulation and prediction became a template for predictions about computer control, and follow that up with a history of computer surveillance and simulation-as-surveillance in BT.

Imagining Futures of Machines and Men

The LRPD was founded in 1966 to advise telecommunications R&D as the Long Range Systems Planning Unit. Its creation came after the McKinsey review of the Post Office, which had recommended that more effective direction of R&D by 'commercially sound' and 'technologically complete' plans over a thirty-year timescale was needed.[5] The Highgate Wood failure, for which the Post Office had attracted criticism in *The Sunday Times* and from the SCNI, also influenced the department's creation. The Post Office's Director-General, Ronald German, answered the SCNI's criticisms by pointing out that a special new group – the Long Range Systems Planning Unit – had been formed to look at the 'broad brush' of technological development.[6]

However, to fully understand the department's creation, a longer history of planning in Britain, 'long range planning', and post-war futurology is required. 'Planning' was high on the agenda in 1960s Britain: the Conservatives created the National Economic Development Council, which I mentioned in Chapter Three, in 1962 as an instrument of economic planning, and in 1964, Labour created the Department of Economic Affairs to provide long-term planning in contrast to the Treasury's supposed short-termism.[7] This bipartisan interest in planning comes against an interest in planning

[5] 'McKinsey and Company: Progress Review with Postmaster General, 23 February 1967, POST 72/906, BPMA'.
[6] 'House of Commons. Minutes of Evidence Taken before the Select Committee on Nationalised Industries. Meeting at Post Office Research Station, Dollis Hill, 12 July 1966, POST 122/10345, BPMA', 7–8.
[7] Glen O'Hara, *From Dreams to Disillusionment: Economic and Social Planning in 1960s Britain* (Basingstoke: Palgrave Macmillan, 2007).

in Britain since at 1930s: in 1931, the think-tank Political and Economic Planning, known as P.E.P., was founded amidst a bipartisan interest in scientific, collectivist planning.[8] However, by the 1960s, concerns were voiced over whether Britain's planning was sufficiently long-term: the economist Andrew Shonfield, in his influential 1965 work *Modern Capitalism*, notably criticised the lack of long range planning in Britain.[9]

The focus on long range planning comes against the growth of futurology after World War II.[10] Long range planning, as a catch-all phrase for business and governmental futurology, was popularised by a 1964 report, 'Report on a Long-Range Forecasting Study', by the American defence and policy think-tank RAND, which outlined the Delphi method for producing forecasts of the future.[11] The journal *Long Range Planning* was subsequently founded in 1967 amidst the popularity of 'long range planning', and various futurological techniques were taken up by industry: Delphi was used by General Electric during the 1970s, whilst Royal Dutch Shell famously used another technique, scenario planning, in the early 1970s to map out strategic responses to potential oil scarcities, which were later used during the 1973 OPEC oil embargo.[12] The creation of a Long Range Systems Planning Unit, which later became the Long Range Planning Department when the Post Office was corporatized, thus came during a broader pattern of industrial interest in futurology and long range planning.

The Long Range Systems Planning Unit was Roy Harris' institutional home during his work on Project ADMITS, which I explored in Chapter Five. Harris wrote the department's founding document, *Telecommunications System of the Future*, and advocated an 'inventive' approach to the future.[13] The document outlined a series of technologies, from videophones to remote computing, for which the department would co-ordinate both research and provision; a long-range plan would allow these possibilities to be 'exploited', whilst also allowing for unexpected demands from telephone service users. The assumptions of R&D's limitless inventive capacity, enshrined within these

[8] Arthur Marwick, 'Middle Opinion in the Thirties: Planning, Progress and Political "Agreement"', *The English Historical Review* 79, no. 311 (1964): 285–98.
[9] Andrew Shonfield, *Modern Capitalism: The Changing Balance of Public and Private Power* (London: Oxford University Press, 1965).
[10] Jenny Andersson, 'The Great Future Debate and the Struggle for the World', *The American Historical Review* 117, no. 5 (2012): 1411–1430.
[11] T. J. Gordon and Olaf Helmer, 'Report on a Long-Range Forecasting Study' (Santa Monica, CA: RAND Corporation, 1964).
[12] Gill Ringland, *Scenario Planning: Managing for the Future* (Chichester; New York: John Wiley & Sons, 1998), 16–21; Ron Bradfield et al., 'The Origins and Evolution of Scenario Techniques in Long Range Business Planning', *Futures* 37, no. 8 (2005): 799–800.
[13] 'Telecommunications System of the Future' 1967, TCB 662/1, BTA.

plans, are perfectly encapsulated by Harris' sentiment that 'the prime purpose of planning was to invent the future, not to predict it'.[14] Harris' turn of phrase here echoes the Hungarian-British electrical engineer Dennis Gabor's expression 'the future cannot be predicted, but futures can be invented', which appeared in his 1963 popular science book, *Inventing the Future*.[15] Perhaps coincidentally, Harris and Gabor both attended the Imperial College information theory symposia in the early 1950s, and Gabor later collaborated with the Research Department on computer simulation of human speech compression.[16]

The department's inventive approach to the future is evident in its reports on Viewphone, an early videophone trialled by the Post Office in 1969. I briefly addressed Viewphone in Chapter Four and Chapter Five, where I drew attention to its recurrent appearance in plans for the integrated digital network. The Viewphone was a desk-top terminal with a 7" x 5½" screen and loud-speaking telephone for two-way speech and vision, and LRPD reports concluded that it would have vast potential in the business world as part of a wideband vision/data/fax network – the integrated digital network. It was believed that, with rising income, growing business advantages, and the 'continuing advance in technological capability', it was 'virtually certain that demand for a viewphone service will arise in the future'.[17] The Viewphone was a key technology in Harris' *Telecommunications System of the Future*, and featured in a 1969 promotional R&D video, *Telecommunications Services for the 1990s*.[18]

The LRPD's visions for Viewphone were heavily influenced by AT&T's Picturephone, which I explored in the previous chapter. Both Picturephone and Viewphone reified their respective designers' visions of future national needs for integrated networks of voice and video communication. Picturephone's failure thus did nothing to dent the Post Office's confidence: the LPRD's report on Picturephone suggested that it had failed not because it was fundamentally flawed, but because the public were simply not ready for video telephony.[19] The LRPD's view was that, given video telephony's huge potential and the impending saturation of the normal telephone

---

[14] Harris, *Automatic Switching in the UK*, 16.
[15] Dennis Gabor, *Inventing the Future* (London: Secker and Warburg, 1963), 207.
[16] 'Computer Simulation of Professor Gabor's Speech Compression System' December 1966, TCB 422/21230, BTA.
[17] 'Long Range Studies Report 8: A Marketing and Technical Appreciation of Viewphone' 1969, TCC 252/8, BTA.
[18] *Telecommunication Services for the 1990s* (The Post Office, 1969), https://www.youtube.com/watch?v=EUcF_OuV19k; 'Telecommunications System of the Future, 1967, TCB 662/1, BTA'.
[19] 'Long Range Studies Report 11: Picturephone - The American Motivation' 1969, TCC 252/11, BTA.

market, the Post Office could not afford to wait for commercial pressures and public demand, and that preparatory work should therefore start immediately.[20] Viewphone development subsequently continued throughout the 1970s, culminating in a poor trial in 1976, after which it was quietly shelved.[21] These reports on Picturephone and Viewphone showcase the LRPD's inventive approach to the future: its reports concluded that the Post Office did not need to wait for externalities like public demand, but should instead create futures of video telephony.

The department's inventive approach was not just about engineering ingenuity, but was also used to articulate ideas about the social ordering of man and machine. J.S. Whyte joined the Post Office from Treasury O&M in 1969 to take charge of the LRPD, which had been upgraded from the Long Range Systems Planning Unit upon the Post Office's corporatisation in 1969. The department's shift from a small R&D advisory unit a fully-fledged department, headed by another Treasury O&M man like Merriman, is perhaps indicative of a growing appreciation within the Post Office for long range planning. Whyte, as I have addressed, would go on to become Director of Operational Programming, overseeing network modernisation, and would then succeed Merriman as Engineer-in-Chief and Board Member for Technology, but for now I will explore his time at Long Range Planning.

Whilst at the LRPD, Whyte voiced concerns, at various future-minded events and in a range of publications, about the dangers of machine control. Whyte urged that 'machines must not be permitted to erode the dignity of man', and titled one paper *Telecommunications in the Service of Man* – inviting the question of what the alternative might be.[22] On a proposed radio-tracking and paging system, Whyte said, 'We are progressively raising serious questions of the invasion of privacy and the community will have to make basic decisions about the extent to which it desires to move in this direction'.[23] Whyte most explicitly articulated his views at a 1969 conference, *City in the Year 2000*, on the future of post-industrial cities, which included eminent speakers such as Ray Pahl, sociologist of post-industrial communities; the public health expert Alexander Macara, who would go on to chair the British Medical Association; John

[20] 'LRSR 11: Picturephone - The American Motivation, 1969, TCC 252/11, BTA'; 'LRSR 8: A Marketing and Technical Appreciation of Viewphone, 1969, TCC 252/8, BTA'.
[21] 'The Viewphone Trial - Questionnaire Results' 1976, TCC 23/563, BTA.
[22] 'Long Range Studies Report 19: City in the Year 2000' 1969, TCC 252/19, BTA; 'A Panorama of Telecommunications in the Year 2000' 1970, TCC 274/2, BTA; 'Changing Characteristics of Telecommunications and Their Influence Upon Society' 1970, TCC 274-3, BTA; 'Telecommunications in the Service of Man' 1971, TCC 274/4, BTA.
[23] 'LRSR 19: City in the Year 2000, 1969, TCC 252/19, BTA'.

Dennis Carthy, the biologist and prominent BBC science communicator; and Meredith Thring, fuel scientist, mechanical engineer, and future co-author (with Eric Laithwaite, the creator of maglev transportation) of the 1977 popular science book *How to Invent*.[24]

Whyte spoke on the future of telecommunications and how it would affect social life, narrating a 'bleak mechanistic prospect' where automation and communications networks would degrade humankind:

> There seems to be no reason in principle why we should not envisage the fully automated situation in which the individual need rarely leave his home but merely manipulates the knobs and dials and screens around him in order to obtain his education, conduct his business, do his shopping and get his entertainment. This bleak mechanistic prospect is unacceptable because it pays no regard to the fundamental nature of man, and his indispensable need to interact with other men and seek self-fulfilment … If men are to have any hope of controlling their own destiny, they must attempt to reduce the gap between our explosively growing technological capability and our lack of understanding of its social consequences.[25]

Whyte's 'bleak mechanistic prospect' bears considerable resemblance to *The Machine Stops*. In both, the main character never needs leave their home because of the knobs, buttons, and dials which control their environment, and both have screens through which they can communicate. Whyte's story also expresses similar concerns to Forster's, as Whyte laments the mechanistic prospect's ignorance of humanity's need for sociability and self-fulfilment. Whyte never explicitly references Forster, but I would suggest a connection is likely, beyond the similarity of language and intent: three years earlier, on October 6th, 1966, the second series of BBC's *Out of the Unknown* premiered on BBC 2 with an adaptation of *The Machine Stops*, which featured on the front cover of the *Radio Times*, was praised highly in *The Times* and awarded first prize at the Fifth International Science Fiction Film Festival.[26]

Whyte's motivation to warn of machine-controlled dystopias can be contextualised against a longer history of concerns about machine control within and outside the telephone business. In Chapter Three I explored how the rollout of GRACE, the 'robot telephone operator', could be contextualised against post-war concerns about automation. However, Whyte's dystopias were not just about automation: both his

---

[24] M.W. Thring and E.R. Laithwaite, *How to Invent* (London; Basingstoke: Macmillan, 1977).
[25] 'LRSR 19: City in the Year 2000, 1969, TCC 252/19, BTA'.
[26] Mark Ward, *Out of the Unknown: A Guide to the Legendary BBC Series* (Bristol: Kaleidoscope, 2004), 172.

concerns about radio-tracking and the 'bleak mechanistic prospect' concern the intrusion of technology into domestic private life.

Mechanisation had increasingly been linked with privacy in the late 1960s and early 1970s. Alan Westin's influential 1967 book, *Privacy and Freedom*, warned of the new, and often technological ways, of invading man's 'fundamental' right to privacy.[27] Devices to monitor and locate individuals, such as the radio-trackers highlighted by Whyte, but also CCTV, phone taps, and video telephony were all noted as threats to privacy, alongside the newer threat of the computer revolution, which would permit surveillance of individuals' data, held in electronic data banks controlled by computers. Westin was subsequently invited to present evidence to the Younger Committee, Britain's first large-scale official study of privacy.[28] The Younger Committee's 1972 report highlighted the threats of mass communication and computerised record-keeping systems and data banks, underscoring the historical consensus that 'by the early 1970s the computer had become cast as a threat to privacy'.[29] Whyte's concerns regarding privacy thus have a common thread with earlier concerns over automation: in both cases, the Post Office was responsible for developing technologies intimately linked with societal concerns, and so Whyte's dystopias represent a natural evolution from the labour-driven 'machines must be servants' to the privacy-driven concerns about computers which might 'erode the dignity of man'.[30]

There is a somewhat contradictory dynamic here between Whyte's public concerns about machine control, and the Post Office's various visions and applications of computer control: Harris' plans for an adaptable, dispersed system of computerised telephone exchanges, Merriman's vision of a computer-controlled, self-governing, self-healing network, and Whyte's supervision of computer model development for the UKTTF and TXE4 exchange modernisation. This latter activity, as I explored in Chapter Four, particularly surfaced resistance to computer control as Plessey and GEC both took issue with the idea that decision-making had been handed to computer models, even though Whyte argued that the model served a purely advisory function. There appears to be a tension between Whyte's fears about the 'bleak mechanistic prospect' and his development of computer models used to inform Post Office decision-making. In the

[27] Alan F. Westin, *Privacy and Freedom* (London: Bodley Head, 1967).
[28] *Report of the Committee on Privacy*, Cmnd. 5012 (London: HMSO, 1972).
[29] Agar, *The Government Machine*, 360; David Vincent, *The Culture of Secrecy: Britain, 1832-1998* (Oxford; New York: Oxford University Press, 1998); Colin J. Bennett, *Regulating Privacy: Data Protection and Public Policy in Europe and the United States* (Ithaca; London: Cornell University Press, 1992).
[30] 'LRSR 19: City in the Year 2000, 1969, TCC 252/19, BTA'.

remainder of this section, I therefore explore two case-studies of the LRPD's modelling activity under Whyte in order to reconcile these two attitudes to computerisation.

ALEM 6, the model used to simulate TXE4 modernisation, started out as a three-part study at the LPRD, 'A Review of Premature Obsolescence and Depreciation Policy', in 1970. The first study explored how the Post Office should assess depreciation policies for premature obsolescence, i.e. determining which equipment was most likely to go obsolete ahead of time and, if so, when would be ideal to replace it. The report made the fairly self-evident conclusion that assets vulnerable to premature obsolescence should be depreciated at a faster rate, but also highlighted the inadequacies of conventional accounting techniques for making such assessments.[31] The second study took a broad overview of various at-risk telecommunications equipment, and concluded that the outdated electromechanical Strowger exchanges were the highest priority for depreciation.[32]

The third and final study combined the conclusions of the two to apply more sophisticated techniques – computer modelling – to simulate the optimal rates of depreciation and replacement of Strowger exchanges.[33] The model simulated depreciation over a thirty-year period, from 1971 to 2000, starting with the present system size and calling rate, and setting Strowger exchanges at various levels of historical depreciation. The costs for depreciation and replacement were then simulated at varying rates of replacement, and every simulation strategy found that replacing Strowger with a hypothetical electronic exchange would be economically cost-effective, although a fast strategy was favoured. Various assumptions were used in the model – for example, that electronic equipment would have a normal life of thirty years, and the model also incorporated the UKTTF simulation's predictions of rapid network expansion – but the critical, important, assumption for my purposes here is that the hypothetical replacement electronic exchanges had the same cost and traffic capacity as had been quoted to the Post Office by STC for TXE4. The model therefore justified a strategy of replacing Strowger as quickly as possible, but only on the assumption that Strowger was replaced with a hypothetical exchange identical to STC's TXE4, rather than GEC and Plessey's Crossbar exchange.

31 'Long Range Studies Report 16: A Review of Premature Obsolescence and Depreciation Policy - Part 1' 1970, TCC 252/16, BTA.

32 'Long Range Studies Report 17: A Review of Premature Obsolescence and Depreciation Policy - Part 2' 1970, TCC 252/17, BTA.

33 'Long Range Studies Report 18: A Review of Premature Obsolescence and Depreciation Policy - Part 3' 1970, TCC 252/18, BTA.

These reports, which were still at this point theoretical studies undertaken under the auspices of long range planning, were considered by the Managing Director's Committee for Telecommunications in July 1970, which Whyte was invited to attend.[34] The committee noted that the models favoured replacing Strowger as quickly as practicable, but requested that Whyte further develop the model to incorporate the feasible production of replacement electronic exchanges, the possible reuse of displaced Strowger, and the physical constraints of building and manpower availability. It was also requested that the next model exclude areas of the network already earmarked for Crossbar upgrades, which reinforces the idea that the model assumed that the Post Office would choose TXE4, but does also suggest that Crossbar had been simulated in previous studies and so had not been entirely ignored.[35] The committee also requested that the Operational Programming Department liaise with Whyte to examine the potential for using the model in practice, showing an early interest in the operational, rather than theoretical, uses of the model.

A fourth study was thus commissioned to incorporate the requests of the Managing Director's Committee. The new model found that 'very rapid modernisation is the ideal course', showing that, even with the requested considerations, TXE4 would be much more cost-effective than Strowger, based on anticipated maintenance costs.[36] The study was completed by December 1970 and the Managing Director's Committee subsequently met in January 1971, endorsing the model's conclusions, and determined that the model should be passed onto the Operational Programming Department.[37] Whyte subsequently delivered a presentation on the model to the Post Office Board in April 1971, who 'thanked Mr Whyte for his clear and comprehensive presentation of the telecommunications business proposals for exchange equipment', and approved the purchase of TXE4 telephone exchanges for the modernisation of the telephone network.[38] Whyte and his model had made it to the highest levels of the Post Office and contributed to one of the corporation's most important procurement decisions of the 1970s. The model was handed over to the Operational Programming Department and, later that year, Whyte was appointed Director of Operational Programming. The Post Office published its TXE4

[34] 'Managing Director's Committee: Telecommunications' 31 July 1970, TCC 55/2/113, BTA.
[35] 'Long Range Studies Report 25: A Review of Premature Obsolescence and Depreciation Policy - Part 4' 1970, TCC 252/25, BTA.
[36] 'LRSR 25: A Review of Premature Obsolescence and Depreciation Policy - Part 4, 1970, TCC 252/25, BTA'.
[37] 'Managing Director's Committee: Telecommunications' 8 January 1971, TCC 55/3/11, BTA.
[38] 'Post Office Board Meeting' 26 April 1971, TCC 15/4, BTA.

modernisation plans in September 1971, in turn triggering the controversy with its manufacturers which took place across 1972, as discussed in Chapter Five.

There are some intermediary points I wish to make before moving onto explore further modelling activity in the LRPD. An overview of ALEM 6's origins shows that, from the outset, it assumed that TXE4, or a theoretical exchange identical to TXE4, would replace Strowger. In this sense, the model did not have, as Weinstock protested in 1972, decision-making capacity – it did not change the Post Office's base preferences for the electronic TXE4 over the electromechanical Crossbar – but the model also built on those assumptions and affected how certainly and quickly the Post Office selected and rolled out TXE4. The Managing Director's Committee for Telecommunications and the Post Office Board's reception of the model, as well as the Post Office's manufacturing partners, all show that the model supported a surprisingly fast timeline which caused the Post Office, as I showed in Chapter Five, to order TXE4 quickly and in large numbers. There are parallels here with Viewphone: in both instances, the LRPD selected a technology to 'exploit', studied the different ways to develop and roll out that technology, and informed Post Office decisions for those technologies, thus inventing its futures instead of predicting them.

This inventive approach was also apparent in another LRPD modelling study, albeit a study which bore no fruit. In 1969, the LRPD commissioned a report into morphological modelling, which had been developed at the California Institute of Technology by Swiss astrophysicist and aerospace scientist Fritz Zwicky, known both as the first person to infer the existence of dark matter, and the father of the modern jet engine.[39] Morphological analysis was not a forecasting model, but rather a problem-solving approach for technological development. Morphological analysis had five steps:

1. The problem which is to be solved must be exactly formulated.
2. All of the parameters which might enter into the solution of the given problem must be localised and characterised.
3. The morphological box or multidimensional matrix which contains all the solutions of the given problem is constructed.
4. All of the solutions which are contained in the morphological box are closely analysed and evaluated with respect to the purpose which are to be achieved.

[39] 'Long Range Studies Report 21: A Morphological Approach to Telecommunications System Modelling' 1969, TCC 252/21, BTA; Tom Ritchey, 'Problem Structuring Using Computer-Aided Morphological Analysis', *Journal of the Operational Research Society* 57, no. 7 (2006): 792–801.

5. The best solutions are being selected and are carried out, provided that the necessary means are available. This practical application requires an additional morphological study.[40]

Two key features of morphological modelling are that it works backwards and is non-numeric. In most models, input variables are defined and the model runs a simulation; with morphological modelling, the problem is defined first, and the model identifies conflicts between various input parameters to solve the problem. For example, in Zwicky's analysis of jet engine development, one parameter was travel medium – atmosphere, ocean, or subterranean – and another was intake medium – gaseous, liquid, or solid. The model would identify conflicts between parameters, such as between gaseous intake and subterranean travel. This example also shows that the qualitative nature of parameters meant that non-technical, or social, parameters could be introduced. Zwicky encouraged this in his books on morphological modelling, and saw it as a major asset of his approach: 'One of the major tasks of morphological research therefore is to establish the morphological box of all human values and to recognise their various characteristics'.[41]

The LRPD undertook a report into morphological modelling shortly after Zwicky's publications. Ostensibly, the Post Office's interest was only in its technological applications, but its potential to use computers to incorporate human values into long range planning was seen as instrumental: 'it represents the beginning of an attempt in the field of long term planning to exploit the potential power of a system combining human judgement with the ability of the computer to apply rigid logic according to defined roles in complex situations'.[42] The LRPD's report proposed the creation of an auxiliary, non-technical, list of parameters, for modelling alongside technical parameters. A planning matrix for data processing also shows how the LRPD embedded its high expectations for Viewphone within technical parameters: the prospects of digital speech compression were deemed 'doubtful economic prospects unlikely to improve' whereas the prospects of digital video compression were deemed 'of possible importance in Viewphone field'.[43]

---

[40] Fritz Zwicky and Albert George Wilson, *New Methods of Thought and Procedure* (New York: Springer-Verlag, 1967).
[41] Zwicky and Wilson, 297; Fritz Zwicky, *Discovery, Invention, Research: Through the Morphological Approach* (New York: Macmillan, 1969).
[42] 'LRSR 21: A Morphological Approach to Telecommunications System Modelling, 1969, TCC 252/21, BTA'.
[43] 'LRSR 21: A Morphological Approach to Telecommunications System Modelling, 1969, TCC 252/21, BTA'.

The appearance of Viewphone suggests a reason for the LRPD's interest in morphological modelling. Morphological modelling worked backwards from a defined output, and combined non-numeric statements describing technical and social parameters, and so it was effectively an alternative, computerised method for 'inventing the future'. Morphological modelling was not taken up – the cost of computerisation was deemed too high – but it nevertheless highlights the LRPD's openness to new methods of planning which would preserve its inventive approach to the future.

These case-studies show how Whyte's public warnings of machine control can be reconciled with the LRPD's internal uses of computer modelling. Modelling during this period was entirely consistent with the departmental philosophy that the future 'should be invented, not predicted': the ALEM 6 and UKTTF models were not used to predict the future, but instead supported, as I have shown in this chapter and Chapter Five, the Post Office's decisions to roll out certain technologies – TXE4 and digitalisation – across the network. In both cases, modelling was used to simulate the financial implications of different strategies, not to dictate to the Post Office which technologies to roll out. This approach is also consistent with Whyte's previous history in Treasury O&M, where, as Agar has shown, expert mechanisers like Merriman and Whyte undertook extensive programs of mechanisation, but did so in carefully-couched language to avoid the implication that machines had taken over decision-making responsibilities from generalist executives.[44]

Whyte's defence that ALEM 6 'cannot of itself come to conclusions or take decisions' perfectly fits this strategy, and I would suggest that Whyte's warning of the 'bleak mechanistic prospect' was a transmutation of this strategy for the Post Office and LPRD. Within the Post Office, Whyte was no longer an office mechaniser, but instead part of an organisation that – as had been established by Harris and Merriman in 1967 – intended to insert computer control throughout the telephone network at a time of deepening concern about computers, telecommunications, and privacy. Whyte's language thus changed to reflect these concerns: as Merriman and other Civil Service expert mechanisers avoided the implication that government mechanisation would transform government into a machine, whilst proceeding to do exactly that, so Whyte explicitly combatted the idea that network computerisation would transform the network itself into a giant computer. However, as I shall show in this chapter's final section, computer modelling's capacity for simulation and prediction was extended to the telephone network

[44] Agar, *The Government Machine*, 293–343.

in the 1980s and beyond. Before that, I will first explore the LRPD's predictive turn during the 1970s, and show how computer modelling was reflexively turned to study the Post Office corporation itself.

Competition and Diversity are Ideas of the Future

In the early 1970s, the inventive attitude of the LRPD shifted to a more predictive and outward-facing mode of future-making. Where previously the department had invented telecommunications futures, it moved to forecasting broader social and economic futures. This shift came from two different influences: the first was *The Limits to Growth*, an influential 1972 report published by the Club of Rome, a think tank formed in 1968 to draw attention to issues requiring global action.[45] *Limits* was based on a form of computer modelling known as 'system dynamics', developed by the computer engineer Jay Forrester at MIT. Three models were developed for *Limits*, known as World1, World2, and World 3. Forrester's work formed the direct basis for the World1 and World2 models, whilst the Club of Rome's research team at MIT, headed by management researcher Dennis Meadows, refined World2 into World3. The models simulated the interaction of five variables – world population, industrialisation, pollution, food production, and resource use – and the report concluded, from the World3 model, that there would be an 'overshoot and collapse' of society by the end of the 21st century.[46] The Club of Rome thus called for a halt to population and economic growth, and its report received significant popular attention.[47]

The second influence was Britain's 1973-74 energy crisis, which had resulted from an oil embargo by OPEC, the consortium of oil exporting nations, in October 1973, and a domestic strike by the National Union of Mineworkers which had slowed domestic production of coal. Together, these forced Ted Heath to introduce a three-day work week to conserve energy in December 1971. The energy crisis impacted the telephone network – the board initiated a Telecommunication Energy Conservation Programme as a result, and the LRPD studied the potential for nuclear-powered telephone exchanges in the event

[45] Donella H. Meadows et al., *The Limits to Growth* (New York: Universe Books, 1972); see the following for an overview of the Club of Rome, the Limits to Growth, and its reception: Elodie Vieille Blanchard, 'Modelling the Future: An Overview of the "Limits to Growth" Debate', *Centaurus* 52, no. 2 (2010): 91–116; Elke Seefried, 'Towards The Limits to Growth? The Book and Its Reception in West Germany and Britain 1972–73', *German Historical Institute London Bulletin* 33, no. 1 (2011): 3–37.
[46] Meadows et al., *The Limits to Growth*.
[47] Vieille Blanchard, 'Modelling the Future'; Seefried, 'Towards The Limits to Growth?'

of future crisis[48] – and was compounded by the economic restraints already placed on the Post Office in the early 1970s. This combination of economic restraints, energy crisis, and the three-day week meant that telephone growth dropped severely, declining by 50% for long-distance calling.[49]

The influence of the combined energy and economic crises, and the intellectual contribution of *Limits*, appear in the LRPD's first Long Range Economic Forecast, 'Economic Consequences of Energy Scarcity'. This 1974 report directly responded to *Limits* and explored the potential consequences of the OPEC oil embargo, synthesising forecasts from other think tanks and policy units, such as the University of Sussex's Science Policy Research Unit, with the Post Office's own analyses.[50] The report emphasised that its main concern was long-term developments, not transient crises, but also admitted that 'short-term events are not, however, entirely irrelevant to the study of the longer term. In particular, transient shortages of petroleum products may well stimulate early economic, social and technological adaptations which would otherwise have come much more slowly through the operation of market forces'.[51] OPEC was mentioned as a potential cause of such crises. The report dismissed *Limits*' gloomy predictions of a total collapse to society, but concluded that a long-term energy problem was nevertheless likely to occur. The report's main emphasis was that, to weather this inevitable energy problem, more sophisticated long-term planning was needed in business and government: 'our cautiously optimistic interpretation of the situation in the 1990s rests on an assumption of far-sighted long term planning by business and government; the importance of such planning cannot be stressed too strongly'.[52]

This increased importance of long-range planning crystallised within the LRPD as an expansion of futures research. There were further Long Range Economic Forecasts on material scarcities, which also explicitly referred to *Limits* in their conclusions that there was no impending crisis, but rather a slower long-term increase in the costs of maintaining and expanding resources.[53] In particular, the 'extremely favourable' long

---

[48] 'Post Office Report and Accounts' 1979, TCC 11/10, BTA; 'Long Term Economic and Technological Trends' 1974, TCC 55/6/33, BTA.
[49] 'Post Office Report and Accounts' 1974, TCC 11/5, BTA.
[50] 'Long Range Intelligence Bulletin 1: Long Range Economic Forecasts: The Economic Consequences of Energy Scarcity' 1974, TCC 90/1, BTA.
[51] 'LRIB 1: Long Range Economic Forecasts: The Economic Consequences of Energy Scarcity, 1974, TCC 90/1, BTA', 5.
[52] 'LRIB 1: Long Range Economic Forecasts: The Economic Consequences of Energy Scarcity, 1974, TCC 90/1, BTA', 6.
[53] 'Long Range Intelligence Bulletin 7: Long Range Economic Forecasts: Long Term Materials Scarcities' 1976, TCC 90/7, BTA.

term prospects for aluminium were highlighted, which may have informed the Post Office's experiments with aluminium, rather than copper, local telephone networks in the late 1970s.[54] The department also expanded its personnel to employ information scientists, statisticians, sociologists, and psychologists.[55] The LRPD also developed collaborations: with the Civil Service Departments of Management Science and Operations Research, the LRPD launched and supported the Communications Studies Group at University College London, which conducted research throughout the 1970s into the effectiveness and impact of advanced forms of person-to-person communications, such as teleconferencing.[56] The department also had a name change to match, becoming the Long Range Intelligence Division (although for brevity's sake I will continue to refer to it as the LRPD).

Another telling change was the introduction of Long Range Social Forecasts, which reveal the Post Office's continuing expectations for computerisation and an information revolution. In these social forecasts, Joan Glover, the department's sociologist, performed quantitative analyses of customer interviews and questionnaires in order to predict changes in the world of work and forecast changing attitudes to working from home and telecommuting.[57] Glover concluded that, in the future, professional and managerial workers were more likely to work from home, and that if clerical workers did so too, it would likely be under tight remote supervision. Attention was also drawn to the role of machines in changing professional structure, with the new century's work characterised as the 'co-ordination of people and machines to produce knowledge' in contrast to the last century, where 'people and machines were co-ordinated to produce goods'.[58] Glover concluded that the distinction between manual and clerical work was slowly being eroded, and that this may lead to shifting social status for clerical workers.

These social forecasts showcase a much more expansive and academic orientation. They were situated in academic literature, citing Max Weber, Michael Young, Anthony Giddens, Peter Hall, Georges Friedmann and Peter Berger on the nature of work, family, leisure, cities, and alienation. They also showed the continuing influence

[54] 'Cable Procurement' 1979, TCC 304/591, BTA.
[55] 'Long Range Intelligence Division, Post Office Telecommunications Headquarters: Information Scientist', *New Scientist*, 28 February 1974.
[56] 'Long Range Research Report 14: Research at the Communications Studies Group, 1970-1977' 1977, TCC 92/14, BTA.
[57] 'Long Range Intelligence Bulletin 2: Long Range Social Forecasts: Working from Home' 1974, TCC 90/2, BTA; 'Long Range Intelligence Bulletin 8: Long Range Social Forecasts: Attitudes to Work' 1975, TCC 90/8, BTA.
[58] 'LRIB 8: Long Range Social Forecasts: Attitudes to Work, 1975, TCC 90/8, BTA'.

of futurology, citing reports from the Institute of the Future, a futurology think-tank spun off from RAND in 1968, and *The Year 2000: A Framework for Speculation on the Next Thirty Years*, a highly influential futurological text by Herman Kahn and Anthony Wiener, the former of whom had worked at RAND and developed the scenario planning methodology famously used by Shell.[59]

However, perhaps the greatest influence was Daniel Bell's *The Coming of Post-Industrial Society: A Venture in Social Forecasting*, published in 1973, a year before these social forecasts were produced.[60] I outlined Bell's work in Chapter Two and will briefly restate it here. Bell argued that society was becoming post-industrial in two ways: first, that knowledge, or information, rather than matter, would be the primary resource upon which society would operate for economic growth; second, that the computerisation of society would transform the world of work. Bell's ideas about the applications of computerisation and telecommunications to work pervade these social forecasts, particularly in the idea that automation would re-order class by turning clerical labour into the post-industrial society's equivalent of manual labour. Another noteworthy feature of these reports is that the mechanistic threat to privacy and labour was invisible: instead, machines were used to remotely supervise clerical staff and re-ordered labour and class hierarchies. The broad power of computerisation was increasingly tacitly accepted, which, along with the 1970s' turbulent economic climate and the influence of *Limits to Growth*, partly explains the LRPD's next change: the reflexive computerisation of planning.

Computer modelling, as I have shown, had been used previously, but in 1977, the department introduced its first corporate model, the Long Range Planning Model (LRPM), which simulated the future of the telephone business itself. The model was developed in collaboration with the Department of Control and Management Systems at the University of Cambridge, and Cambridge's lead developer, David Probert, was subsequently employed as Head of Strategic Modelling to further integrate modelling into the telephone business.[61]

[59] 'LRIB 2: Long Range Social Forecasts: Working from Home, 1974, TCC 90/2, BTA'; 'LRIB 8: Long Range Social Forecasts: Attitudes to Work, 1975, TCC 90/8, BTA'; Herman Kahn and Anthony J. Wiener, *The Year 2000: A Framework for Speculation on the Next Thirty-Three Years* (New York: Macmillan, 1967).
[60] Bell, *The Coming of Post-Industrial Society*.
[61] David Probert, 'Systems Dynamics Modelling within the British Telecommunications Business', *Dynamica* 8, no. 2 (1982): 69–81.

The model, like the World models of *Limits*, was based on Jay Forrester's system dynamics, which had started life as 'industrial dynamics', whilst Forrester was at MIT.[62] Forrester was recruited by the MIT School of Industrial Management in 1956 to develop a new industrial management programme, and it was during this time that he developed industrial dynamics.[63] Industrial dynamics was not designed as a tool for specialist forecasters, but as a conceptual foundation and heuristic guide for managers to understand the industrial systems they managed, through the representation of system variables as input-output loops and feedback signals.[64] William Thomas and Lambert Williams thus argue that industrial dynamics was not a computerised managerial problem-solving system, but rather a conscious attempt to develop a pedagogy for managers and management students.[65] Thomas and Williams point out the critical assumption in this approach: the model, as a representation of the industrial system, is also a representation of the model builders' assumptions and ideologies about the system, and so its pedagogy can also imbue those assumptions into management. Industrial dynamics was a popular corporate modelling methodology: Clarke and Tobias argue that it was the major innovation in corporate modelling of the 1960s, and was notably used by the Sprague Electric Company, and extensively used in the textiles and leather industries.[66]

Reflecting its lineage from industrial dynamics, the LRPM did not predict global futures like the World models of *Limits*, but instead predicted corporate futures. The LRPM was written in FORTRAN, about 5,000 statements in length, based on an IBM 3033 time sharing system, and took about 5-10 seconds of CPU time to execute a thirty-year forecast.[67] It had over three hundred input parameters, which were mapped onto four conceptual modules: marketing, which included parameters such as aggregate demand and supply; personnel, including, for example, the mobility of Post Office manpower; finance, with comprehensive details of current and capital accounts; and last but not least, technology, which included prosaic parameters such as equipment volumes, but also parameters mapping the rollout of new technologies, such as rate of optical fibre development.[68] When a simulation was run, a cluster of up to ten parameters would be

---

[62] Jay Wright Forrester, *Industrial Dynamics* (Cambridge, MA: MIT Press, 1961).
[63] William Thomas and Lambert Williams, 'The Epistemologies of Non-Forecasting Simulations, Part I: Industrial Dynamics and Management Pedagogy at MIT', *Science in Context* 22, no. 2 (2009): 245–70.
[64] Jay Wright Forrester, 'Industrial Dynamics', *Harvard Business Review* 36, no. 4 (1958): 37–66.
[65] Thomas and Williams, 'The Epistemologies of Non-Forecasting Simulations, Part I'.
[66] Clarke and Tobias, 'Complexity in Corporate Modelling', 20–21.
[67] David Probert, 'The Development of a Long-Range Planning Model for the British Telecommunications Business: "From Initiation to Implementation"', *The Journal of the Operational Research Society* 32, no. 8 (1981): 695–719.
[68] 'Strategic Modelling in British Telecom' 1982, TCD 278/PR 42, BTA.

altered and the effects tracked in up to one hundred and eighty different variables which gave a picture of the company's finances, equipment needs, total manpower, and so on.

Unlike the predictive forecasts of energy, materials, and social futures, the LRPM was intended to stimulate management thinking about a variety of possible futures. Probert described how the LRPM was not used to predict a singular corporate future, but to generate a range of alternative futures for management to 'expand our own "mental models"'.[69] Several types were simulated: the 'uncontrollable future', a predetermined future for which the model would identify the resources needed to execute short-term plans; the 'designed future', which simulated 'considerable freedom in controlling the corporate destiny'; the 'self-fulfilling future', which assumed that a designed future would achieve 'full implementation'; and finally, the 'future as a game', which blended the above types to convey to management that the future would in reality be an outcome of conflict between various corporations, each attempting to effect its own designed future and each influenced by inertia and historical trends.[70] The basic premise was that the model was not intended to represent or simulate a singular ideal future, but instead inform management's business plans and projections through the 'generation of alternative futures'.[71] Nevertheless, in the expansion of computer modelling, from early technology strategy to reflexive simulations of the corporate future, envisioning the future had been further ceded to computers.

The model's development continued with the addition of a new program in 1979, the Strategic Control Unit (SCU). The SCU permitted the simulation of corporate crises, such as 'economic recession and severe constraints on tariff increases,' and the likely ability of the corporation to recover from such crises, by 'spiking' certain groups of policies, called macro-policies.[72] The SCU would assign target values to thirteen key indicators of corporate performance, and, once the crisis was initiated, the LRPM would simulate corporate performance during the crisis, whilst the SCU would prioritise normalisation of the thirteen key indicators over other variables. A full run of the simulation would thus show the impact of disaster on the corporation and how the corporation would fare if certain facets of the business were prioritised over others. The deployment of the SCU went beyond mere simulation of crisis and paths to recovery: the

---

[69] Probert, 'The Development of a Long-Range Planning Model for the British Telecommunications Business', 704.
[70] Probert, 696.
[71] Probert, 700.
[72] B.M. Allenstein and D.E. Probert, 'A Strategic Control Module for a Corporate Model of British Telecom', in *Forecasting Public Utilities*, ed. O.D. Anderson (Amsterdam: North-Holland, 1980), 43.

Copyright Material Removed

Figure 7.1. The relationship between management and modelling.

SCU was also envisioned as charting paths for managers to follow to recovery during disaster.[73]

It is this notion – that modelling could not only simulate the effects of future crises, but also chart paths to recovery – which is particularly revealing. Modelling had become more than a method for simulating alternative futures: it was also a resource to consult within those futures to change corporate direction and strategy. This reliance on the SCU is shown in Figure 7.1, from a paper published by Probert, where management and the SCU are depicted on equal footing, and corporate objectives are determined from a dialogue between the two.[74] The name 'Strategic Control Unit' renders visible the contrast between modelled and invented futures: computers had not just been handed control over the making of futures, but within those futures also.

A new model, the Integrated Communications Demand Model (ICDM), started development in 1980, in preparation for the creation of BT and liberalisation. The ICDM embraced the liberalisation of telecommunications through a greatly enhanced marketing module, which simulated market share and competing companies, although not to the

[73] Allenstein and Probert, 'A Strategic Control Module for a Corporate Model of British Telecom'.
[74] Allenstein and Probert, 43.

same degree of detail as BT itself was simulated.[75] The ICDM could thus simulate the effect of changing market share on both BT and its competition, enabling the corporation to better chart its passage through the murky waters of the free market. The ICDM is superficially a similar concept to the SCU: a way of modelling and charting the organisation through an uncertain, turbulent period. However, with the SCU, these futures were concerning, composed of disaster and crisis; with the ICDM, the futures of the free market and competition were not framed through risk, but through opportunity. This is most clearly seen in a visualisation of the model's predictions of future economic and organisational change, captioned with the quote that 'competition and diversity are ideas of the future' (Figure 7.2).[76] The liberalised corporate future was not something to fear, but something to leverage.

The ICDM played a further important role during liberalisation in educating managers about competition and the market. Probert undertook a campaign to use modelling to educate middle management on market dynamics; this came at a time when BT's board had expressed concerns about the attitudes of middle management to liberalisation and competition.[77] In this sense, the ICDM here can be seen as a return to Forrester's industrial dynamics, where modelling was not a tool to predict the future, but a pedagogical tool for managers to understand the systems they worked within. Probert wrote articles for company magazines and journals, produced brochures, and arranged presentations, seminars, and drop-in clinics.[78] He also designed the ICDM to be manager-friendly, with a colour graphics interface and display menu which would allow the presentation of simulations 'in a neat and compact manner which is acceptable to management'.[79] Coloured curves, bar charts, and numerical values could be manipulated in various ways to facilitate a management-friendly output of the model's analyses; these were not seen as gimmicks, but instead as necessary for enrolling managers in use of the model. Probert wrote that 'the extent to which managers are prepared to entertain model-based approaches is significantly affected by the 'friendliness' of the interface'.[80]

---

75 '"Strategic Modelling in British Telecom", 1982, TCD 278/PR 42, BTA'; C.F. Doubleday and D.E. Probert, 'The Development of an Integrated Communications Demand Model for the British Telecommunications Business', *The Journal of the Operational Research Society* 36, no. 12 (1985): 1083–93.

76 Probert, 'The Development of a Long-Range Planning Model for the British Telecommunications Business', 697.

77 'Telecommunications Board: Arrangements for Liberalisation' 25 November 1980, TCC 59/1, BTA.

78 Doubleday and Probert, 'The Development of an Integrated Communications Demand Model for the British Telecommunications Business'.

79 Doubleday and Probert, 1087.

80 Doubleday and Probert, 1092.

Copyright Material Removed

Figure 7.2. ‘Competition and diversity are ideas of the future’.

Probert undertook this marketing campaign not only to showcase the value of modelling, but also to spread the ‘ideas of the future’ – competition and the free market – to middle managers: ‘Using the model to demonstrate to a manager the implications of the high degree of uncertainty associated with, say, a demand elasticity for a new service can be a valuable stimulus to more flexible thinking on the questions of market demand’.[81] Probert had thus ‘marketed’ the ICDM in more ways than one: first, in the simplistic sense of advertising its use to management; second, in the sense that the model had been progressively ‘marketed’ from the LRPM and SCU through the incorporation of free market principles into its code; and finally, in the sense that the model was used to ‘market’ management by encouraging the adoption of free market sensibilities.

This latter point is particularly important. The ICDM was initially developed as an input for the business’s long term financial plans, but there is no evidence it was ever used at this level, or by any of BT’s senior management. Instead, what can be found is Probert’s reports of using the model to educate middle management about competition and liberalisation, which, as I shall show in Chapter Nine, tallies with the wide range of tactics used by BT’s senior management to overcome potential resistance from middle

[81] Doubleday and Probert, 1092.

management and lower staff to liberalisation. Middle management were particularly relied on to enrol their teams in liberalisation, and so I would argue that the ICDM was not about whole-heartedly embracing liberalisation, but was instead a technique to maintain internal control during a period of profound organisational change. This corresponds with the Chandlerian view of the managerial corporation, in which managerial strategies were not used to cede control to the market, but instead to develop internal strategies and structures to maintain control within the market. Modelling did not mean embracing the market, but, as I will suggest in the next section, it had important consequences for the futures of computer control in the telecommunications network.

From 1980 to *Nineteen Eighty-Four*

The idea that modelling was about computer control, rather than the market or other externalities, is reinforced by Probert's hypothetical – but seemingly incomplete – ambition to follow up the ICDM with expert systems, rather than further modelling. Expert systems – artificial intelligences used to emulate the decision-making capacity of an expert – enjoyed a vogue during the 1980s, and Probert saw a common lineage from the SCU to expert systems. Probert described that the SCU had incorporated 'intelligence' into the LRPM, so that the SCU became 'a substitute user and hence a primitive form of expert system'.[82] Probert predicted that in the future, all executive managers' offices would come fitted with an expert system for policy analysis, which would replace the specialist modeller who the manager would ordinarily have consulted.[83] The expert system would be 'essentially a representation of the "mental model" of the specialist'.[84] With enough decision-making experience, these expert systems would eventually come to contain mental models of executive managers themselves.

At first glance, this may seem a curious campaign on Probert's part, deploying expert systems to, in effect, replace his job and the jobs of other specialist modellers within BT. However, it also extends the 'government machine' strategy which I have previously explored with Merriman and Whyte. Probert, using the same language of specialists and generalists, planned that specialist modellers, soon to be replaced by computers, would instead become generalists by synthesising their ability to educate

[82] David Probert, 'Towards Expert Systems for Telecommunications Policy Analysis', *Computer Communications* 6, no. 2 (1983): 59.
[83] Probert, 'Towards Expert Systems for Telecommunications Policy Analysis'.
[84] Probert, 62.

management on models and expert systems with knowledge from other fields. The modeller would need to be an 'interdisciplinary "non-specialist" spanning fields such as operational research, economics, behavioural studies, technology, accountancy besides many others', which would enable the 'multi-functional corporate planner' to create 'the corporate synthesis within the long term design'.[85] Interdisciplinarity, in this context, was an avenue by which the specialist could become a generalist, moving from one managerial problem to another.

Probert's plan for expert systems highlights two aspects of the computing culture within long-range planning and BT. First is that the language of the government machine, of mechanisable specialists and executive generalists, still had considerable sway. These ideas were not just invoked once, by Merriman in his 'information and control' speech, but recurrently, by Merriman, Whyte, and even Probert, who had no background in government mechanisation. Second is that computer modelling had been positioned in a lineage of computerised intelligence and decision-making. Probert spoke about expert systems and the SCU in terms of their decision-making capacity, and this uses the same language as Whyte's defence of ALEM 6 that 'the model cannot of itself come to conclusions or take decisions'. Clearly there is a difference between Whyte and Probert's positions, but it should also be noted that one position was a defence of modelling to external partners, whereas the other position was a hypothetical future of expert systems. Moreover, over a decade had passed between the two arguments, between which, as I have shown above, notions of transformative computer control, as articulated by the likes of Daniel Bell, had become much more commonplace.

The commonality between Whyte and Probert is that computer modelling was not framed by its subjects – exchange modernisation, corporate planning, competition and the free market – but instead by its decision-making capacity, echoing Merriman's description of the 'self-governing, self-healing' telephone network. Merriman's description contrasted with the Post Office's earlier declaration that 'machines must be servants not masters', and this change intensified with the use of computer modelling in long-range planning: a new language surrounding the future took root following the use of corporate modelling. In contrast to the idea, in the department's early years, that the future should be 'invented', computer models were instead described as 'scanning' the future. The idea that long-range planning had become an act of observing the future, rather than inventing it, also accompanied the re-organisation of the department during

[85] Probert, 'The Development of a Long-Range Planning Model for the British Telecommunications Business', 696.

Figure 7.3. The Business Planning and Strategy Department's new logo. Courtesy of BT Archives.

the creation of BT. Long-range planning was amalgamated with business planning and the Business Planning and Strategy Department (BPSD) was created. The BPSD was also given a logo: an all-seeing eye, gazing into the temporal distance (Figure 7.3).[86] This language and imagery, which had accompanied the expansion of modelling within long range planning, suggest that the future, in contrast to its active invention in the early years of planning, had been objectified by the gaze of computer modelling. 'Scanning the future' and the BPSD's logo were the linguistic and aesthetic realizations of the perceived power of computer modelling. Computer modelling, by the creation of BT, entangled the idea of computers as intelligent decision-makers, and the idea of computers as predictive surveillance machines.

[86] 'The Demand for Residential Information Services' 1981, TCC 75/2, BTA.

The idea that computer prediction and simulation constitutes a form of surveillance is not new. William Bogard argues that simulation is a form of '*hypersurveillant control* … the effort to push surveillance technologies to their absolute limit. That limit is an imaginary line beyond which control operates, so to speak, in "advance" of itself'.[87] Simulation, deployed in settings such as military training, ecological science, road engineering, and corporate marketing, constitutes surveillance of battlefields, ecosystems, traffic, and customers ahead of time, predicting the actions of real processes by displacing them with virtual counterparts.[88] In this view, the ICDM could be interpreted as a way of putting BT's new competition, such as Mercury, under hypersurveillance in order to exert pre-emptive control. Stephen Graham and David Lyon have both pointed out, however, that Bogard's Baudrillardian characterisation of virtual processes entirely displacing their actual counterparts, reducing hypersurveillance to control by and of signs and symbols alone, is a form of social essentialism, and that his analysis insufficiently integrates the idea of simulation-as-surveillance with empirical detail.[89]

Nevertheless, Graham and Lyon both also find good reason to analyse simulation as a form of surveillance. Graham establishes an empirical basis for the concept through a range of case-studies: supermarket loyalty cards, when combined with electronic sales data, are used to simulate and anticipate consumer spending behaviour; speeding camera algorithms on the M1 are used to flash potentially dangerous drivers' number plates on large neon signs; rail stations use 'smart' CCTV cameras to warn commuters of platforms at risk of over-crowding. Graham concludes, in contrast to Bogard, that the ways in which these simulations create complementary virtual selves, and their disconcerting applications to corporate and state interests, necessitates an analysis which does not divorce actual and virtual, but instead shows how the virtual influences the actual.[90] Lyon reads simulation-as-surveillance as potentially indicative of a transition from modernity to postmodernity. Lyon argues that, in a Weberian mode, surveillance constitutes modernity through its facilitation of organisational influence, management and control over its subjects, and suggests that the increasing use of simulation, a polycentric,

---

[87] William Bogard, *The Simulation of Surveillance: Hypercontrol in Telematic Societies* (Cambridge: Cambridge University Press, 1996), 4.
[88] Bogard, 3–4.
[89] Stephen Graham, 'Spaces of Surveillant Simulation: New Technologies, Digital Representations, and Material Geographies', *Environment and Planning D: Society and Space* 16, no. 4 (1998): 486; David Lyon, 'Surveillance Technology and Surveillance Society', in *Modernity and Technology*, ed. Thomas J. Misa, Philip Brey, and Andrew Feenberg (Cambridge, MA: MIT Press, 2003), 176–78.
[90] Graham, 'Spaces of Surveillant Simulation', 496.

Table 7.1. Major delegates at BT's Long Range Strategy Seminar, November 1980

Attendee	**Organisation**	**Position**
Sir George Jefferson	BT	Chairman and Chief Executive
Peter Benton	BT	Managing Director
Sir George MacFarlane	BT (formerly TRE, MinTech, and NPL)	Board member
J.S. Whyte	BT	Engineer-in-Chief (replaced Merriman in 1978)
J.M. Harper	BT	Deputy Managing Director: Inland Telecommunications
Charles May	BT	Director of Research
Roy Harris	BT	System X Director
Alex Reid	BT	Director of Business Services
J.J. Wheatley	BT	Head Economics Adviser
Jim Hodgson	BT	Deputy Chairman and Managing Director: BT International
G.G. Scarrott	ICL	Research Manager
Philip Sadler	Ashridge Management College	Principal
Professor Marvin Sirbu	MIT Center for Policy Alternatives	Research Associate and Professor of Electrical Engineering
Dr Bill Robinson	London Business School (formerly at No. 10 and HM Treasury)	Senior Research Fellow

computerised, partially predictive, mode of surveillance, might be construed as indicative of a shift away from a centralised, bureaucratic modernity of control over labour, to a polycentric, consumerist postmodernity of pre-control over consumers.[91]

Lyon's account is not wholly convincing – it takes more than decentralisation, consumerism and computerisation to propose a transition from modernity to postmodernity – but he does valuably draw attention to simulation as an 'idolatrous dream of omniperception' and here, at least, he agrees with Bogard, who characterises

[91] Lyon, 'Surveillance Technology and Surveillance Society', 161–62.

simulation as an 'imaginary of surveillant control'.[92] Simulation's power, in addition to the empirical applications which Graham rightly devotes attention to, is also in its imaginary allure. Combining this allure with empirical examples, I will now explore actors' interpretations and enactments of computer simulation and prediction as surveillance amongst BT's senior management.

In November 1980, the BPSD organised a Long Range Strategy Seminar for senior management to prepare for liberalisation, competition, and the formal establishment of BT.[93] The seminar took over two days, and attended by twenty-eight senior figures from inside and outside BT (see Table 7.1). This was an important seminar for BT and the BPSD, and it highlights the extent to which the computer capacity for intelligence, prediction, and observation had become embedded within BT's senior management.

An early presentation by Charles May, BT's Director of Research, placed computer intelligence and surveillance centre-stage. May argued that advances in computer intelligence would diminish the need for human engineers:

> The tremendous advances in computer power and versatility will be harnessed so that, as time goes by, the need for these people – particularly software people – diminishes. One rather heretical idea sometimes occurs to me: if computers and control equipment are generally getting so cheap and so fast is there any point any longer in trying to program them optimally? Couldn't an intelligent machine program itself well enough?[94]

May also explained the benefits computerised surveillance for global tracking of users' whereabouts:

> I believe there are about 6 thousand million people in the world ... I see no problem of keeping track of them all so that the international telephone system - already the most elaborate and complex thing man has ever created - can find and call anyone in the world wherever he may be.[95]

A discussion including May, George MacFarlane and Roy Harris discussed the potential for a heuristic machine-controlled network which could shape users and predict their demands and desires:

[92] Lyon, 176; Bogard, *The Simulation of Surveillance: Hypercontrol in Telematic Societies*, 4–5.
[93] 'Into the 21st Century: Proceedings of a Long Range Strategy Seminar' 1980, TCC 75/1, BTA.
[94] 'Into the 21st Century, 1980, TCC 75/1, BTA', 4.
[95] 'Into the 21st Century, 1980, TCC 75/1, BTA', 8.

> Although it is argued that technology is only justified if it serves people and that it should not be self-perpetuating, the increasing power and complexity of machines shapes people's demand and desires. Human desire for information is not random: the assembly and accessing of databases reflects users' interests and heuristic machines will judge what individual users are most likely to want to know.[96]

The machine capacity for observation and prediction had transcended modelling and entered speculation over the potential for computers to monitor and predict users' information requests, which was further extended to suggest that BT could be 'involved in the selection and manipulation of that information; there is potential for moulding society by selecting the contents of the databases'.[97]

The negative connotations of predictive computer control over society were not ignored. The destruction of human labour by intelligent machines was admitted as a 'heretical idea', whilst 'ethical problems' were also noted in using predictive computer databases to mould society.[98] The dystopian science fictions of George Orwell and H.G. Wells were deployed to distinguish BT's utopias from sci-fi dystopias. Charles May, on his global computer tracking proposal, distanced himself from the 'big brother' approach and argued that, so long as users could opt-out from such a system – a 'god-given right' that he, 'as a technologist, would defend to the death' – it would be permissible to enact global surveillance.[99] Meanwhile, J.J. Wheatley, BT's Head Economics Adviser, labelled dystopic interpretations of surveillance and computer control as the 'politics of the pessimists', which lazily deployed cultural references such as the 'dictatorship of technology' of Wells' *The Shape of Things to Come* and 'the enslavement by the information society' of Orwell's *Nineteen Eighty-Four*.[100]

Superficially, *The Shape of Things to Come* and *Nineteen Eighty-Four* seem natural touchstones for discussions about the negative consequences of computer control and surveillance. However, a closer reading of both reveals that these science fictions were distorted in ways which further highlights the internalisation of computers as surveillance and control technologies amongst BT's senior management.

In *The Shape of Things to Come*, published in 1933, the world disintegrates after years of heavy bombing during a second world war, and a benevolent dictatorship is set

[96] 'Into the 21st Century, 1980, TCC 75/1, BTA', 19.
[97] 'Into the 21st Century, 1980, TCC 75/1, BTA', 103.
[98] 'Into the 21st Century, 1980, TCC 75/1, BTA', 4, 103.
[99] 'Into the 21st Century, 1980, TCC 75/1, BTA', 8.
[100] 'Into the 21st Century, 1980, TCC 75/1, BTA', 23; H.G. Wells, *The Shape of Things to Come* (London: Gollancz, 2017); George Orwell, *Nineteen Eighty-Four* (London: Penguin Books, 2003).

up by the technocratic airmen, who use their control of aircraft, the world's only surviving means of transport, to promote science, laying the path for utopia, which eventually arrives in the form a world-state. *The Shape of Things to Come* is thus neither an unambiguous dystopia nor even a dictatorship of technology: the novel follows a Wellsian convention also appearing in *The War in the Air*, *The World Set Free* and *Men Like Gods* where societal collapse is a necessary pre-condition for the emergence of utopia, and moreover, it is not technology which rules the world, but the scientists and technocrats which command that technology.[101]

Similarly, the Orwellian framing of surveillance in *Nineteen Eighty-Four*, as David Lyon notes, has its limitations.[102] *Nineteen Eighty-Four's* Oceania is a violent society with a centralised state, neither of which fit the deployment of computerised modelling during the liberalisation of telecommunications, which distanced the use of modelling, along with its connotations of machine surveillance, from the state. Moreover, its modes of surveillance are visible and low-tech – cameras, telescreens, bugging devices – in contrast to the invisible and informational modes of surveillance characterised by BT's proposed computer monitoring and data manipulation. As Krishan Kumar notes, even *Nineteen Eighty-Four*'s innovations – telescreens, speakwrite, inkpens – are small adjustments of contemporaneous technologies – television, dictaphones, and biros.[103] Charlotte Sleigh argues that *Nineteen Eighty-Four*'s over-riding message is the utopian potential of scientific, empirical observation: Winston Smith, *Nineteen Eighty-Four*'s main character, holds on to his ability to observe empirical truths in the face of state propaganda, whilst O'Brien, Winston's primary antagonist and Inner Party member, proudly proclaims that the state shall eventually 'have no more need of science'.[104] As Kumar points out, *Nineteen Eighty-Four* is thus not a simple dystopia, but a message that utopia can be attained, or anti-utopia avoided, through scientific, empirical, observation.

The Shape of Things to Come was thus misleadingly invoked as a 'dictatorship of technology' because BT's senior management had internalised the idea of intelligent computer control, whilst *Nineteen Eighty-Four* was referred to because of its underlying theme of empirical observation, which corresponded to the perception of computer modelling and prediction established by long-range planning. Wheatley's reference to the

---

[101] Krishan Kumar, *Utopia and Anti-Utopia in Modern Times* (Oxford: Basil Blackwell, 1987), 221–22.
[102] David Lyon, *The Electronic Eye: The Rise of Surveillance Society* (Cambridge: Polity Press, 1994), 57–80.
[103] Kumar, *Utopia and Anti-Utopia in Modern Times*, 296.
[104] Charlotte Sleigh, *Literature and Science* (Basingstoke: Palgrave Macmillan, 2011), 48–49; Orwell, *Nineteen Eighty-Four*, 306.

'dictatorship of technology' in *The Shape of Things to Come* could thus only be made if computer control had been tacitly accepted as part of BT's future. May and Wheatley's selection of *Nineteen Eighty-Four* for its connotations of informational surveillance, and their neglect of its violence and physicality, further highlights how the idea of computer observation and prediction had permeated BT's senior management. In doing so, they betray how the connotation of being watched and controlled, with its roots in intelligent computer models 'scanning' the future, had predisposed them to select cultural icons – Wells' *The Shape of Things to Come* and Orwell's *Nineteen Eighty-Four* – which thematically mirrored their perceptions of computers as predictive machines of observation and control.

The computer's capacity for control and surveillance were also linked to BT's new neoliberal political environment. Wheatley envisioned how computerisation would enable the neoliberal state:

> There could be a convergence of computing and communication technology, with "small government" aspirations:
>
> - Small is beautiful
> - Small is cheaper
> - Large is unnecessary
> - Devolution gets government closer to people
> - Small is anti-bureaucratic[105]

This vision of political liberalism was also joined by another neoliberal tenet: individualism. May's proposal for a global computer tracking system came in the context of his belief that mobile telephony would liberate individuals from 'the tyranny of the local line':

> I am convinced that the next generation of businessmen - or perhaps the next but one - is going to want a truly universal pocket telephone accessible through the nation-wide cellular mobile radio scheme I mentioned earlier. This would completely release him from this "tyranny of the local line" and enable him to make and receive calls wherever he happened to be.[106]

This contradictory fusion of computer control and liberation continued as the LRPD's earlier social forecasts of the future of work returned. Work and lifestyles would be transformed by the rise of the 'electronic office', as 'new technology will provide vast

[105] 'Into the 21st Century, 1980, TCC 75/1, BTA', 24.
[106] 'Into the 21st Century, 1980, TCC 75/1, BTA', 7.

opportunities for wealth creation and individual self-realisation', which would restore 'the importance of the individual'.[107] It is not hugely surprising to see popular neoliberal ideas – individualism and small government – articulated at a senior management retreat dedicated to preparing for the liberalisation of BT. The creation of BT and the liberalisation of telecommunications were direct and popular consequences of neoliberal policies, and, as I expand on in Chapter Nine, BT's senior management had needed little convincing of Thatcher's plans to liberate the corporation from governmental financial controls.

It does seem unusual that BT management saw political, economic, and individual liberalism as best achieved through various means of computer control. However, this also is not unexpected: various scholars have shown how, in the late 1970s and early 1980s, cyberculture and neoliberalism fused to produce 'digital utopianism', an ideology that the tenets of neoliberalism – liberal economics, individualism, and a small state – were best achieved through digital networked computing, which, through online communities and electronic marketplaces, would facilitate individuality and free market liberalism.[108] Within this discourse, it makes sense that BT's senior management would have viewed computer control as a means of achieving various registers of liberalism, although, as I will argue in Chapter Nine, the British vein of digital utopianism, in which BT's privatisation played a significant role, has been an under-appreciated component of digital utopianism. However, digital utopianism also dangerously obscures disquieting registers of computer control. I previously said that I would show how BT's senior management had enacted computer control and simulation-as-surveillance in both their imaginations and in reality: having shown the former, I now turn to the latter.

In Chapter Five, I described System X as enacting computer control through automatic operator services and automation of engineering labour; but System X also enabled unprecedented electronic surveillance of telecommunications users in the United Kingdom. A 1998 report to the European Parliament's Scientific and Technological Options Assessment Unit described System X's dual role in Britain: first, that it would route telephone calls, and second, that it would permit telephones to be used as listening devices.[109] Built into System X from the ground-up was the ability to take phones 'off-

---

[107] 'Into the 21st Century, 1980, TCC 75/1, BTA', 60.

[108] Richard Barbrook and Andy Cameron, 'The Californian Ideology', *Science as Culture* 6, no. 1 (1996): 44–72; Fred Turner, *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism* (Chicago: University of Chicago Press, 2006).

[109] Steve Wright, 'An Appraisal of Technologies of Political Control' (Luxembourg: Scientific and Technological Options Assessment Unit, European Parliament, 1998).

the-hook' and listen to conversations happening nearby the phone.[110] System X – which was also sold to Russia and China – was directly integrated into the ECHELON network used by the 'Five Eyes' (Australia, Canada, New Zealand, the UK, and the USA) party to the UKUSA surveillance agreement. The new computer switching technologies developed by BT enabled 'routine' and 'indiscriminate' interception of communications data, which, when combined with mobile telephones, provided a 'custom built mobile track, tail and tap system par excellence'.[111] Charles May, BT's Director of Research, was thus startlingly prescient when, in November 1980, he speculated that, in the future, there would be no foreseeable technical barrier to tracking all six billion people around the world – except, in reality, there is no opt-out from ECHELON.

BT also deployed simulation-as-surveillance on at least two separate occasions. The first instance comes in an experiment that BT Labs conducted with MIT and the supermarket chain Marks and Spencer in 1995. BT installed facial recognition software in an M&S store which was networked with a database of known shoplifters.[112] The software would then identify, via CCTV, potential shoplifters, at approximately 90% accuracy, and alert store security, who could either monitor shoplifters or remove them ahead of any actual crime. The simulation of suspects' virtual selves was used to target their actual selves, and it should be noted that, at only 90% accuracy, one in ten would not have prior criminal records, let alone future criminal records. BT also undertook further simulation-as-surveillance between 2006 and 2009 in conjunction with the online advertising company Phorm.[113] BT passed its internet service subscribers' browsing data to Phorm, which analysed customers' data for keywords; the frequency of certain keywords was used to model customers' future purchasing interests, so BT and Phorm could sell individually-targeted adverts on partner websites in anticipation of a customer's purchase. In 2008, it emerged that Phorm and BT had conducted two trials without customers' knowledge or consent, and that this instance of simulation-as-surveillance had in fact broken British wiretapping laws.[114] BT subsequently broke off its relationship with Phorm in 2009, but it is important to note that these instances are merely the publicly-known episodes, and are also by no means limited in the telecommunications sector to BT. In 1995, Mercury used a simulated map of its network to predict, based on past calling

---

[110] Wright, 19.
[111] Wright, 19.
[112] Robin McKie, 'Never Mind the Quality, Just Feel the Collar', *The Observer*, 13 November 1994.
[113] Christopher Williams, 'BT and Phorm: How an Online Privacy Scandal Unfolded', *The Telegraph*, 8 April 2011, http://www.telegraph.co.uk/technology/news/8438461/BT-and-Phorm-how-an-online-privacy-scandal-unfolded.html.
[114] Williams.

data and regional concentration, 'whether the revenues it gets from its infrastructures justifies the costs', or, as Mercury also put it, 'The level of information we're getting now has enabled us to question almost all our relationships with customers'.[115] In the mid-1990s, Bell Atlantic in the USA developed a computer simulation for its video-on-demand system, similar to BT's FttH trial outlined in the previous chapter, which monitored movies watched, predicted future movie rentals and other product interests based on viewing history, and targeted individual consumers accordingly.[116] These examples may all sound familiar because they are the systems upon which the modern internet is built: websites like Amazon, Facebook and Netflix all use forms of simulation to predict future interests and activities in order to serve up content which keeps consumers watching and buying. Simulation is surveillance, and this was a fact which BT had been aware of since at least 1980.

Conclusion

In this chapter I have drawn together many parallel threads from the history of the telephone network through the lens of the Post Office's Long Range Planning Department and its successor, BT's Business Planning and Strategy Department. I explored the department's early history, relating its inventive approach to the future, which surfaced both in its reports on technologies like Viewphone and its uses of computer modelling, to concerns, both within the department and outside the Post Office, about the impact of computerised telecommunications on privacy and dignity. In the early 1970s, long range planning became more expansive and sophisticated in the wake of global futurological reports about societal collapse and energy and economic crises. This was reflected in the development of economic and social forecasts, the hiring of new expertise, and uses of academic theories, particularly Daniel Bell's post-industrial society, to understand and re-interpret the Post Office's own plans for a computer-controlled telecommunications network.

Corporate computer modelling also started development during this period, and gradually moved from simulations designed to enhance management's 'mental models' of the future to simulations which would take over from management in the event of crisis and were used to control middle management responses to liberalisation during the creation of BT. The model of computer control demonstrated by these simulations, which

[115] Paul Bray, 'A Map That Fills in the Gaps', *The Guardian*, 2 February 1995.
[116] Graham, 'Spaces of Surveillant Simulation', 489.

were accompanied by the idea that computer models could 'observe' the future, reinforced ideas about computer control and surveillance in the telephone network. These fused with broader ideas about computerisation and neoliberalism to produce a vision of the telecommunications network which would monitor and predict telecommunications users as a form of liberation. I have suggested that this model of computer control and simulation-as-surveillance eventually filtered through to applications of surveillance and simulation by BT with System X, Marks & Spencer, and Phorm, and was used elsewhere in telecommunications, as evidenced by Mercury and Bell Atlantic's uses of simulation.

This chapter thus speaks to 'control' as one of this thesis' organising concepts. Information was not completely invisible in this chapter – reports on Viewphone and post-industrial society show that long-range planning also explored information age futures – but computer control, both as an instrument of tyranny and of liberation, was clearly at the forefront of many of the LRPD and BPSD's ideas. In a sense, this chapter is thus a counterpart to Chapter Five, which focussed on the technological development of computer control within the telephone network from Merriman's 'self-governing' system and Harris' Project ADMITS to its reification in System X. In this chapter, I have looked at less central applications of computer control – Whyte's experimental obsolescence model, investigations of morphological modelling, the development of corporate models, and visions of expert systems and simulation – and contextualised these against changing cultural conceptions of computerisation, from privacy fears, to post-industrial society, and digital utopianism. I opened this chapter with quotes from *The Machine Starts*, Forster's performative effort to prevent a mechanistic future. I think a history of the Long Range Planning Department shows that computer modelling here was also performative, computerising the future and in turn begetting computerised futures.

As this chapter explored similar themes to Chapter Five, so does the next chapter for Chapter Six. In the next chapter, I return to the development of the 'information discourse', and explore its intersection with the technologies and environments of transatlantic communications.

8 The Single World System

Submarine Cables and Communication Satellites from the Cold War to the Information Age

In 1988, British Telecom ran an advert to promote their international communication services. 1988 was the same year that TAT-8, the first fibre-optic transatlantic cable, was laid between the USA, Britain, and France. The advert opens with a shot of an empty business office, a desk and chair on the right, and a computer terminal on the left. A businessman picks up a Filofax and begins to dial his telephone. The camera pulls out to reveal that the shot is coming from outside the businessman's office window. The camera pulls out further until all London – including BT Tower – are in view, and carries on pulling out: the UK, Europe, until, finally, Earth, floating in space. A communications satellite flies in front of the camera, momentarily obscuring the view of Earth, until the camera, quickly, begins to zoom back in – this time, to an office in Manhattan, New York. Another businessman picks up his phone and answers the call. A closing title card shows 'British Telecom International', and a voice-over says, 'It's you we answer to' – an acknowledgement of British Telecom's privatisation in 1984, advertised as 'A public company goes public'.[1]

One year later, in 1989, AT&T, the American telephone operator, also ran an advert promoting their international communication services. This advert, in contrast to BT's, mentioned TAT-8, with an early sequence early in the commercial showing the cable laying. However, using imagery similar to BT, the AT&T advert opened and closed with a shot of the earth from space. After the cable-laying sequence, the advert shifted to AT&T's new information services, through which customers could access the 'worldwide

[1] *British Telecom International... It's You We Answer To* (BT, 1988), https://www.youtube.com/watch?v=WIDrUsx1Tf8.

intelligent network'. This sequence was interspersed with images of computers and space age motifs, from satellites and earth stations to a NASA-style communications and telemetry control centre, culminating with a phone call with the space shuttle. The advert's closing title card contained AT&T's slogan, 'The right choice' – a nod to AT&T's divestiture in 1982, in which the company was broken up into regional telephone providers and the American telephone network opened to competition.[2]

These adverts prompt important questions: why, having just laid the most significant transatlantic communications cable in thirty years, were BT and AT&T deploying satellites and other space-age motifs in their adverts for international communications? Why, in both adverts, were satellites and computers juxtaposed? Finally, how were the privatisation and divestiture of BT and AT&T entangled with this international communications discourse? In this chapter, I will explore how communication satellites obscured submarine cables and became part of an information age discourse articulated by BT and AT&T.

In the first section, 'Conquering the Atlantic', I will explore AT&T and the Post Office's collaboration on the first transatlantic telephone cable, TAT-1, laid in 1956. In the second section, 'Hostile Environments', I will look at the history of the Telstar communications satellite, operated by AT&T, and Goonhilly Earth Station, the Post Office's earth station built in 1962 to communicate with Telstar. In the third section, 'The Single World System', I will explore the expansion of satellite communications by INTELSAT, the international communications satellite organisation, of which the Post Office was the second-largest owner, and focus on the ways in which INTELSAT presented communication satellites, particularly in relation to submarine telephone cables. Finally, in the fourth section, 'Cables Orbit Satellites', I explore the development of submarine cables in the 1970s and 1980s, highlighting the influence of satellites and environmental pressures on cable development, and then return to the marketing of international communications, highlighting the entanglement of communication satellites, the information age, and BT and AT&T's organisational changes in this discourse.

This chapter also addresses two areas of communications history which have received remarkably little attention: the dynamic between submarine communication cables and communication satellites, and their environmental histories. The history of submarine communication cables has predominantly explored the technical histories of

---

[2] *AT&T's Universal Telephone Service* (AT&T, 1989), https://www.youtube.com/watch?v=KklN1DCRmCU.

submarine telegraphy before World War II, although John Tully and Nicole Starosielski have both recently devoted attention to cables' environmental histories.[3] Starosielski also explores the post-war history of cables, mainly in the Pacific, and notes that satellites have overtaken cables as a symbol of global communications, although she does not explore satellites' rise to prominence. Likewise, communication satellite histories tend not to include submarine cables or satellites' environment, but rather focus on the early history of space communications, including the formation – but not later history – of INTELSAT, although Lisa Ruth Rand has recently drawn attention to environmental concerns about satellites as 'space junk', whilst James Schwoch has briefly explored the Cold War interplay of cables and satellites, but only in TV transmission.[4] This chapter thus explores the dynamic between submarine cable and satellite communications, whilst following Helen Rozwadowski and Roger Lanius' respective calls to pay more attention to the history of the ocean and space environments.[5] This chapter is therefore not only about the rise of the information discourse in the context of transatlantic communications, but about how that discourse was built upon increasingly discreet registers of environmental control. I will draw attention to these forms of environmental control, starting with TAT-1, the first transatlantic cable, where the hazardous undersea environment played a significant role not only in the cable's design, but also in the rhetoric articulated about TAT-1 in the UK and the USA.

[3] Paul M. Kennedy, 'Imperial Cable Communications and Strategy, 1870-1914', *The English Historical Review* 86, no. 341 (1971): 728–752; Daniel R. Headrick, *The Invisible Weapon: Telecommunications And International Politics, 1851-1945* (New York; Oxford: Oxford University Press, 1991); Jill Hills, *Telecommunications and Empire* (Urbana: University of Illinois Press, 2008); Bernard Finn and Daqing Yang, eds., *Communications Under the Seas: The Evolving Cable Network and Its Implications* (Cambridge, MA; London: MIT Press, 2009); John Tully, 'A Victorian Ecological Disaster: Imperialism, the Telegraph, and Gutta-Percha', *Journal of World History* 20, no. 4 (2009): 559–79; Nicole Starosielski, *The Undersea Network* (Durham, NC: Duke University Press, 2015).
[4] Andrew J. Butrica, *Beyond the Ionosphere: Fifty Years of Satellite Communication* (Washington, DC: NASA History Office, 1997); Hugh Richard Slotten, 'Satellite Communications, Globalization, and the Cold War', *Technology and Culture* 43, no. 2 (2002): 315–50; Hugh Richard Slotten, 'The International Telecommunications Union, Space Radio Communications, and U.S. Cold War Diplomacy, 1957-1963', *Diplomatic History* 37, no. 2 (2013): 313–71; Hugh Richard Slotten, 'International Governance, Organizational Standards, and the First Global Satellite Communication System', *Journal of Policy History* 27, no. 3 (2015): 521–49; Lisa Ruth Rand, 'Orbital Decay: Space Junk and the Environmental History of Earth's Planetary Borderlands' (PhD diss., University of Pennsylvania, 2016); James Schwoch, *Global TV: New Media and the Cold War, 1946-69* (Urbana: University of Illinois Press, 2008).
[5] Helen M. Rozwadowski, 'Ocean's Depths', *Environmental History* 15, no. 3 (2010): 520–25; Roger D. Launius, 'Writing the History of Space's Extreme Environment', *Environmental History* 15, no. 3 (2010): 526–32.

Conquering the Atlantic

On September 25th, 1956, AT&T and the Post Office opened TAT-1, the first transatlantic telephone cable. TAT-1 incorporated various new and old techniques for surviving the Atlantic environment. The cable route, across the far north of the Atlantic from Oban in Scotland to Clarenville in Newfoundland, had to be carefully chosen for both infrastructural and environmental purposes: further south were telegraph cables, which might disrupt the new cable, and dangerous areas of the sea-bed, susceptible to turbidity currents, which were sediment-laden flows of water that could snap cables, as had happened following the 1929 Grand Banks earthquake and the 1954 Orleansville, Algeria, earthquake. TAT-1 had been enabled, technologically, by undersea repeaters developed at Bell Labs. These repeaters, which amplified and extended telephone signals, had to both survive the immense pressure at the bottom of the Atlantic, and also work reliably – a failure in the repeater could not be fixed. Interestingly, the repeaters used the Atlantic environment itself as an input: their metal casings, which were unavoidably deformed during the cable-laying process, relied on the immense pressure at the ocean floor to pressure them back into the correct shape.[6] The Post Office had contributed to TAT-1 by designing its shallow-water repeaters, used in the link between Newfoundland and the North American mainland, and through the use of Her Majesty's Telegraph Ship, *Monarch*, the largest cable ship afloat at the time, and the only ship capable of transporting the entire length of cable for one direction (TAT-1 was made of two cables, one for each direction of transmission). TAT-1's final novelty, again demonstrating the intersection of technology and the environment, was its innovative use of polyethylene cladding, used to resist biological attack from marine bacteria, in contrast to previous cables' more susceptible polyvinyl chloride coatings.[7]

These tough environmental conditions formed a major part of AT&T's publicity about transatlantic telephony in the late 1950s and early 1960s. Youth audiences were particularly targeted: adverts in boys' magazines talked about how the sea 'could make a

---

[6] T.F. Gleichmann et al., 'Repeater Design for the North Atlantic Link', *The Bell System Technical Journal* 36, no. 1 (1957): 69–101.

[7] M.J. Kelly et al., 'A Transatlantic Telephone Cable', *Transactions of the American Institute of Electrical Engineers, Part I: Communication and Electronics* 74, no. 1 (1955): 124–39; C.H. Elmendorf and B.C. Heezen, 'Oceanographic Information for Engineering Submarine Cable Systems', *The Bell System Technical Journal* 36, no. 5 (1957): 1035–94; L.R. Snoke, 'Resistance of Organic Materials and Cable Structures to Marine Biological Attack', *The Bell System Technical Journal* 36, no. 5 (1957): 1095–1127; J.S. Jack, C.W.H. Leech, and H.A. Lewis, 'Route Selection and Cable Laying for the Transatlantic Cable System', *The Bell System Technical Journal* 36, no. 1 (1957): 293–326.

Figure 8.1. The sea could make a 'meal' of telephone cables! Courtesy NMAH Archives Center.

'meal' of telephone cables' (Figure 8.1) and explained Bell Labs' 'experimental ocean', used to test cable specimens in saline conditions.[8] Business audiences were also targeted, with adverts in *American Banker*, *The Wall Street Journal*, and *Fortune* explaining how AT&T's 'stormproof' Atlantic cable would allow them to expand American business interests in Europe.[9] A series of adverts by AT&T called 'Tele-Facts' deployed

[8] AT&T and N.W. Ayer, 'The Sea Could Make A "Meal" of Telephone Cables' 1958, Folder 1, Box 32, Series 3, Collection 59: N.W. Ayer Advertising Agency Records, NMAH; AT&T and N.W. Ayer, 'Why We Have Our Own "Ocean"' 1959, Folder 1, Box 32, Series 3, Collection 59: N.W. Ayer Advertising Agency Records, NMAH.

[9] AT&T and N.W. Ayer, 'Beneath the Broad Atlantic' 1954, Folder 3, Box 13, Series 3, Collection 59: N.W. Ayer Advertising Agency Records, NMAH; AT&T and N.W. Ayer, 'You Can Telephone Britain

militaristic language to portray TAT-1 and, by extension, AT&T, as 'conquering the Atlantic'; this militaristic tone pervaded many of AT&T's TAT-1 adverts.[10] The same adverts which ran in *American Banker* and *Fortune* explained how TAT-1 would be of 'far-reaching value in national defense', whilst articles in Bell Telephone Magazine compared TAT-1 to Cold War projects like the Distant Early Warning Line and the Ballistic Missile Early Warning System.[11]

These Cold War geopolitical concerns were particularly evident in the trilateral negotiations for TAT-1 between the USA, Britain, and Canada. TAT-1's route, which had been drawn up by AT&T and Post Office officials, also fulfilled a British goal of strengthening UK-Canadian communications and allowing an extension of the 'all-red' Commonwealth communications route to reach New Zealand via Canada and the Pacific.[12] This was initially problematic for the USA, which had two security concerns: first, regarding the cable landing in Canada, rather than the USA, and second, over the plans for the Post Office, rather than AT&T, to design and contract out construction of the shallow-water Newfoundland-Nova Scotia section.[13] The USA's proposed solution to the first issue was to staff the cable stations on Canadian soil with American AT&T staff, which Canada in return expressed concerns over, both on security and commercial grounds, fearing that it would pave the way for the commercial expansion of US telecommunications into Canada.[14] This subsequently caused concerns for the UK, where Foreign Office and Post Office officials worried that Canadian intransigence would cause the US to decide to lay a cable directly to France instead.[15] The resulting compromise was that Canadian sections would be operated by Eastern Telephone and Telegraph Company, a Canadian AT&T subsidiary, the Canadian Overseas Telecommunication Corporation would take a 10% minority stake in TAT-1, and that the Post Office would design the

over New Stormproof Cables' 1956, Folder 2, Box 24, Series 3, Collection 59: N.W. Ayer Advertising Agency Records, NMAH; AT&T and N.W. Ayer, 'Transatlantic Telephone Cable Is Now Being Laid' 1955, Folder 3, Box 13, Series 3, Collection 59: N.W. Ayer Advertising Agency Records, NMAH.

[10] AT&T and N.W. Ayer, 'Tele-Facts: Laying the First Atlantic Telephone Cable' 1955, Folder 2, Box 32, Series 3, Collection 59: N.W. Ayer Advertising Agency Records, NMAH.

[11] Cleo F. Craig, 'Equipping Ourselves for Today's Responsibilities', *Bell Telephone Magazine* 34, no. 4 (1955): 217–24; C.C. Duncan, 'Communications and Defense', *Bell Telephone Magazine* 37, no. 1 (1958): 15–24.

[12] 'Route of the Proposed Transatlantic Cable' July 1953, DO 35/4940, TNA.

[13] Ben Barnett to Alexander Little, 'Secret: From Washington to Foreign Office', 11 April 1953, FO 371/105731, TNA; R.R.G. Watts to Gibson, 'Phone Call with Wolverson and Barnett on the Trans-Atlantic Telephone Scheme', 30 June 1953, DO 35/4940, TNA.

[14] 'Route of the Proposed Transatlantic Cable, July 1953, DO 35/4940, TNA'.

[15] J.J.S Garner to Ben Barnett, 'Canadian High Commissioner', 24 July 1953, DO 35/4940, TNA.

Newfoundland-Nova Scotia section but that, in return, the next transatlantic cable, TAT-2, would run from the USA to France, to avoid concentrating traffic through the UK.[16]

An AT&T publicity film for TAT-2, laid in 1959, further shows the entanglement of US Cold War geopolitical concerns about Europe with these cables' environments. The film opens with scenes of waves crashing on rocks and emphasises the cable's victories over the 'many-mooded sea', going on to describe battles against the wind, cold, and icebergs, before concluding that the cable 'should do much to bring many nations closer together, both politically and economically, and contribute significantly to the defence needs of the free world' and was 'man's newest memorable victory over distance and the sea'.[17] This film captures how the cable's environments were crucial to a discourse emphasising the importance of extending US military and economic influence into Europe; the early transatlantic telephone cables could thus be positioned, from the US perspective, in John Krige's trend of 'consensual hegemony', describing the USA's use of scientific and technological projects in the early Cold War to aid European reconstruction and serve its Cold War defence interests.[18]

In Britain, TAT-1's environmental dimensions were instead used to emphasise the British scientific and technological ingenuity which had made TAT-1 a 'world first'. At the cable's opening ceremony, Charles Hill, the Postmaster-General, highlighted the engineering prowess and patient research behind the cable, whilst the Post Office's official souvenir booklet emphasised British oceanographic knowledge and manufacturing skill.[19] Gordon Radley, by then Director-General, spoke on the BBC radio Home Service program *Science Survey* in September 1956 about TAT-1 as a 'significant scientific achievement'.[20] Radley described the cable resting in the 'perpetual darkness and ooze of the sea bed', evoking another passage which highlighted the environment of submarine communication cables, Rudyard Kipling's 'The Deep-Sea Cables': 'There is no sound, no echo of sound, in the deserts of the deep, Or the great grey level plains of ooze where the shell-burred cables creep'.[21] However, where Kipling's poem portrayed cables as a globally unifying force, transcending their environment, Radley's talk, and

[16] Barnett to Little, 'Secret: From Washington to Foreign Office'; Kelly et al., 'A Transatlantic Telephone Cable', 128.
[17] *Cable to the Continent* (AT&T, 1959), https://www.youtube.com/watch?v=yqRj3lvvg7Y.
[18] John Krige, *American Hegemony and the Postwar Reconstruction of Science in Europe* (Cambridge, MA; London: MIT Press, 2006).
[19] 'Speeches at the Opening of the Transatlantic Telephone Cable' 1956, HIC W04/03 Network/Cable/Submarine Cables/Trans-Atlantic, BTA.
[20] 'The Transatlantic Telephone Cable', *Science Survey* (BBC Home Service, 27 September 1956), HIC W04/03 Network/Cable/Submarine Cables/Trans-Atlantic, BTA.
[21] Rudyard Kipling, 'The Deep Sea Cables', in *The Seven Seas* (London: Methuen, 1896).

other Post Office publicity for TAT-1, can instead be positioned within 'defiant modernism'.[22] TAT-1, a collaborative project, is, at first glance, not an ideal example of defiant modernism, which refers to uniquely British projects. However, the Post Office's emphasis on British contributions to TAT-1, a project enabled by AT&T-developed deep-sea repeaters, reveal the defiant aspect of this discourse. Just as defiant modernism highlights British emphasis on 'world firsts' amidst Britain's perceived international decline, so the Post Office's emphasis on its contributions to TAT-1, which had been enabled by American innovation, also took on a defiant tinge.

Hostile Environments

In the early 1960s, space-based communications took off, and the rhetoric deployed in its support by AT&T and the Post Office were similar to the discourses deployed in support of TAT-1, although new attitudes to space as an environment and zone of Cold War conflict also began to appear. In the USA, this occurred with the launch of AT&T's Telstar satellite, whilst in Britain, this happened with the Post Office's construction of Goonhilly Downs, Britain's first satellite earth station.

Telstar, launched in July 1962, was the first satellite to relay telephony and television across the Atlantic, from AT&T's earth station in Andover, Maine, to British and French earth stations at Goonhilly Downs, Cornwall, and Pleumeur-Bodou, Brittany. Bell Labs' initial investigation into satellite telephony came in 1955, but its R&D programme began in earnest in 1959, and AT&T entered an agreement with NASA: AT&T would design and construct an active communications satellite, and NASA would launch it.[23] The satellite itself was roughly spherical, composed of seventy-two facets, covered in sixty solar cells and three mirrors, which aided satellite tracking from Earth. The satellite weighed 170lb and contained a single, one-way amplifier, capable of transmitting a full-band signal one way, or two narrow-band signals two ways (for example, a one-way television signal, or a two-way phone call). Telstar's purpose was not only to prove the viability of satellite communications, but also to gain an understanding of the space environment, particularly the Van Allen radiation belt

[22] Bud, 'Penicillin and the New Elizabethans'.
[23] A.B. Crawford et al., 'The Research Background of the Telstar Experiment', *The Bell System Technical Journal* 42, no. 4 (1963): 747–51; 'Project Telstar' 1962, HIC W04/02 Network/Transmission Systems/Satellites 2, BTA.

surrounding Earth, discovered by James Van Allen at the University of Iowa in 1958, using data from the Explorer 1 and Explorer 3 satellites.[24]

AT&T situated its space activities alongside transatlantic telephone cables in its publicity. After its early experiments in space communications in the late 1950s, AT&T ran a widely-published series of adverts with the header 'From Beyond the Sky to Beneath the Seas' in military and science magazines (Figure 8.2), juxtaposing the sea and space environments to demonstrate the breadth of AT&T's accomplishments.[25] The adverts' appearance in military magazines further demonstrates the imbrication of transatlantic communications and Cold War military interests. TAT-1 and Telstar were also used as recruitment tools in college advertising: one poster described how 'Between Outer Space and the Deep Sea There's a Wide Range of Opportunity in the Bell Telephone Companies', whilst another explained how 'progress in the Bell System', amongst other things, 'swims' and 'orbits'.[26]

The Telstar experiment also interlinked the hazards of the space environment with the growing environmental awareness of the 1960s, which raised concerns about American militarisation of the space environment after the Telstar experiment. Telstar, as mentioned above, had not just been launched as a communications satellite, but also, as AT&T publicity explained, a 'space laboratory', 'operating in the unknown environment of hostile radiation and micrometeorite dust', and so sent back data about the space environment to Bell Labs.[27] The day before Telstar launched, the USA detonated Starfish Prime, the largest man-made nuclear explosion in outer space, part of a series of high-altitude nuclear weapons tests called Operation Fishbowl. This detonation energised the Van Allen belt, and this extra radiation damaged transistors on Telstar, causing it to fail.

The failure of Telstar and seven other satellites, including Ariel I, Britain's first satellite, caused by Starfish Prime, highlighted the hazardous environment of space and fed environmental concerns about the damage American military programs were doing to outer space. John McNeill and Corinna Unger have noted the inter-relationship between Cold War militarism and the rise of environmentalism, calling environmentalism 'a child

[24] Crawford et al., 'The Research Background of the Telstar Experiment'; 'Project Telstar, 1962, HIC W04/02 Network/Transmission Systems/Satellites 2, BTA'.

[25] AT&T and N.W. Ayer, 'From Beyond the Sky to Beneath the Seas' 1958, Folder 3, Box 15, Series 3, Collection 59: N.W. Ayer Advertising Agency Records, NMAH.

[26] AT&T and N.W. Ayer, 'Between Outer Space And The Deep Sea There's A Wide Range Of Opportunity In The Bell Telephone Companies' 1964, Folder 1, Box 30, Series 3, Collection 59: N.W. Ayer Advertising Agency Records, NMAH; AT&T and N.W. Ayer, 'Progress in the Bell System...' 1964, Folder 1, Box 30, Series 3, Collection 59: N.W. Ayer Advertising Agency Records, NMAH.

[27] 'Facts from Space via Telstar', *Bell Telephone Magazine* 41, no. 3 (1962): 38–39.

Figure 8.2. Telstar and TAT-1: 'From beyond the sky to beneath the seas'. Courtesy NMAH Archives Center.

---

of the Cold War', but what is especially relevant is how space communications, and the concept of space as an environment, played a role here.[28] Lisa Ruth Rand has argued that Telstar's failure, and its linkage by the media with Operation Fishbowl, constituted a 'proto-environmentalist' moment;[29] Toshihiro Higuchi has also argued that Operation Fishbowl stirred Cold War environmental insecurities, and Jacob Hamblin has shown

[28] J.R. McNeill and Corinna R. Unger, 'Introduction: The Big Picture', in *Environmental Histories of the Cold War*, ed. J.R. McNeill and Corinna R. Unger (Cambridge: Cambridge University Press, 2010), 11.
[29] Rand, 'Orbital Decay', 127.

how nuclear weapon detonations in space were not just about weapons testing, but also about investigating environmental transformation.[30]

This entanglement of militarism and environment was also evident in other early approaches to space communications. In 1961, MIT's Lincoln Laboratory began Project West Ford, an attempt to create an artificial ionosphere in outer space which communication signals could be bounced off. The artificial ionosphere was created by placing 480 million copper needles into orbit to act as a reflective antenna, and so reduce the US military's reliance on undersea cables – in 1959, the US Navy had boarded a Russian fishing trawler in the North Atlantic, suspected of deliberately cutting transatlantic telephone and telegraph cables owned by AT&T and Western Union.[31] Project West Ford was protested in the both Britain and the USSR, and eventually came under criticism within the USA as well. British radio-astronomers, such as Bernard Lovell, were concerned with how the needles might affect radio astronomy, whilst in the USSR, *Pravda* attacked the USA with the heading 'USA dirties space', calling the needles 'space junk'.[32] In the USA, *The New York Times* argued that the USA had no unilateral right to influence the space environment.[33] Telstar's failure was linked in newspaper articles to Operation Fishbowl's potential damage to the space environment, and Van Allen criticised the military tests, which used data from Telstar to study the explosions before its failure, for projecting a 'sinister' air around the programme.[34] Whilst AT&T thus initially positioned Telstar alongside TAT-1 as a high-tech link to Europe, another technology conquering its environment to effect US Cold War aims, Telstar escaped its rhetorical frame and instead represented tension between the American space and military programmes and the emerging environmental movement.

Goonhilly Downs Earth Station, like Telstar, was also initially situated alongside TAT-1, before experiencing environmental challenge. Goonhilly, and satellite earth stations in general, are an important part of this history given their relative neglect in

---

[30] Toshihiro Higuchi, 'Atmospheric Nuclear Weapons Testing and the Debate on Risk Knowledge in Cold War America, 1945-1963', in *Environmental Histories of the Cold War*, ed. J.R. McNeill and Corinna R. Unger (Cambridge: Cambridge University Press, 2010), 319; Jacob Darwin Hamblin, *Arming Mother Nature: The Birth of Catastrophic Environmentalism* (Oxford; New York: Oxford University Press, 2013), 12.

[31] Jack Raymond, 'U.S. Gives Soviet Report on Search of Fishing Vessel', *The New York Times*, 28 February 1959.

[32] Bernard Lovell, 'The Challenge of Space Research', *Nature*, no. 4845 (1962): 195; 'Protests Continue Abroad', *The New York Times*, 22 October 1961.

[33] 'More Needles in Space', *The New York Times*, 8 May 1963.

[34] 'Van Allen Sees Science "Clique"', *The New York Times*, 31 December 1962; 'AT&T Sets Telstar II Launch for Spring; Lessening of Radiation Damage a Main Goal', *Wall Street Journal*, 2 January 1963.

satellite histories, which tend to focus on the cosmic and not the terrestrial.[35] Satellite communications is more than satellites in space: it is also a vast, material, terrestrial infrastructure composed of, by now, hundreds of earth stations around the world. Earth stations are thus important nodes in communication satellite infrastructure, and for the Telstar experiment, three earth stations in three different countries were required.

Goonhilly Earth Station was built by the Post Office in 1962 on Goonhilly Downs, an isolated, elevated plateau on the Cornish peninsula with broad sightlines. The Post Office pursued a unique direction for the design of Goonhilly: the first antenna, Antenna One – also known as 'Arthur' – was the world's first satellite communication antenna with a parabolic design. The antenna was designed by Charles Husband, the engineer behind Jodrell Bank's Lovell Telescope, the world's largest steerable radio telescope, which had also used a parabolic design, and had been the world's first satellite 'dish'.[36] The Post Office proudly touted Antenna One's parabolic design as a uniquely British design concept which did not need environmental protection, in contrast to AT&T's Andover, Maine, earth station, which utilised a 'horn' antenna that required protection from the environment by a distinctive 'golf ball' protective radome.[37] Goonhilly's dish was mobilised as part of Post Office publicity, featuring in the Progress poster series which has appeared throughout this thesis (Figure 8.3).[38] The Post Office later proudly touted how the British parabolic design became the template for subsequent earth stations around the world, and in so, Goonhilly, as with TAT-1, is another example of 'defiant modernism'. Goonhilly, however, was not a complete success: initial communication with Telstar failed because a component had been accidentally inverted, which disrupted the Post Office and Britain's image of technological sophistication. The Prime Minister, Harold MacMillan, demanded an explanation from the Post Office, which explained both the simple error behind Goonhilly's failure, and also that Goonhilly had cost a quarter as much as the French earth station and had demonstrated Britain's expertise in antenna construction.[39]

[35] For a study from the perspective of the ground station, see Craig B. Waff, 'Project Echo, Goldstone, and Holmdel: Satellite Communications as Viewed from the Ground Station', in *Beyond the Ionosphere: Fifty Years of Satellite Communication*, ed. Andrew J. Butrica (Washington, DC: NASA History Office, 1997), 41–50.
[36] Jon Agar, 'Making a Meal of the Big Dish: The Construction of the Jodrell Bank Mark 1 Radio Telescope as a Stable Edifice, 1946–57', *The British Journal for the History of Science* 27, no. 1 (1994): 3–21.
[37] 'Ten Years of Technological Progress' 1972, HIC W04/02 Network/Transmission Systems/Satellites 2, BTA.
[38] 'Progress: Goonhilly' 1962, TCB 420/IRP (PR) 1, BTA.
[39] 'Prime Minister: TELSTAR' July 1962, TCB 2/184, BTA.

Figure 8.3. Goonhilly also appeared in the 'Progress' poster series. Courtesy of BT Archives.

The expansion of space communications brought concerns about interference in the radio spectrum, which would have consequences for Goonhilly. As international satellite communication developed, and telephone companies developed domestic microwave networks for domestic communication (as discussed in Chapter Six), the radio spectrum became increasingly congested and wireless communication susceptible to interference. Mitigating interference had been an early priority for Telstar: AT&T's Andover earth station had been duplicated and exported to France at considerable cost for the French earth station at Pleumeur-Bodou, in order to standardise and ensure the replicability of communications.[40] This strategy suggests that earth stations, whilst neglected nodes in satellite communications, also have much in common with scientific laboratories, which have also been highlighted as standardised settings permitting the ‘export’ and replication of scientific knowledge around the world. Strategies to mitigate interference with scientific instruments is not a new phenomenon: Agar has highlighted various strategies of spatial organisation and control taken to control interference for Jodrell Bank, while Cahan has outlined the architectural and political techniques used to reduce interference at the Physikalische-Technische-Reichsanstalt, the Imperial German metrological laboratory founded in 1887.[41]

By the 1970s, interference meant that Goonhilly could no longer serve as Britain’s only earth station. The Cornish peninsula had been ideal for transatlantic satellites, but south-east facing aerials, pointed at Indian ocean satellites, proved susceptible to interference from French microwave networks across the channel. By 1974, it was difficult for Goonhilly to maintain a reasonable connection with Indian Ocean satellites, as the low angle of inclination needed to transmit from the UK to the Indian Ocean satellite meant that signals passed straight through the French atmosphere (Figure 8.4).[42]

Britain’s second earth station, Madley, therefore opened in 1978, and its northern, inland position in Herefordshire had better sightlines and was protected from interference not only from the continent, but also Goonhilly, which continued to work until 2008. The fate of Goonhilly and construction of Madley demonstrates earth stations and, indeed, all wireless communication stations, are not only susceptible to interference, but also producers of it, and this is important for an historical and environmental analysis of the radio spectrum. The electromagnetic spectrum is an invisible environment which intersects with the spatiality of communications infrastructure and other scientific and technological institutions such as radio telescopes and metrological laboratories; by 1968, this was already such a concern that an article in AT&T’s *Bell Telephone Magazine* described the spectrum, in which AT&T had invested a significant amount with its

[40] ‘Prime Minister: Telstar, July 1962, TCB 2/184, BTA’.

[41] Bruno Latour, ‘Give Me a Laboratory and I Will Raise the World’, in *Science Observed*, ed. Karin Knorr-Cetina and Michael Mulkay (London: Sage, 1983), 141–69; Agar, *Science and Spectacle*; Cahan, ‘The Geopolitics and Architectural Design of a Metrological Laboratory: The Physikalische-Technische Reichsanstalt in Imperial Germany’.

[42] D.I. Dalgleish and V.C. Meller, ‘Communication-Satellite Earth Stations: The First Ten Years’ 1973, HIC W04/02 Network/Transmission Systems/Satellites 2, BTA; Edward Fennessy, ‘Provision of Fourth UK INTELSAT Earth Terminal: Development of New Earth Station Site’ October 1974, TCC 55/6/145, BTA.

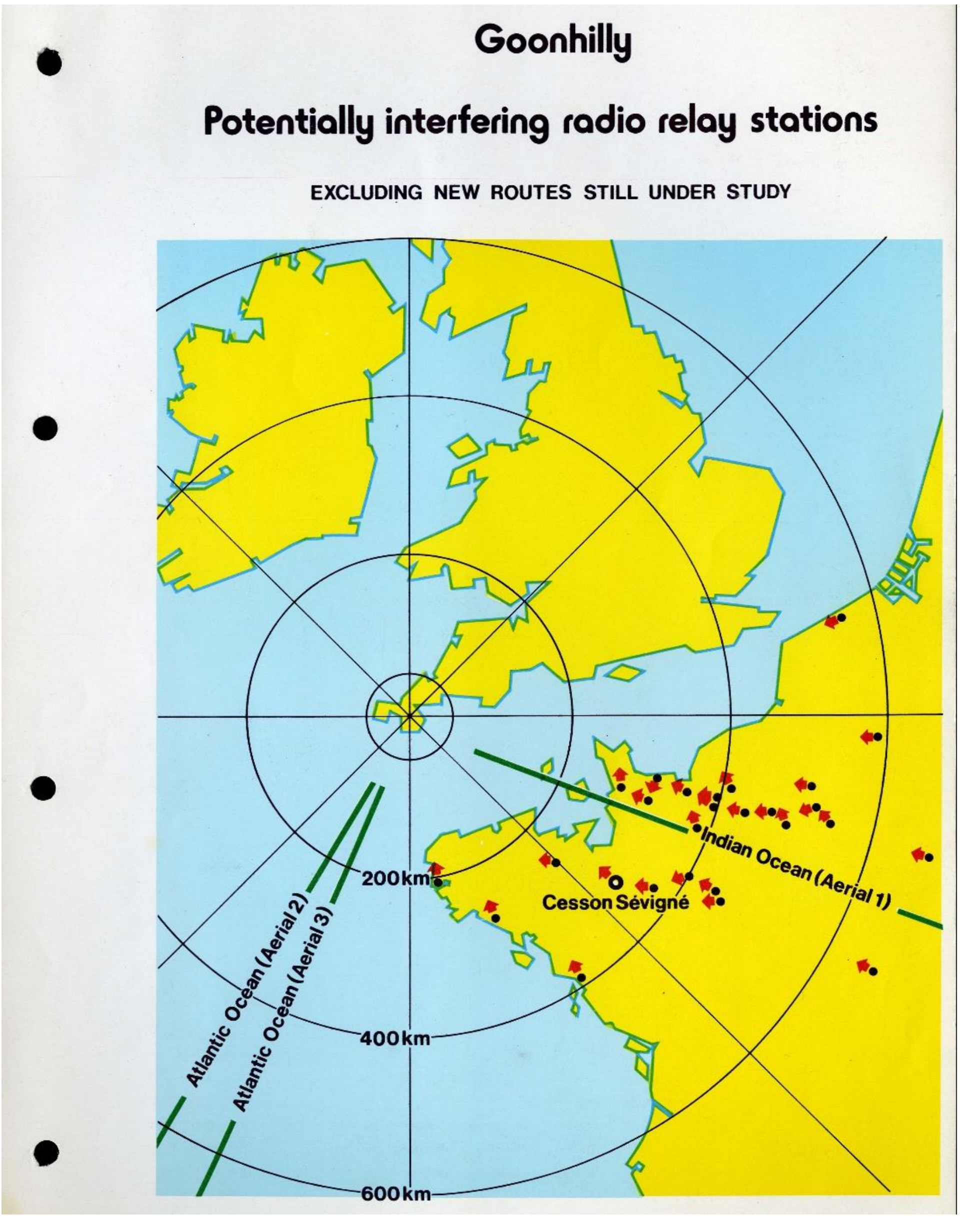

Figure 8.4. Interference between Goonhilly and French microwave relay stations. Courtesy BT Archives.

---

domestic microwave network, as a 'natural resource' being 'polluted'.[43] A history of Goonhilly and Madley shows that not only was the natural environment important to their function, but also the electromagnetic environment, and suggests that further work is needed in this field.

[43] H. Edward Weppler, 'The Radio Spectrum Squeeze', *Bell Telephone Magazine* 47, no. 6 (1968): 28–32.

The Single World System

Telstar showed the viability of satellite communications, and so attention turned to global satellite systems, which ultimately took form in the INTELSAT 'single world system'. INTELSAT had a profound organisational and discursive influence on the development and presentation of international communications by the Post Office/British Telecom and AT&T from the late 1970s. However, before I explore that influence, I will first address INTELSAT's organisation and rhetoric for international communications.

The USA spearheaded the creation of INTELSAT as a satellite system with global access and Cold War objectives. Soviet success with Sputnik and Yuri Gagarin had left the USA lagging in the space race, and the Kennedy administration saw a global satellite system as a way to gain prestige, catch up to the USSR, and align neutral developing nations in the Third World with the USA. Hugh Slotten notes that, on this latter point, the USA needed to match the USSR in an 'ideological struggle for the minds of men in these countries'.[44] Transmitting television and propaganda from the USA across the world through a global satellite system was seen as a powerful weapon for American foreign policy. The USA thus started negotiations with foreign governments to gather a consortium of nations to invest in and support the global system. The 1962 Communications Satellite Act created COMSAT, a publicly-traded corporation which represented the USA in these negotiations, and the courtship of foreign governments began.[45]

In the UK, the Post Office had to negotiate its commitment to submarine cables with the growing support for a single global satellite system. Nigel Wright and Hugh Slotten have both demonstrated that the Post Office's early interest in satellites came from its desire to create a complementary Commonwealth satellite system which would interlink with cables, rather than a single global system.[46] There was also potential for a European satellite system, which the Post Office were reluctant to invest in given that it would have to pay both purchase costs for the European launcher, developed by ELDO, the European Launcher Development Organisation, and also development costs, as the

[44] Slotten, 'Satellite Communications, Globalization, and the Cold War', 328.
[45] Slotten, 'Satellite Communications, Globalization, and the Cold War'; Slotten, 'The International Telecommunications Union, Space Radio Communications, and U.S. Cold War Diplomacy, 1957-1963'.
[46] Nigel Wright, 'The Formulation of British and European Policy Toward an International Satellite Telecommunications System: The Role of the British Foreign Office', in *Beyond the Ionosphere: Fifty Years of Satellite Communication*, ed. Andrew J. Butrica (Washington, DC: NASA History Office, 1997), 157–70; Slotten, 'International Governance, Organizational Standards, and the First Global Satellite Communication System'.

launcher was still in development. The Foreign Office foresaw political problems with both Commonwealth and European systems, and, given the Americans' head-start on satellite development, convinced the Post Office that participation in the American system represented the best option for British industrial, telecommunications, and Commonwealth interests. The Commonwealth were enrolled in this strategy through the Commonwealth Conference on Satellite Communications in 1962, which recommended that the Post Office, in conjunction with Canada, should undertake exploratory talks with the USA, although the Post Office was still keen to emphasise its preference for a complementary cable and satellite system at the meeting.[47] European interests coalesced through the Conference of European Postal and Telecommunication Administrations, which agreed not to establish a regional satellite system in opposition to the USA, although the European Conference on Satellite Telecommunications, CETS, was established for long-term planning. Through concerted negotiations by COMSAT and the American State Department, groundwork for a single global satellite system had been laid by 1963.

However, a significant opportunity to voice further opinions came in 1963, at the Extraordinary Administrative Radio Conference, organised by the International Telecommunications Union. Slotten has already addressed the USA's use of the 1963 conference to secure frequency allocations for the single global system, to strengthen ties with its European allies, and to undertake 'missionary' work, promoting technical assistance programs, with potential Third World supporters.[48]

Two of the Post Office's noteworthy contributions came from a paper describing Goonhilly and a proposed resolution regarding the inter-connection of satellites with other transmission systems.[49] In the first, the Post Office again touted Goonhilly's unique, parabolic, unprotected antenna, and described another unique feature: its use of computer prediction, rather than automatic tracking, for the steering aerial. Goonhilly demonstrates an early example of the Post Office's interest in computer techniques, and its computer used orbital data to predict satellite movement, so that the antenna would not need to be

[47] 'Draft Paper for Circulation to the Members of the Conference of European Postal and Telecommunications Administrations: Commonwealth Conference on Satellite Communications' 25 July 1962, TCB 2/182, BTA.
[48] Slotten, 'The International Telecommunications Union, Space Radio Communications, and U.S. Cold War Diplomacy, 1957-1963'.
[49] 'Experimental Earth Station at Goonhilly Downs', Documents for the Space Radiocommunication Conference (Geneva: International Telecommunications Union, 1963); 'Draft Resolution - The Interconnection of Communication-Satellite Systems and Other Transmission Systems', Documents for the Space Radiocommunication Conference (Geneva: International Telecommunications Union, 1963).

steered to acquire satellites as they appeared over the horizon. The Goonhilly computer proved useful at the conference, and was used, via Telex, to calculate degrees of interference between different radio-communication services, which was another opportunity for the Post Office to deploy Goonhilly to emphasise its technological prowess.[50] The Post Office's resolution also highlighted its commitment to undersea cables and an inclusive satellite system. The resolution argued that the time-delay and Doppler frequency shifts associated with satellite transmission necessitated an interconnected system which provided various transmission routes, such as undersea cables, to mitigate these issues. This resolution, as well as the continuing commitment by countries such as France to its cable networks, meant that the USA eventually did concede and sharing criteria were put in place for satellite systems to interconnect with terrestrial services.

In 1964, INTELSAT was finally established through an interim agreement, to be formalised in 1971. The USA, through COMSAT, owned half, whilst the other half was jointly owned by major partners from Europe and around the world, including Canada, Japan and Australia. The Post Office, as Britain's representative, was the second-largest single shareholder behind the USA, with an 8.4% ownership share.[51]

Reflecting its goals and organisation as a 'single world system', INTELSAT was associated with a globalising liberal democratic Cold War discourse though the 1960s and 1970s, and emphasised satellites as superior and environmentally transcendent compared to submarine cables. 'One world' discourses of various valences proliferated through the 1960s. In 1962, the media theorist Marshall McLuhan, in *The Gutenberg Galaxy*, popularised the term 'global village', but it is often overlooked that McLuhan's term was, at best, ambivalent, and at worst, an expression of serious concern about the impact of global communications on mankind. McLuhan described the global village as 'a single constricted space resonant with tribal drums',[52] and warned that:

> Instead of tending towards a vast Alexandrian library the world has become a computer, an electronic brain, exactly as in an infantile piece of science fiction. And as our senses have gone outside us, Big Brother goes inside. So, unless aware of this dynamic, we shall

[50] 'Goonhilly Computer Helps International Planning' 28 October 1963, TCB 2/179, BTA.
[51] Slotten, 'International Governance, Organizational Standards, and the First Global Satellite Communication System', 538.
[52] Marshall McLuhan, *The Gutenberg Galaxy* (London: Routledge & Kegan Paul, 1962), 31.

at once move into a phase of panic terrors, exactly befitting a small world of tribal drums, total interdependence, and super-imposed co-existence.[53]

Humankind's forays into space also fed this growth of 'one world' discourses. The writer-entrepreneur Stewart Brand, amongst many others, seized on the first photos of Earth from space as a call-to-arms for his environmentalist magazine, *Whole Earth Catalog*.[54] Before the stabilisation of a specific INTELSAT discourse, the first INTELSAT satellite, Early Bird, was caught up in a McLuhan-esque 'communications explosion' discourse. Early Bird appeared on the front cover of *TIME* magazine, directly beaming an unsettling jumble of geometric shapes, designed to convey the view of space communications as 'a maze of reflections of one thing to another' and 'the somewhat frightening prospect of man's new capability to store a mass of information and, on signal, send it to anywhere in the world' (Figure 8.5).[55]

However, by the end of the 1960s, the INTELSAT discourse had stabilised into a rhetoric of communication satellites as agents of global peace and unity, with registers of liberal democratic capitalism and the highly-anticipated information revolution. An advert by Hughes, Early Bird's manufacturer, explained that with the satellite, 'The future looks bright. It includes increased world trade and better understanding between nations'.[56] A COMSAT fact sheet explained how satellites would 'increasingly handle even more futuristic chores' such as data exchange and facsimile, whilst at the Early Bird inaugural address, President Lyndon B. Johnson proclaimed that the Early Bird service 'brings closer together lands and people who share not only a common heritage but a common destiny'.[57] Two years later, in 1967, at the launch of the second INTELSAT II satellite over the Pacific, Johnson invoked similar rhetoric, describing that satellites would make space 'a zone of peace, devoted to the purposes of all mankind', whilst Rosel Hyde, Chairman of the Federal Communications Commission, described how the satellite would improve 'the flow of knowledge and commerce across new high-capacity highways of communications'.[58]

This discourse peaked at the signing of the official INTELSAT accords in Washington in 1971 with the contributions of science-fiction author Arthur C. Clarke.

---

[53] McLuhan, 32.
[54] Stewart Brand, ed., 'Whole Earth Catalog', Fall 1968.
[55] 'The Communications Explosion: Early Bird - And After', *TIME*, 14 May 1965.
[56] 'Early Bird Advert by Hughes, Aviation Weekly' 17 May 1965, OE-037000-01, NASM.
[57] 'Fact Sheet II: Early Bird and Future Communications Satellites, COMSAT' 1965, OE-037000-03, NASM.
[58] 'Johnson, Sato, Exchange Messages via Pacific Satellite, COMSAT.' 1967, Folder 3, Box 58, Acc. No. 1987-0125, NASM.

Copyright Material Removed

Figure 8.5. *TIME* magazine's cover, 'The Communications Explosion', May 14, 1965.

Clarke had originally proposed the geosynchronous satellite system which INTELSAT used in a 1945 article in *Wireless World*, and as such his fame and predilection for grand predictions were regularly invoked about INTELSAT. At the accords' signing, Clarke explained his belief that 'communication satellites can unite mankind' and informed the signatories that they had 'just signed a first draft of the Articles of Federation of the United States of Earth'.[59] In a 1971 article for *Popular Science* about the new INTELSAT IV series of satellites, Werhner von Braun, the famed German-American aerospace engineer, wrote that INTELSAT would establish what 'Arthur Clarke, prophetic writer on space, has called "mankind's first nervous system," which will "link together the whole human race"'.[60] The same quote was used in the INTELSAT III series press

[59] 'INTELSAT Agreements Signed, U.S. Department of State' 20 August 1971, OI-435000-01, NASM.
[60] Wernher von Braun, 'Now at Your Service - The World's Most Talkative Satellite', *Popular Science*, May 1971, 56.

handbook, and Clarke also wrote a guest editorial in *Bell Telephone Magazine*, in which he linked communication satellites with computers, suggesting that, whilst the enormous channel capacity of satellites may not be needed for a billion simultaneous human conversations, they would certainly be needed for computers, 'which are becoming more talkative than their human creators'.[61]

The large capacity of communication satellites, as well as the fragility of undersea cables and satellites' apparent environmental transcendence, became key features of an INTELSAT discourse which proclaimed the superiority of satellites over submarine cables. Wernher von Braun's article, mentioned above, touted the superior capacity of INTELSAT IV compared to the 'puny' capacity of the 'most sophisticated transatlantic cable', whilst a COMSAT brochure entitled 'New Communications Era' explained how the 'archaic' cable system was no longer necessary and how Early Bird nearly doubled the capacity of a transatlantic cable, at less than a fifth of the cost.[62] Submarine cables' fragility was also emphasised: in June 1965, COMSAT seized on the failure of the Canada-to-England transatlantic cable, CANTAT, to petition the USA's Federal Communications Commission (FCC) for temporary replacement service via Early Bird, and quickly publicised Early Bird's rescue of transatlantic communications.[63] The same occurred three years later, when COMSAT publicised how INTELSAT satellites had carried their heaviest ever load of Atlantic traffic after two transatlantic cables had been damaged.[64] An INTELSAT educational booklet explained how satellites were superior to cables both as agents of global peace and understanding and as a medium for the many new types of communication that were being developed.[65] In particular, it perpetuated the notion that satellites could escape the environment, the 'inherent limitations' of terrestrial communication', whereas terrestrial communications, in the environmental degradation of radio communications or the intrinsic, fragile, materiality of cables, could not.[66] These ideas were also articulated outside INTELSAT and COMSAT: *Aviation Week* reported INTELSAT IV's capacity of 3,000-9,000 circuits in comparison to the 750 of the most

---

[61] TRW, 'INTELSAT III Press Handbook' 1969, OI-435100-01, NASM; Arthur C. Clarke, 'Spinoff from Space', *Bell Telephone Magazine* 48, no. 5 (1969): 30.

[62] COMSAT, 'New Communications Era' 1967, Folder 5, Box 58, Acc. No. 1987-0125, NASM; von Braun, 'Now at Your Service - The World's Most Talkative Satellite', 56.

[63] COMSAT, 'Early Bird to Provide Emergency Service after Transatlantic Cable Break' 18 June 1965, OE-037000-03, NASM.

[64] COMSAT, 'Interruption of Service on Two Transatlantic Cables' 15 February 1968, OI-435000-01, NASM.

[65] 'Commercial Satellite Communications, INTELSAT.' 17 February 1969, Folder 9, Box 58, Acc. No. 1987-0125, NASM.

[66] 'NASM OI-435100-01. INTELSAT III Press Handbook, TRW. 1969'.

recent transatlantic cable, whilst *TV Guide* drew together the supposed differences in capacity and environment in an article about the growing demand for international communications.[67] *TV Guide* simultaneously emphasised the superior capacity of INTELSAT and the environment of submarine cables with the rhetorical question, 'Meet that demand with undersea cables? They'd drown in an ocean of words. But satellites can handle it'. Cables had been submerged, both literally and figuratively, whilst satellites were presented as a capable and transcendent technology.

Cables Orbit Satellites

The INTELSAT system and communication satellites had a significant influence on the development of transatlantic cables and international communications. In this section, I will outline three ways in which this occurred: first, in an organisational mirroring of the INTELSAT system through the North Atlantic System Conference; second, in the invocation of satellites and other space age motifs in BT and AT&T's promotion of international communications; and third, in the deployment of a similar unifying discourse to that articulated by INTELSAT, with a greater emphasis on computerisation and free enterprise capitalism. Before that, however, I shall explore the Post Office's appraisals of submarine cables and communication satellites, and the various techniques deployed during the 1960s and 1970s to protect and maintain undersea cables in the ocean environment.

From INTELSAT's early days, the Post Office researched and monitored the proficiency of both satellites and submarine cables. In 1968, five reports comparing satellites and cables were produced.[68] One paper addressed noise performance, concluding that cable circuits had marginally better performance, whilst satellites were more susceptible to rain and atmospheric conditions causing bursts of noise. One compared propagation conditions, whilst another addressed the fallibility of earth stations, noting that a satellite TV broadcast from Germany had been cancelled because the German earth station's radome had been covered in snow, and that radome repairs had also been responsible for putting Andover and Pleumeur-Bodou out of action for extended periods. The final paper compared satellites and cables' relative secrecy, concluding that submarine cables offered better prospects, but it was also noted that in

[67] 'First Intelsat 4 Placed in Orbit', *Aviation Week*, 1 February 1971; 'Switchboard In Orbit', *TV Guide*, 4 December 1971.
[68] 'Long Distance Cable and Satellite Systems' 6 May 1968, TCB 711/2/5, BTA.

the future, satellites with highly direction aerials could illuminate only a few square miles around the earth stations, increasing security. Donald Wray, the Deputy Director of Engineering, and the Post Office engineer who had planned Goonhilly, dryly noted that if 'the Red Chinese started building an earth station in Cornwall their activity would not pass unnoticed'. However, Wray's overall analysis of the reports was conclusive, noting the advantages cables had over satellites: greater secrecy, simplicity, life-span, transmission time were simple advantages, whilst the relative complexity and manpower requirements of earth stations over cable stations was another. The Post Office's Joint Submarine Systems Development Unit (run with Cable & Wireless) also noted that satellites were less susceptible to malicious and electrical interference, but pointed out that, in the event they were damaged, cables could be repaired, whereas satellites could not.[69]

By 1976, eight cables crossed the Atlantic – six in the TAT series and two in the CANTAT series – and various techniques were developed to protect and repair these cables. In 1970, the Post Office used a 'sea-plough', developed by AT&T, to bury 80 miles of TAT-3 off the Cornish coast.[70] The shallow continental shelf was where submarine cables were most vulnerable to damage from fishing trawlers, and so was where most protection effort was focussed. Into the 1970s, new methods for accessing cables for maintenance were pursued. In 1970, I.R. Finlayson, the Post Office's Submarine Superintendent, commissioned a report from a marine consultant, Lieutenant Commander Lovell Smith, on the viability of a diving unit to repair submarine cables whilst on the sea-bed.[71] Finlayson also collaborated with the Marine Technology Support Unit at Wantage Research Laboratory, part of the United Kingdom Atomic Energy Authority, on commissioning underwater habitats which submarine cables could be pulled into for repair.[72] The diving unit was never established, and submersible habitats were apparently never deployed, but the Post Office's interest in these strategies highlights the powerful incentives to devise new ways of quickly repairing damaged cables. One successful strategy was the use of submersibles: in the early 1970s, the Post Office used mini-submarines called 'Pisces' to bury and repair cable, and later in the 1970s, a consortium of North Atlantic telecommunications companies, the North Atlantic

[69] 'Joint Submarine Systems Development Unit (P.O. and C.&.W.): General Appraisal of Present and Future Activities' 3 March 1967, TCB 711/29/9, BTA.
[70] O. Bates, 'Ploughing the Seabed', *Post Office Telecommunications Journal* 22, no. 4 (1970): 2–4.
[71] 'The State of the Art of Diving at the Present Time and in the Foreseeable Future, with Particular Reference to the Repair of Buried Submarine Cable' 1970, TCB 711/30/5, BTA.
[72] I.R. Finlayson to F.A. Hough, 'Proposed Organisation of R&D by the Underwater Engineering Group, CIRIA', 19 November 1969, TCB 711/30/5, BTA.

Cable Maintenance Agreement, which included the Post Office and AT&T, pooled funds to purchase two unmanned submersibles, known as SCARABs, for submarine maintenance work.[73] Another project, developed by the Post Office, was a new grapnel for cutting deep sea cables and bringing them to the surface for repairs. By 1979, Martlesham Heath had developed the 'cut and hold grapnel', which was able to simultaneously cut a cable and then immediately lift it for repairs. The grapnel could work at depths of 5,000 fathoms, had a sonar surveillance system, and used a built-in power source to provide hydraulic operation. This new grapnel reduced grapping time by a third and total repair time by just over a fifth, was heralded as a leap forward in cable repair, and quickly found customers abroad.[74]

The corporations laying these North Atlantic cables transformed their organisational alliances in the late 1970s, mirroring the INTELSAT organisation in order to legitimise cable planning. The technical and diplomatic considerations which influenced cable planning, as well as the benefits of pooling resources – already demonstrated by arrangements such as the North Atlantic Cable Maintenance Agreement – meant that, in 1977, the Post Office hosted the first North Atlantic Systems Conference.[75] The conference met in Eastbourne, was attended by telephone administrations from Western Europe and North America, and was ostensibly transmission-neutral, claiming to be about all communication links across the North Atlantic – both satellites and cables – which is apparent in the meeting's name: the North Atlantic *Systems* Conference. As such, it was not just telephone administrations which were invited to attend, but also representatives from COMSAT and INTELSAT. However, the conference contained an ulterior motive: re-establishing cables' place in transatlantic communications. In 1976, AT&T and the Post Office, along with CTNE, the Spanish telephone administration, held meetings regarding the development of the next round of transatlantic cables, TAT-7 and TAT-8.[76] AT&T had found it difficult to secure FCC approval for transatlantic telephone cables, given the USA's commitment to communication satellites, and the security of the COMSAT-INTELSAT diplomatic and legal instrument. The telephone companies thus conspired to give transatlantic telephone

[73] Edward Fennessy, 'Submarine Recovery' 13 September 1973, TCB 711/30/5, BTA; 'Purchase of Submersible Vehicles for North Atlantic Cable Maintenance' 28 January 1975, TCB 711/30/5, BTA.
[74] The British Post Office, 'Cut & Hold Grapnel' 1979, TCB 711/35/3, BTA; J.E.H. Cosier, 'Getting to Grips with Undersea Cables', *Post Office Telecommunications Journal* 30, no. 1 (1978): 7–8.
[75] 'Report of the First Session of the North Atlantic Systems Conference' 18 February 1977, Folder 11, Box 62, MS2137: Joseph V. Charyk Papers, GWSC.
[76] J Hodgson, 'Conference on North Atlantic Systems: Discussions in New York with AT&T and CTNE, 8-9 July 1976' 12 July 1976, TCB 711/29/25, BTA.

cable planning greater weight in the FCC's eyes, and the result was the North Atlantic Systems Conference, which earned legitimacy by claiming system neutrality and having COMSAT and INTELSAT as participants. Somewhat too late, COMSAT's representative realised that the conference was, in his words, an attempt to 'INTELSATIZE the cable planning process to achieve a comparability with the satellite process in the eyes of the US government'.[77] However, by this point, plans for TAT-7 had been approved, the groundwork for TAT-8 laid, and agreements made by the North American and European telephone companies for further conferences in the series.

In 1978, TAT-7, the last analogue, coaxial cable in the TAT series, was laid, and ten years later, in 1988, TAT-8, the first transatlantic digital, fibre-optic cable, was laid. TAT-8 was a joint venture between the newly-privatised BT, the newly-divested AT&T, and France Telecom, created in 1988 in preparation for privatisation in 1998 in accordance with EU law. The cable cost ~£225 million, of which British Telecom contributed £34 million, the second largest share. The cable's novelty lay not just in its new transmission medium – optical fibre – nor its new transmission mode – digital – but also its use of an underwater branching unit on the continental shelf off the British coast. This meant that the cable provided links from the USA to both Britain and France, as well as a cross-channel fibre-optic link.[78] TAT-8 could carry 40,000 simultaneous telephone calls – an almost ten-fold leap over the 4,200-circuit capacity of TAT-7, and an over three-fold increase from the most recent INTELSAT series, INTELSAT V, which could carry 12,000 calls.[79]

However, by 1988 submarine cables had not just organisationally imitated satellite planning, but had also been almost completely obscured by communication satellites in an 'information age' discourse. Satellites had been linked with the information age as early as the 1960s. Lewis Bohn, an analyst at Herman Kahn's Hudson Institute, identified communications satellites as a developing 'information technology' in 1968, whilst Edwin Parker, a Stanford economist, interlinked communication satellites as a 'key information technology' with Daniel Bell's concept of the 'post-industrial society'.[80] Donald Lamberton, the Australian economist, edited a special issue of *Annals*

[77] Jack Oslund to R.R. Colino, 'Eastbourne Meeting', 1 March 1977, Folder 11, Box 62, MS2137: Joseph V. Charyk Papers, GWSC.
[78] 'Go-Ahead for TAT-8', *BT Journal* 4 (Winter 1984): 35.
[79] Roger Smith, 'BT Bites Back ... New Cable More than a Match for "Jaws"', *BT Journal* 8, no. 2 (1987): 38–41; 'INTELSAT V Facts' 1981, OI-435400-01, NASM.
[80] Lewis C. Bohn, 'Information Technology in Development' (Croton-on-Hudson, NY: Hudson Institute, 1968); Edwin B. Parker, 'Information and Society', *Annual Review of Information Science and Technology* 8 (1973): 345–73.

of the American Academy of Political and Social Science in 1974 on 'The Information Revolution', and similarly positioned satellites within an industrial transition.[81] Lamberton explained that 'new information technology, for example computers and satellites, symbolise the movement of society into a new industrial revolution: the information revolution'. In the 1980s, this linkage of satellites and the information age would be deployed within BT and AT&T's discourse about international communications.

BT's inter-linkage of communication satellites and the information age particularly targeted business customers, and underscored the influence privatisation and liberalisation had on the telephone company. After privatisation, BT created British Telecom International to oversee and market international communications. The BTI television advert mentioned at the start of this chapter notably juxtaposes satellites, computers, and business, all in the same year that TAT-8 launched. This marketing angle was also present in prior BTI publicity, which also borrowed from the 'one world' discourses associated with communication satellites. In 1984, an advert informed BTI customers that international communication was 'uniting the business world', whilst a 1986 advert announced that international video-conferencing was a business's 'short cut to the global village', recasting McLuhan's ambivalence into a free-enterprise market-oriented opportunity.[82] Another 1986 advert publicising global data communication links as 'The Information World'.[83] These adverts thus show the various overlaps of global communications and the information age.

The clearest linkages of satellites, business, and the information age come in two developments: the creation of the London 'Teleport', and BT's SatStream variant of its X-Stream services. London Teleport, which I previously addressed in Chapter Six, opened for service on February 1st, 1984 in London Docklands, to bring 'high-speed telecommunications to the fingertips of the City', using the City's new optical-fibre network.[84] The name 'teleport' connotes the instantaneous, dematerialised qualities attributed to global communications, suggesting the popular sci-fi 'teleporter' device, such as *Star Trek*'s transporters. However, such space age implications were unnecessary, as BT publicity explicitly announced that the teleport was 'bringing space-age

---

[81] Donald Lamberton, ed., 'The Information Revolution', *Annals of the American Academy of Political and Social Science*, 1974.
[82] 'Uniting the Business World' 1984, TCD 265/BTIPR 253, BTA; 'Videoconferencing' 1986, TCE 310/BTI AP 1174(a), BTA.
[83] 'The Information World' 1986, TCE 310/BTI AP(a), BTA.
[84] 'The London Teleport' October 1984, TCD 265/BTIPR 263, BTA.

communications to the heart of London'.[85] The business orientation of the teleport was further reinforced by BT's emphasis on its videoconferencing capabilities, offering 'the busy executive the ability to conduct real time, face-to-face meetings without the need to commit valuable time and resources to travel'.[86]

SatStream, part of BT's X-Stream services, also highlighted the intertwining of satellites with business services.[87] I have already addressed the X-stream services in Chapter Four, but here I want to particularly focus on SatStream, an international service which allowed customers to connect directly to a European satellite through small dishes installed on their buildings' roofs. SatStream thus bypassed both earth stations and global satellites, instead permitting European businesses to deal with one another directly. The satellite here thus took on a new form, marketed towards the free enterprise needs of the 1980s rather than the centralised Cold War needs of the 1960s and 1970s' 'single global system', and formed an 'integral part of British Telecom's network market strategy' as it searched for new business and attempted to remain competitive in the wake of privatisation.[88]

A similar process can be seen in AT&T's publicity, which also interlinked global communications and the space age with the information age and the economic trends of the 1980s. In 1982, AT&T's monopoly over the American telephone network was divested: AT&T's regional subsidiaries were broken up into regional Bell operating companies, also known as 'Baby Bells', whilst AT&T remained as a long distance and international operator. The telephone network was also opened to competition from companies such as MCI. AT&T's advertising in the 1980s reflected its loss of domestic local telephony, instead presenting itself as 'The Knowledge Business' and emphasising that, through its international services, 'Bell Brings the World Closer'.[89] International services were linked with the information age in a series of adverts addressing divestiture: in one, AT&T's CEO of Overseas Services, Morris Tanenbaum, explained that AT&T's global network was 'the foundation for the information age'. Here, this parallels the AT&T TV advert described at the beginning of this chapter, in which AT&T promoted

[85] 'The London Teleport, October 1984, TCD 265/BTIPR 263, BTA'.
[86] 'The London Teleport, October 1984, TCD 265/BTIPR 263, BTA'.
[87] 'X-Stream, 1981, Folder 4, Box 80, MS2137, GWSC'.
[88] 'X-Stream, 1981, Folder 4, Box 80, MS2137, GWSC'.
[89] AT&T and N.W. Ayer, 'Data 99.5% Pure' 1982, Folder 3, Box 28, Series 4, Collection 59: N.W. Ayer Advertising Agency Records, NMAH; AT&T and N.W. Ayer, 'Call the UK $1.25' 1982, Folder 6, Box 28, Series 4, Collection 59: N.W. Ayer Advertising Agency Records, NMAH.

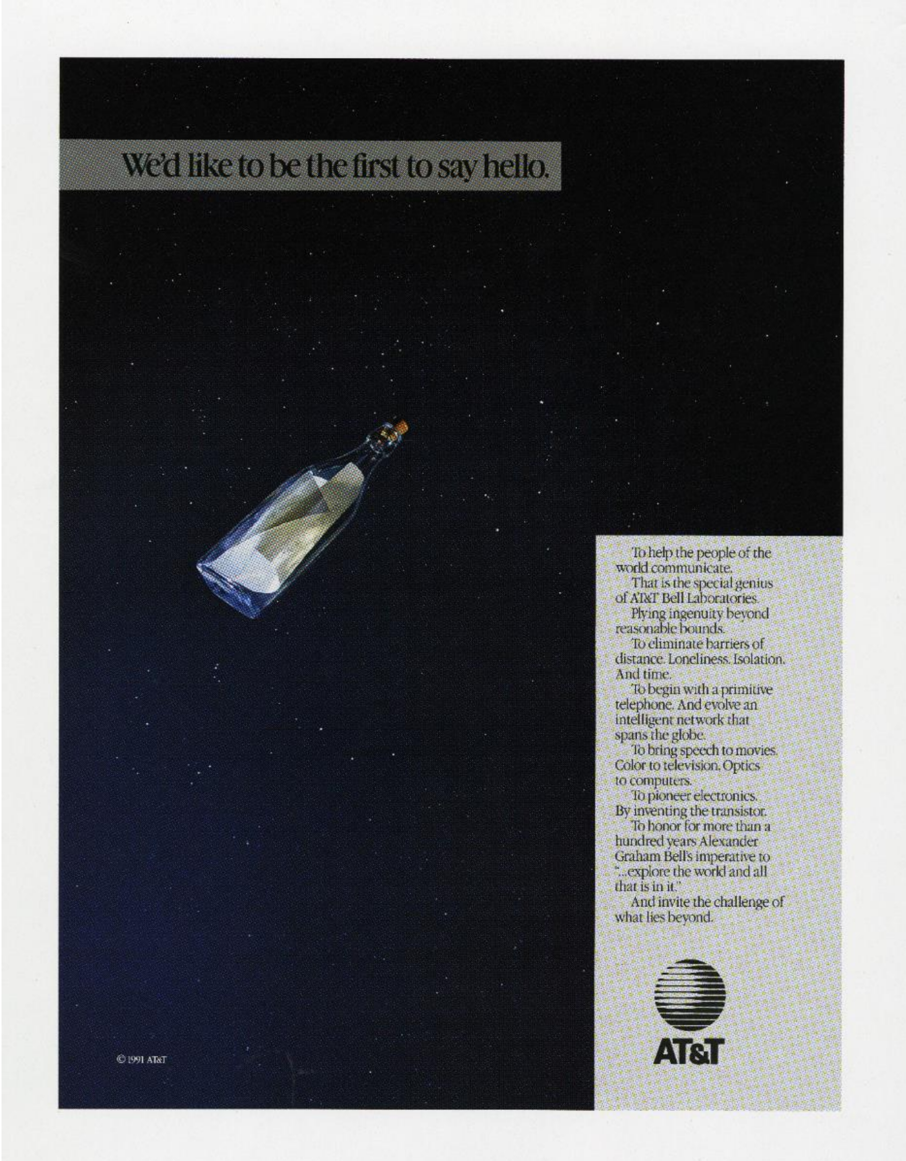

Figure 8.6. The message in a bottle floats in space, not on the ocean. Courtesy of NMAH Archives Center.

---

its 'worldwide intelligent network'.[90] In a 1986 advert, 'Issues of the Information Age: Promises Kept, Promises to Keep', which ran in the *Wall Street Journal*, AT&T explained how international communications was key to achieving a worldwide 'Telecommunity', a 'vast global network of networks, the merging of computers and communications'.[91] However, one advert in particular, which ran in 1991, highlighted, like AT&T's 1989 TAT-8 commercial, how this merging of global communications and the information age

[90] AT&T and N.W. Ayer, 'Our Network Is the Foundation for the Information Age' 1983, Folder 1, Box 30, Series 4, Collection 59: N.W. Ayer Advertising Agency Records, NMAH.
[91] AT&T and N.W. Ayer, 'Issues of the Information Age: Promises Kept, Promises to Keep' 1986, Folder 2, Box 31, Series 4, Collection 59: N.W. Ayer Advertising Agency Records, NMAH.

was also supported by invoking satellites and the space age. The 1991 advert bore the slogan ‘We’d like to be the first to say hello’, and depicted a message in a bottle (Figure 8.6).[92] However, underscoring the importance of the satellite age to the information age discourse, and outer space’s victory over the sea, the bottle was not afloat on the ocean, but instead in space.

Conclusion

This chapter can broadly be divided into three stages: in the first, transatlantic communications – TAT-1 and Telstar – were pioneered by the state and state-sanctioned monopolies of the Post Office and AT&T; in the second, Cold War interests motivated a greater deal of state involvement, resulting in the INTELSAT system; in the third, corporate direction resurfaced with TAT-8, London Teleport, and SatStream. In each stage, different discourses predominated and surfaced, or obscured, the environment in different ways. In the first period, TAT-1 and Goonhilly were, in the UK, entangled with a discourse of ‘defiant modernism’, emphasising British – and Post Office – technological proficiency, whilst in the USA, AT&T highlighted TAT-1 and Telstar’s hazardous ocean and space environments to accentuate its contributions to the projection of US military and economic interests abroad. In the case of Telstar however, this rhetoric escaped its discursive box and became entangled with a growing environmentalist mode of thinking which problematized the American approach to the space environment.

In the second period, the communication satellite became a symbol of global togetherness, whilst practically working as an instrument of US foreign policy. I showed how the conflict between the American commitment to satellites and British and French commitment to cables played out both in public, with INTELSAT and COMSAT’s publicity campaign in the late 1960s and 1970s emphasising cables’ fragility and satellites’ environmental transcendence, and in private, with Britain and France favouring their own international communications agendas at the 1963 Extraordinary Administrative Radioconference.

Finally, in the third period, I demonstrated the stabilisation of the satellite as a symbol of global communications, the effects of this on North Atlantic cables, and the entanglement of international communications and the ‘information age’. North Atlantic cable planning was ‘INTELSATIZED’ to mirror satellite planning, in a successful

[92] AT&T and N.W. Ayer, ‘We’d like to Be the First to Say Hello’ 1991, Folder 13, Box 33, Series 4, Collection 59: N.W. Ayer Advertising Agency Records, NMAH.

attempt to move forward with TAT-7 and TAT-8, but, as the publicity campaigns of BT and AT&T from the 1980s showed, the cable had disappeared from the public eye. Instead, the satellite, which had been presented as an ‘information technology’ since the 1960s, was juxtaposed with computers and free enterprise to perpetuate the idea of a new ‘information age’. London Teleport and SatStream materialised the shift in satellite infrastructure from the state-based, centralised earth stations of the 1960s and 1970s to the corporate, distributed, private earth stations and small dishes of the 1980s.

However, there are also commonalities through these three stages. At each stage, international communication was presented in the USA as an opportunity to project American business interests abroad, and, whilst the INTELSAT ‘single world system’ declined relative to international fibre-optic links, another idealistic ‘single world system’ – that of the information age as an era of free enterprise and rapid, global communications links between computers and satellites – remained in its wake. This single world system was perpetuated by corporations adjusting to their own new positions in liberalised markets, although this should not be read as an embracing of those ideals, but rather a strategy to maximise their own competitiveness in the public eye and thus maintain their positions as market leaders, built on their former state-sanctioned monopolies. I therefore hope to have shown in this chapter that, on a transatlantic stage, the intertwining of neoliberal politics, business interests, and international communications was displayed through the lens of a satellite.

In this chapter, I have mainly focussed on ‘information’, although the struggles for control over transatlantic communications, both organisationally and environmentally, have also played an important role. In the next chapter, I turn my attention to the intersection of the information discourse with British politics in the privatisation of BT, and the strategies of internal control deployed by BT to prepare its staff for the transition for public to private, as I explore the history of BT’s privatisation.

9 The London Ideology

Constructing the Privatisation and Information Movements

In September 1992, Margaret Thatcher delivered a speech, 'The Principles of Thatcherism', in Taiwan and Seoul, South Korea, in which she outlined the core features of Thatcherism: liberty, monetarism, enterprise, privatisation, justice, defence, and sovereignty. Thatcher called privatisation 'one of Britain's most successful exports' and boasted that it had both trebled the number of individual shareholders in Britain and 'put a stop to the idea that inefficient management would always be subsidised by the taxpayers'.[1] These two dimensions – managerial efficiency and individual share-ownership – are the axes along which the privatisation of BT is near-universally drawn. In contrast, the relation of BT's privatisation to the technological system it shaped and was shaped by is conspicuously absent. This is even more perplexing considering the major emphasis given by the Thatcher government to information and communication technologies, and the global significance which these particular technologies were appointed during the 1980s.

Another feature curiously neglected in Thatcher's speech and many accounts of privatisation (as I shall address below) is the liberalisation of the telephone monopoly in 1981. Liberalisation, as I pointed out in Chapter Three and as it has featured in subsequent chapters, was a significant moment for the shape and orientation of the British telephone system; by 'liberalisation', I mean the end of the telephone monopoly and its opening up to competition, which, as has been evident throughout this thesis, had numerous effects on BT's activities, such as Martlesham Enterprises, X-Stream Services, ISDN, London

[1] Margaret Thatcher, 'The Principles of Thatcherism' (Taiwan, 1 September 1992), http://www.margaretthatcher.org/document/108301; Margaret Thatcher, 'The Principles of Thatcherism' (Seoul, South Korea, 3 September 1992), http://www.margaretthatcher.org/document/108302.

TeleCity, SatStream, and London Teleport. Of course, liberalisation did not only involve BT – it also involved the numerous companies which were permitted to enter the telecommunications market in the UK, not least Mercury, which would become BT's primary competitor, as the only other company licensed to provide an alternative public telecommunications network. However, as I pointed out in Chapter Three, Frank Webster has argued that Mercury was only ever a public telecommunications operator in name: Mercury, like BT after liberalisation, prioritised lucrative business traffic, particularly in London and Birmingham, which formed the centres of its 'figure of eight' network, linking London, Birmingham, Manchester, Leeds and Bristol. However, where BT had a national network to attend to, Mercury was instead free to choose its own priorities, which meant that by 1990, after eight years of protected duopoly, Mercury had less than 10% market share and yet was earning 30% of *total* nationwide revenue from bulk customers.[2] Webster thus argues that Mercury shows how liberalisation was less about competition, and more about the business-orientation of telecommunications in Britain.[3] This chapter addresses liberalisation and privatisation in the context of BT, but Mercury merits a full history as a unique example of the *de novo* creation of a technological system in a liberalised, and yet protected, duopolistic environment, where the system was free to set its own priorities, in contrast to the momentum of BT's existing network.

However, despite liberalisation's significance, it is unusually invisible in Thatcher's own account of her management of the state-owned industries. This chapter thus poses two questions: what roles did liberalisation and privatisation play in shaping the British telephone system, and what was the relationship between these processes and the broader 1980s enthusiasm for information technology and an 'information revolution'? I will answer these questions by exploring perspectives and experiences from BT's privatisation in two sections, addressing privatisation externally and internally to BT, and paying attention to the articulations of technology throughout. In the first section, I explore external dimensions, looking at the politics of BT's privatisation and its broader reception, whilst in the second, I look at the internal dimensions, addressing the experiences of management and staff, as well as exploring the technological developments addressed in previous chapters in more detail in relation to privatisation and liberalisation.

---

[2] Webster, *Theories of the Information Society*, 173.
[3] Webster, 173.

Before that, however, I will outline a brief chronology of liberalisation and privatisation, and address accounts of BT's privatisation.[4] As covered in Chapter Three, Keith Joseph, the Secretary of State for Industry, announced in July 1980 that he would restructure the Post Office and relax the state's telecommunications monopoly over customer premises equipment (CPE) and value-added network services (VANS). In November 1980, the British Telecommunications Bill was published and preparations went underway for the separation of posts and telecoms. In April 1981, the Beesley report was published, recommending not only the full liberalisation of VANS and licensing of private telephone line providers, but also that rival operators should also be able to set up competing telephone networks with BT. In November 1981, the liberalisation of CPE provision was hastened so that full CPE liberalisation would be completed by July 1983 and in February 1982, Mercury, BT's first competitor, was licensed. Later that year, in July 1982, a government white paper, *The Future of British Telecommunications*, was published, proposing the sale of 51% of BT and the creation of a new independent telecommunications operator, OFTEL. In February 1983, the government removed BT's right to install the first telephone in new telephone line installations and two months later, in April 1983, Mercury launched in the City of London (note here the prioritisation given to business and financial institutions in the liberalised British telecommunications system). In July 1983, a new British Telecommunications Bill was drawn up in response to the July 1982 white paper, which had been reintroduced after Thatcher's successful second general election. In November 1983, the government announced that Britain would have a duopoly system for public telephone networks, composed of BT and Mercury, until 1990. The next year, the 1984 Telecommunications Act passed, paving the way for the June 1984 creation of OFTEL, Britain's new telecommunications regulatory agency, and the November 1984 share issue for BT. BT's share issue was the largest share issue ever, amounting to almost £4 billion, and so BT became a private company, although the state still owned a 49% minority stake. The process which had begun in July 1980 completed in October 1985, as OFTEL formalised Mercury's rights to interconnect with BT's network (this had previously been negotiated directly between Mercury and BT), allowing any Mercury customer to call any BT customer, and vice versa.

Most scholarship on BT's privatisation situates it politically, rather than technologically, and relates it to an ideological shift within Thatcherism, from privatisation as a tool for increasing efficiency, to privatisation as a method for increasing

[4] Here I have been greatly aided by the succinct overview of this period by Cento G. Veljanovski, *Selling the State: Privatisation in Britain* (London: Weidenfeld and Nicolson, 1987), 191.

popular share-ownership. Richard Stevens notes that, in 1981, the main objectives of privatisation were relieving pressure on the public sector borrowing requirement (PSBR) by relocating publicly-owned industries to the private sector, and this is indeed a recurring theme in histories of BT's privatisation.[5] BT desperately needed to borrow to finance investment in the telephone network, and so the PSBR restrictions became a major motivation for privatisation. Stevens argues that BT's sale, which was unexpectedly successful, was responsible for a distinctive change in the presentation of privatisation, from the economic emphases on the PSBR, managerial inefficiency, and competition, to the ideological emphasis on share-owning democracy.[6] Kenneth Morgan takes a broadly similar line, arguing that the privatisation of BT was not about technological advance or spurring efficiency, but that it was driven by PSBR restrictions and the goal of a share-owning democracy.[7] There is a slight contradiction here, in that the borrowing limited by the PSBR was necessary for technical investment, but Morgan makes a useful distinction, important throughout this chapter, in separating out the different motivations for privatisation – technical advance, efficiency, the PSBR, share-owning democracy – as each became more and less relevant at different stages of the longer liberalisation and privatisation process.

These histories also emphasise BT's privatisation as an important plank of Thatcherism. Privatisation, until BT, was a relatively minor industrial policy; before BT, there had been nine privatisations (not including subsidiary corporations, such as British Airways' International Aeradio), and the largest sale had been the £627m tender offer for Britoil in November 1982, over six times smaller than BT's share offer.[8] Bishop and Thompson argue that the unexpected popularity of BT's privatisation transformed privatisation into a central feature of the Conservative policy – the share issue was massively oversubscribed with 2.25m applications receiving shares.[9] Veljanovski notes that Britain privatised harder and faster than anywhere else in the world, and sees BT as especially pivotal in the acceleration of that movement; he also presents privatisation as

---

[5] Richard Stevens, 'The Evolution of Privatisation as an Electoral Policy, c.1970–90', *Contemporary British History* 18, no. 2 (2004): 56–61.
[6] Stevens, 61.
[7] Kenneth O. Morgan, 'Nationalisation and Privatisation', *Contemporary Record* 2, no. 4 (1988): 34.
[8] David Parker, *The Official History of Privatisation: Volume 1, The Formative Years 1970-1987* (London; New York: Routledge, 2009), 180–81.
[9] Matthew Bishop and David Thompson, 'Privatisation in the UK: Deregulatory Reform and Public Enterprise Performance', in *Privatisation: A Global Perspective*, ed. V.V. Ramanadham (London; New York: Routledge, 1993), 6–7.

primarily oriented towards disciplining the nationalised industries, supporting broad private ownership, and generating an entrepreneurial society.[10]

Monica Prasad locates BT's privatisation as one of three 'pillars' of Thatcherism, alongside the 1981 monetarist tax budget and the sales of council houses. Prasad argues that privatisation was Britain's particular flavour of free market neoliberalism, compared to deregulation, for example, in the USA, and argues, like all the scholars above, that BT's privatisation was initially not ideological, but instead motivated by a need to raise capital.[11] Prasad argues that the success of BT's privatisation radicalised Thatcherism, transforming it into a moral movement oriented around 'popular capitalism' and 'property-owning democracy'.[12] David Parker, in his official history of privatisation, also reinforces the PSBR and efficiency narrative, and identifies privatisation's success as a transformative moment for popular capitalism, but unlike above accounts, distinguishes between popular share-ownership as a results of privatisation's success, and its role prior to privatisation. Parker shows that the flotation of BT was anticipated as so large that alternative sources of finance were required, and so individual shareholders were tapped into as a new market, ideologically compatible with Thatcherism.[13] These histories all make clear that BT's privatisation was a pivotal moment for Thatcherism, originating a popular capitalist ideology, but it remains to be seen how this was interlinked with the growing popularity of information technology and information age discourses in the 1980s.

Histories of utilities have approached privatisation from a more technological angle, although BT's privatisation is less extensively addressed, and the role of technology is still unsatisfactory. Robert Millward casts the long history of utility regulation in the West in four phases: first, broad support for free market initiatives in the dawn of infrastructure; second, municipally-owned infrastructure; third, state ownership of infrastructure; fourth, free-market privatisation.[14] Millward relates these transitions to technological change: private enterprise railways demonstrated the capacities of the free market; local and regional electricity networks favoured municipal enterprise; the post-war dependence on oil and natural gas encouraged state solutions; and the growth of ICTs in the 1980s – particularly the opportunities for competition in ICT services – incentivised

[10] Veljanovski, *Selling the State*, 1–2, 8–9.
[11] Prasad, *The Politics of Free Markets,* 99–102.
[12] Prasad, 103, 131–35.
[13] Parker, *The Official History of Privatisation: Volume 1, The Formative Years 1970-1987*, 254–55, 291–94.
[14] Robert Millward, *Private and Public Enterprise in Europe: Energy, Telecommunications and Transport, 1830-1990* (Cambridge: Cambridge University Press, 2005), 7.

free market privatisation and competition. Millward's phasing is problematic – it is heavily generalised and some explanations, particularly the post-war relevance of oil and natural gas to state-owned infrastructure, feel quite weak. However, his work is interesting for his argument that BT's liberalisation was more significant than its privatisation, noting that BT's privatisation was the only major telecommunications operator privatisation until the 1990s, whereas liberalisation and deregulation became more established trends in the 1980s.[15] Judith Clifton, Pierre Lanthier, and Harm Schröter follow Millward's phasing and take pains to expand out the dimensions for his transitions to include military, political and social pressures.[16] However, they do agree that technological change in telecommunications, which meant lower sunk costs and greater potential for network services, made competition easier, incentivising regulatory change as natural monopoly and economies of scale no longer applied; here they highlight BT's privatisation as an ambitious programme which subsequent regulatory change in telecommunications sought to emulate.[17]

Synthesising these accounts, two points emerge: first, the privatisation of BT was hugely significant both for Thatcherism and broader regulatory change for telecommunications; second, that privatisation can be framed not just within the rise of popular capitalism, but within the intertwining of neoliberal deregulatory movements and ICTs. The utility history perspectives are somewhat undercooked in their conceptualisation of ICTs and the free market – there is a lingering sense that ICTs are viewed as intrinsically market-oriented – but the larger and more important fact to note is that, whilst support for a share-owning democracy has faded, the information age ideology persists. BT's privatisation thus needs to be fully considered from this perspective.

Pillar of Thatcherism

There are two areas I will explore in the external framings of BT's privatisation: first, the government's enacting of privatisation, paying special attention to the mutual shaping of technology and policy and the role of privatisation within the Thatcher government's broader attention to information technologies, and situating these against the canonical

[15] Millward, 244–54.
[16] Judith Clifton, Pierre Lanthier, and Harm Schröter, 'Regulating and Deregulating the Public Utilities 1830–2010', *Business History* 53, no. 5 (2011): 661.
[17] Clifton, Lanthier, and Schröter, 663.

popular capitalism and efficiency narratives of privatisation. Second, I will also address wider perceptions and consequences of BT's privatisation, both in the UK and more broadly.

The question of whether BT should be broken up into regional companies shows one way in which technology influenced policy. Thatcher, drawing on those recurring themes of information and control, favoured a similar regional reorganisation to AT&T's break-up into 'Baby Bells', as she believed it would provide more information on performance – through comparison between regional networks – and that local monopolies would enable greater local control.[18] Patrick Jenkin, the Secretary of State for Industry, was less open to regionalisation, believing that BT did not have the management apparatus to oversee the break-up, arguing that it could damage rural interests, and pointing out that BT's network, unlike AT&T's, was nationally integrated and so less amenable to regionalisation.[19] Jenkin and Thatcher were both also agreed that, much to Thatcher's vexation, regionalisation would delay privatisation and so the idea was abandoned primarily for that reason.[20] Nevertheless, this policy-making episode, despite its failure, is fascinating for two reasons: first, it surfaces a conflict between the telephone system's long-standing goal of integration and universality, which I primarily explored in Chapter Five, and the deregulatory goal of regionalisation; second, contra to the consensus narrative, Thatcher's interest in local monopolies' capacity for local control shows her lack of ideological commitment to competition.

Security concerns also highlighted the tension between ideology and technology. William Whitelaw, the Home Secretary, expressed concerns from July 1980 that any regulatory change in telecommunications would compromise the nation's security apparatus: at that point, the Post Office was carrying out telephone interception on behalf of the police, Customs and Excise, and the Security Service, MI5.[21] Whitelaw's initial concern was about a potential inquiry into the monopoly from the Monopolies and Mergers Commission jeopardising these special intelligence-gathering services; Whitelaw's fears never materialised as the government blocked the inquiry, fearing it would pre-empt deregulatory policy initiatives. However, Whitelaw conceded that he would inevitably have to accept 'degradation' and risk to the nation's intelligence

[18] M.C. Scholar to Jonathan Spencer, 'British Telecommunications: Regionalisation', 9 November 1982, PREM 19/1100, TNA.
[19] Scholar to Spencer.
[20] Scholar to Spencer.
[21] William Whitelaw to Margaret Thatcher, 'Telecommunications Monopoly', 7 July 1980, PREM 19/562, TNA.

gathering capacity in the face of the 'overriding political and economic case' for competition.[22] Here then, in contrast to regionalisation, competition was mobilised to serve the broader goal of organisational change for BT; in a sense, this reinforces that competition was not the ultimate ideological goal for Thatcherist industrial policy, but rather another rhetoric that could be invoked when useful.

Liberalisation and privatisation also intersected with telephone exchange supply and manufacturing. In July 1980, Keith Joseph, then Secretary of State for Industry, argued to Thatcher that liberalisation should be gradual, as opening manufacturing markets too fast would mean a dangerous influx of imports from abroad; instead, Joseph argued for a three-year phased introduction to competition in order to allow British manufacturers to prepare.[23] The manufacturers were also concerned: D.H. Pitcher, the Managing Director of Plessey, lobbied Number 10 in 1980 to broaden liberalisation to include BT's monopoly over equipment maintenance, arguing that otherwise BT could favour its own equipment over maintaining competitors' equipment.[24] This lobbying continued with Arnold Weinstock lobbying Joseph to give BT access to private finance and escape the PSBR in order to further fund System X procurement. Weinstock was still bitter about losing out during the TXE4 modernisation process 'on the basis of unreliable output from a computer study of the economic case', and argued that private finance would allow BT to move past its prior modelling-induced ineptitude.[25]

In the end, more pressing concerns about international competition and the political desire to grow the domestic IT manufacturing base ended up working against Weinstock. In 1982, BT notified GEC, Plessey, and STC that, with the government, it had decided to narrow down System X procurement to just one supplier, which would guarantee that supplier a revenue stream to grow its manufacturing base, resist international competition, and market System X abroad.[26] By September 1982, the final terms had been agreed: the American-owned STC backed out altogether, Plessey became the prime development contractor, BT withdrew from System X development altogether, procurement was divided between Plessey and GEC to prepare both for domestic and

[22] Whitelaw to Thatcher.
[23] Keith Joseph to Margaret Thatcher, 'Telecommunications Monopoly', 1 July 1980, PREM 19/333, TNA.
[24] D.H. Pitcher to John Hoskyns, 'Post Office Monopoly', 19 November 1980, PREM 19/562, TNA.
[25] Arnold Weinstock to Keith Joseph, 'Post Office Switching Systems and Liberalisation', 16 March 1981, PREM 19/875, TNA.
[26] J.S. Whyte to J. Samson, W.D. Morton, and D.H. Pitcher, 'Organisation and Prospects for System X', 18 May 1982, PREM 19/876, TNA.

international competition, and fully competitive procurement would start from 1985.[27] This aspect of liberalisation supports Schiller's thesis, covered in Chapter Two, that the expansion of ICTs in the early 1980s was nationalistic, with states seeking to develop, expand, and privatise the domestic ICT sectors in order to become internationally competitive.[28]

Competition, liberalisation, and privatisation had also been articulated by government actors within a growing discourse about the opportunities provided by information technologies and services. Keith Joseph's July 1980 announcement of liberalisation outlined a vision of information and communication technologies as inherently competitive and providing immense opportunities for domestic markets – opportunities too great to be left to one organisation alone – and this continued with proposals for privatisation.[29] In May 1982, Patrick Jenkin, Joseph's successor, first proposed the privatisation of BT as both a way of raising equity for BT outside the PSBR, by selling 25% of the state's stake, and as a way of encouraging enterprise and the expansion of ICTs, asserting that 'I believe that this Bill will prove to be the most lasting legacy of Information Technology Year'.[30] From the very start, privatisation was entangled with political understandings of information technology. A subsequent white paper, *The Future of Telecommunications in Britain*, announced government plans to privatise BT, entangling notions of government control with the emancipation of technology.[31] The white paper outlined that PSBR restrictions meant the 'need to free BT from traditional forms of government control', which would be replaced by 'the most liberal [IT regulations] in the world'; it was further explained that 'competition and the advent of new technology are stimulating BT to respond to market opportunities'. Here, competition was matched by information technology as an equal market pressure for BT.

The Thatcher government's announcement of 1982 as IT-82, a national Information Technology Year, was also used to interlink BT's privatisation with IT, the market, and competition. Thatcher, speaking at an IT conference at the Barbican in December 1982, further expanded on the government's liberal economic approach to information technology, arguing that IT required 'free enterprise' – which she noted would soon include the privatised BT – and 'competition', and explaining that IT had

[27] Kenneth Baker to Margaret Thatcher, 'System X', 29 September 1982, PREM 19/877, TNA.
[28] Schiller, *Information and the Crisis Economy*, 2–7.
[29] 'Telecommunications' 21 July 1980, HC Deb Vol 989 cc29-40, Hansard.
[30] Patrick Jenkin to Leon Brittan, 'Future Policy on Telecommunications', 12 March 1982, PREM 19/875, TNA.
[31] *The Future of Telecommunications in Britain*, Cmnd. 8610 (London: HMSO, 1982).

thus necessitated the end of BT's monopoly and the creation of Mercury.[32] Kenneth Baker, the Minister for Information Technology, in a speech to the British Association for the Advancement of Science, contrasted the dystopic visions of the 'Electronic State' in Aldous Huxley's *Brave New World* and George Orwell's *1984* with the opportunities that micro-electronics and information technology in the 'post-industrial society' would provide for greater personal freedom, the retreat of the state, and privatisation.[33] Baker did not explicitly reference the privatisation of BT, but portrayed privatisation as a key weapon against the Electronic State: 'We should enhance the opportunities of private ownership for what the State owns it has to control. The State will provide much, the Electronic State could provide more, but it would exact a price in terms of personal freedom'.[34]

Information and control were here interlinked again with privatisation and the neoliberal state; in Baker's vision, information technologies offered either dystopia or utopia, and it was only through weakening state control – and implicitly strengthening corporate control – that dystopia could be avoided. As with the Long Range Strategy Seminar in Chapter Seven, Baker's use of science fiction is particularly revealing: neither Huxley's *Brave New World* nor Orwell's *1984* are particularly good models for the electronic state; the former is characterised by domination using psychological conditioning and reproductive technology, and the latter, as I showed in Chapter Seven, by primarily (but not exclusively) low-tech surveillance techniques. However, by invoking these fictions, both of which feature strong states, Baker reveals the great extent to which information technology had become ideologically entangled with the retreat of the state. For Kenneth Baker, Britain's Minister for Information Technology, and as with J.J. Wheatley, BT's Head Economics Adviser, in Chapter Six, information and communication technologies had become a pillar of the neoliberal state.

This casts a new light on the consensus view that privatisation, popular capitalism, and share-holding democracy were ideological outputs of BT's privatisation, in which its unexpected success showed an appetite for individual share-ownership and fuelled an ideology of emancipatory, individualistic 'financial consumerism'.[35] There are two points I wish to make which re-frame this history. First, as Parker has argued, and as discussed

---

[32] Margaret Thatcher, 'Speech Opening Conference on Information Technology' (The Barbican Centre, London, 8 December 1982), http://www.margaretthatcher.org/document/105067.
[33] Kenneth Baker, 'Towards an Information Economy' 7 September 1982, T 471/45, TNA.
[34] Baker.
[35] Amy Edwards, '"Financial Consumerism": Citizenship, Consumerism and Capital Ownership in the 1980s', *Contemporary British History* 31, no. 2 (2017): 210–29.

above, individual share-ownership actually had its origins in the need to find alternative sources of capital for BT's flotation.[36] From early 1984, individual share-ownership had been identified as a strategy for this purpose; a February 1984 report by Barclays Merchant Bank for Thatcher's Cabinet proposed targeting individual investors to raise capital, whilst also noting that such a policy might be an opportunity to ideologically develop a 'share-owning democracy' in Britain.[37] Ironically, given that Barclays pointed out that the 'traditionalism' of the City had previously discouraged wider share ownership, this report shows how Barclays Merchant Bank – itself a large financial institution – helped to shape BT's privatisation. This was reinforced in a July 1984 memorandum from John Redwood, Director of 10 Downing Street's Policy Unit, to Thatcher, emphasising that the main aim of the share issue should be to sell to individual investors for two reasons: first, the size of the sale demanded additional markets; second, as a way of coercing British financial institutions to invest.[38] Redwood argued that the key to getting these institutions to invest was to create the illusion that the government could sell substantial stakes in BT to other markets; overseas financial institutions were politically out of the question, and so individual investors became key.

Herein lies the origins of individual share-holding in BT's privatisation: not an unexpected success, but a crafted strategy from the start, influenced by and designed to influence the large financial institutions of the City. Indeed, in the actual BT share offer, domestic financial institutions were the largest shareholding group, buying 47% of available shares, ahead of individual shareholders' 39% and the 14% sold overseas.[39] As Amy Edwards has argued, Thatcherism was never really about popular capitalism or wider share-ownership, but 'financial capitalism' instead; Edwards shows how the privatisation of BT was initially popular, but individual investors either quickly offloaded shares, incentivised by discounted pricing schemes, or became rapidly uninterested in further investments.[40] Hence, as Parker writes, '"popular capitalism" was always more political rhetoric than economic reality', and it did not reverse the trend of growing concentration of corporate ownership within powerful financial institutions.[41]

---

[36] Parker, *The Official History of Privatisation: Volume 1, The Formative Years 1970-1987*, 291–94.
[37] Barclays Merchant Bank Ltd., 'Proposals for the Issue of Shares by British Telecom: A New Strategy for Widening Share Ownership in the United Kingdom' 2 February 1984, PREM 19/1345, TNA.
[38] John Redwood to Margaret Thatcher, 'British Telecom Meeting', 27 July 1984, PREM 19/1345, TNA.
[39] 'British Telecom Share Offer' 1984, PREM 19/1599, TNA.
[40] Amy Edwards, '"Manufacturing Capitalists": The Wider Share Ownership Council and the Problem of "Popular Capitalism", 1958–92', *Twentieth Century British History* 27, no. 1 (2016): 117, 122.
[41] Parker, *The Official History of Privatisation: Volume 1, The Formative Years 1970-1987*, 317.

The second point I wish to make is that the emancipatory discourse of individual share-ownership has significant commonalities with the political framings of information technology before and during privatisation. The histories of privatisation and 'popular capitalism', which take centre stage in accounts of BT's privatisation, have obscured the more significant discursive importance of privatisation. Popular capitalism has fallen by the wayside, but the ideology of 'digital utopianism', critically labelled the 'Californian ideology' by Barbrook and Cameron, has persisted, and here I want to highlight the significance of BT's privatisation to the 'Californian ideology'.[42] Barbrook and Cameron define the Californian ideology as a belief in the emancipatory potential of new information technologies, enabling a libertarian society characterised by freedom of expression; they highlight the emergence of these ideals from the engagement of West Coast counterculture with emerging information technologies and cyberculture and these ideals' fusion with neoliberal information technology policies designed to revive Western economies. This fusion produced a vision of IT as not just enabling individual freedoms, but also entrepreneurialism and, by extension, the privileging of the 'electronic marketplace', competition, deregulation, and the reduced power of the nation-state. This ideology, as I have shown, was pervasive through the privatisation of BT, from Baker and Thatcher's IT-82 speeches to Jenkin's belief that IT-82's greatest legacy would be BT's privatisation.

Baker's IT-82 speech confirms the politics of BT's privatisation as an early locus for digital utopian ideologies. Baker called the 'free flow of information' a necessary condition for a liberated information society, greater personal freedoms and private ownership, and the retreat of the state;[43] in this sentiment is an expression which resembles and yet predates *WIRED* founder and cyberculture guru Stewart Brand's maxim that 'information wants to be free', which has since become one of the rallying calls of digital utopianism.[44] However, the expression 'free flow of information' has its own longer history as a key term in late 1970s and early 1980s economic and industrial policy. Herbert Schiller describes the 'free flow of information doctrine', a policy programme supported in the USA and Britain, by international organisations such as the OECD, and transnational companies such as Coca-Cola and IBM, as an openness to 'transborder data flows' which were necessary for many transnational companies,

---

[42] Barbrook and Cameron, 'The Californian Ideology'.
[43] Baker, 'Kenneth Baker, Towards an Information Economy, 7 September 1982, T 471/45, TNA'.
[44] Turner, *From Counterculture to Cyberculture*, 254.

especially banks and airlines, to operate across multiple countries.[45] Remaining closed to the free flow of information would mean that these companies, which brought jobs and investment, would not be able to operate on British soil. The 'free flow of information' started as a policy of deregulated trans-border data flows, but, as shown by Baker, also became associated with broader registers of liberalism.

Of course, not all in Britain felt this way about the liberating capacities of information technology. Tony Benn decried the microchip as 'tyranny in the form of liberation', and yet the broader context for this quote shows how even in opposition, information technology had become entangled with liberalisation.[46] In 1982, Benn featured in a film, *New Technology, Whose Progress?*, which attacked IT-82 as endorsing job destruction and de-skilling through micro-electronics. Benn believed that micro-electronics were being used 'to remove decision-making from the worker and increase management control', and yet still saw information technology as having an emancipatory capacity, arguing that these technologies 'can give people a sense of freedom'.[47] What is important to note here is that this film, and Benn's arguments, were not anti-technology, but anti-politics, and against a specific register of liberalisation. 'Tyranny in the form of liberalisation' was not an attack against the idea of information technology as emancipatory – Benn's arguments about IT giving people 'a sense of freedom' show that is not the case – but rather, an argument against the neoliberalisation of information technology's emancipatory capacity. Even on the left, therefore, information technology was attributed liberating qualities, despite opposition to neoliberal interpretations of those qualities.

This was also the case with how BT's privatisation – the first major privatisation of a state telephone administration – was analysed outside Britain: for many, privatisation was not about share-owning democracy, but about the information technology revolution. Tom Forester's 1987 popular science book *The High-Tech Society* referred to the privatisation of BT, along with the break-up of AT&T and the 1985 Japanese deregulation of NTT, as necessary moves to market access, required to realign the telecommunications industry for the IT revolution.[48] This became the European consensus as well: a 1994 European Commission report, 'Europe and the Global Information Society', prepared by Martin Bangemann, the Commissioner for the Internal Market and Industrial Affairs

[45] Schiller, *Information and the Crisis Economy*, 45–72.
[46] 'Telecommunications Bill: 2nd Reading' 29 November 1982, PREM 19/1100, TNA.
[47] 'Screen Test', *The Guardian*, 26 February 1982.
[48] Tom Forester, *High-Tech Society: The Story of the Information Technology Revolution* (Cambridge, MA: MIT Press, 1987), 92–95.

under Jacques Delors, staunchly advocated privatisation as a necessary condition for spreading the information revolution throughout Europe; as the report announced, this would be a 'market-driven revolution'.[49] Others took more critical views: Herbert Schiller, writing in 1984, was deeply critical of the privatisation and deregulation of telecommunications, viewing the entanglement of IT and privatisation as a new strategy for solidifying corporate and financial power.[50] Frank Webster, writing more recently, and as I addressed in Chapter One, has also highlighted the role BT's liberalisation and privatisation played in empowering corporate capitalism.[51] The crucial feature of all these perspectives, both positive and negative, is that the privatisation of information and communication technologies, in contrast to the individualistic, libertarian tone to the Californian ideology, is oriented towards privileging and positioning large corporations to take advantage of the 'information revolution'. This is yet another commonality with the popular capitalism discourse: whilst superficially, both were about emancipating individuals, beneath the surface, it was large corporations and institutions which were empowered.

It is thus important to also understand how privatisation was enacted within the corporation itself. BT is important here on two levels: first, in how staff negotiated privatisation, and second, in how the larger technological system was reconfigured for private enterprise. As Wendy Larner and Nina Laurie point out, it is the technocrats within these organisations who enacted privatisation strategies and techniques, and yet there has been surprisingly little attention to these groups.[52]

The Power Behind The Button

Privatisation within BT can be studied along several lines. First, I will explore the ways management and staff enacted privatisation on several levels, from the views of senior management and the Board, through to the strategies of resistance and acceptance undertaken by ordinary staff. Second, I will study how BT marketed privatisation to potential customers through its 'The Power Behind the Button' advertising campaign, before finally concluding by reflecting on how privatisation featured in the technological developments addressed in previous chapters.

---

[49] 'Report on Europe and the Global Information Society' (Brussels: European Commission, 1994).
[50] Schiller, *Information and the Crisis Economy*, 32–36.
[51] Webster, *Theories of the Information Society*, 169–75.
[52] Wendy Larner and Nina Laurie, 'Travelling Technocrats, Embodied Knowledges: Globalising Privatisation in Telecoms and Water', *Geoforum* 41, no. 2 (2010): 218–26.

Senior management at BT were quite amenable to privatisation. In April 1982, George Jefferson, BT's Chairman, wrote to Patrick Jenkin to explain that he was being pressured by the Post Office Engineering Union (POEU) to take a stance against privatisation, but that he was also keen to explore any options which would remove BT from the PSBR restraints.[53] This did not mean that Jefferson and the board were unequivocally in favour of privatisation: a later letter to Jenkin explained that the Board would prefer the government to defer privatisation until liberalisation had been completed to avoid further strain on management and staff, pointing out that, 'This organisation has been a Civil Service/Public Corporation for the past seventy years, and this has naturally been a major factor in shaping staff attitudes. Such ingrained attitudes take a long time to change'.[54] Nevertheless, as soon as it became clear that privatisation would proceed after the 1983 general election, the Board started an internal communications campaign to persuade staff of the benefits of privatisation.

This internal campaign on privatisation's benefits also presented information technology as a necessary pillar of liberalisation. In July 1982, Patrick Jenkin held a Q&A with senior BT managers in which he explained that Britain 'cannot afford to keep BT trammelled by the mesh of bureaucratic controls at a time when technological and commercial developments really set this organisation at the centre of our electronic future'.[55] The board circulated Jenkin's message to all managers so that they could communicate these explanations to staff and 'calm any exaggerated fears'.[56] The board also emphasised that privatisation would not mandate any job losses – although, as I have shown in Chapter Five, forecasts from the System X rollout showed that there would be job losses in any event. Communiques in this style continued in the run up to privatisation, with staff informed that competition would provide a positive pressure to stimulate BT and reminded that, with the Conservative victory in the 1983 general election, any industrial action against privatisation would be seen as defying the will of the electorate.[57]

This, of course, did not stop all staff, and POEU industrial action against both privatisation and interconnection between the Mercury and BT networks caused

---

[53] George Jefferson to Patrick Jenkin, 'Privatisation', 19 April 1982, TCD 69/2/45, BTA.
[54] George Jefferson to Patrick Jenkin, 'Privatisation', 16 June 1982, TCD 69/2/68, BTA.
[55] 'Extracts from a Speech, and Answers to Questions, given by the Secretary of State to Senior BT Managers' 29 July 1982, TCD 69/2/115, BTA.
[56] Michael Bett to Board Members, 'Privatisation', 13 October 1982, TCD 69/2/115, BTA; 'BT and Privatisation: A Situation Report for All Managers and Their Staff' October 1982, TCD 69/2/115, BTA.
[57] Michael Bett, 'British Telecom: Assurances for Staff about Privatisation' 25 April 1983, TCD 69/3/67, BTA; Michael Bett, 'Assurances for Staff about Privatisation' 25 April 1983, TCD 69/3/118, BTA; 'Mercury Interconnection and Privatization' 21 June 1983, TCD 69/3/96, BTA.

headaches within BT and government. The July 1982 announcement of privatisation, and BT's agreement of interconnection terms with Mercury in November 1982, brought POEU action on two grounds: anti-privatisation action, consisting of work-to-rule on international traffic, and anti-Mercury action, in which BT engineers refused to interconnect lines with Mercury's network and undertake maintenance on equipment used by Mercury and its owners, Cable & Wireless, BP, and Barclays.[58] This last action – the refusal to undertake maintenance for Mercury's owners – had put the POEU on shaky legal ground, and so was only announced in name only; BT engineers continued to maintain these customers' equipment to avoid anti-union legal action. After industrial action started, the board held a crisis meeting in April 1983 with the POEU, in which union leaders emphasised their grievances that the government had unexpectedly liberalised international telecommunications alongside domestic, allowing Mercury to enter international telephony; BT's board were also vexed by this decision, having operated under the assumption that they would remain the sole carriers of international traffic from the UK, but were unable to persuade the POEU to cease action.[59] Industrial action thus continued and, by October 1983, BT had suspended 2,000 engineers. Industrial action also took shape in the form of local resistances: at Martlesham, BT research engineers banded together to produce anti-privatisation material, such as a badge featuring Buzby, the telephone service's mascot, with the slogan 'Save Buzby from the Vultures' (Figure 9.1).[60] In Manchester, the POEU successfully lobbied the Labour-controlled city council to temporarily block planning permission for Mercury to install rooftop microwave transmitters, on the grounds of possible health risks from microwave radiation, and in complete disregard of both Manchester's City Planning Officer's advice and the Post Office and BT's long history of using microwave transmission in city centres.[61]

However, not all BT staff were quite so resistant to privatisation, and the government's targeting of individual shareholders formed a significant part of BT's internal strategy for involving staff in privatisation. Drawing inspiration from the growth of employee shareholding in early privatisations of Britoil, British Aerospace, and Amersham International, the potential for employee shareholding in BT had been

[58] Norman Tebbitt to Margaret Thatcher, 'POEU Action', 17 October 1983, PREM 19/1344, TNA.
[59] 'Notes of a Meeting with POEU to Discuss Liberalisation' 7 April 1983, TCD 69/3/61, BTA.
[60] 'Save Buzby from the Vultures - BT Research Engineers' 1983, Buzby Badges, Buzby Collection, Computer Networking and Telecommunications Research Technology Collection, University of Salford.
[61] Kenneth Baker to Patrick Jenkin, 'Mercury Communications', 29 December 1983, PREM 19/1344, TNA; 'Councils Back Phone Union over Mercury Transmitters', *The Sunday Times*, 18 December 1983.

Copyright Material Removed

Figure 9.1. BT Research Engineers' anti-privatisation badge featuring Buzby.

identified by November 1982 and by January 1983 was seen as a 'highly desirable' strategy for involving staff and bringing the unions onside.[62] Kenneth Baker and Cecil Parkinson, Secretary of State for Trade and Industry, were also both influential supporters of employee shareholding in BT, meeting with George Jefferson in June 1983 about employee share-ownership.[63] Baker was such a staunch supporter that later in 1983 he inquired if BT could offer staff £600 loans to buy even more shares during the issue, to which Jefferson responded with appreciation for Baker's enthusiasm, but declined on the grounds that BT might get in trouble over legal and tax implications, as well as the moral argument that they should not encourage staff to get into debt.[64]

Regardless, BT still set a UK record for employee share-ownership, with 10% of shares reserved for BT staff and pensioners.[65] There were three different offers for privatisation: first, all employees were given a free gift of fifty-four shares; second, a 2-for-1 matching offer for investments of up to £100.10, which bought 77 shares, tripling that to 231 shares total; third, each employee could apply for up to 1,600 shares at a 10% discount.[66] The first and second offers combined were known as the 'blue' offer, which

[62] Michael Bett, 'Privatisation - Employee Shareholding' January 1983, TCD 69/3/5, BTA.
[63] 'Note of the Main Points Arising at a Meeting Held at the Department of Industry' 15 June 1983, TCD 69/3/98, BTA.
[64] George Jefferson to Kenneth Baker, 'BT Privatisation: Employee Share Scheme', 12 December 1983, TCD 69/3/194, BTA.
[65] Karin Newman, *The Selling of British Telecom* (London: Holt, Rinehart and Winston, 1986), 150.
[66] Newman, 151.

gave employees the option to buy 285 shares, worth approximately £450, for only £100, whilst the third offer was known as the 'red' offer. BT set up a special internal communication programme to persuade employees to buy shares, including setting up 350 employees as 'shareholding liaison officers' to run seminars, distribute briefing materials, and hold practice sessions for filling out dummy blue and red forms.[67] Internal computer control over employees was also used to enhance BT's employee share-holding persuasion strategy: BT's first computerised central register of all employees, PRISM, was given to Hill Samuel Registrars, the administrators of the employee share scheme, to build a central register for direct mailing about employee share-ownership.[68] BT's scheme was considered a great success, with 96% of staff applying for shares, ignoring union directives. A little over 222,000 out of 238,000 staff – over 93% - applied for the 54-share gift, and 84% took the matching offer option, whilst a much smaller proportion – just over 25% – applied for the red offer.[69]

Individual share-ownership was also a recurring feature in oral histories with former research staff. Dennis Wheeler remembers that, as a manager, he had 'to give presentations, and monthly meetings, and I did try and talk them all into doing it at one point, you know, "You've got to do this"'.[70] Dennis also raised the specific terms of the share-ownership schemes, recalling that 'you almost couldn't lose your money, which we didn't… Well, I might have done by now, but you could hardly lose your money, and I remember saying to other people, "For goodness sake, get on to this sharesave scheme because they're giving you money, just do it"'.[71] Thomas O'Brien attributed staff's acceptance of privatisation to the 'goodies' offered along with privatisation, remembering that 'there were a lot share options and goods like that so, yeah that sort of, people were happy with that, you know, you almost made a few hundred over night because of share options!'.[72] Colin Whitlum similarly related the smoothness of privatisation to the share schemes:

> When we did privatise actually it went smoothly, very smoothly indeed, and in fact a lot of people made a lot of money out of it I think, because the shares when they did sell,

[67] Newman, 151–52.
[68] Newman, 153.
[69] Newman, 151.
[70] Wheeler, Oral Histories of Martlesham Heath.
[71] Wheeler.
[72] O'Brien, Oral Histories of Martlesham Heath, 11 August 2016.

> they got an offer to buy the shares at a very reasonable price and then they went up, a lot of people made a lot of money.[73]

Jeanette Higgins recalled the excitement associated with investing for the first time: ‘I got shares, sharesave schemes, things like that, so it was kind of a bit exciting … I’d never been a shareholder before so it’s just interesting’.[74]

Tracking share prices, and the money made – and lost – on those shares also featured. Chris Wheddon remembers that BT’s development of a car-phone with speech recognition ‘put 10p on the share price’,[75] but more prominent was Dennis Wheeler and Jeanette Higgins’ recollection of BT shares’ £15 peak and subsequent collapse in the dotcom crash. Jeanette remembered that shares ‘went all the way up to £15 and then down, down, down, that was the highest it went ever as one of the dotcom companies’.[76] For Dennis, the dotcom crash – BT shares peaked in the summer of 2000 and then lost a third of their value over the following year[77] – wiped a huge amount of value off his shares:

> I’ve got a portfolio of BT shares which I lost £40,000 on because when… now when what happened? There was a time when they were worth £15 a share they collapsed to £5 a share so I lost £10 a share on 4,000 shares, so on paper I lost £40,000.[78]

Dennis still owns his portfolio of shares, which he checked before our oral history interview, telling me that ‘I’ve noticed today have absolutely bombed! Gone below £4 a share for the first time ever, but yeah that was the main thing I think I got out of the privatisation’.[79] As addressed earlier in this chapter, Amy Edwards and David Parker have both pointed out the larger failure of Thatcher’s ‘share-owning democracy’, but it is clear from these oral histories that this movement still played a significant role in negotiating privatisation for BT’s employees and persists to this day – in only memories for some, but for others, still in their portfolios.

However, BT did not only have to convince its employees to invest, but also the wider public, and did so through its widespread ‘The Power Behind The Button’ marketing campaign. This campaign, undertaken on behalf of BT by Dorland

---

[73] Whitlum, Oral Histories of Martlesham Heath.
[74] Higgins, Oral Histories of Martlesham Heath.
[75] Wheddon, Oral Histories of Martlesham Heath.
[76] Higgins, Oral Histories of Martlesham Heath.
[77] ‘The Rise and Fall of BT’, *BBC News*, 26 April 2001, http://news.bbc.co.uk/1/hi/business/1014978.stm.
[78] Wheeler, Oral Histories of Martlesham Heath.
[79] Wheeler.

Advertising, attempted to convince individuals to invest in BT based on the corporation's technological sophistication, particularly tapping into the growing information technology vogue.[80] The £16m campaign kicked off in Spring 1984 with a significant TV presence, and went through three phases.[81] In the first phase, potential investors were shown BT's range of information technologies, including optical fibre, System X, and, in another demonstration of the popular iconography of the satellite, Goonhilly Earth Station. High technology, the information revolution, and BT's size, scale, and sophistication were all key features of this phase. The second phase addressed the social anxieties surrounding privatisation by emphasising the social role of the telephone – here the push-button telephone handset was a pervasive image (Figure 9.2), intended as a reassuring reminder of the mundane social technologies of the home, as opposed to the abstracted infrastructure of System X and optical fibre.[82] The third phase returned to the information revolution, emphasising BT's R&D activities and financial services, such as the City Business System used by money dealers to place global telephone calls and transactions.[83] The TV advert for the latter closed with, 'Helping London stay at the heart of the world's financial markets, British Telecom is the power behind the button'.[84] The campaign concluded by returning to a familiar symbol of both BT's longer history and the hegemonizing rhetoric of the information revolution: Goonhilly Downs' satellite aerial dishes.[85]

My point here is that this campaign did not revolve around denationalisation, around the opportunities of efficiency and competition to be gained by relocating public enterprise into the private sector, but instead around information technology and, furthermore, did not tap into the 'popular capitalism' rhetoric of entrepreneurial financial consumerism, but instead played up BT's size, strength, and sophistication. The implicit and overt message about BT and information technology in this campaign was thus that the power did not lie with the individual user-shareholder, in front of the button, but with the corporation and technology behind it.

The narrative of the information revolution, and of the importance of privatisation, is further challenged by the histories of BT's technologies. As I have shown throughout this thesis, the technologies underpinning the 1980s telecommunications network have

[80] Newman, *The Selling of British Telecom*, 86.
[81] Newman, 86.
[82] 'British Telecom: The Power behind the Button' 1984, TCB 325/EHA 1837, BTA.
[83] Newman, *The Selling of British Telecom*, 87.
[84] *BT's City Business System: The Power Behind the Button* (BT, 1984), https://www.youtube.com/watch?v=1rGl6wnnWQM.
[85] Newman, *The Selling of British Telecom*, 87.

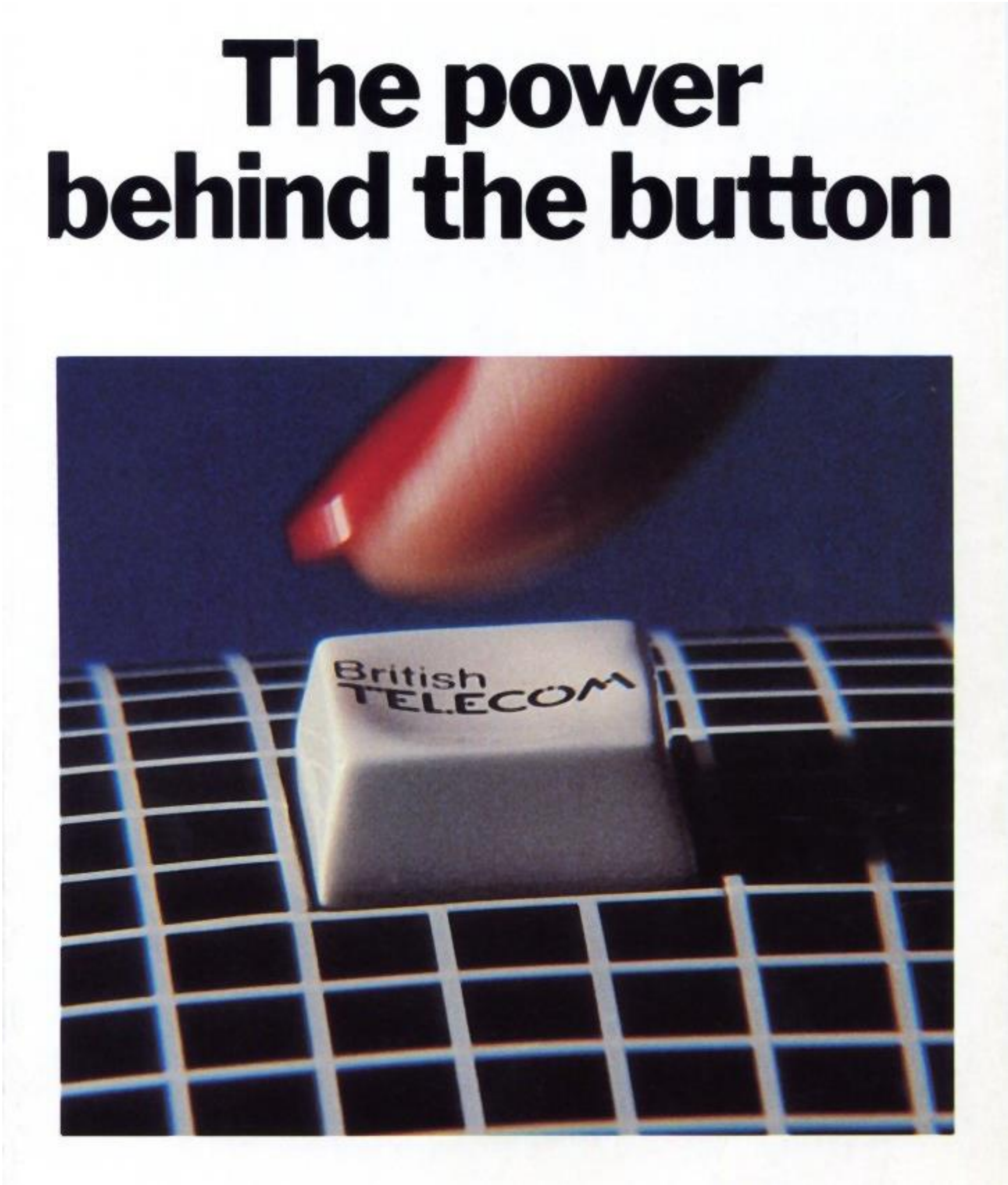

Figure 9.2. Phase Two of ‘The Power Behind The Button’. Courtesy of BT Archives.

much longer histories. System X has its origins in the Post Office’s fusion of cybernetics, information theory, and the government machine, and the computer modelling of exchange procurement and digitalisation remained utterly discreet. Optical fibre development started in the late 1960s and its presentation as an ‘information highway’ borrowed not only from the failed waveguide project, but also from longer notions of communications as a ‘highway’. Goonhilly, as previously mentioned, was an icon of British defiant modernism during the 1960s, and was only reconfigured as an icon of information technology through the convergence of the INTELSAT discourse and information age rhetoric during the late 1970s; this reconfiguration was itself misleading as submarine cables began to reassert their dominance after the North Atlantic Systems Conference in 1977.

These technologies were of course reshaped during the 1980s, but this shaping reveals further complexities to these histories of liberalisation and privatisation. After liberalisation, BT's 'X-Stream' services were all oriented towards business customers as BT faced competition in the City from Mercury. The Lightlines campaign started in late 1980 and the City was again prioritised as the first public optical fibre links in the UK were laid down to network London's financial institutions. It was a similar story with international communications as well, as London Teleport opened in October 1984 to specifically enhance the City's international communication links via cable and satellite. These were all drawn together by London TeleCity, which ended the uniformity principle and privileged the City of London over the rest of the country.

Internally, futurology and computer modelling within the telephone service had been reshaped during the late 1970s and early 1980s to reflect BT's new competitive environment, used as a tool to prepare managers for liberalisation and acting as a model for a predictive, watchful, telephone network, simulating and shaping its customers. These developments show that it was liberalisation, rather than privatisation, which had a far greater impact in reorienting the technologies developed by BT towards new directions and markets; however, as I asserted above, in relation to the historical novelty of the 'information age', it is also important to bear in mind the much longer historical roots that these technologies have in the state-ownership of the telephone system, which cannot be overlooked amidst the attention-grabbing re-orientation of BT towards business and financial interests.

Conclusion

I opened this chapter by posing two questions: what roles did liberalisation and privatisation play in shaping the British telephone system, and what was the relationship between these processes and the broader 1980s enthusiasm for an 'information revolution'? In exploring answers to the first question, I have shown how liberalisation played a more significant role than privatisation in orienting various ongoing technological developments towards the business and financial communities, but have also emphasised the longer historical basis to these projects. I have also addressed the role of individual share-ownership in privatisation and argued that, counter to traditional historical narratives, this role was relatively minor and, indeed, was in large part shaped by and oriented towards large financial institutions; however, I have also pointed out that this episode, whilst historically exaggerated, was nevertheless important within BT for resolving staff antipathy to privatisation, and its legacy lasts to this day amongst former BT staff.

In addressing the second question, regarding the role of BT's privatisation within the wider popularity of 'information revolution' discourses since the 1980s, I have explored the British political discourse about BT's privatisation, and its international reception and influence. I have situated my analysis in reference to Barbrook and Cameron's thesis that the digital utopianism originated in a fusion of 1970s California counterculture and cyberculture with New Right neoliberal and libertarian politics, and shown that BT's privatisation also combined these views of information technology, emancipatory individualism, and free market economics. I have argued that this happened in ways that predates certain aspects of digital utopianism – such as Stewart Brand's maxim that 'information wants to be free' – and which also shows that various ideologies previously attributed by other historians to BT's privatisation – competition, efficiency, free markets, entrepreneurialism, and individual share-ownership – can instead also be situated within various registers of the Californian ideology's fusion with Thatcherism.

I also argued that BT's privatisation influenced the development of this discourse beyond Britain. BT's privatisation was not patient zero for the Californian ideology, but it was certainly one of the early major vectors for this way of thinking, and combined information technology with corporate power in ways which Barbrook and Cameron neglect. I showed how privatisation – particularly the example of BT's privatisation – was interpreted as a pre-requisite of the information revolution both in American popular science and European policy-making, and that critical analyses of information technology interlinked privatisation with the 'information revolution' almost immediately after BT's privatisation. In particular, these critical analyses have drawn attention to how the privatisation of information technologies has been used to cement market and corporate power, and this resonates with the history of privatisation which I have outlined above: the longer liberalisation and privatisation of BT has undoubtedly shaped Britain's telecommunications system to be more attentive to large corporate and financial customers, and, as the first major telecommunications privatisation in the world, has set a global example.

The privatisation of BT fused the Californian ideology with a political and corporate infatuation with the City of London financial centre. Given the ways that analysts such as Schiller, Webster, Castells and Harvey have all drawn attention to the deep entanglement of information technologies with financial institutions and corporate power, I would argue that the privatisation of BT transmuted the Californian ideology into a 'London ideology'. The London ideology, seen in the principles of IT-82 as ostensibly similar to the Californian ideology's technologically-enabled individualism, entrepreneurialism, competition, and small state, has in practice merely re-oriented telecommunications from the needs of the state to the needs of the private sector. Margaret Thatcher called privatisation 'one of Britain's most successful exports', but I would suggest that she was being too modest: denationalisation and individual share-ownership have been out-stripped by the London ideology's privatisation and financialization of telecommunications across the Western world since the 1990s.

10 Conclusion

I opened this thesis with James Merriman's 1967 assertion that 'the concepts of information and control are fundamental to any telecommunications system'. As I have argued in Chapter Five, 'information' here spoke to both Merriman's concerns that specialist information networks would grow to compete with and threaten the Post Office's monopoly, and his plans for an integrated network which would distribute all forms of information. Merriman retired from the Post Office in 1976, whilst the ISDN was still under development, but his career in retirement highlights how significantly the political economic environment around him had changed since 1967. Merriman went on to become Chairman of the National Computing Centre and, in 1982, was commissioned by the Thatcher government to write a report on the uses of the radio frequency spectrum in anticipation of the decommissioning of frequencies used for outdated 405-line television broadcasting. The Merriman Report, as it became known, recommended preserving approximately one-third of the spectrum used for defence purposes – perhaps reflecting Merriman's wartime work on wireless – but made two further interesting recommendations: first, that the economic importance of the radio spectrum for new diverse uses by information technology meant that new users should be given greater opportunities for access compared to existing users; second, that, as an extension of this, regulation of the radio waves should transfer from the Home Office to the Department of Trade and Industry.[1]

This last recommendation was immediately accepted by government and, whilst the Merriman Report itself was quite cautious on new mechanisms for allocating

[1] *Report of the Independent Review of the Radio Spectrum: 30-690 MHz.*, Cmnd. 9000 (London: HMSO, 1983); Peter Large, 'Call for New Department to Control IT and Broadcasting', *The Guardian*, 28 July 1983.

frequencies, the government seized upon this opportunity to introduce market mechanisms by commissioning a report in 1985 by CSP International (now part of PricewaterhouseCoopers) into managing the spectrum via price mechanisms. Several reports in *The Guardian* criticised this as the 'privatisation' of the air waves, and cast the Merriman Report as creating the scope for this new unwelcome advance of market forces into the public domain.[2] In 1987, the government officially accepted CSP's recommendations that spectrum allocation take place through commercial sales, rather than allocating them on a first-come, first-serve basis, as had previously been the case.[3]

By 2000, this had evolved into spectrum auctions for the mobile phone industry, the first of which raised £22.5 billion. The auctioning of tranches of the radio frequency spectrum in Britain – a quintessentially neoliberal policy reflecting the view that markets must be created[4] – thus has a lineage from Merriman. I am not saying that the Merriman Report was at all responsible for this policy – to do so would ignore Merriman's own caution about such radically new ways of allocating the spectrum, as well as overlook the crucial rise of the neoliberal policy-making view of markets over the course of the 1980s and 1990s – but my point is that a line can be traced from Merriman's 1967 view of information's versatility as threatening competition to his 1983 recommendation that the radio spectrum was an important economic resource for diverse information technology applications, which in turn provided further incentive for the Conservative government to pursue a way of using the market to allocate the spectrum, and opened the path to the current auction format.

These themes of information, privatisation and neoliberalism, along with control, have been central to this thesis. I have aimed to uncover the historical processes which linked and shaped the British telephone system as both central to the enacting of the neoliberal state and the British political and cultural understandings of the 'information age'. In Chapter One, I suggested that Paul Edwards' concept of mutual orientation – identifying the moments in history where micro, meso, and macro trends orient one another – would be helpful in writing micro and meso histories of information and control,

[2] Peter Large, 'After Jaguar, North Sea Oil and British Telecom, the Government Has Found Something Else to Privatise. No, Not British Airways but British Air Waves.', *The Guardian*, 29 March 1985; Peter Large, 'Even Air Waves Are up for Sale', *The Guardian*, 18 November 1986; Peter Large, '"Sell off Air Waves and Buy in Software"', *The Guardian*, 3 April 1987.
[3] Large, '"Sell off Air Waves and Buy in Software"'.
[4] E. D. Melillo, 'Spectral Frequencies: Neoliberal Enclosures of the Electromagnetic Commons', *Radical History Review* 2012, no. 112 (1 January 2012): 147–61.

the subjects of so many macro theories of society.[5] I have spent most of this thesis addressing micro and meso histories, and so here I will point to moments where these histories have oriented and been oriented by macro trends. First, I will recount my arguments so far, and then I will reflect on how these histories inform, and are informed by, macro theories of information and control. Finally, I will outline avenues for further research and conclude this thesis.

Defiance, Compliance/Discretion, and Digitalism

This thesis' chapters have been organised in parallel, rather than in series: most start in the mid-1950s and end in the late 1980s or early 1990s. In this section, rather than repeat the thesis' parallel structure, I will recount my arguments chronologically, through which I aim to identify broader trends and speak to one of this thesis' broader goals of understanding how the British telephone system interlinked and was implicated in the dual appearances of the 'information age' and neoliberalism.

A repeating trend across this thesis is Robert Bud and the Science Museum's 'defiant modernism' – the national technological triumphalism and search for 'world firsts' in late 1950s and early 1960s Britain.[6] I have suggested that many of the Post Office's projects align with this trend. I showed how the national prestige of achieving a 'world first' motivated development of Highgate Wood in the face of clear design issues, and also suggested that the Post Office Tower could represent defiant modernism, although with reservations which I shall turn to shortly. I cast TAT-1 and Goonhilly Downs as both defiantly modern: for the former, in the Post Office's defiant emphases on British engineering ingenuity in a collaborative project; in the latter, in Goonhilly's environmentally-resilient design, which used the same design concepts as Britain's prestigious Jodrell Bank.

However, defiant modernism does not capture everything from this period. Most obvious are the fears about automation in the late 1950s which surfaced around GRACE, the Post Office's 'robot telephone operator'. The Post Office's internationalism also evades capture, in its collaboration on Telstar, and in the influence of American corporate research campuses on Martlesham Heath. The ideals of circulatory, redistributive democracy which informed the Post Office Tower's viewing gallery and revolving

[5] Edwards, 'Infrastructure and Modernity: Force, Time, and Social Organisation in the History of Sociotechnical Systems', 213–15.
[6] Bud, 'Penicillin and the New Elizabethans'.

restaurant, and in the influence of new towns, government dispersal, and new universities on Dollis Hill's relocation, are also missing. Also overlooked is the technocratic managerialism of British government and the Post Office, seen in the Post Office's computer centres, the growth of marketing research, the hiring of McKinsey's, and the interest in long-range planning and futurology.

For the late 1960s and 1970s, Sumner and Agar's concepts of compliance and discreet modernism are helpful. Sumner argues that, in British computing, complying with international computing systems in the 1960s and 1970s made defiant modernism harder to sustain.[7] Agar's discreet modernism describes a long twentieth-century trend of opaque governmental computing projects.[8] However, this discreet modernism became more obvious in the 1970s: the ALEM 6 model breached discreet modernism, and the ensuing controversy was resolved by re-establishing the model's discretion. Discreet modernism is perhaps also visible in J.S. Whyte's 'bleak mechanistic prospect', which I suggested was a public recalibration of Treasury O&M discreet modernism for the Post Office and for telecommunications, in which it became a denial of the computerisation of decision-making, privacy, and dignity.

Compliance featured in several Post Office projects: integrated digital network development was enveloped by ITU standard-setting, and growing data needs meant that the Post Office had to follow broader trends and develop packet-switching networks. Compliance with INTELSAT and FCC transatlantic communications policy restricted North Atlantic cables until cable planning was 'INTELSAT-IZED'. The waveguide also shows the consequences of defiance, or non-compliance: touted as a technology for the information revolution and as a uniquely British project with export potential, it became redundant due to economic depression and slow telephone growth in the 1970s. The City of London also increasingly fought the Post Office's non-compliance, lobbying for packet-switching and dismissing the integrated digital network, which it viewed as monopolistic; the Post Office was aware that if it did not serve the City, it would anger a pro-liberalisation lobby.

As with defiance, compliance and discretion are imperfect frames; they do not capture the Post Office's aborted attempts to secure a national cable TV network, the outward turn of long-range planning, or the increasing reflexivity of computer modelling, of which the latter two were responses to economic and energy crises. The 'controlled chaos' of Martlesham Heath also does not fit, although there are two points to make here:

[7] Sumner, 'Defiance to Compliance'.

[8] Agar, *The Government Machine*, 424–30.

first, Martlesham Heath's traditional aesthetic was an explicit response to the perceived instabilities of society, and so can be compared to the expansion of long-range planning and reflexivity of computer modelling, which were both also responses to societal instability. Second, Martlesham Heath village's design carefully screened technology, from the bans on TV aerials and caravans, to the landscaped concealing of the research centre. This is a form of discretion, albeit different to Agar's, and I would suggest that keeping technology discreet during the 1970s was perhaps part of a broader unease with technology and technological systems, responding to issues such as the three-day week, and the highly-politicised, troubled Concorde and Advanced Gas-Cooled Reactor projects.

Unlike defiance, compliance, and discretion, there is no version of British technological modernism which captures much of the telephone system's activity in the late 1970s and 1980s. Agar argues that discreet modernism disappeared as government IT became more transparent in the 1980s, and Sumner suggests a partial return to defiance in Thatcherist IT policy.[9] In this section, I will later propose a new modernism – 'digital modernism' – to describe the neoliberal information aesthetic of the late 1970s and 1980s, but first I want to explore in more detail the important historical changes underlying this aesthetic, as they speak to the entanglement of technological change in the telephone system with the rise of neoliberalism in Britain.

As I have established at various points through this thesis, the privatisation of British Telecom was a hugely important moment for Thatcherism: it served to support an industrial policy emphasising information technology's market power, and its success sustained the privatisation movement in Britain, as well as firing the starter gun for the deregulation and privatisation of telecommunications around the world. However, as I argued in the previous chapter and at various other points through this thesis, liberalisation was the more important change for the telephone system. In the late 1970s, the pressures of impending liberalisation shaped decision-making in the telephone system, such as the orientation to the needs of the City of London in the creation of London TeleCity and London TelePort.

However, a crucial finding of this thesis is that the spectre of competition has a longer history with roots in Post Office engineers' and management's interpretations of information theory. In 1968, Merriman articulated how the versatility of information, which was understood as capable of synthesising all forms of communication into digital

[9] Agar, 430–32; Sumner, 'Defiance to Compliance', 326.

data streams, also threatened competition: the rise of specialist information networks would threaten the Post Office's monopoly. From this point, several important developments started – System X, the ISDN, computer modelling, and the waveguide – all of which, in various ways, served the Post Office's goal of creating a high-capacity, general-purpose, integrated information network which would preserve the Post Office's monopoly.

System X, as a digital system of computer control over information flows, provided a versatile 'family' of telephone exchanges which enabled the integration of various types of traffic – international, local, trunk, and data – into one series of telephone exchanges, as opposed to the Post Office/BT having to purchase distinct exchanges for distinct traffic forms. Furthermore, as I have shown in Chapters Five and Seven, System X also buffered the power of technical labour and provided an important role for BT in the electronic surveillance state. The ISDN provided the technical standard for the integrated digital network and, despite lagging behind the development of packet-switched networks, its rise in the 1980s was used by BT to defend against a regional break-up and its incorporation of multiple information forms into the telephone network meant that information was effectively more monopolised, rather than liberalised. Computer modelling, in both the Long Range Planning Department and Operational Programming Department, reinforced the Post Office's invented futures of monopoly power, used by J.S. Whyte to justify TXE4 purchasing and, with UKTTF, the viability of a high-capacity nationwide information network. By the 1980s, the perceived predictive power of computer modelling was used by David Probert to educate middle managers about the opportunities provided by liberalisation, whilst also acting as a template for predictive electronic surveillance.

The waveguide, whilst a technical failure, was similar to the UKTTF model in that it sustained the idea of an information revolution, which underpinned the monopolising developments outlined above. This dissonance, between the promise of a diverse, competitive information revolution (which, as mentioned above, had evolved from information's threat of competition in the 1960s) and a monopolising system behind the scenes, continued with the 'highway' metaphor which the waveguide introduced: BT's 'Business Highway' privileged market-oriented privatised information infrastructure, but was actually an advert for the ISDN, a monopolising technical standard with origins in 'government machine' visions of a state information network. This dissonance between aesthetic and actuality is why I propose 'digital modernism' to describe the technological aesthetic of the late 1970s and 1980s. Digital modernism describes the appearance of digital technologies promoting one set of things – competition, diversity, flexibility, freedom – whilst effecting, in the case of BT, the preservation of technological control within BT, and the reorientation of control to large businesses and financial institutions.

Digital modernism's superficial aesthetic of the freedom, flexibility, and diversity has been apparent throughout this thesis. X-Stream marketed 'the flow of digital information through the network', whilst System X would apparently create jobs and free engineers to apply their creative talents elsewhere. The 'highway' metaphor, particularly with fibre-optic 'Lightlines' and the ISDN 'Highway', connoted high-speed, lightness, and instantaneity, whilst London TeleCity was marketed as liberating the City for the benefit of the national economy. London Teleport's name connoted instantaneity and virtuality, whilst SatStream's decentralised small-dish rooftop aerials enabled faster international information flows and business transactions. Kenneth Baker and Margaret Thatcher captured this aesthetic in their speeches on IT, describing the opportunities for competition, flexible enterprise, and personal freedom provide by information technology and the 'free flow of information'. This was also summarised well by J.J. Wheatley, BT's Head Economics Adviser, at the Long Range Strategy Seminar, where he argued that the convergence of computing and communications would enable the small, anti-bureaucratic state, and by David Probert, who suggested that computer modelling would realise competition and diversity as 'ideas of the future'.

However, these digital technologies merely reoriented control, rather than dispersing and decentralising it. Inspired by cybernetics, information theory and the government machine, the Post Office pursued an integrated, self-governing network. System X's automation of operator services and engineering labour shifted control away from customers and engineers; BT board's knowledge of System X-induced redundancies later materialised in the 1990s with Project Sovereign. Computer modelling was used to control managerial responses to liberalisation, and embedded ideas of computerised surveillance, resulting in experiments where BT used simulation to influence customers ahead of themselves. London TeleCity ended BT's uniformity principle, prioritising the City, and London Teleport, a prime example of digital modernism's instantaneous aesthetic, served the City with a purpose-built satellite earth station. The ISDN captures this reorientation of control best: it was a contributing factor preventing BT's regionalisation and was seen by both the Post Office and the City as a monopolising technology. The government's rejection of universally-accessible nationwide cable TV and optical-fibre monopolies in part reflected the prior existence of ISDN, which, along with the London fibre-optic grid and X-Stream services, was turned by BT towards the City, and ISDN was marketed in ways which reinforced hierarchies between executive and clerical labour, showing the lasting influence of the government machine.

I have not called this 'informational modernism' for two reasons. First, information technology has broader definitions, inside and outside this thesis. LEAPS and the Kensington Computer Centre are two information technologies from the 1950s and 1960s, and others have argued that both the state and technology have been informational for far longer than the last few decades.[10] This derives from the looseness of 'information' as a descriptor, which leads into my second reason. Post Office engineers' broad interpretations of information theory in the 1950s laid the foundation for the Post Office's pursuit of a digital information network. Information's true power in the Post Office was in its status as a flexible, broadly-defined imaginary, rather than a concrete artefact. In contrast, digitalisation was a concrete technological change which happened from the late 1960s and which permitted 'digital modernism'.

I should also explain what is modernist about 'digital modernism'. Here, I conceive of modernism as a specific attitude to technology, as seen in interwar 'heroic modernism', appealing to the 'machine' as an image of rationality for working and living in response to this period's disasters, the 'reactionary modernism' of elite Weimar and Nazi reconciliations of mechanical technology with German romantic nationalism, and the defiant and discreet modernisms previously addressed throughout this thesis.[11] Despite digital modernism's appearance at a time conventionally associated with postmodernity, I deliberately do not call it 'digital postmodernism'. This is because it bears much more resemblance to the other modernisms I have presented – forward-looking, hegemonic, with close connections to the state – than the ephemerality, fragmentation, anachronisms, and ambivalent attitudes to technology of postmodernism.

Digital modernism does not capture all the important developments in this thesis. Adastral Park was more important for its physical co-location of residences, research, and industry, and the corresponding invocations of historicity which supported this. The history of cable TV also shows how fragmentation and regionalisation was supported over monopolisation. Finally, I have also argued that the space age and environment both had important intersections with the 1980s aesthetic of international communications; this

[10] Giddens, *The Nation-State and Violence*, 178; Edwards, 'Infrastructure and Modernity: Force, Time, and Social Organisation in the History of Sociotechnical Systems', 208.
[11] Harvey, *The Condition of Postmodernity*, 30–32; Jeffrey Herf, *Reactionary Modernism: Technology, Culture, and Politics in Weimar and the Third Reich.* (Cambridge: Cambridge University Press, 1984), 1.

is important to acknowledge, as ‘digital modernism’ runs the risk of obscuring its own longer history. It is also important to emphasise that digital modernism is not digital utopianism: the latter describes, as with the Californian ideology, or the London ideology, a belief system, whilst the former describes those ideologies’ aesthetics and the dissonance between aesthetic and reality. Digital modernism is intended as a helpful frame for the technological aesthetic of the late 1970s and 1980s, whilst also recognising the processes behind that aesthetic. In that spirit, I now turn to address information and control as the two guiding concepts for this thesis.

Information

I argued in the previous section that digital, rather than information, technologies mattered, and that information was more powerful rhetorically. In this section, I will point out how information age theories insufficiently capture digital technologies’ significance and information’s power by reference to the British telephone system.

I earlier criticised Castells’ insufficient conceptualisation of information technology’s history and his deterministic networking logic.[12] I have shown that, rather than a 1970s technological revolution, digitalisation and computerisation of British telecommunications originated in the 1950s with cybernetics, information theory, and the ‘government machine’. I also argued that, whilst optical fibre development accelerated in the 1970s, it has a lineage from millimetric waveguides and microwave transmission in the incremental expansion of electromagnetic frequencies available for telecommunications. The Thatcher government’s rejection of national cable TV and optical fibre networks also shows a denial of the networking logic, as does computer modelling which shows that more attention is needed on the tools used for planning networks, rather than any technological logic within the network. Finally, the interactions of transatlantic communications with Cold War politics and the ocean and space environment – something neglected by Castells and practically every other information age scholar – are also historically important. Digitalisation’s concentration of information into single networks is perhaps the closest approximation to Castells’ networking logic, but I have also shown the contingencies of digitalisation and, with BT’s liberalisation and privatisation, its re-orientation to corporate, business and financial interests.

[12] Castells, *The Rise of the Network Society*, 38–62, 70, 500.

Herbert Schiller highlighted the growing significance of information and communication technologies from the late 1970s, as national administrations sought ways to remain competitive in a 'crisis economy'.[13] This was supported by the Thatcher government and BT's plans to reduce System X procurement to one supplier, in order to prepare that supplier for international markets; however, here there are also historical parallels with 1960s industrial policy, seen in, for example, the Industrial Reorganisation Corporation's consolidation of the British computing industry into ICL.[14] Schiller also argued that liberalisation of telecommunications reinforced the private sector, and I supported this point in showing the City's lobbying of BT and BT's subsequent attention to the City with London TeleCity, Teleport, ISDN, and so on. I also showed the role played by financial institutions in lobbying for liberalisation and privatisation, and the orientation of BT's flotation to securing financial institutions as shareholders. However, Schiller, like Castells, is too inattentive to the longer history of information technology, and, as I critiqued his neglect of state involvement in ICT development in Chapter Two, so this thesis has shown how state philosophies, such as the government machine, informed digitalisation, which in turn reinforced monopoly power. Schiller and Castells both buy too easily into the novelty of 'information' and neglect the discourse which has supported its appearance. It is this discourse which reveals information's true power in the telephone system.

Ronald Kline has shown the construction of the information age, and this has been information's true importance for the British telephone system: a constructed ideal which telephone engineers strived for.[15] I showed how, in the 1950s, information theory informed visions of a universal information network, which were reinforced by cybernetics and the government machine general-purpose philosophy. This ideal sustained the pursuit of integrated digital networks, Viewphone, waveguides, cable television and optical fibre, whilst slowing packet-switching. I also showed how UKTTF modelling supported the information vision, whilst satellites, a Cold War communications technology, were enveloped by the information discourse. Daniel Bell, another information theorist I addressed in Chapter Two, was also invoked in support of the information ideal: the LRPD built from his post-industrial society to forecast the computerisation of work and home life, and Kenneth Baker also invoked the post-industrial society in his speech to the British Association for the Advancement of Science

[13] Schiller, *Information and the Crisis Economy*, 2–12.
[14] Martin Campbell-Kelly, *ICL: A Business and Technical History* (Oxford: Clarendon Press, 1989).
[15] Kline, *The Cybernetics Moment*.

to support visions of an information society. These applications of information all reinforce my point that information, for the actors in this thesis, was more important as a discursive imaginary, rather than as a concrete transition.

Control

I wish to make a similar point with regards to control: whilst control theorists are more useful than information theorists in identifying important changes for the telephone system, they are less helpful when it comes to analysing the discursive importance of 'control' to telephone system engineers. I will first explore how control theories have informed my analysis, and then highlight the ways in which they fail to capture the discursive importance of control to the telephone system.

First, on control and postmodernity: Deleuze, the postmodern scholar, and Harvey, the scholar of postmodernity. Neither theorist has provided ways to fully appreciate control in the telephone system, although that is partly a limitation of this thesis, and suggest further research below to address this. Electronic control over employees and users has mixed support for Deleuze's society of control:[16] simulation-as-surveillance and System X's mobile track, tail and tap system show remote, mutable, instantaneous forms of control over users, but LEAPS and PRISM, the two employee databases from 1957 and 1984 respectively, suggest more incremental, rather than revolutionary, computerisation of staff control. In contrast, the change from rigid patterns of spatial control at Dollis Hill – car parking passes and strict working hours – to the flexible work arrangements of contracting, consultancy, and zero-hours contracts at Martlesham support Harvey's connection of flexible accumulation and changing experiences of time-space.[17] Harvey, however, is less helpful in understanding how technological change has produced the condition of postmodernity beyond 'time-space compression'. As I have shown, time-space compression was not the explicit goal of telephone engineers, who were instead informed by cybernetics, information theory, and the government machine for System X and the ISDN, the Cold War and space age for transatlantic communications, and by information discourses for Viewphone, the waveguide, and satellite development. There are, however, changes which reinforce Harvey's view that the crisis of capitalism in the 1970s demanded greater attention to

[16] Deleuze, 'Postscript on the Societies of Control'.
[17] Harvey, *The Condition of Postmodernity*.

time-space compression: the City of London's increasing pressure on the telephone business from the mid-1970s supports this view.

Beniger has been helpful in showing the longer history to technologies of control, but is less useful in understanding the digitalisation philosophy, temporal expressions, and political-economic change. System X and digitalisation show how new technologies to control information flows were developed, and the City's emphasis on these technologies supports Beniger's view of control over information flows as crucial to control over commodity flows.[18] However, the origins of these technologies in cybernetics and information theory, and particularly the state-oriented government machine, are not easily situated within control over information and commodity flows. Computer modelling could be cast as another control technology, in its facilitation of planning and control over digitalisation and exchange modernisation, although Beniger is less helpful in appreciating how modelling's relationship to surveillance. Environmental control and cultural expression also sit uneasily within Beniger's control revolution: Beniger neglects environmental control entirely, and the invocations of tradition and heritage at Martlesham Heath do not easily fit into Beniger's analysis of control over production, distribution, and consumption. Finally, the political economy of control is insufficiently detailed by Beniger, who argues that techniques of control have contributed to increasingly centralised political and economic control, but does not expand on this point.

Giddens's allocative and authoritative control is more helpful in identifying political-economic shifts.[19] State regulation meant that telephone system had limited allocative control, as shown in governmental regulation of manufacturing relationships and national cable networks. However, it also apparent that liberalisation and privatisation did not drastically change this, as the state still exerted allocative control over the fibre-optic national grid, and foreign states and international organisations, through the FCC and INTELSAT, still influenced transatlantic communications. ISDN was thus an important technology of allocative control, as it helped BT preserve a pseudo-monopoly over information services. The relationship between allocative and authoritative control helps understand computerisation better: System X and modelling, as 'self-optimising' system technologies, exerted allocative control over traffic regulation, integrated digitalisation, network planning, and manufacturing relationships, and subsequently became authoritative forms of control. System X, in automating director

[18] Beniger, *The Control Revolution*.
[19] Giddens, *Power, Property and the State*, 50–52.

inquiries, shifted ‘initiative’ from the user to the computer, and computer modelling was used to plan and predict customers, and to control internal responses to liberalisation. Giddens is thus helpful in showing that neoliberalism was a limited change to allocative control, and that focussing on the political-economic ownership of the telephone system alone can obscure the relations between allocative and authoritative control.

Franklin has perhaps been the most insightful theorist in his framing of control as a late capitalist episteme, built on digital technologies, which reduces humans to inputs and outputs.[20] Franklin’s insight into digitality’s obfuscation of its material consequences is echoed in transatlantic communication’s environmental history, and his characterisation of control’s cybernetic rendering of humans into machine systems of input, output, and self-optimisation is particularly evident with System X, computer modelling, and simulation-as-surveillance. Franklin’s emphasis on the importance of digitalisation is also a key finding of this thesis, but his stress on the digital metaphor-fantasy overlooks the importance of the information fantasy, which I addressed in the previous section. Finally, Franklin’s view of digitalisation is too singular, extending its apparent logic of capitalist control across numerous digital technologies. As I have shown through this thesis, digitalisation was a historically contingent process which did shape financial institutions in the City of London, but was also shaped by them.

These theorists are still unhelpful in understanding why ‘control’, as a concept, was so important to actors within the telephone system. Control, both explicitly and implicitly, clearly dominated engineering thought. Foremost was Merriman’s ‘information and control’, which manifested the ‘self-governing, self-healing, self-optimising’ system. Automation, and machines as ‘servants not masters’, had surfaced earlier control concerns, and System X development was subsequently framed as an autonomous, self-controlling system which could take ‘initiative’ from users. Modelling also raised control issues, in controversy over modelling’s ‘decision-making ability’, and the ‘Strategic Control Unit’, from Cambridge’s ‘Department of Control and Management Systems’, as a technology for ‘controlling the corporate destiny’ and preventing an ‘uncontrollable future’. This evolved with predictions of intelligent expert systems, and of computers and control equipment programming themselves, to explore the possibility of heuristic machines judging users and controlling information access.

However, it is important to recognise that ‘control’ is not without issue as a core interpretive theme for this thesis: the historical actors in this thesis did not all subscribe

[20] Franklin, *Control*.

to a cybernetic vision of control, domesticated by the British government machine. It is important to disentangle the various notions of control used by actors across this thesis in order to analyse how important and useful the cybernetic government machine version of control is.

A different version of control which has also recurred across this thesis is that of external control of the telephone system, which became a problem for different parties at different points. In the 1960s, this was an issue for Tony Benn, who felt that the telephone system's status as a division of the Post Office, itself a Civil Service department, was restricting telecommunications management's freedom. During the 1970s, senior managers and board members at various times rankled over the continued control which government exercised over the Post Office, particularly during periods of price restraint and the industrial democracy experiment. Meanwhile, members of the City of London's Telecommunications Committee increasingly took issue with the Post Office's monopoly, viewing its efforts to create an integrated digital network as too far an extension of monopoly power. Another control which is at first glance of an entirely different sort, but also speaks to the perceived power of state institutions, is Christopher Parker's 'controlled chaos' in the development of Martlesham Heath new village. For Parker, Martlesham Heath was a rejection of the state's control over new town developments, and so his efforts at an aesthetic of 'controlled chaos' served to show the possibility of handing control to the private sector.

Control in managerial planning should also be distinguished from Merriman's meaning in 'information and control'. The planning initiatives seen in the Operational Programming Department's use of ALEM 6 to justify TXE 4 purchasing and the Long Range Planning Department's UKTTF study, whilst computerised, clearly speak to a different kind of control than cybernetic informational feedback loops; rather, they are conventional plans, laid out by management, which used computers as an additional source of credibility (in the case of ALEM 6, with near-disastrous results). However, it is equally difficult to discern the influence of a Fayolian sense of managerial control: one must remember that, as I discussed in Chapter Two, for Fayol, planning, as long-term forecasting, and control, as the monitoring of outputs, are quite different activities. Fayol, whilst almost invisible as a historical influence, nevertheless provides a useful clarification of the differences between planning and control which means that the planning activities in the Post Office which have been so important to this thesis should not be superficially read as yet more 'control'.

That said, in the case of the LRPD, there is a clear overlap with Merriman's cybernetic meanings also – Probert's introduction of Jay Forrester's cybernetic system dynamics to the Post Office whilst he was a consultant from Cambridge's Department of Control and Management Systems show how extensively cybernetic versions of control had taken hold. This particular mode of understanding the world *was* influenced by cybernetics, as a theory of control, and met with the government machine, a frame for general-purpose and special-purpose control, and so cast the telephone system as itself a system of control, motivating the pursuit of control through universal, intelligent machines. There were layered, sometimes conflicting, versions of control in the Post Office and the historical importance of each kind should not be devalued, but in terms of some of the most significant changes this thesis outlines – namely the developments which stemmed from Merriman's 'information and control' speech, such as System X, the ISDN, and the 'information highway', which negotiated privatisation and liberalisation in a way which preserved monopoly power within BT – it was the fusion of cybernetic control with the government machine which were at the heart of these changes.

Further Research

It is thus clear that this thesis provides only a partial, limited history of control, exploring its immediate origins, connotations, and influences within the British telephone system. The first avenue for further research I therefore suggest is a history of 'control'. Control is evidently important, both for actors and analysts, and yet its history is unclear. Hughes has pointed to control as part of a growing inter-war 'language of systems', and this appears to have accelerated during and after World War II; control was an integral part of the cybernetics discourse and made its way into the engineering lexicon in the Post Office.[21] Finally, control entered academic discourse, amongst analysts like Giddens, Deleuze, Beniger, and Webster, and more recently with Franklin. Unpicking this term's history would provide a context for these analysts' theories as well as this thesis.

A second area is telecommunications users, which would provide several important angles not addressed in this thesis. Deleuze and Harvey's insights into the micro-scale of control and the experiences of time-space compression respectively have not been fully addressed, and user histories can engage with these views. As Edwards points out, Fischer's history of telephone users in early-twentieth century America

[21] Hughes, *Networks of Power*, 368; Kline, *The Cybernetics Moment*, 18–26.

confounds the alienation view of technology and modernity, and so a history of British telecommunications users may also problematise these macro theories.[22]

This has been an extensive, but not exhaustive, history of the British telephone system since the 1950s. I called this thesis *Information and Control* because information and control were important to the actors in this history, and because they are important to scholars who analyse history. Information dominates theories about an information society, but for telecommunications engineers, information was a vision to realise, not a law by which society operated; realising this would helpfully re-orient debate to investigate information's power over both actors and analysts. Control, in contrast, was, for telecommunications engineers, the law by which society operated, and computer control, alongside a host of other types of control – environmental, organisational, spatial, temporal – were all deployed in service of the information vision. Telephone engineers built a control system because they perceived a control society; in this understanding of society, there is less difference between engineers and scholars than the latter would think. Realising that must be the first step to a history of control.

[22] Edwards, 'Infrastructure and Modernity: Force, Time, and Social Organisation in the History of Sociotechnical Systems', 202; Fischer, *America Calling*.

Bibliography

Archives Consulted

Bank of England Archive, London, UK

The British Postal Museum and Archive, Farringdon, London, UK

British Telecom Archives, Holborn, London, UK

Computer Networking and Telecommunications Research Technology Collection, University of Salford, Salford, UK

George Washington University Special Collections, Washington, D.C., USA

National Air and Space Museum Archives Center, Washington, D.C., USA

The National Archives, Kew, London, UK

National Museum of American History Archives Center, Washington, D.C., USA

Oral Histories

Higgins, Jeanette. Oral Histories of Martlesham Heath. Interview by Jacob Ward, 14 July 2016.

Hooper, Ray. Oral Histories of Martlesham Heath. Interview by Jacob Ward, 15 July 2016.

Johnson, Andrew. Oral Histories of Martlesham Heath. Interview by Jacob Ward, 14 July 2016.

Johnson, Beverley. Oral Histories of Martlesham Heath. Interview by Jacob Ward, 14 July 2016.

O'Brien, Sheila. Oral Histories of Martlesham Heath. Interview by Jacob Ward, 11 August 2016.

O'Brien, Thomas. Oral Histories of Martlesham Heath. Interview by Jacob Ward, 11 August 2016.

Sellon, Andrew. Oral Histories of Martlesham Heath. Interview by Jacob Ward, 17 June 2016.

Snow, Allen. Oral Histories of Martlesham Heath. Interview by Jacob Ward, 14 July 2016.

Wheddon, Chris. Oral Histories of Martlesham Heath. Interview by Jacob Ward, 4 August 2016.

Wheeler, Dennis. Oral Histories of Martlesham Heath. Interview by Jacob Ward, 15 June 2016.

Whitlum, Colin. Oral Histories of Martlesham Heath. Interview by Jacob Ward, 15 July 2016.

Published Sources

‘A Commercial Post Office’. *The Financial Times*. 1 March 1967.

‘A Year of Challenge and Change’. *Post Office Telecommunications Journal* 19, no. 4 (1967): 10–14.

‘Adastral Park’. *Wikipedia*, 26 June 2017. https://en.wikipedia.org/w/index.php?title=Adastral_Park&oldid=787639388.

Agar, Jon. ‘Making a Meal of the Big Dish: The Construction of the Jodrell Bank Mark 1 Radio Telescope as a Stable Edifice, 1946–57’. *The British Journal for the History of Science* 27, no. 1 (1994): 3–21.

———. *Science and Spectacle: The Work of Jodrell Bank in Postwar British Culture*. Amsterdam: Routledge, 1998.

———. *The Government Machine: A Revolutionary History of the Computer*. Cambridge, MA: MIT Press, 2003.

Aglietta, Michel. *A Theory of Capitalist Regulation: The U.S. Experience*. London: Verso, 2000.

Aldous, Tony. ‘Controlled Chaos Proves a Winner’. *Chartered Surveyor Weekly* 4, no. 13 (1983): 662–63.

———. ‘Suffolk Sensibilities’. *Building Design*, no. 680 (1984): 14–15.

‘All Change At The Post Office’. *The Times*. 4 August 1966.

Allenstein, B.M., and D.E. Probert. ‘A Strategic Control Module for a Corporate Model of British Telecom’. In *Forecasting Public Utilities*, edited by O.D. Anderson, 39–58. Amsterdam: North-Holland, 1980.

Andersson, Jenny. ‘The Great Future Debate and the Struggle for the World’. *The American Historical Review* 117, no. 5 (2012): 1411–1430.

Annan Committee. *Report of the Committee on the Future of Broadcasting*. Cmnd. 6753. London: HMSO, 1977.

‘Appointment of Mr. J.H.H. Merriman as Senior Director of Engineering’. *The Post Office Electrical Engineers’ Journal* 60, no. 2 (1967): 139.

Ardill, John. ‘Worker-Directors Dropped by Post Office Management’. *The Guardian*, 13 December 1979.

Ashworth, William. *The State in Business: 1945 to the Mid-1980s*. Basingstoke; London: MacMillan, 1991.

'AT&T, British Telecom Set $10B Venture'. CNN, 27 July 1998. http://money.cnn.com/1998/07/27/deals/bt/.

'AT&T Sets Telstar II Launch for Spring; Lessening of Radiation Damage a Main Goal'. *Wall Street Journal*, 2 January 1963.

AT&T's Universal Telephone Service. AT&T, 1989. https://www.youtube.com/watch?v=KklN1DCRmCU.

'Automation Firm Sacks 2,600 Men'. *Daily Herald*, 31 May 1956.

Bagrit, Leon. 'The Age of Automation'. *The Reith Lectures*. BBC Radio 4, 1964.

Barbrook, Richard, and Andy Cameron. 'The Californian Ideology'. *Science as Culture* 6, no. 1 (1996): 44–72.

Barnard, Malcolm. 'Advertising: The Rhetorical Imperative'. In *Visual Culture*, edited by Chris Jenks. London; New York: Routledge, 1995.

Barres-Baker, M.C. 'A Brief History of the London Borough of Brent'. *Brent Museum and Archive Occasional Publications*, no. 5 (2007).

Barron, D.A. 'Dialling for Trunk Calls: A Cheaper Telephone Service'. *The Manchester Guardian*, 4 December 1958.

Barrow, Becky. 'BT's Bunker Is a Brave New World in the Making'. *The Daily Telegraph*, 15 March 2001.

Bates, O. 'Ploughing the Seabed'. *Post Office Telecommunications Journal* 22, no. 4 (1970): 2–4.

Bauman, Zygmunt. *Liquid Modernity*. Cambridge: Polity Press, 2000.

———. *Modernity and Ambivalence*. Cambridge: Polity Press, 1991.

Bealey, Frank. *The Post Office Engineering Union: The History of the Post Office Engineers, 1870-1970*. London: Bachman & Turner, 1976.

Beesley, M., and S. Littlechild. 'Privatisation: Principles, Problems and Priorities'. *Lloyds Bank Review*, July 1983, 1–20.

Beesley, M.E. *Privatization, Regulation and Deregulation*. London: Routledge, 1992.

Beesley, M.E., and S.C. Littlechild. 'The Regulation of Privatized Monopolies in the United Kingdom'. *The RAND Journal of Economics* 20, no. 3 (1989): 454–72.

Beesley, Michael E. *Liberalisation of the Use of British Telecommunications Network*. London: HMSO, 1981.

Bell, Daniel. *The Coming of Post-Industrial Society: A Venture in Social Forecasting*. New York: Basic Books, 1973.

Beloff, Michael. *The Plateglass Universities*. London: Secker and Warburg, 1968.

Beniger, James R. *The Control Revolution: Technological and Economic Origins of the Information Society*. Cambridge, MA: Harvard University Press, 1986.

Bennett, Colin J. *Regulating Privacy: Data Protection and Public Policy in Europe and the United States*. Ithaca; London: Cornell University Press, 1992.

Berghoff, Hartmut, and Adam Rome, eds. *Green Capitalism?: Business and the Environment in the Twentieth Century*. Philadelphia: University of Pennsylvania Press, 2017.

Birch, Kean. 'Neoliberalism: The Whys and Wherefores … and Future Directions: Neoliberalism'. *Sociology Compass* 9, no. 7 (2015): 571–84.

Bishop, Matthew, and David Thompson. 'Privatisation in the UK: Deregulatory Reform and Public Enterprise Performance'. In *Privatisation: A Global Perspective*, edited by V.V. Ramanadham, 1–28. London; New York: Routledge, 1993.

Bogard, William. *The Simulation of Surveillance: Hypercontrol in Telematic Societies*. Cambridge: Cambridge University Press, 1996.

Bohn, Lewis C. 'Information Technology in Development'. Croton-on-Hudson, NY: Hudson Institute, 1968.

Boltanski, Luc, and Eve Chiapello. *The New Spirit of Capitalism*. Translated by Gregory Elliott. London; New York: Verso, 2007.

Boon, Rachel. 'The Post Office Research Station, Dollis Hill, 1933-1965'. PhD diss., PhD diss., University of Manchester, in progress.

Booth, Alan. *The Management of Technical Change: Automation in the UK and USA since 1950*. Basingstoke; New York: Palgrave Macmillan, 2007.

Bowler, Peter J. *Science for All: The Popularization of Science in Early Twentieth-Century Britain*. Chicago: University of Chicago Press, 2009.

Boyer, Robert, and Yves Saillard, eds. *Regulation Theory: The State of the Art*. Translated by Carolyn Shread. London; New York: Routledge, 2002.

Bradfield, Ron, George Wright, George Burt, George Cairns, and Kees Van Der Heijden. 'The Origins and Evolution of Scenario Techniques in Long Range Business Planning'. *Futures* 37, no. 8 (2005): 795–812.

Brand, Stewart, ed. 'Whole Earth Catalog', Fall 1968.

Braun, Wernher von. 'Now at Your Service - The World's Most Talkative Satellite'. *Popular Science*, May 1971, 56–57, 138.

Bray, Paul. 'A Map That Fills in the Gaps'. *The Guardian*, 2 February 1995.

Breary, D. ‘A Long-Term Study of the United Kingdom Trunk Network, Part 1 - General Methodology: Forecasts: Plant Study’. *The Post Office Electrical Engineers’ Journal* 66, no. 4 (1974): 210–16.

———. ‘A Long-Term Study of the United Kingdom Trunk Network, Part 2 - Network-Layout Studies and General Conclusions’. *The Post Office Electrical Engineers’ Journal* 67, no. 1 (1974): 37–41.

British Telecom International... It’s You We Answer To. BT, 1988. https://www.youtube.com/watch?v=WIDrUsx1Tf8.

Bruton, Elizabeth. ‘Beyond Marconi: The Roles of the Admiralty, the Post Office, and the Institution of Electrical Engineers in the Invention and Development of Wireless Communication up to 1908’. PhD diss., PhD diss., University of Leeds, 2012.

‘BT and Privatisation: A Situation Report for All Managers and Their Staff’, October 1982. TCD 69/2/115. BTA.

‘BT Enterprise in Venture to Exploit R&D Spin-Off’. *Electronics and Power* 28, no. 2 (1982): 141.

‘BT Exits Tech Mahindra’. *The Hindu*. 12 December 2012. http://www.thehindu.com/business/companies/bt-exits-tech-mahindra/article4191751.ece.

BT’s City Business System: The Power Behind the Button. BT, 1984. https://www.youtube.com/watch?v=1rGl6wnnWQM.

Bud, Robert. ‘Penicillin and the New Elizabethans’. *The British Journal for the History of Science* 31, no. 3 (1998): 305–333.

‘Building Dossier: Martlesham Heath’. *Building* 253, no. 7575 (1988): 43–54.

Butrica, Andrew J. *Beyond the Ionosphere: Fifty Years of Satellite Communication*. Washington, DC: NASA History Office, 1997.

Cable to the Continent. AT&T, 1959. https://www.youtube.com/watch?v=yqRj3lvvg7Y.

Cahan, David. ‘The Geopolitics and Architectural Design of a Metrological Laboratory: The Physikalische-Technische Reichsanstalt in Imperial Germany’. In *The Development of the Laboratory: Essays on the Place of Experiments in Industrial Civilization*, edited by Frank A.J.L. James, 137–54. Basingstoke: Macmillan, 1989.

Campbell-Kelly, Martin. *ICL: A Business and Technical History*. Oxford: Clarendon Press, 1989.

Campbell-Kelly, Martin, William Aspray, Nathan Ensmenger, and Jeffrey R. Yost. *Computer: A History of the Information Machine*. 3rd ed. Boulder, CO: Westview Press, 2014.

Campbell-Smith, Duncan. *Masters of the Post: The Authorized History of the Royal Mail*. London: Penguin, 2012.

Cane, Alan. ‘Hewlett-Packard Purchase’. *The Financial Times*. 17 May 1993.

Caporaletti, Silvana. ‘Science as Nightmare: “The Machine Stops” by E.M. Forster’. *Utopian Studies* 8, no. 2 (1997): 32–47.

‘Car Workers Vote to Stay Out Against Automation’. *Daily Herald*, 1 May 1956.

Castells, Manuel. *End of Millennium*. 2nd ed. The Information Age: Economy, Society and Culture, Vol. 3. Chichester: Wiley-Blackwell, 2010.

———. *The Power of Identity*. 2nd ed. The Information Age: Economy, Society and Culture, Vol. 2. Chichester: Wiley-Blackwell, 2009.

———. *The Rise of the Network Society*. 2nd ed. The Information Age: Economy, Society and Culture, Vol. 1. Chichester: Wiley-Blackwell, 2010.

Castells, Manuel, and Peter Hall. *Technopoles of the World: Making of 21st-Century Industrial Complexes*. London; New York: Routledge, 1994.

Caves, Richard, ed. *Britain’s Economic Prospects*. Washington: Allen & Unwin, 1968.

Chandler Jr., Alfred D. *The Visible Hand: Managerial Revolution in American Business*. Cambridge, Mass.: Harvard University Press, 1977.

Chapman, Colin. ‘The Torment of the Post Office’. *The Observer*, 20 July 1975.

Childs, D.R. ‘Harlow’. *Architects’ Journal*, no. 116 (1952): 196.

Clark, Pete. ‘Tower to the People’. *The Scotsman*, 30 June 1995.

Clarke, Arthur C. ‘Spinoff from Space’. *Bell Telephone Magazine* 48, no. 5 (1969): 26–32.

Clarke, S., and A.M. Tobias. ‘Complexity in Corporate Modelling: A Review’. *Business History* 37, no. 1 (1995): 17–44.

Clifton, Judith, Pierre Lanthier, and Harm Schröter. ‘Regulating and Deregulating the Public Utilities 1830–2010’. *Business History* 53, no. 5 (2011): 659–72.

Cole, A.C. ‘The Computer Exchange’. *Post Office Telecommunications Journal* 22, no. 1 (1970): 22–23.

‘Communist Link in Car Strike. Party Activity at Standards. Orders given to Fight Automation’. *Daily Telegraph*, 2 May 1956.

‘Companies | Innovation Martlesham’. Accessed 21 July 2017. http://www.innovationmartlesham.com/companies/.

Copeland, B. Jack. ‘Colossus and the Rise of the Modern Computer’. In *Colossus: The Secrets of Bletchley Park’s Codebreaking Computers*, edited by B. Jack Copeland, 101–15. Oxford: Oxford University Press, 2006.

———, ed. *Colossus: The Secrets of Bletchley Park’s Codebreaking Computers*. Oxford: Oxford University Press, 2006.

———. ‘Machine against Machine’. In *Colossus: The Secrets of Bletchley Park’s Codebreaking Computers*, edited by B. Jack Copeland, 64–77. Oxford: Oxford University Press, 2006.

‘Corning in Deal With NetOptix, 2 Other Firms’. *Los Angeles Times*, 15 February 2000. http://articles.latimes.com/2000/feb/15/business/fi-64359.

Cortada, James W. *The Digital Hand: How Computers Changed the Work of American Manufacturing, Transportation, and Retail Industries*. Oxford: Oxford University Press, 2004.

Cosier, J.E.H. ‘Getting to Grips with Undersea Cables’. *Post Office Telecommunications Journal* 30, no. 1 (1978): 7–8.

‘Councils Back Phone Union over Mercury Transmitters’. *The Sunday Times*, 18 December 1983.

Cowe, Roger. ‘BT’s Operation Sovereign Will Cost Nearly 400m: Outlook’. *The Guardian*, 25 May 1990.

Craig, Cleo F. ‘Equipping Ourselves for Today’s Responsibilities’. *Bell Telephone Magazine* 34, no. 4 (1955): 217–24.

Crawford, A.B., C.C. Cutler, R. Kompfner, and L.C. Tillotson. ‘The Research Background of the Telstar Experiment’. *The Bell System Technical Journal* 42, no. 4 (1963): 747–51.

‘Dan Dare, Pilot of the Future, in The Big City Caper’. *Eagle and Swift*, 23 May 1964.

Daunton, M.J. *Royal Mail: The Post Office since 1840*. London: Athlone Press, 1985.

Deleuze, Gilles. *Negotiations, 1972-1990*. Translated by Martin Joughin. Columbia University Press, 1997.

———. ‘Postscript on the Societies of Control’. *October* 59 (1992): 3–7.

Dennis, Michael Aaron. ‘Accounting for Research: New Histories of Corporate Laboratories and the Social History of American Science’. *Social Studies of Science* 17, no. 3 (1987): 479–518.

Doubleday, C.F., and D.E. Probert. ‘The Development of an Integrated Communications Demand Model for the British Telecommunications Business’. *The Journal of the Operational Research Society* 36, no. 12 (1985): 1083–93.

‘Draft Resolution - The Interconnection of Communication-Satellite Systems and Other Transmission Systems’. Documents for the Space Radiocommunication Conference. Geneva: International Telecommunications Union, 1963.

Duncan, C.C. ‘Communications and Defense’. *Bell Telephone Magazine* 37, no. 1 (1958): 15–24.

Edgerton, David. *Shock Of The Old: Technology and Global History since 1900*. London: Profile Books, 2006.

———. ‘The “White Heat” Revisited: The British Government and Technology in the 1960s’. *Twentieth Century British History* 7, no. 1 (1996): 53–82.

Edwards, Amy. ‘“Financial Consumerism”: Citizenship, Consumerism and Capital Ownership in the 1980s’. *Contemporary British History* 31, no. 2 (2017): 210–29.

———. ‘“Manufacturing Capitalists”: The Wider Share Ownership Council and the Problem of “Popular Capitalism”, 1958–92’. *Twentieth Century British History* 27, no. 1 (2016): 100–123.

Edwards, Paul N. ‘Infrastructure and Modernity: Force, Time, and Social Organisation in the History of Sociotechnical Systems’. In *Modernity and Technology*, edited by Thomas J. Misa, Philip Brey, and Andrew Feenberg, 185–224. Cambridge, MA: MIT Press, 2003.

Elmendorf, C.H., and B.C. Heezen. ‘Oceanographic Information for Engineering Submarine Cable Systems’. *The Bell System Technical Journal* 36, no. 5 (1957): 1035–94.

‘Experimental Earth Station at Goonhilly Downs’. Documents for the Space Radiocommunication Conference. Geneva: International Telecommunications Union, 1963.

‘Facts from Space via Telstar’. *Bell Telephone Magazine* 41, no. 3 (1962): 38–39.

Fayol, Henri. ‘Adminstration Industrielle et Générale’. *Bulletin de La Société de l’Industrie Minérale*, no. 10 (1916): 5–164.

Fensom, Harry. ‘How Colossus Was Built and Operated - One of Its Engineers Reveals Its Secrets’. In *Colossus: The Secrets of Bletchley Park’s Codebreaking Computers*, edited by B. Jack Copeland, 91–100. Oxford: Oxford University Press, 2006.

Finn, Bernard, and Daqing Yang, eds. *Communications Under the Seas: The Evolving Cable Network and Its Implications*. Cambridge, MA; London: MIT Press, 2009.

‘First Intelsat 4 Placed in Orbit’. *Aviation Week*, 1 February 1971.

‘First Report from the Select Committee on Nationalised Industries: The Post Office. Volume 1: Report and Proceedings of the Committee’. London: HMSO, 1967.

Fischer, Claude S. *America Calling: A Social History of the Telephone to 1940*. Berkeley, CA: University of California Press, 1994.

Fletcher, Richard, and Mary Fagan. ‘BT Sets up £2bn Venture Arm’. *The Telegraph*, 19 November 2000. http://www.telegraph.co.uk/finance/4472832/BT-sets-up-2bn-venture-arm.html.

Flowers, Thomas H. ‘Colossus’. In *Colossus: The Secrets of Bletchley Park’s Codebreaking Computers*, edited by B. Jack Copeland, 91–100. Oxford: Oxford University Press, 2006.

———. ‘D-Day at Bletchley Park’. In *Colossus: The Secrets of Bletchley Park’s Codebreaking Computers*, edited by B. Jack Copeland, 78–83. Oxford: Oxford University Press, 2006.

Floyd, C.F. ‘The Design of Martlesham Research Centre: Part 1 - Basic Design Requirements and Design of Buildings’. *The Post Office Electrical Engineers’ Journal* 69, no. 3 (1976): 146–53.

———. ‘The Design of Martlesham Research Centre: Part 2 - Services Provided’. *The Post Office Electrical Engineers’ Journal* 69, no. 4 (1977): 258–64.

Foreman-Peck, James. ‘The Development and Diffusion of Telephone Technology in Britain, 1900–1940’. *Transactions of the Newcomen Society* 63, no. 1 (1991): 165–79.

Forester, Tom. *High-Tech Society: The Story of the Information Technology Revolution*. Cambridge, MA: MIT Press, 1987.

Forrester, Jay Wright. ‘Industrial Dynamics’. *Harvard Business Review* 36, no. 4 (1958): 37–66.

———. *Industrial Dynamics*. Cambridge, MA: MIT Press, 1961.

Forster, E.M. ‘The Machine Stops’. *The Oxford and Cambridge Review*, 1909.

———. *The Machine Stops*. London: Penguin Classics, 2011.

Foster, Christopher. ‘Michael Beesley’. *The Guardian*, 8 October 1999.

Foucault, Michel. *Discipline and Punish: The Birth of the Prison*. Translated by Alan Sheridan. London: Penguin Books, 1991.

Franklin, Seb. *Control: Digitality as Cultural Logic*. Cambridge, MA: MIT Press, 2015.

‘Freedom for the GPO’. *The Guardian*, 4 August 1966.

Fry, G.K. *The Administrative ‘Revolution’ in Whitehall*. London: Croom Helm, 1981.

Full Automation of the Telephone System. Cmnd. 303. London: HMSO, 1957.

Gabor, Dennis. *Inventing the Future*. London: Secker and Warburg, 1963.

Galambos, Louis. ‘Recasting the Organizational Synthesis: Structure and Process in the Twentieth and Twenty-First Centuries’. *The Business History Review* 79, no. 1 (2005): 1–38.

———. ‘Technology, Political Economy, and Professionalization: Central Themes of the Organizational Synthesis’. *The Business History Review* 57, no. 4 (1983): 471–93.

———. ‘The Emerging Organizational Synthesis in Modern American History’. *The Business History Review* 44, no. 3 (1970): 279–90.

Gershuny, Jonathan, and Ian Miles. *The New Service Economy: The Transformation of Employment in Industrial Societies*. New York: Praeger, 1983.

Giddens, Anthony. *Power, Property and the State*. A Contemporary Critique of Historical Materialism, Vol. 1. London: Macmillan, 1981.

———. *Social Theory and Modern Sociology*. Cambridge: Polity Press, 1987.

———. *The Consequences of Modernity*. Cambridge: Polity Press, 1990.

———. *The Nation-State and Violence*. A Contemporary Critique of Historical Materialism, Vol. 2. Cambridge: Polity Press, 1985.

Gleichmann, T.F., A.H. Lince, M.C. Wooley, and F.J. Braga. ‘Repeater Design for the North Atlantic Link’. *The Bell System Technical Journal* 36, no. 1 (1957): 69–101.

Glynn, Sean, and Alan Booth. *Modern Britain: An Economic and Social History*. London; New York: Routledge, 1996.

‘Go-Ahead for TAT-8’. *BT Journal* 4 (Winter 1984): 35.

Godin, Benoît. ‘Research and Development: How the “D” Got into R&D’. *Science and Public Policy* 33, no. 1 (2006): 59–76.

Godin, Benoît, and Désirée Schauz. ‘The Changing Identity of Research: A Cultural and Conceptual History’. *History of Science* 54, no. 3 (2016): 276–306.

Goldie, C.T. ‘“Radio Campanile”: Sixties Modernity, the Post Office Tower and Public Space’. *Journal of Design History* 24, no. 3 (2011): 207–22.

Gooday, Graeme. ‘Placing or Replacing the Laboratory in the History of Science?’ *Isis* 99, no. 4 (2008): 783–95.

Gordon, T. J., and Olaf Helmer. ‘Report on a Long-Range Forecasting Study’. Santa Monica, CA: RAND Corporation, 1964.

Gore, Jr, Al. ‘Remarks at Superhighway Summit’. presented at the The Superhighway Summit, Royce Hall, UCLA, Los Angeles, 11 January 1994. https://clinton1.nara.gov/White_House/EOP/OVP/other/superhig.html.

‘GRACE’ in Action. British Movietone, 1958. https://www.youtube.com/watch?v=YUy1f1eGNew.

Graham, Stephen. ‘Spaces of Surveillant Simulation: New Technologies, Digital Representations, and Material Geographies’. *Environment and Planning D: Society and Space* 16, no. 4 (1998): 483–504.

Haigh, Alice. ‘The Origins and Early Years of the P.O. Research Station at Dollis Hill, 1908-38’. PhD diss., PhD diss., University of Leeds, in progress.

Hale, Constance, ed. *Wired Style: Principles of English Usage in the Digital Age*. San Francisco: Wired Books, 1997.

Hamblin, Jacob Darwin. *Arming Mother Nature: The Birth of Catastrophic Environmentalism*. Oxford; New York: Oxford University Press, 2013.

———. ‘Exorcising Ghosts in the Age of Automation: United Nations Experts and Atoms for Peace’. *Technology and Culture* 47, no. 4 (2006): 734–756.

Hamilton, Adrian. ‘Joseph to Split Post Office’. *The Observer*. 9 September 1979.

Harper, J.M. *Monopoly and Competition in British Telecommunications: The Past, the Present and the Future*. London; Washington: Pinter, 1997.

Harris, L. Roy F. *Automatic Switching in the UK*. Sunbury, Middlesex: The Communications Network, 2005.

Harvey, David. *A Brief History of Neoliberalism*. Oxford; New York: Oxford University Press, 2005.

———. *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change*. Oxford: Blackwell, 1990.

‘HC Deb: Government Offices (Dispersal)’, 29 January 1964. Vol 677 cc486-506. Hansard.

‘HC Deb: Ministry (Staff)’, 28 January 1964. Vol 688 c34W. Hansard.

‘HC Deb: Post Office Board (Industrial Democracy)’, 12 December 1979. Vol 975 cc1303-12. Hansard.

‘HC Deb: Research Centre, Dollis Hill’, 28 July 1964. Vol 699 cc234-5W. Hansard.

‘HC Deb: Telephone Service’, 11 March 1959. Vol 601 cc1260-63. Hansard.

Headrick, Daniel R. *The Invisible Weapon: Telecommunications And International Politics, 1851-1945*. New York; Oxford: Oxford University Press, 1991.

Hecht, Jeff. *City of Light: The Story of Fiber Optics*. Oxford; New York: Oxford University Press, 1999.

Henderson, P. D. 'Two British Errors: Their Probable Size and Some Possible Lessons'. *Oxford Economic Papers* 29, no. 2 (1977): 159–205.

Hennessy, Peter, Susan Morrison, and Richard Townsend. 'Routine Punctuated by Orgies: The Central Policy Review Staff, 1970-83'. *Strathclyde Papers on Government and Politics*, no. 31 (1985).

Herf, Jeffrey. *Reactionary Modernism: Technology, Culture, and Politics in Weimar and the Third Reich.* Cambridge: Cambridge University Press, 1984.

Hewison, Robert. *The Heritage Industry: Britain in a Climate of Decline*. London: Methuen, 1987.

Higuchi, Toshihiro. 'Atmospheric Nuclear Weapons Testing and the Debate on Risk Knowledge in Cold War America, 1945-1963'. In *Environmental Histories of the Cold War*, edited by J.R. McNeill and Corinna R. Unger, 301–22. Cambridge: Cambridge University Press, 2010.

Hills, Jill. *Telecommunications and Empire*. Urbana: University of Illinois Press, 2008.

Hounshell, David A. 'Hughesian History of Technology and Chandlerian Business History: Parallels, Departures, and Critics'. *History and Technology* 12, no. 3 (1995): 205–24.

'How the Post Office Got Its Lines Crossed'. *The Observer*. 4 June 1972.

Hudson, Richard L. 'British Phone Firm Sets Job Cuts' Cost At $660.7 Million'. *Wall Street Journal*, 25 May 1990.

Hughes, Thomas P. *Networks of Power: Electrification in Western Society, 1880-1930*. Baltimore; London: Johns Hopkins University Press, 1983.

———. 'The Evolution of Large Technological Systems'. In *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, edited by Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, 51–82. Cambridge, MA; London: MIT Press, 1987.

Hunt Report. *Report of the Inquiry into Cable Expansion and Broadcasting Policy*. Cmnd. 8679. London: HMSO, 1982.

Hutton, Will. 'Why Britain Is So Slow In Getting A Fibre Optic Network'. *The Guardian*, 28 July 1994.

Huurdeman, Anton A. *The Worldwide History of Telecommunications*. Hoboken, NJ: John Wiley & Sons, 2003.

‘In This Concluding Article, Joe Roeber Analyzes the Attitudes of Top Management to Their Consultants’. *The Times*, 7 July 1969.

‘Industrial Democracy “Test Case”’. *The Guardian*, 17 May 1977.

Information Technology Advisory Panel. ‘Report on Cable Systems’. London: HMSO, 1982.

‘Introducing You to LEAPS’. *Post Office Magazine*, October 1957, 300.

‘It’s Lonely up There at the Top’. *The Independent*, 16 November 1994.

Jack, J.S., C.W.H. Leech, and H.A. Lewis. ‘Route Selection and Cable Laying for the Transatlantic Cable System’. *The Bell System Technical Journal* 36, no. 1 (1957): 293–326.

Jencks, Charles. *The New Paradigm in Architecture: The Language of Post-Modernism*. New Haven; London: Yale University Press, 2002.

Jones, D.G., and P.J. Edwards. ‘Post Office Tower, London, and the United Kingdom Network of Microwave Links’. *The Post Office Electrical Engineers’ Journal* 58, no. 3 (1965): 149–59.

———. ‘The Post Office Network of Radio-Relay Stations. Part 1 - Radio-Relay Links and Network Planning’. *The Post Office Electrical Engineers’ Journal* 57, no. 3 (1964): 147–55.

Jordanova, Ludmilla. *The Look of the Past: Visual and Material Evidence in Historical Practice*. Cambridge: Cambridge University Press, 2012.

Kahn, Herman, and Anthony J. Wiener. *The Year 2000: A Framework for Speculation on the Next Thirty-Three Years*. New York: Macmillan, 1967.

Kay, Michael. ‘Troublesome Telephony: How Users and Non-Users Shaped the Development of Early British Exchange Telephony’. *Science Museum Group Journal* 3, no. 3 (9 April 2015). http://journal.sciencemuseum.org.uk/browse/issue-03/troublesome-telephony/.

Keegan, Victor. ‘Through a Glass Fibre Darkly’. *The Guardian*, 22 May 1993.

Kelly, M.J., S.G. Radley, G.W. Gilman, and R.J. Halsey. ‘A Transatlantic Telephone Cable’. *Transactions of the American Institute of Electrical Engineers, Part I: Communication and Electronics* 74, no. 1 (1955): 124–39.

Kennedy, Paul M. ‘Imperial Cable Communications and Strategy, 1870-1914’. *The English Historical Review* 86, no. 341 (1971): 728–752.

Kerswell, B.R., and W.G.T. Jones. ‘Conclusions from the Empress Digital Tandem Exchange Field Trial’. *The Post Office Electrical Engineers’ Journal* 72, no. 1 (1979): 9–14.

Khurana, Rakesh. *From Higher Aims to Hired Hands: The Social Transformation of American Business Schools and the Unfulfilled Promise of Management as a Profession*. Princeton; Oxford: Princeton University Press, 2007.

Kipling, Rudyard. 'The Deep Sea Cables'. In *The Seven Seas*. London: Methuen, 1896.

Kline, Ronald R. *The Cybernetics Moment*. Baltimore: Johns Hopkins University Press, 2015.

Knowles, Scott G., and Stuart W. Leslie. '"Industrial Versailles": Eero Saarinen's Corporate Campuses for GM, IBM, and AT&T'. *Isis* 92, no. 1 (2001): 1–33.

Krige, John. *American Hegemony and the Postwar Reconstruction of Science in Europe*. Cambridge, MA; London: MIT Press, 2006.

Kumar, Krishan. *Utopia and Anti-Utopia in Modern Times*. Oxford: Basil Blackwell, 1987.

Lakoff, George, and Mark Johnson. *Metaphors We Live By*. Chicago: University of Chicago Press, 1980.

Lamberton, Donald, ed. 'The Information Revolution'. *Annals of the American Academy of Political and Social Science*, 1974.

Large, Peter. 'After Jaguar, North Sea Oil and British Telecom, the Government Has Found Something Else to Privatise. No, Not British Airways but British Air Waves.' *The Guardian*, 29 March 1985.

———. 'Call for New Department to Control IT and Broadcasting'. *The Guardian*, 28 July 1983.

———. 'Even Air Waves Are up for Sale'. *The Guardian*, 18 November 1986.

———. '"Sell off Air Waves and Buy in Software"'. *The Guardian*, 3 April 1987.

Larner, Wendy, and Nina Laurie. 'Travelling Technocrats, Embodied Knowledges: Globalising Privatisation in Telecoms and Water'. *Geoforum* 41, no. 2 (2010): 218–26.

Lash, Scott, and John Urry. *The End of Organized Capitalism*. Cambridge: Polity Press, 1987.

Latour, Bruno. 'Give Me a Laboratory and I Will Raise the World'. In *Science Observed*, edited by Karin Knorr-Cetina and Michael Mulkay, 141–69. London: Sage, 1983.

Launius, Roger D. 'Writing the History of Space's Extreme Environment'. *Environmental History* 15, no. 3 (2010): 526–32.

Lean, Tom. *Electronic Dreams: How 1980s Britain Learned to Love the Computer*. London: Bloomsbury Sigma, 2016.

Liffen, John. ‘Telegraphy and Telephones’. *Industrial Archaeology Review* 35, no. 1 (2013): 22–39.

Lipartito, Kenneth. ‘Failure to Communicate: British Telecommunications and the American Model’. In *Americanization and Its Limits: Reworking US Technology and Management in Post-War Europe and Japan*, edited by Jonathan Zeitlin and Gary Herrigel, 153–79. Oxford; New York: Oxford University Press, 2000.

———. ‘Picturephone and the Information Age: The Social Meaning of Failure’. *Technology and Culture* 44, no. 1 (2003): 50–81.

Lipietz, Alain. ‘New Tendencies in the International Division of Labour: Regimes of Accumulation and Modes of Regulation’. In *Production, Work, Territory: Geographical Anatomy of Industrial Capitalism*, edited by Allen J. Scott and Michael Storper. London: Allen & Unwin, 1986.

Llewellyn, Mark. ‘Producing and Experiencing Harlow: Neighbourhood Units and Narratives of New Town Life 1947–53’. *Planning Perspectives* 19, no. 2 (2004): 155–74.

‘London’s New Landmark’. *Eagle and Swift*, 23 May 1964.

‘Long Range Intelligence Division, Post Office Telecommunications Headquarters: Information Scientist’. *New Scientist*, 28 February 1974.

‘Long-Distance Transmission by Waveguide’. *The Post Office Electrical Engineers’ Journal* 52, no. 3 (1959): 213–14.

‘Longest Lightlines for UK Cities’. *BT Technical Review*, Autumn 1982.

Lovell, Bernard. ‘The Challenge of Space Research’. *Nature*, no. 4845 (1962): 195.

Lowe, Rodney. ‘Milestone or Millstone? The 1959–1961 Plowden Committee and Its Impact on British Welfare Policy’. *The Historical Journal* 40, no. 2 (1997): 463–491.

Lowenthal, David. *The Past Is a Foreign Country*. Cambridge: Cambridge University Press, 1985.

Lyon, David. ‘Surveillance Technology and Surveillance Society’. In *Modernity and Technology*, edited by Thomas J. Misa, Philip Brey, and Andrew Feenberg, 161–83. Cambridge, MA: MIT Press, 2003.

———. *The Electronic Eye: The Rise of Surveillance Society*. Cambridge: Polity Press, 1994.

Marchand, Roland. *Creating the Corporate Soul: The Rise of Public Relations and Corporate Imagery in American Big Business*. Berkeley, CA: University of California Press, 1998.

March-Russell, Paul. '"IMAGINE, IF YOU CAN": Love, Time and the Impossibility of Utopia in EM Forster's' The Machine Stops''. *Critical Survey* 17, no. 1 (2005): 56–71.

Margetts, Helen. *Information Technology in Government: Britain and America*. London: Routledge, 1999.

'Martlesham Heath • 100 Groundbreaking Years'. Accessed 20 July 2017. https://mh100.org.uk/.

'Martlesham Heath Township Proposals for about 10,000 People'. *The Surveyor and Municipal Engineer*, 20 March 1965, 31–35.

Marwick, Arthur. *British Society Since 1945*. 3rd ed. London: Penguin, 1996.

———. 'Middle Opinion in the Thirties: Planning, Progress and Political "Agreement"'. *The English Historical Review* 79, no. 311 (1964): 285–98.

Mayr, Otto. *Authority, Liberty, and Automatic Machinery in Early Modern Europe*. Baltimore: Johns Hopkins University Press, 1986.

McKenna, Christopher D. *The World's Newest Profession: Management Consulting in the Twentieth Century*. Cambridge: Cambridge University Press, 2006.

McKie, Robin. 'Never Mind the Quality, Just Feel the Collar'. *The Observer*, 13 November 1994.

McLuhan, Marshall. *The Gutenberg Galaxy*. London: Routledge & Kegan Paul, 1962.

McNally, Kevin. *Corporate Venture Capital: Bridging the Equity Gap in the Small Business Sector*. London: Routledge, 1997.

McNeill, J.R., and Corinna R. Unger. 'Introduction: The Big Picture'. In *Environmental Histories of the Cold War*, edited by J.R. McNeill and Corinna R. Unger, 1–18. Cambridge: Cambridge University Press, 2010.

Meades, Jonathan. *Museum Without Walls*. Unbound, 2012.

Meadows, Donella H., Dennis L. Meadows, Jørgen Randers, and William W. Behrens III. *The Limits to Growth*. New York: Universe Books, 1972.

Melillo, E. D. 'Spectral Frequencies: Neoliberal Enclosures of the Electromagnetic Commons'. *Radical History Review* 2012, no. 112 (1 January 2012): 147–61.

Merlo, D. 'The Millimetric Waveguide System: The Current Situation'. *The Post Office Electrical Engineers' Journal* 69, no. 1 (1976): 34–37.

Merriman, J.H.H. 'Men, Circuits and Systems in Telecommunications'. *The Post Office Electrical Engineers' Journal* 60, no. 4 (1968): 241–51.

'Middlesex XI.14 (Includes: Willesden)'. 1:2500. Southampton: Ordnance Survey, 1914. http://maps.nls.uk/view/103657949.

‘Middlesex XI.14 (Includes: Willesden)’. 1:2500. Southampton: Ordnance Survey, 1938. http://maps.nls.uk/view/103657946.

Midwinter, J.E. ‘Optical-Fibre Transmission Systems: Overview of Present Work’. *The Post Office Electrical Engineers’ Journal* 70, no. 3 (1977): 146–53.

Miller, Arthur I. *Insights of Genius: Imagery and Creativity in Science and Art*. Cambridge, MA; London: MIT Press, 2000.

Millward, Robert. *Private and Public Enterprise in Europe: Energy, Telecommunications and Transport, 1830-1990*. Cambridge: Cambridge University Press, 2005.

Milne, Graeme J. ‘British Business and the Telephone, 1878–1911’. *Business History* 49, no. 2 (2007): 163–85.

‘More Needles in Space’. *The New York Times*, 8 May 1963.

Moreton, Anthony. ‘Survey: Science Parks’. *The Financial Times*. 21 January 1983.

Morgan, Kenneth O. ‘Nationalisation and Privatisation’. *Contemporary Record* 2, no. 4 (1988): 32–34.

Morus, Iwan Rhys. ‘“The Nervous System of Britain”: Space, Time and the Electric Telegraph in the Victorian Age’. *The British Journal for the History of Science* 33, no. 4 (2000): 455–75.

Muthesius, Stefan. *The Post-War University: Utopianist Campus and College*. New Haven; London: Yale University Press, 2001.

Nava, Mica. ‘Framing Advertising: Cultural Analysis and the Incrimination of Visual Texts’. In *Buy This Book: Studies in Advertising and Consumption*, edited by Mica Nava, Andrew Blake, Iain MacRury, and Barry Richards, 34–50. London; New York: Routledge, 1997.

Negrine, Ralph. ‘Cable Television in Great Britain’. In *Cable Television and the Future of Broadcasting*, edited by Ralph Negrine, 103–33. London; Sydney: Croom Helm, 1985.

Newman, Karin. *The Selling of British Telecom*. London: Holt, Rinehart and Winston, 1986.

‘No Adastral New Town’. Accessed 20 July 2017. http://noadastralnewtown.com/.

Noam, Eli. *Telecommunications in Europe*. New York; Oxford: Oxford University Press, 1992.

Noble, David F. *Forces of Production: A Social History of Industrial Automation*. New York: Knopf, 1984.

O'Hara, Glen. *From Dreams to Disillusionment: Economic and Social Planning in 1960s Britain*. Basingstoke: Palgrave Macmillan, 2007.

'On the Lightlines...' *British Telecom Journal* 3, no. 3 (Autumn 1982): 15.

'Optical Fibre Systems'. *BT Technical News*, July 1979.

'Optoelectronics: Building on Our Investment'. Advisory Council on Science and Technology, 1988.

Orwell, George. *Nineteen Eighty-Four*. London: Penguin Books, 2003.

Parker, Christopher, and Gillian Darley. 'Martlesham Heath Village'. *Architects' Journal* 170, no. 36 (1979): 485–503.

Parker, David. *The Official History of Privatisation: Volume 1, The Formative Years 1970-1987*. London; New York: Routledge, 2009.

Parker, Edwin B. 'Information and Society'. *Annual Review of Information Science and Technology* 8 (1973): 345–73.

Peaucelle, Jean-Louis, and Cameron Guthrie. 'Henri Fayol'. In *The Oxford Handbook of Management Theorists*, edited by Morgen Witzel and Malcolm Warner, 49–70. Oxford: Oxford University Press, 2013.

'Phone Foresight'. *The Guardian*, 7 October 1971.

Pinch, Trevor, and Wiebe E. Bijker. 'The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other'. In *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, edited by Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, 17–50. Cambridge, MA; London: MIT Press, 1987.

Piore, Michael, and Charles Sabel. *The Second Industrial Divide: Possibilities For Prosperity*. New York: Basic Books, 1984.

Pitt, Douglas C. *The Telecommunications Function in the British Post Office: A Case Study of Bureaucratic Adaptation*. Farnborough: Saxon House, 1980.

'Post Office at Grips with Suppliers'. *Daily Telegraph*, 10 February 1972.

'Post Office Democratic Pioneers'. *The Financial Times*. 5 January 1978.

'Post Office Equipment Row Brought into the Open'. *The Financial Times*, 2 February 1972.

Prasad, Monica. *The Politics of Free Markets: The Rise of Neoliberal Economic Policies in Britain, France, Germany, and the United States*. Chicago: University of Chicago Press, 2006.

Prichard, David. 'Village Values'. *RIBA Journal* 95, no. 8 (1988): 42–45.

Probert, David. ‘Systems Dynamics Modelling within the British Telecommunications Business’. *Dynamica* 8, no. 2 (1982): 69–81.

———. ‘The Development of a Long-Range Planning Model for the British Telecommunications Business: “From Initiation to Implementation”’. *The Journal of the Operational Research Society* 32, no. 8 (1981): 695–719.

———. ‘Towards Expert Systems for Telecommunications Policy Analysis’. *Computer Communications* 6, no. 2 (1983): 58–64.

‘Professor Merriman Retires... and so Does Dollis Hill’. *Post Office Telecommunications Journal* 28, no. 4 (1976): 30.

‘Protests Continue Abroad’. *The New York Times*, 22 October 1961.

Queen Dials Edinburgh. British Pathé, 1958. https://www.youtube.com/watch?v=wfH0Xr1rIcY.

Rand, Lisa Ruth. ‘Orbital Decay: Space Junk and the Environmental History of Earth’s Planetary Borderlands’. PhD diss., PhD diss., University of Pennsylvania, 2016.

Randell, Brian. ‘Of Men and Machines’. In *Colossus: The Secrets of Bletchley Park’s Codebreaking Computers*, edited by B. Jack Copeland, 141–49. Oxford: Oxford University Press, 2006.

Raymond, Jack. ‘U.S. Gives Soviet Report on Search of Fishing Vessel’. *The New York Times*, 28 February 1959.

‘Recent Major Events in the Evolution of British Telecom’s Optical-Fibre Network’. *British Telecommunications Engineering* 1, no. 3 (1982): 178–79.

Reorganisation of the Post Office. Cmnd. 3233. London: HMSO, 1967.

Report of the Committee on Privacy. Cmnd. 5012. London: HMSO, 1972.

Report of the Independent Review of the Radio Spectrum: 30-690 MHz. Cmnd. 9000. London: HMSO, 1983.

Report of the Post Office Review Committee. Cmnd. 6850. London: HMSO, 1977.

‘Report on Europe and the Global Information Society’. Brussels: European Commission, 1994.

Report on Post Office Development and Finance. Cmd. 9576. London: HMSO, 1955.

Ringland, Gill. *Scenario Planning: Managing for the Future*. Chichester; New York: John Wiley & Sons, 1998.

Ritchey, Tom. ‘Problem Structuring Using Computer-Aided Morphological Analysis’. *Journal of the Operational Research Society* 57, no. 7 (2006): 792–801.

Rosen, Christine Meisner. ‘Industrial Ecology and the Greening of Business History’. *Business and Economic History* 26, no. 1 (1997): 123–37.

———. ‘The Business-Environment Connection’. *Environmental History* 10, no. 1 (2005): 77–79.

Rosen, Christine Meisner, and Christopher C. Sellers. ‘The Nature of the Firm: Towards an Ecocultural History of Business’. *The Business History Review* 73, no. 4 (1999): 577–600.

Rosen, P. ‘The Social Construction of Mountain Bikes: Technology and Postmodernity in the Cycle Industry’. *Social Studies of Science* 23, no. 3 (1993): 479–513.

Rowbotham, T.R. ‘Plans for a British Trial of Fibre to the Home’. *British Telecommunications Engineering* 8, no. 2 (1989): 78–82.

Rozwadowski, Helen M. ‘Ocean’s Depths’. *Environmental History* 15, no. 3 (2010): 520–25.

Rutkowski, Anthony. *Integrated Services Digital Networks*. Dedham, MA: Artech, 1985.

Rybczynski, Witold. ‘Behind the Façade of Prince Charles’s Poundbury’. Architect, 3 December 2013. http://www.architectmagazine.com/Design/behind-the-facade-of-prince-charless-poundbury_o.

‘Ryland’s Row’. *The Economist*, 5 February 1972.

Sabel, Charles F., and Jonathan Zeitlin, eds. *World of Possibilities: Flexibility and Mass Production in Western Industrialization*. Cambridge: Cambridge University Press, 1997.

Sabel, Charles, and Jonathan Zeitlin. ‘Historical Alternatives to Mass Production: Politics, Markets and Technology in Nineteenth-Century Industrialization’. *Past & Present*, no. 108 (1985): 133–176.

Samuel, Raphael. *Theatres of Memory: Past and Present in Contemporary Culture*. London: Verso, 1994.

Scarborough, R.J.D., K.H. Ferguson, and A.W. Searls. ‘The Generation of Stable Carrier Frequencies in the Range 3,800-4,200 Mc/S’. *The Post Office Electrical Engineers’ Journal* 52, no. 2 (1959): 125–28.

Schiller, Dan. *Telematics and Government*. Norwood, NJ: Ablex, 1982.

Schiller, Herbert I. *Culture, Inc.: The Corporate Takeover of Public Expression*. New York; Oxford: Oxford University Press, 1989.

———. *Information and the Crisis Economy*. Norwood, NJ: Ablex, 1984.

———. *Information Inequality: The Deepening Social Crisis in America*. New York; London: Routledge, 1996.

———. *Mass Communications and American Empire*. 2nd ed. Boulder, CO; Oxford: Westview Press, 1992.

Schwoch, James. *Global TV: New Media and the Cold War, 1946-69*. Urbana: University of Illinois Press, 2008.

Scott, Peter. 'Still a Niche Communications Medium: The Diffusion and Uses of the Telephone System in Interwar Britain'. *Business History* 53, no. 6 (2011): 801–20.

Scranton, Philip. *Figured Tapestry: Production, Markets and Power in Philadelphia Textiles, 1855-1941*. Cambridge: Cambridge University Press, 1989.

'Screen Test'. *The Guardian*, 26 February 1982.

Seefried, Elke. 'Towards The Limits to Growth? The Book and Its Reception in West Germany and Britain 1972–73'. *German Historical Institute London Bulletin* 33, no. 1 (2011): 3–37.

Shannon, Claude E. 'A Mathematical Theory of Communication, Part 1'. *Bell System Technical Journal* 27 (1948): 379–423.

———. 'A Mathematical Theory of Communication, Part 2'. *Bell System Technical Journal* 27 (1948): 623–56.

Sheppard, S.H. 'The Leighton Buzzard Electronic Telephone Exchange'. *The Post Office Electrical Engineers' Journal* 59, no. 4 (1967): 255–61.

Shonfield, Andrew. *Modern Capitalism: The Changing Balance of Public and Private Power*. London: Oxford University Press, 1965.

Sleigh, Charlotte. *Literature and Science*. Basingstoke: Palgrave Macmillan, 2011.

Slotten, Hugh Richard. 'International Governance, Organizational Standards, and the First Global Satellite Communication System'. *Journal of Policy History* 27, no. 3 (2015): 521–49.

———. 'Satellite Communications, Globalization, and the Cold War'. *Technology and Culture* 43, no. 2 (2002): 315–50.

———. 'The International Telecommunications Union, Space Radio Communications, and U.S. Cold War Diplomacy, 1957-1963'. *Diplomatic History* 37, no. 2 (2013): 313–71.

Smith, Roger. 'BT Bites Back ... New Cable More than a Match for "Jaws"'. *BT Journal* 8, no. 2 (1987): 38–41.

Smith, Trevor. *The Politics of the Corporate Economy*. Oxford: Martin Robertson & Company, 1979.

Snoke, L.R. ‘Resistance of Organic Materials and Cable Structures to Marine Biological Attack’. *The Bell System Technical Journal* 36, no. 5 (1957): 1095–1127.

Starosielski, Nicole. *The Undersea Network*. Durham, NC: Duke University Press, 2015.

Stevens, Richard. ‘The Evolution of Privatisation as an Electoral Policy, c.1970–90’. *Contemporary British History* 18, no. 2 (2004): 47–75.

Stine, Jeffrey K., and Joel A. Tarr. ‘At the Intersection of Histories: Technology and the Environment’. *Technology and Culture* 39, no. 4 (1998): 601–40.

Sumner, James. ‘Defiance to Compliance: Visions of the Computer in Postwar Britain’. *History and Technology* 30, no. 4 (2014): 309–33.

‘“Super” Link Installed’. *British Telecom Journal* 6, no. 4 (Winter 1985): 41.

Sutton, Peter. ‘Technological Change and Industrial Relations in the British Postal Service, 1969-1975’. PhD diss., PhD diss., King’s College London, 2013.

Suvin, Darko. *Metamorphoses of Science Fiction: On the Poetics and History of a Literary Genre*. Edited by Gerry Canavan. Oxford: Peter Lang, 2016.

‘Switchboard In Orbit’. *TV Guide*, 4 December 1971.

Telecommunication Services for the 1990s. The Post Office, 1969. https://www.youtube.com/watch?v=EUcF_OuV19k.

‘Telecommunications’, 21 July 1980. HC Deb Vol 989 cc29-40. Hansard.

Telephone Policy: The Next Steps. Cmnd. 436. London: HMSO, 1958.

Telephone Service and the Customer. London: HMSO, 1959.

Thatcher, Margaret. ‘Speech Opening Conference on Information Technology’. The Barbican Centre, London, 8 December 1982. http://www.margaretthatcher.org/document/105067.

———. ‘The Principles of Thatcherism’. Taiwan, 1 September 1992. http://www.margaretthatcher.org/document/108301.

———. ‘The Principles of Thatcherism’. Seoul, South Korea, 3 September 1992. http://www.margaretthatcher.org/document/108302.

Thatcher, Mark. *The Politics of Telecommunications: National Institutions, Convergence, and Change in Britain and France*. Oxford; New York: Oxford University Press, 2000.

‘The Communications Explosion: Early Bird - And After’. *TIME*, 14 May 1965.

‘The Computer Centre in Kensington’. *Post Office Telecommunications Journal* 17, no. 1 (1965): 6–8.

The Development of Cable Systems and Services. Cmnd. 8866. London: HMSO, 1983.

‘The Fight for the New Telephone System’. *The Financial Times*, 28 January 1972.

The Future of Telecommunications in Britain. Cmnd. 8610. London: HMSO, 1982.

The Inland Telephone Service in an Expanding Economy. Cmnd. 2211. London: HMSO, 1963.

‘The Main Event – Martlesham Heath • 100 Groundbreaking Years’. Accessed 21 July 2017. https://mh100.org.uk/the-main-event/.

The Post Office. Cmnd. 7292. London: HMSO, 1978.

‘The Post Office Enters the Computer Age’. *Post Office Telecommunications Journal* 17, no. 1 (1965): 2–4.

‘The Rise and Fall of BT’. *BBC News*, 26 April 2001. http://news.bbc.co.uk/1/hi/business/1014978.stm.

‘The World’s First PCM Exchange’. *Post Office Telecommunications Journal* 20, no. 2 (1968): 7–11.

Thomas, Graham, and Sally Wyatt. ‘Shaping Cyberspace—Interpreting and Transforming the Internet’. *Research Policy* 28, no. 7 (1999): 681–698.

Thomas, William, and Lambert Williams. ‘The Epistemologies of Non-Forecasting Simulations, Part I: Industrial Dynamics and Management Pedagogy at MIT’. *Science in Context* 22, no. 2 (2009): 245–70.

Thompson, Paul. ‘“The Voice of the Past” Extract’. In *The Oral History Reader*, edited by Robert Perks and Alistair Thomson. Abingdon: Routledge, 2006.

Thomson, Andrew, and John Wilson. ‘Lyndall Urwick’. In *The Oxford Handbook of Management Theorists*, edited by Morgen Witzel and Malcolm Warner, 114–32. Oxford: Oxford University Press, 2013.

Thring, M.W., and E.R. Laithwaite. *How to Invent*. London; Basingstoke: Macmillan, 1977.

‘Tommy Flowers Institute | BT Adastral Park’. Accessed 21 July 2017. http://atadastral.co.uk/about/tommy-flowers-institute/.

Tucker, D.G. ‘The Early Development of the British Underground Trunk Telephone Network’. *Transactions of the Newcomen Society* 49, no. 1 (1977): 57–74.

Tully, John. ‘A Victorian Ecological Disaster: Imperialism, the Telegraph, and Gutta-Percha’. *Journal of World History* 20, no. 4 (2009): 559–79.

Turner, Fred. *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism*. Chicago: University of Chicago Press, 2006.

‘Twentieth Century Village’. *Building Design*, no. 406 (1978): 8.

‘UK Ministers Defend Chinese Deals after Security Risk Warning’. *BBC News*, 6 June 2013. http://www.bbc.co.uk/news/uk-politics-22795226.

‘University of Essex: Chair in Telecommunication Systems’. *The Observer*, 15 January 1967.

‘University of Essex: Electronic Engineering’. *The Guardian*, 22 December 1967.

‘University of Essex/Post Office Research Centre. SRC Case Studentship: Optical Communications’. *The Guardian*, 29 May 1979.

Vallis, Peter. ‘Martlesham Heath Village’. *ERA*, no. 45 (August 1977): 64–68.

‘Van Allen Sees Science “Clique”’. *The New York Times*, 31 December 1962.

Van Dijk, Jan. ‘The One-Dimensional Network Society of Manuel Castells’. *New Media & Society* 1, no. 1 (1999): 127–138.

Veljanovski, Cento G. *Selling the State: Privatisation in Britain*. London: Weidenfeld and Nicolson, 1987.

Vieille Blanchard, Elodie. ‘Modelling the Future: An Overview of the “Limits to Growth” Debate’. *Centaurus* 52, no. 2 (2010): 91–116.

Vincent, David. *The Culture of Secrecy: Britain, 1832-1998*. Oxford; New York: Oxford University Press, 1998.

Waff, Craig B. ‘Project Echo, Goldstone, and Holmdel: Satellite Communications as Viewed from the Ground Station’. In *Beyond the Ionosphere: Fifty Years of Satellite Communication*, edited by Andrew J. Butrica, 41–50. Washington, DC: NASA History Office, 1997.

Wagner, Peter. *A Sociology of Modernity: Liberty and Discipline*. London; New York: Routledge, 1994.

Ward, K.E. ‘The Heart That Makes The Tower Tick’. *Post Office Telecommunications Journal* 20, no. 2 (1968): 22–27.

Ward, Mark. *Out of the Unknown: A Guide to the Legendary BBC Series*. Bristol: Kaleidoscope, 2004.

Webster, Frank. *Theories of the Information Society*. London; New York: Routledge, 2014.

Webster, Frank, and Kevin Robins. ‘Plan and Control’. *Theory and Society* 18, no. 3 (1989): 323–51.

Wells, H.G. *The Shape of Things to Come*. London: Gollancz, 2017.

Weppler, H. Edward. ‘The Radio Spectrum Squeeze’. *Bell Telephone Magazine* 47, no. 6 (1968): 28–32.

West, W. 'Facilities for Experimental Work in the Engineering Department'. *The Post Office Electrical Engineers' Journal* 47, no. 1 (1954): 10–14.

Westin, Alan F. *Privacy and Freedom*. London: Bodley Head, 1967.

White, R.W. 'Waveguides - Highways of Communication'. *Post Office Telecommunications Journal* 22, no. 3 (1970): 5.

Wiener, Norbert. *Cybernetics: Or Control and Communication in the Animal and the Machine*. New York: John Wiley & Sons, 1948.

Wilby, Dave. 'Inside Adastral: BT's Belgium-Sized Broadband Boffinry Base', 26 March 2013. https://www.theregister.co.uk/2013/03/26/geeks_guide_adastral_park/.

Williams, Christopher. 'BT and Phorm: How an Online Privacy Scandal Unfolded'. *The Telegraph*, 8 April 2011. http://www.telegraph.co.uk/technology/news/8438461/BT-and-Phorm-how-an-online-privacy-scandal-unfolded.html.

Williamson, Adrian. 'The Bullock Report on Industrial Democracy and the Post-War Consensus'. *Contemporary British History* 30, no. 1 (2016): 119–49.

Wilson, Harold. 'Labour's Plan for Science'. presented at the Labour Party Annual Conference, Scarborough, 1 October 1963.

'World's First Commercial 140 Mbit/s Optical Link Fibre Tested'. *BT Technical News*, Winter 1983.

Wright, Nigel. 'The Formulation of British and European Policy Toward an International Satellite Telecommunications System: The Role of the British Foreign Office'. In *Beyond the Ionosphere: Fifty Years of Satellite Communication*, edited by Andrew J. Butrica, 157–70. Washington, DC: NASA History Office, 1997.

Wright, Patrick. *On Living in an Old Country: The National Past in Contemporary Britain*. London: Verso, 1985.

Wright, Steve. 'An Appraisal of Technologies of Political Control'. Luxembourg: Scientific and Technological Options Assessment Unit, European Parliament, 1998.

Yates, David M. *Turing's Legacy: A History of Computing at the National Physical Laboratory 1945-1995*. London: Science Museum, 1997.

Yow, Valerie Raleigh. *Recording Oral History: A Guide for the Humanities and Social Sciences*. 2nd ed. Walnut Creek, California: AltaMira Press, 2005.

Yueh, Linda. ‘Huawei Boss Says US Ban “Not Very Important”’. *BBC News*, 16 October 2014. http://www.bbc.co.uk/news/business-29620442.

Zwicky, Fritz. *Discovery, Invention, Research: Through the Morphological Approach*. New York: Macmillan, 1969.

Zwicky, Fritz, and Albert George Wilson. *New Methods of Thought and Procedure*. New York: Springer-Verlag, 1967.