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1

THE TECHNICAL AND THE POLITICAL

A TECHNOLOGICAL SOCIETY

In a lecture at the London School of Economics in November 1997, Mme Edith Cresson, the then European Commissioner for Science, Research and Development and former French Socialist Prime Minister, spoke of the need to move 'towards a knowledge-based Europe'. The theme is a familiar one in European and North American political life. Euro-American political and social elites have long reckoned that knowledge and expertise are critical to the conduct of government, while European identity has historically been associated with notions of enlightenment, science and invention.[1]

But if Cresson's talk repeated familiar themes it gave them a particular contemporary twist. One theme was technology and training. Whereas in the past, education might have been thought of as a one-off affair, a process of apprenticeship, the rapidity of technological change demanded a different attitude. 'Knowledge and skills become obsolete and must continually be refreshed.'[2] Societies and individuals must be prepared to re-tool, adapt and update. Technical innovation continued apace and neither individuals nor societies could afford to be left behind. The other strand was the threat of what she termed globalisation.[3] Europe had, she noted, both an aging population and, as a proportion of the world's population, a declining one. At the same time new actors on the international scene such as India (in software), China (in biotechnology) and Brazil (in aeronautics) were beginning to compete in those knowledge-based industries in which Europe had traditionally had a competitive advantage. It was not so much a question of a declining relative population, but a declining proportion of the number of technologically equipped persons; a fragile technological culture. In the

context of the globalisation of technology Europeans had 'no choice'. 'If they wish to survive they must pool their strengths and turn their backs on the limited strategy of protecting national interests.'[4] The knowledge-based society of Europe could survive but only if the barriers dividing it were reduced, and new connections were forged. Mme Cresson's argument echoed those of earlier commentators on European integration. In post-1945 politics, the European Community can be considered as something of a political invention; a remarkable attempt, however flawed, to establish a system of government which operated across national boundaries. But, as her remarks indicate, it has also been one whose history is bound up with a sense of both the potential, and the threat, of technology.

How should one conceive of the relation between government, politics and technology today? In this book I argue that we should speak of the government of a technological society. In saying this I do not wish to claim that society is simply more technological than it has been in the past, or is becoming more so. Nor do I wish to mark an epochal shift from an earlier form of society (industrial, modern, capitalist) to a later (technological) one.[5] Nor do I aim to identify a new stage in the history of modes of government which might be compared to the era of liberalism, welfare-state social democracy or neo-liberalism.[6] Rather, in speaking of a technological society I want to interrogate a quite specific contemporary political preoccupation. This is a political preoccupation with the problems technology poses, with the potential benefits it promises, and with the models of social and political order it seems to make available. We live in a technological society, I argue, to the extent that specific technologies dominate our sense of the kinds of problems that government and politics must address, and the solutions that we must adopt. A technological society is one which takes technical change to be the model for political invention. The concept of a technological society does not refer to a stage in history, but rather to a specific set of attitudes towards the political present which have acquired a particular contemporary intensity, salience and form.[7]

In this book I examine the contemporary preoccupation with technology in political life along two interrelated dimensions. The first is the centrality of technology to the reconfiguration of what one can call the space of government.[8] Traditionally, the space of government has been conceived in terms of a relation between a national population and a national territory. 'Societies' and 'economies' have been contained within

the territorial boundaries of the nation-state. Here, however, I argue that government operates not just in relation to spaces defined and demarcated by geographical or territorial boundaries but in relation to zones formed through the circulation of technical practices and devices. Practices of government are as much oriented towards the problems of defending, connecting and reconstructing such technological spaces, as with older concerns with the defence and demarcation of physical territory. This sense of a need to create technological connections and maintain technological zones is not confined to national administrations, nor manifested simply in statements of public policy. It also figures in the calculations of firms, international organisations, public organisations and individual persons. In the nineteenth century a measure of population was reckoned to be a key indicator of the health and wealth of a nation, a race or a society.[9] Today, however, it is more likely that national, organisational and individual capacities will be judged against a measure of intellectual productivity or property, skill or scientific or computer literacy. This is an era obsessed by a series of interconnected technological problems: with the maintainance of technological competitiveness and the improvement of research productivity; with the need to patent and protect intellectual property; with the dangers posed by the unintended consequences of technological development; with the public understanding of science; with the risks and prospects for e-commerce and electronic democracy; and with the need for life-long learning in the face of rapid technical change.[10] Mme Cresson's anxieties about the threat and the potential of technology to the future of Europe are certainly not original. They have been expressed in different forms and with different rationales from the nineteenth century onwards. But they have acquired a new sense of urgency and centrality in contemporary political life.

The second axis of this book follows on from this. In the second part of the book I argue that a feature of today's technological society is a concern with the technical skills, capacities and knowledge of the individual citizen. To live in a technological society is thought to require much more than the capacity to make judgements about the prices and quality of commodities, and the suitability of parties and politicians for government office. It also implies the need to possess and develop one's knowledge and skill. It demands a mind and a body able to meet the exacting demands of new flexible work routines, new technologies and emerging environmental hazards. If it was once thought rational to

accept the judgement of scientific experts without question, today a reliance on experts is said by many to be an inadequate basis for good government. The citizen of a technological society expects and is expected to be informed and updated. She should be knowledgeable about the risks of smoking and the side-effects of drugs, be ready to learn about the latest advances and advantages of new information technologies, the strengths and weaknesses of 'medical' and 'natural' approaches to childbirth, the possible consequences of eating fats, sugars or GM foods, and the advantages and disadvantages of different forms of exercise and diet. She has to be knowledgeable about the multiple intersections and connections between her body and pollutants, drugs and technical devices, and the dangers and possibilities such connections may open up. Her health and her environment are matters of choice.[11] Technological innovation forms new artefacts. The government of a technological society implies the formation of new human capacities and attributes.

This demand for ordinary citizens to improve their own technical capacities and knowledge comes from diverse directions and has various motivations. Some scientific organisations expect greater 'public understanding of science' will act as a counter to the scepticism towards science which is thought to be so prevalent within the wider population.[12] Sociologists and others argue for greater public understanding of the limits and weaknesses of scientific expertise. Many environmental groups such as Friends of the Earth reckon that the availability of scientific and technical information will help foster more rational environment policies on the part of government. National governments, international organisations and firms argue that the scientific and technical literacy of a population is a measure of its value as a workforce. Individuals need to be better informed, and continually updated.

In reflecting on the place of technology in the shifting orders of government, three considerations should be uppermost. One concerns the complex cross-overs between political and scientific and technical discourse. Today, images and concepts such as networking, chaos, fractal geometry, interactivity, evolution, potential and complexity, figure routinely in political debate *and* cultural criticism, in scientific practice *and* social theory. This is not a new phenomenon. For example, one can point to the significance of notions of mechanism, of the body, and of organic function throughout the histories of science and government. One can consider the importance of evolutionary theory and of concepts

of degeneration in late nineteenth- and early twentieth-century political thought; and the earlier conception of the body politic; or the more recent prominence of ideas of system and structure; or the way that the state has so often been figured as a machine or an apparatus.[13] This book argues, however, that the particular form and extent of the contemporary interplay between political, technical and social scientific discourse demands interrogation. Such an interrogation should encourage reflexivity about our own analytical categories and metaphors and their histories. What does the prevalence of such metaphors suggest about the connections between developments in the information and biosciences and changing forms of government? In these circumstances what is the appropriate analytical vocabulary for the social sciences? And what is the relation between the conceptual inventiveness of the social sciences and other sites and practices of invention?

The second concerns the complexity of technical practices, and their relation to government. On the one hand, as historians and sociologists of science have shown, scientific and technical work is much more an untidy, practical, uncertain and collective business than is often imagined.[14] Moreover, despite the 'transnational' or 'global' character of science and technology the difficulty of applying scientific or technical practices outside very specific sites is often not recognised. Technical practices are often extremely localised in their possible application. Specific technologies, such as diagnostic instruments, may only be used effectively within particular laboratory conditions. On the other hand, rather than conceive of government as an institution, one might view it, following Foucault, as a practice of government or self-government.[15] In this way one might speak of the government of populations, of children, and of individual conduct. In Foucault's account, government is inevitably a technical matter. Practices of government rely on an array of more or less formalised and more or less specialised technical devices from car seat-belts and driving codes to dietary regimes; and from economic instruments to psychotherapy. Moreover, government operates both on and across many distinctions which are so critical to our sense of the terrain of politics: public and private; state and market; the realm of culture (language, identity, cultural institutions) and the domain of nature (the body, sexuality, the environment). In this way, the study of government, in Foucault's sense of the term, opens up a much broader field of politics to inspection. The political need not be only associated with the control of political institutions, the activities of the state or the formation of

social movements. Instead, I take the political to refer to the ways in which artefacts, activities or practices become objects of contestation.

The third concerns the relation between government and the politics of protest and opposition. As some critics have observed, research on government, following Foucault, has been largely concerned with what one might call 'the political mentality of rule'. In studying the formation of objects such as 'the economy', 'the school child' or 'unemployment', researchers have largely confined themselves to the study of the documents of experts and administrators. Such studies have focused 'on the various incarnations of ... "the will to govern", as it is enacted in a multitude of programmes, strategies, tactics, devices, calculations, negotiations, intrigues, persuasions, seductions aimed at the conduct of the conduct of individuals, groups populations – and indeed onself'.[16] In this context, 'resistance' has sometimes simply been equated with the inevitable failures of government to forge a correspondance between the idealised objects of political and economic thought ('the free market', 'the responsible parent', 'the disinterested bureaucrat', 'the self-disciplined student') and the knowledge that is generated about such objects by experts, administrators and individual citizens as part of the messy practice of governing.[17]

But to speak of opposition and protest is not simply to talk of the failure of government. For, as we shall see, opposition and protest may itself have their own logic and inventiveness; their own spaces and temporalities; their own forms of knowledge and technique; their own ways of restricting as well as opening up the terrain of politics.[18] Moreover, it would be a mistake to think that the characteristic forms of opposition that exist within a technological society are necessarily anti-technological in character, or to draw an opposition between the rational calculating and technological character of an administered society and more or less romantic and utopian forms of resistance. As we shall see, even the most apparently anti-technological of protests has a certain technical dimension. Moreover, even the most bureaucratic institutions may contain practices and activities which are politically inventive. In investigating opposition and protest it is important neither to romanticise protest nor to view it simply as an expression of a pre-existing antagonism or a manifestation of an underlying historical logic. Nor should we assume that a clear line can be drawn between zones of rational administration and sites of political invention.

THE POLITICAL AND THE TECHNICAL

If government is conceived of not so much as an institution but more broadly as an activity of governing and self-governing, then what of the political? Instead of equating the political with particular institutionalised conflicts – such as those between and within political parties and the state – in this book I propose to understand the political as an index of space of contestation and dissensus. That which is political is that which opens the space of politics. Public politics often remains centred on the conduct of political parties and national government, but this does not mean that the political can be reduced to such conflicts. There can be a politics of national identity in so far as identity is not fixed, but potentially contestable, multi-dimensional and irreducible.[19] There can be a politics to private life given the ways in which the boundaries of the private and the public have been reconfigured and contested. There can be a politics of the body given the complex ways in which the body and its acts are made up. To say this is not to say that there is a politics to every aspect of life, or there should be. Refusing to open up certain questions to political contestation can be an appropriate and necessary response; for there can be an *excess* of politics; an overproduction of dissensus; an over-evaluation of the political. Rather, it is to say that although, in practice, the institutional and discursive spaces of a democratic politics will always be circumscribed, in principle, where the limits are set is always open to question.[20] A democratic politics is not one which demands that every issue should be made a political issue; it is a politics which claims that anything can be political in principle. Whether to make something a political issue, and how to resolve an issue which has been made political, is a matter of judgement.

Technology, by contrast, is often regarded as something that exists outside of politics. If we understand technology to refer to any kind of association of devices, techniques, skills and artefacts which is intended to perform a particular task, then the deployment of technology is often seen as a way of avoiding the noise and irrationality of political conflict. From this perspective, if the political is a conflictual relation, technology offers a set of skills, techniques, practices and objects with which it is possible to evade and circumscribe politics. Indeed, there is a tradition in social and political thought which sees technology as a way out of the apparent irresolvability of political controversies – as an anti-political instrument.[21] Scientific and technical methods are thought to provide

solutions which transcend ideological differences. Moreover, in so far as technical instruments play a critical role in the production of scientific knowledge, technology gives society an access to reality in a way that cannot be contested for interested reasons; a firm foundation on which optimal solutions might be found to practical problems. In those international political arenas in which consensus may be difficult to reach, it is thought that science and technology have a large role to play.[22]

A great deal of political thinking is certainly untroubled by the idea that technology can provide ways of avoiding political disagreements, or of putting limits on them. Indeed technical solutions are actively sought. Scientific and technical experts are often welcomed as arbiters, and in many cases rightly so. Scientific arguments and technical practices offer ways of reducing controversy and circumventing potential disagreements. In the advanced industrial countries, a whole series of hybrid politico-technical institutions – from expert advisory committees to public inquiries – exist in order to resolve, bypass or defer political disputes.[23] Recommendations are made on the considered judgement of experts. But whether such institutions achieve the results that are expected of them, social and political thinkers have rightly been worried by the notion that political controversy can or should be short-circuited through the application of expertise. In response to this danger, a critical alternative is often offered. This takes the form of developing a higher form of reason against which the limitations of what is termed the instrumental rationality of science and technology can be measured, or can be judged impoverished.[24] It is a solution which suggests that civil society or the public sphere can, in principle, provide a *more rational* solution to political controversy than that offered by the application of technical methods. In this view, it is the public sphere rather than science and technology that is the instrument of an anti-political enterprise.

In this book I take a different view. This is a view which is certainly ambivalent about technology, but not on the basis of the imagined existence of space uncontaminated by technology. Two points can be made. First, there is no straightforward opposition between technology, on the one hand, and human and social capacities, on the other; nor is there such an opposition between the realm of technology, and the realm of politics. In part this is because technology plays a formative part in making up what we are as humans, and what we take to be social institutions. Social institutions have to be made, and technology is a key element in their make-up. Technology is an integral feature of what we

take to be a hospital or a firm, a family, the state or a person. In part it is because there is always a social or human element to technology. A distinction can be made between a *technical device*, conceived of as a material or immaterial artefact, and a *technology*, a concept which refers not just to a device in isolation but also to the forms of knowledge, skill, diagrams, charts, calculations and energy which make its use possible.[25] The idea that a non-human device or instrument can somehow work autonomously of its multiple connections with other (human and non-human) elements (language, bodies, minds, desire, practical skills, traditions of use) is a fantasy.[26] Many have argued that it is possible for machines to be intelligent. But the intelligence attributed to machines hinges on the cultural invisibility of the human skills which accompany them. It is only by making the human invisible that it might be possible to make machines seem intelligent or creative.[27]

Seen in these terms, techniques and devices can become political – not just in the sense that they are used as instruments in conflicts between political parties or interests (of course they can be), or the sense that the deployment of expertise offers a way of resolving political controversy (for better and for worse, it can do) – but in the sense that technical designs and devices are bound up with the constitution of the human and the social. Any attempt to contest or challenge the social order may then involve – and probably will involve – an effort to contest the development and deployment of technology as well. To say that a technology can be political is not to denounce it, or to condemn it as a political instrument, or to say that its design reflects particular social or economic interests. Technology is not reducible to politics.[28] Nor is to claim that technical devices and artefacts are 'social constructions' or are 'socially shaped':[29] for the social is not something which exists independently from technology. Rather it is to say that the contestation of technical designs and practices may open up new objects and sites of politics. Technical controversies are *forms* of political controversy, although it is open to question whether, in particular instances, such disputes take place in a public political arena.

Second, if we regard the public sphere as a set of spaces within which matters of truth and justice can be raised in public, then there is always a technical dimension to the specific forms that the public sphere can take, and the connection and distinction between the realms of 'public' and 'private' politics.[30] Whether in the public demonstrations of scientific experts at public inquiries, or the televisual form of the studio debate or

investigative documentary, or the 'virtual architecture' of discussion groups on the Internet, there is always a technology to the public sphere and to the complex configuration of the public and private realm.[31] The contemporary public sphere cannot be understood as something like a set of spaces in which rational discussion simply takes place in an unmediated fashion. They are not like the Greek *polis* of the modern political imagination.[32] Rather they are arrangements of persons and technical devices formed in particular settings, within which it is possible to articulate a range of rhetorical forms. It is these socio-technical arrangements that may allow arguments to be made, differences to be recognised and addressed, and which may include and exclude certain categories of person and argument, whether on the basis of gender or race or otherwise. Different arrangements have different advantages and disadvantages. But there is no ideal socio-technical form for a public sphere. The conduct of politics today is a technical matter. Technical innovation has become part of political life.

ARRANGEMENTS

In thinking about politics and government a concern with technology can be contrasted with the dominant tradition of liberal political thought.[33] For whereas liberal political and philosophical thought has had a great deal to say about science as a rational and autonomous enterprise,[34] it has had very little to say about the apparently more mundane technical objects and practices which have such a critical importance to everyday life. In political thought, although not necessarily in political practice or public-policy debate, thinking about the technical has been marginalised in comparison both to the scientific and to the human. For many political scientists, there is a clear distinction to be made between the social world of politics and the material world of engineering and the natural sciences. Yet to analyse the conduct of political and economic life without considering the importance of material and immaterial devices and artefacts is simply to miss half the picture.[35] Consider, for example, the critical role of a whole series of technical devices – such as computer trading systems – to the development of the capacity of buyers and sellers to make rapid calculations in financial markets; or the function of technologies such as ultrasound and X-ray scanners in the management and representation of the body.[36] Or the importance of certain technical devices – from sleeping policemen to video cameras – in forming

relations between political authorities and citizens. Or the centrality of photography, television and satellite surveillance technologies in the conduct of international relations. Such artefacts and devices are not merely passive objects of human manipulation. In the production of knowledge they are inevitably manipulated; but they also continually resist manipulation. Nor are they the projection of social forms onto matter. They are not merely social constructs. Material (and immaterial) objects produce effects, depending upon how they are related to, the forms and circumstances of their use, and the sites and circumstances within which they are situated. Effects emerge from a combination of persons and materials.[37]

Seen in these terms, instead of drawing a line between the social and the technical, one might instead analyse *arrangements:* of artefacts, practices and techniques, instruments, language and bodies.[38] These arrangements make up what we tend to think of as persons and institutions: states, markets, families and so on. They are collectivities which include technological components. In principle, the complexity of such arrangements is irreducible to their distinct 'social' and 'technical', 'natural' and 'cultural' elements. In practice, in scientific research, in sociology, and in public-policy analysis, distinctions are routinely made between the worlds of nature, technology, psychology, the body, the economy and social relations. Such distinctions are historically contingent and the boundaries between the categories are also contestable. The lines between what is considered 'natural' and 'human' and what is not can shift, and may be become difficult to sustain, or are sustained, but in new ways. Yet, as Marilyn Strathern has argued, in an age of artifice, in which the 'natural' is artificial, 'we still act with Nature in mind'.[39] In so far as distinctions are made between the 'natural', the social, the technical, and may have to be made, they have both costs and benefits.

NETWORKS

To be sure many sociologists and anthropologists of science have emphasised the political character of science and technology. Some radical science scholars, in particular, have been concerned with the critical role of scientific practice in the construction of sexuality and race. Donna Haraway's work is exemplary in this respect.[40] But, with exceptions, mainstream work in science and technology studies has often seemed a rather specialist concern – a specialist interest in the politics *of*

science and technology – with limited relevance to some of the central themes of political and historical debate – such as the origins and future of the nation-state, the need for a political response to globalisation, the development of environmental problems and the fragmentation of political certainties, identities and alignments. Science and technology studies have tended to be dominated by the study of 'cases' which become the objects of theoretical arguments about the character of the scientific and technical, but whose significance for the study of politics is obscure. In this way, the connections between science, technology and politics are not interrogated but reproduced. In these circumstances too, writers in international relations, cultural studies and politics have been inclined to see studies of science and technology as of rather marginal interest. Science and technology are just other areas for social or political analysis – and ones which are reckoned to be of markedly less importance than, for example, the economy, environmental security or gender to those concerned with an account of the changing international order, or with the analysis of emerging forms of global politics.[41] From this perspective, science and technology studies is a specialist field.

In thinking about the connection between technology and the study of politics and government one starting point is the recognition, following the work of Michel Callon and Bruno Latour, that the 'macro' political order of the state is built up from a complex network of localised technical practices and devices.[42] To begin to understand how modern government is possible over extended areas of territory it is critical to understand the spatial connectedness of technical devices.[43] But of what does this connectedness consist? Certainly, it involves technologies of communication and transport. A liberal democracy is one in which all can expect and are expected to observe and engage with, although not directly participate in, public political debate.[44] And in the twentieth century, broadcast media have provided the technical infrastructure of a liberal democratic polity. A capitalist economy is one in which, in principle, the geographical and social mobility of persons, commodities and information is maximised through the development of networks of communication. Such an economy is, it is argued, necessarily too complex, and too dynamic, to be controlled from the centre and any attempt to direct it on the basis of one partial perspective would, in the end, be counter-productive. Centralised control should not necessarily be avoided, but it should be exercised with caution: 'while markets can be established and regulated by political means, they obey a logic that

escapes state control'.[45] At the same time, liberal economic government is exercised through the multiple and mobile perspectives of many centres and many members – a series of visions which will always add up to something more than any centralised gaze. In this context, the idealised member of such an economy is a gendered one: a male citizen or entrepreneur who has the time to keep continually informed and in touch, and who is able to communicate and travel anywhere for his business. He is not rooted in a place, but in a web of extended connections;[46] able to draw things together *without* ever forming them into a vision of the whole and without having need to do so.

But the technical connectedness of social and economic life is more than just a matter of broadcasting stations, telephone lines, satellite connections and transport systems, and data about the properties of products and public and private services. It is more too than the existence of a more or less universal medium of exchange. For in the modern political imagination there is also a demand for technical practices and devices to be comparable with each other. If an empire or international market is to be formed then some common standards and agreements are necessary. If a nation is to be governed technically, then the technology of government must itself possess a certain degree of uniformity and comparability. Max Weber recognised something of the importance of this in pointing to development of the ethical and technical capacities of the modern bureaucrat – a figure who could perform administrative procedures routinely and impartially.[47] In so far as they have been formed in roughly the same mold, it simply should not matter which bureaucrat performs the task entrusted to them. But if this is true of bureaucrats it is also true of a whole variety of more or less scientific techniques which are of critical importance to the functioning of government and the conduct of economic life. One can point to the importance of uniformity and comparability in the practices and techniques from thermometers and police identity parades, to doses of medicine and pollution-monitoring devices. If such technologies are to be relied on they must be in some way comparable to others of a similar kind; and if such techniques and practices are to be owned, patented and reproduced elsewhere they must have more or less comparable and compatible properties. They are expected to have similar effects on the object and persons to which they are applied, or to measure objects and events in comparable ways. Even if there is no visible connection between such devices there is the possibility of a connection.

In an idealised vision, then, technical devices and communication technologies appear to function as the infrastructure of an international economy, or as an infrastructure of the nation – connecting it together. They are the technical base on which social, economic and political life takes place and on which the operation of the law is possible – the base on which the liberal political order and the capitalist economy rests. As such, technical connections appear to form something like a network, and it is perhaps this image of a technological network which, in part, lies behind the prevalence of the idea of the network in contemporary political and intellectual debate. In the late nineteenth century, it was the notion of evolution which operated so effectively in what Gillian Beer has termed the 'open fields' of science, culture and politics.[48] 'Society' was conceived of by social thinkers as something like an evolving and developing organism which possessed an organic unity and an order. But today, it is the language of information and communication theory that has had an increasingly central place in political and intellectual life. This is an era in which *feedback* is an important feature of public service, in which education and entertainment are expected to be *interactive*, and concepts of information, discourse, complexity and translation are deployed across the range of the sciences and humanities.[49] But above all, it is the idea of network which seems easily and routinely to criss-cross the distinction between the technical and the social. Meanings proliferate in this complex metaphorical space. Social theorists assert that we now live in a society of networks.[50] Political scientists talk of networks of governance.[51] Firms are said to be evolving into networks.[52] Activists, firms and public bodies engage in and encourage networking. Technical connections, it is thought, form social networks; social connections are established technically.

To say this is not to say that the metaphor of the network can be easily avoided. Metaphor is an important tool of argumentation and just because the metaphors that we use are historically specific does not, in itself, mean that they should be abandoned. Metaphors are not sinister, nor are they neutral. They are an inescapable feature of scientific and intellectual work and political discourse.[53] Assessing the utility of a metaphor involves examining what it does and does not reveal; what effects it has on thought, and on practice. In this regard, it is certainly necessary to be critical of the pervasiveness of the network metaphor. For although the notion of the network appears to capture something of the discursive and spatial connections which technical work establishes, and both the

connectedness and fragmentation of contemporary social relations, it is a tool which may, particularly in the proliferation of its meanings, obscure as much as it reveals. Certainly, to view socio-technical connections as a network-like infrastructure is mistaken. For far from being simply the infrastructure of government the question of how such technical connections should be organised, and how new scientific and technical work should be supported, has become a key problem for contemporary government. Far from being outside of politics, technology has become a site of political contestation. The notion of the network may be a useful one in conveying the ways in which a complex of localised technical practices can form a web. But it is a problematic metaphor. It may convey an illusory sense of rigidity, order and of structure; and it may give little sense of unevenness of the fabric and the fissures, fractures and gaps that it contains and forms.[54]

Here, I shall suggest three dimensions to these problems. First, to view technical connections as if they were something like a smoothly running railway network would be a mistake. Technical connections rarely function smoothly, and, unlike railway lines, they do not necessarily follow well-defined paths.[55] Moreover, as both engineers and sociologists of technology know, creating and maintaining a network requires work and repair.[56] Technical work is always more disorganised and unpredictable than is often imagined, not least because it always involves human elements. The potential difficulties of technical work are neglected at a cost. Consider a routine problem: trying to install a new piece of software onto a computer. In principle, the problem should be straightforward to solve. It should be easy to make a computer work in the same way as thousands of others. But, in practice sometimes it is not. Maybe the problem lies with the particular machine, or with the way that it has been set up. Maybe there is a fault in the material that has been provided with it, or the user has missed one vital stage in the instructions. There are manuals, but these are seldom clear. There are helplines, but it may be difficult to communicate what the fault is. But this is only a small part of the problem. For the difficulty of communication is also due to the enormous range and forms of tacit knowledge necessary to establish technical connections – knowledge which it is extraordinarily difficult to write down.[57] This is a general problem – a problem which is acute for anyone engaged in the use of technology of any kind. It is particularly true of the development of software, which despite efforts to stabilise it the form of well defined packages, is extremely difficult to communicate

to others without the mediation of human expertise.[58] Making connections is therefore rarely a straightforward matter. Skills, techniques or devices that work in one place rarely work in exactly the same ways in another. Adjustments will always have to be made. Different problems of context or locale or knowledge will have to be taken into account. Failures are to be expected, particularly if rigidly standardised routines are followed. For these reasons, further forms of expertise and technology have developed around the problem of monitoring failure, or helping those who have to deal with it. Indeed, the more sophisticated forms of expertise involve a more or less explicit recognition of their limitations, and of the limitations of their object. In the human sciences, psychoanalysis is exemplary in this respect. In social theory, psychoanalysis tends to be either denounced as a normative therapeutic technology, or used to ground a general theory of the subject. But psychoanalysis can also function, not as a general theory at all, nor as a technology with either a narrowly instrumental purpose or normative agenda, but as a practical reflection on the strengths and weaknesses of using language as a technical instrument, and the inevitability of the limits of psychoanalysis.[59] In some versions, psychoanalysis is a form of expertise which is ambivalent about its own status and efficacy as expertise, and which is both alert to its own position within the scene of analysis, and to the fantasy of a technological solution.[60] The subject cannot be repaired as if she or he were a electronic machine. She or he requires care, not control. An analogy can be made between psychoanalytic practice and sociology. The social world should not be imagined and acted on as if it were a system of networks and flows, which can be grasped and managed as a whole. This is a typically modern political fantasy.[61] The specificities and inconsistencies of the social demand careful attention.[62]

Second, there is a question of where and how networks end or become weaker, or are made more uncertain or contestable.[63] At the surface of the skin? At the borders of a nation-state? At the limits of the law? Inevitably, there will be objects and objects, places and persons included in and excluded from such socio-technical networks: whether partially or as wholes, whether discursively or spatially.[64] Consider an example used by Michel Callon: a polluting chemical plant. Callon notes that if a chemical plant discharges its toxic waste into a river it produces what economists call a negative externality, in so far as the interests of others affected are not recognised. 'The interests of fishermen, bathers and other users are harmed and in order to pursue their activity they will have to

make investments for which they will receive no compensation. The factory calculates its decisions without taking into account the effects on the fishermen's activities'.[65] In these circumstances, the boundaries of the plant are complex and multidimensional. On the one hand, certain objects (including toxic waste) pass outside the factory's property. On the other hand, the plant's own internal methods of calculation (concerning its effectiveness and efficiency) take little or no account of these toxic flows outside, and the chemical firm's scientists take no regular measurements of the toxicity of local rivers, confining their metrology to within the plant. In effect, the plant has what Callon terms a frame: a series of mechanisms which filters not only the flow of workers and capital, but also chemical, toxic wastes and measuring devices. This frame is negotiable and contestable.[66] For through regulation, or political activism, it is possible that the technological borders of the plant will be reconfigured, and connections drawn between what goes on inside the physical site of the plant and what goes on outside its perimeter fence. New measurements will be made which show how the actions of the plant and lives around it are linked. The way that the boundaries of the plant are made is both a technical and a political matter. Considerable investments may be made in maintaining or contesting the frame of analysis. The term 'frame' is both a sociological and a psychoanalytic one.[67] The investments that have to be made in forming and maintaining a frame are at once economic, psychological and technical. They have visible and invisible elements.

Thus, although there is a sense that technology may change anything and be deployed everywhere, its effects will always be restricted. There will always be connections yet to be made visible; and curbs on what is possible. Particular techniques or devices – whether they are drugs, electronic media, or weapons or forms of psychotherapy – are owned or regulated, or knowledge of how they can be used is only possessed by certain persons. Ownership cuts the network, thereby putting in place a blockage on the lines of possible connection.[68] Or they may act on parts of persons, at the expense of other possibilities. Along certain channels knowledge and devices may pass relatively easily.[69] Elsewhere technology generally circulates with difficulty. Inevitably, there is a politics to how technical devices form part of the fabric. And there is a politics, too, to how, where and on what basis devices and techniques circulate. Are particular technologies owned? Are they too difficult or too dangerous to be circulated? Does everyone need to possess or use them if they are

to function effectively as citizens? Do they establish new forms of exclusion as well as inclusion?

Third, there will be intersections and disjunctions between the various zones created through the formation of networks. Networks will always be a part of, and yet not contained by, other collective arrangements or networks. For in so far as technical connections can be thought of as networks, they do not exist in isolation from each other. Technical connections may operate across the distinctions between the private and public, between different scientific disciplines, and across the legal divisions between institutions and between nation-states, but they may run up against technological blockages and impediments. Consider, for example, the technological block that exists between many overground and underground railway systems which prevents overground railway stock running on underground lines; or the technological block between Apple and Personal Computers which may make it difficult to exchange files between computers. At such technological blockages, particular objects and devices may be required to make crossings smooth, or possible, negotiable, or avoidable. Blockages are, after all, always complex; they are never absolute boundaries however they are sometimes imagined to be. And negotiating obstacles and blockages is never an easy matter: the appropriate documents, methods and frame of mind will be required. As we shall see in later chapters, the standardisation of objects and technical procedures between initially distinct domains is an important element of such obstacle work. It is reckoned to be particularly important in the development of new information and communication technologies which depend on the connection between different networks. But the problem of how to negotiate and smooth the points of contact between different socio-technical networks is a general problem in the history of science and technology.[70] Standardisation, for a long time considered a problem just for engineers in enabling border crossings or the 'joining' of previously distinct socio-technical zones, is increasingly recognised to be of considerable economic and political significance.

However, the development of technology involves not just the reduction of blockages through the production of technical standards and other mechanisms, but the development of ways of circumventing or reconfiguring existing impediments and establishing new ones. In the case of devices such the Walkman, the private motor car, and the security camera, technologies may provide methods with which to defend, define and police personal and institutional boundaries. In this way, these

technologies *displace* earlier ways of managing relationships with other persons and institutions, with damaging as well as beneficial consequences.[71] Likewise the deployment of satellite-based surveillance systems may be considered, by those subjected to them, as a threat to territorial integrity. Thus, in diverse ways, the boundaries of persons, households, institutions and nation-states, and public and private spaces, may be rethought, reconfigured or, in some cases, undermined through the deployment of technical devices.[72] Moreover, forms of political action and regulation may emerge which do not correspond to spaces and territorial regions defined in conventional social or geopolitical terms, but to zones defined by technology.[73]

While technology is not reducible to politics, the conduct of government is also more than just a narrowly technological matter. The way in which specific technical devices figure in political life is extraordinarily variable. Foucault gave a sense of this in the contrast he made between the exercise of sovereign power and the conduct of disciplinary power in *Discipline and Punish* (1975). The contrast Foucault draws between the two regimes is not a narrowly technological one – although it has many technical elements. Rather it is a contrast between what Deleuze has called different *diagrams*: between a situation in which force may be exercised more or less arbitrarily by a sovereign, and one in which government is exercised through the proliferation and dispersion of technical devices throughout an entire population.[74] Not only do the instruments of government change, but so to do the forms of their use. And not only do the objects of government change, but so to do the justifications and anxieties with which they are associated. If the preoccupation of sovereign power was with the control of territory, nineteenth-century government shifted attention, in Foucault's account, to a concern with the health and economic well-being and security of a population. The emergence of a series of scientific and moral concerns –with hygiene and public health, with psychopathology and 'race', and with economic performance and political economy – are elements of this broader historical movement in both thinking and practice.[75]

This book is concerned with a different, although not unrelated, set of preoccupations and problems at the end of the twentieth century which have largely been neglected by post-Foucauldian sociologists.[76] Here, technology is both part of a set of political problems, and the solutions to these problems. As we have noted, technical practices are considered as problems in so far as they may cut across and undermine the boundaries

of existing social and administrative arrangements. They disrupt and reconfigure the sense of the boundedness of persons and states which is so central to the modern political imagination. But they are considered part of the solution to this disruption in so far as they provide the key element of novel and perhaps more rigid kinds of socio-technical institution. In this way, technologies may be both the catalysts in processes of change, or sources of inertia working against change.

In considering these problems, this book centres on one example: the European Union. Europe is a good example as well as an important one. As we shall see, the process of what political scientists call European integration has been a technological one. And technology plays a central part in the European political imagination. To understand the political make-up of Europe one must attend not just to the study of formal political institutions and their interrelations, although these are important.[77] One must also address the multitude of devices and instruments which populate the continent, and which figure in European political discourse. The politics of Europe today is, in many respects, a politics of technology. Europe itself is a technological arrangement. The effects that the European Union has in Europe and beyond are an emergent consequence of this arrangement.[78]

SCALE AND PERSPECTIVE

How is it be possible to study such an enterprise? In researching what anthropologists term complex societies, a set of general problems is encountered. How is it possible to deal with the spatial dispersion of complex social forms and their multiple connections? What methods are available to give an account of a political and economic order in which government operates at a peculiarly local level, but is also spatially extensive? What are the difficulties of giving an account of science and technology, when technology involves the development of connections which are so numerous, diverse, extended, and yet also so localised and partially contained? How can one address the problem of the *scale* of the kinds of collective arrangements which make up contemporary industrial societies?

One solution to such problems is a reductionist one. This is to posit the existence of a macro social order, such as the state, society, or the world-system. Through such figures the complexity of institutions and arrangements can be reduced within an overall framework. But this solution is

problematic. On the one hand, such abstractions turn local empirical studies into mere instances of wider truths, and mere case studies of ever wider contexts. At worst, empirical studies are viewed simply as exemplifications of a general social theory of the state, or not even referred to at all. At the same time, concepts of society and the state obscure the contestability and instability of the social, either reducing political antagonisms to one or a few well-known social, economic or environmental conflicts; or by suggesting (in the work of some 'postmodern' or 'late' modern writers) that forms and causes of political conflict used to be simple, but are now fragmented. All too often, postmodernism involves a different form of reduction – a reduction to complete fragmentation or fluidity – in which any sense of texture and difference is lost. Either way, society can easily be summed up in one go. Society is either an organic or a contradictory unity, or it is shattered beyond all possible recognition.

The claim that social life is irreducible and complex is not an empty one. It is certainly not a claim that everything is simply messy and featureless, or always in flux, and that no generalisations are possible. Nor is it a form of relativism which says that all interpretations and arguments have equal validity. Such a position suggests that detailed empirical work is futile, and the object of research can be ignored. It also invites the most banal and moralistic of responses by those who wish to continue to bang on their tables and point to the correspondence of scientific concepts to 'reality', thereby continuing the most unproductive and fruitless of academic exchanges.[79] Scientific practices are much too interesting, historically variable and complex to have need of such a defence.[80]

To emphasise the irreducibility of social and political life suggests something different. Certainly it is a way of refusing certain forms of relativism, in so far as they lead to such an ironic detachment that any sense of the value or significance of what is being studied is lost. Everything turns out merely to be a (social or discursive) construct.[81] Thus, the object of social scientific research disappears. But it is also a way of refusing an objectivism, in so far as objectivism does not make sense given all that we know about the historical and cultural variability of ways of knowing. A relativity of viewpoint is absolutely essential, one which makes it possible to open up a space to imagine things differently, from a different angle, at a different magnification and with different instruments. This is a perspective which tries to learn something from what is studied, without at the same time being in awe of it. Thus,

research can aim to *demonstrate* and contribute something new – and not simply aspire, mistakenly, to attempt the impossible task of trying to mirror the object. A degree of experimentation in ways of knowing is legitimate and necessary, which is not the same as valuing experimentation or avant-gardism for its own sake. Marilyn Strathern has made the point succinctly:

> Too often we disparage movement from one position to another as relativity. This disparagement hides the cumulative achievement of social science, which is constantly to build up conditions from which the world can be apprehended anew. That regenerative capacity constitutes the ability to extend meanings, to occupy different viewpoints. More than mimesis – social science imitating its subject matter – it makes a distinctive contribution to the world that in so many other contexts draws on technology for its models of innovation.[82]

In the light of these remarks, this book is intended to be, in a double sense, empiricist. First, it is empiricist in its emphasis on the detail and complexity of empirical examples. This emphasis is deliberate. For it is through the complexity of the empirical that one gets a sense of the irreducibility and contestability of the social, the disjunctures between the programmatic statements of policy and the messiness of actuality, the contingency of history, and the interference and intersection of diverse historical and geographical movements. Empiricism is, in this sense, opposed to 'social theory' in so far as what is called social theory can all too often over-determine what is and can be said about empirical investigations. The empiricist attitude towards evidence is, in this context, both ethical and theoretical; it is one which is alert to, and respectful of, specificity and difference.[83] Second, this study is intended to be empiricist in a perspectival sense. I make no attempt to provide a general analysis of government and politics today, but rather through a series of localised observations of specific examples, and through the invention of new concepts, to reveal a dimension to political life which is often neglected.[84] In speaking of a technological society my ambition is not to try to sum up an epoch, but rather to make visible a series of interconnected political preoccupations, anxieties and projects which might be otherwise obscure.

But if this is the ambition, what research methods are appropriate? One movement in recent years has been to adopt and adapt the ethnographic

methods of anthropologists to the study of complex societies. Laboratories, museums, families, government offices and cultural institutions have all been objects of ethnographic inquiry.[85] They have been investigated in detail by anthropologists and sociologists who have spent long periods of time within such institutions: observing, listening and interviewing. The advantages of this movement towards ethnography are considerable. Professional institutions and their members are, to use Goffman's terms, experts in the presentation of self. Indeed, they have developed elaborate literary technologies for dealing with the problem of self-presentation: reports, press releases, mission statements, policy documents, brand names, scientific papers.[86] Such devices help to divide the inside from the outside. They establish a space within which professional and scientific work and business is possible. But they also serve to protect the expert, and the institution, from public scrutiny of the (inevitably) imperfect exercise of technical skill and expertise. Ethnographic inquiry provides a critical way of interrogating such public presentations, at the same time as it has to engage with them.[87] In principle, it can present a different picture. It can be attentive to the internal messiness of any organisation; to the ways in which institutions contain elements which are not part of their self conceptions; to the relations between public presentations and other practices; to the *disorder* of scientific research in practice; and to the failures of technologies to meet the expectations which are made of them and the ways in which failures are recognised and addressed.[88] In short, it can be alert to the specificity of the institution.

Indeed, in studies of science and politics, an ethnographic method has a particular relevance. In science, a clear distinction is made between the untidy practical process of laboratory work and the finished public presentation of conclusions and results. The latter appears in public as an embodiment of the rationality of scientific method. The former is generally unobserved. In interrogating the relations and connections between the two, ethnographic studies of science provide a powerful challenge to conventional philosophical accounts of science. That which is made visible through scientific publication can be seen as the achievement of particular historical kinds of technical practice and styles of reasoning, and the contingencies of particular scientific debate. The conclusion should not be a surprising one. The world massively underdetermines what can be said about it. How it is envisaged necessarily depends on what technical instruments, practices and forms of reasoning are brought

to bear on it. Laboratory work is a creative activity: it produces new objects. Knowledge is not discovered in the ground like a fossil.

Yet there are also weaknesses to ethnography in its classical form. In particular it has tended to be bound to the study of specific, spatially localised institutions or groups. It has tended to treat institutions as if they were, as George Marcus observes, following Raymond Williams, localised knowable communities.[89]. Such a centring of analysis on one site was problematic in Marcus's research on American dynastic families. 'I found that a particular family is a complex construction of a number of different kinds of agencies – lawyers, bankers, politicians, scholars, servants, workers, journalists and family members themselves who are only one such agency. I confronted myself with diverse parallel worlds which must be accommodated by my account.'[90] Instead of providing a portrait of one community, he sought to draw an account of several in parallel. Instead of producing one ethnographic image Marcus's solution to the problem was to attempt to produce a montage effect.[91]

These methodological observations lead to an empirical and historical one. This is that if we are to understand the place of technology in political and economic life, we should not concentrate our attention on research and development and on one site: the research laboratory. Certainly, in the popular imagination, in public-policy documents, and in much sociological and economic analysis, science and technology are often equated with what is new and with innovation. At the same time, invention is often taken to be synonymous with technological development; and technical invention is thought to be a part, if not a direct cause, of social change.

Yet this equation of technical activity with research and development is problematic. On the one hand, much technical activity takes places outside of the laboratory, and by non-specialists. This is not just a plea for the analysis of use and consumption – of the ways in which manufactured technological products are used in the home and the office, for example.[92] There is also a need to think of the ways in which innovative activity takes place outside of industry and outside of the laboratory and involves people who would not ordinarily be called technical specialists. On the other hand, much of what professional scientists and engineers do is not straightforwardly innovative; or not innovative in the way that most people – including specialists – would think of as innovative. It involves repairing, monitoring and testing the performance of devices and practices in order to ensure safety and

security or to meet regulatory requirements. It involves fixing and determining what technologies do, however imprecisely, whether for the purposes of marketing and selling or for the purpose of making intellectual property claims. Above all, the properties and effects of technologies are measured, and a significant part of the effort expended by natural and social scientists is aimed at developing novel, more accurate and more appropriate forms of measurement: novel ways of demonstrating the properties of technical practices and devices.[93] To understand the place of technology in politics we also need to rethink what technical activity is.

TECHNOLOGICAL ZONES

The remainder of this book is divided into two parts. In part one I examine how technology is a central preoccupation for national and international government and politics. This preoccupation has two dimensions. First, technology is expected to forge connections across and establish boundaries around an empire, a firm or a nation-state. If the territorial boundaries of states are generally fixed, zones of technological circulation are not. In these circumstances, the question of how technological zones can be established and regulated is reckoned to be of enormous political and economic importance. Second, in a technological society, the quality and success and vitality of an organisation, nation or trading bloc is understood to be dependent on its technological capacity and competitiveness as they are manifested in indicators of skill, intellectual property, scientific literacy and invention.

Chapter two develops an extended discussion of the relation between technology, transnational relations and empire. I examine the question here of whether it is possible talk about technological zones in an analogous way to the way one might talk of geographical territory. Is there a correpondance between technological zones and spaces of political rule? How can we conceive of the blockages and impediments that restrict and channel the circulation of technical objects and practices? What relation exists between what Arjun Appadurai calls technoscapes – the spaces and flows marked by technology – and other spaces of flow – of persons, capital, ideas and media images?[94] How is the flow of technology regulated?

Chapter three focuses on the key problems of harmonisation and standardisation. Many popular and academic accounts of technology

focus their attention on either the process of technical innovation or the use or effects of technical change. Standardisation has often been regarded as a rather mundane issue, barely worthy of much comment or analysis; a minor chapter in the history of industrial development. In this chapter I follow the work of Ken Alder, Norton Wise, Simon Schaffer, David Noble and others in suggesting that if one is to properly understand the place of technology in modern political life a concern with standardisation must be central.[95] Technological standardisation is, I argue, above all a political project. The point is a general one, but the critical importance of technical standards to government and politics is particularly clear in the case of the European Union. For, as I argue in chapter three, a significant part of what the EU has come to do is attempt to reduce differences between technical practices and instruments across Europe. This attempt is much more complex and problematic than is often imagined. Sociologists have long recognised the mismatch between social norms and social realities. But technical devices and procedures and material artefacts may also resist normalisation. A materialist analysis of politics is one which must attend to the resistance of matter to political control.

My discussion of these issues draws primarily on arguments developed from the history and sociology of science, from anthropology, and from poststructuralist social theory. However, it also intersects with the work of a number of specialists in public-policy analysis. In particular, as I shall discuss further in chapter three, there are parallels between my analysis of Europe and that of Giandomenico Majone who has, in recent years, developed the notion of the European 'regulatory state'. In Majone's account, Europe is interesting and significant not just because it is a supra-national political entity but because of the way it both produces and reflects a break with the general model of the twentieth-century European state. For Majone, European states have been viewed as centred on two functions: redistribution and stabilisation. They were welfare states, in Majone's analysis, in so far as they were concerned with the transfer of resources from one social group to another; and they were Keynesian states in so far as they were concerned 'with the preservation of satisfactory levels of economic growth, employment and price stability'.[96] The notion of the 'regulatory state' is different from both of these possibilities and is closer to an American model. In this conception, the State can be understood as something like a network of more or less independent regulatory agencies devoted to the

correction, in Majone's account, of 'market failure' through, for example, environmental and consumer protection and health and safety legislation. Regulatory expertise plays a key part in the make-up of Europe.[97]

In chapter four I turn to what has come to be the key term in contemporary political and economic discourse: the network. Firms, states, societies, communities and families are often reckoned to take a network form. In general terms, I take the prevalence of the idea of the network to be both one indicator of the centrality of the information sciences and technologies to contemporary forms of government, and a manifestation of the contemporary political preoccupation with the problem of forming and maintaining technological zones. Yet, in practice, the reasons why the term has become so ubiquitous can not be understood through such a simple formulation. Again I turn to the case of the European Union as exemplary of the contemporary preoccupation with networks and networking. For if harmonisation has been a central problem for the European Union, the notion of the network has come to provide the key metaphor for the European political project. Indeed, according to Manuel Castells the European Union is a 'network state'.[98] Chapter four interrogates the ways in which the idea of the network has become the key term in European political discourse. The chapter explores the multiple, ambiguous and contested senses of the term, and how these are associated with competing spatialisations of the European project. The development of European networks is, I argue, both an index of the complex intersections between 'political' and 'technological' developments in Europe and a focus for struggles to define what Europe is to become. Castells' functionalist account of the European network state both confuses different senses of the term 'network', and obscures the critical role of networks in European political life.

In chapter five, I turn from a consideration of the key function of standards and networks in the formation of technological zones to the role of intellectual property rights. In thinking about the government of a technological society, an analysis of intellectual property is critical. For two reasons. First, the acquisition of intellectual property by technological invention is given a particularly high economic and moral value. Technological inventiveness is a virtue which should be both rewarded and fostered. Today, a whole series of institutions from national governments and schools, to firms and families are expected to foster the conditions within which technically inventive persons can thrive and develop. Government ministers extol the virtues of innovative activity,

and the need to realise the value of intellectual property and to forge an inventive culture. Second, despite the growing political importance of intellectual property, it is difficult to maintain a stable legal basis on which intellectual property rights can be claimed. This is not surprising. For technological invention produces both new kinds of objects and new kinds of subjects of invention. Yet the acquisition of intellectual property rights depends not just on the identity of the object but on the identity of the subject; an identity which, as I argue, may be problematic and in flux. The government of a technological society involves forging and managing the relation between persons and objects. The topic of intellectual property shows how problematic that process is.

POLITICS AND GOVERNMENT

It is commonplace to note the historical importance of scientists and experts to liberal forms of government. But historically this position has been complex. On the one hand, social, economic and natural scientific expertise has been expected to provide the basis on which government is possible. Whether in relation to the economy, health, education, hygiene or pollution, scientific and technical work was expected both to identify problems for government and determine solutions. It is no wonder, given the political importance of science, that some critical sociologists and philosophers feared, wrongly as it turned out, that science would displace politics altogether. On the other hand, despite the centrality of scientific and technical work to political life, the scientist was supposed to be allowed some autonomy from political and economic pressures. To be sure, this autonomy was as much *ethical* as institutional. A scientist who was employed directly by central government, for example, was expected to be able to make judgements which did not so much reflect his or her institutional position, but a dispassionate assessment of the facts. In this view of the relation between science and political life, there should be no a-priori reason to expect that say the scientific judgements of say, a government scientific advisor, a university professor, or a scientist working for a firm or organisation representing the interests of consumers or patients should be any different.[99]

In comparison to this classical liberal model of the political function of scientific expertise, the prevalent model today is somewhat different. The difference lies less in the decline in trust in abstract systems which is often said to be a feature of contemporary society.[100] There is no empirical

evidence of such a generalised decline.[101] Rather it lies in the sense that not only scientists and experts but ordinary citizens should acquire some kind of knowledge of technology and nature, even if it is not necessarily of a technical sort. In part two of this book I argue that a characteristic feature of the contemporary technological society is not a decline in trust in science and technology, but rather the expectation that citizens and consumers should be knowledgeable about scientific objects and technical devices: their uses, consequences and effects. This expectation comes from different directions, is addressed towards different concerns and anxieties and can take different forms, some of which are represented as anti-scientific. For scientists concerned about a lack of state funding for research it has taken the form of a demand for more 'public understanding of science' or a clear recognition of the difference between scientific and pseudo-scientific expertise.[102] For some sociologists this demand is expressed in a modified form in a call for more understanding of the sociology of science and more democratic participation in science-policy making.[103] For many national governments, it can take the form of calls for better scientific and technical education, for lifelong learning, for skills training for the unemployed or for the provision of computing and Internet facilities in classrooms and libraries. Environmental groups, consumer organisations and individuals request more and more technical information whether about pollution, or the risks of hospital treatment, or the ingredients and origins of manufactured food, or the safety of this or that household device. Others call for more radical rejections of technological artifice, and the return to a more natural order on the basis of different forms of knowledge of the relations between humans and others. The citizen of a technological society is expected to have a certain knowledge of technology, and to make choices on the basis of this knowledge. This does not mean the everyone will be willing or able to meet these expectations.[104]

How is it possible to adapt and manage within a rapidly changing technological culture? How can individuals become active subjects in a technological society? One dominant set of solutions is itself technological, and is framed by metaphors drawn from the field of information technology: feedback, network, interactivity. Network technology is associated with a network society; interactive technology with interactive relations between authorities and citizens, and between firms and consumers. Today, government ministers in Britain call for a rapid growth in the level of information technology provision in schools while

at the same time calling for greater networking between schools, and between schools and parents and local industry. These processes are thought to be interlinked. According to one educationalist they will foster a culture of permanent innovation:

> Networks de-privatise the classroom and so are the key to [a] different model of dissemination in which all schools can not be linked through ICT [information and communication technology] and so all can take part in the activities of professional knowledge creation, application and dissemination. Again, the business world provides a model for education. In industries where the knowledge is both complex and expanding and the sources of expertise are widely dispersed – as is becoming the case in education – *the locus of innovation is to be found in networks of learning.*[105]

In this book I focus on a related example. Chapter six ('On interactivity') revolves around the development of two of the largest European museums devoted to the display of science and technology: La Villette in Paris and the National Museum of Science and Industry in London. Rather than suggest that a concern with interactivity is simply the inevitable product of a shift from an industrial to informational society, for example, the chapter traces the convoluted biography of the concept and the technique as it moves from London and Paris to the Exploratorium in San Francisco and back again, and the diverse and contingent forms which interactivity takes within the different institutions it inhabits. A central argument of the chapter is that interactivity has become central to the configuration of what we can call, following Foucault, the 'political anatomy' of the museum visitor. The visitor is not expected to contemplate the museum collection from a distance, nor to engage in critical reflection on the messiness and complexity of scientific practice, but to have a quite immediate physical and practical connection with the museum display. Thus, as a family of quite diverse techniques, 'interactivity' is intended to direct and enhance the activity and engagement of the museum visitor. In effect, too, the museum visitor becomes herself an artefact of the museum. Her activity, too, becomes an object of further research and investigation.

For many educationalists and museum designers, techniques of interactivity and networking provide a solution to many of the problems which confront the contemporary school and the museum. They promise

to turn museum visitors, university students and school children into more active, inventive and experimental learners, through methods which are simultaneously popular and act as models for later experiments in thought and research. Technology itself, in the form of interactive and networked devices, is thought to provide a significant part of the solution to the problem of forming the kind of person who can exist, manage, compete, experiment, discover, invent and make choices in a technological society. Citizenship of a technological society demands active participation. At the same time, consumers are expected to forge new interactive relations with firms. Interactivity is much less than information technology (for not all information technologies are interactive). But it is also much more than technology; it is a diagram of contemporary social organisation. Disciplinary technology is associated with the injunction 'You must!' It forms docile subjects. By contrast, interactive technology has come to be associated with the injunction, highlighted by Slavoj Zizek, 'You may!'[106] It reduces the space for creative forms of passivity.

Along with an anxiety that adults and school children are insufficiently engaged with technology and science, there is also a desire for greater quantities of routine technical information. While there is little evidence of widespread mistrust of scientific expertise in general, there is a remarkable demand, articulated from different directions, for more information. Consider, for example, the growing quantity of technical data on food packaging and other media; or the importance given to placing as much information as possible on the Internet so that it is made available to the widest possible public; or the provision of detailed and up-to-date indicators of the performance of schools, hospitals, universities, water authorities and rail companies.[107] The idea of publishing technical information for public consumption is certainly not new: but the incessant demand for more detailed and up-to-date information is. Chapter seven ('Political chemistry') interrogates the contemporary preoccupation with the continuous production of technical information through a study of the apparently routine activity of daily air-quality monitoring. In part the chapter illustrates the themes of part one. It shows how a mundane technical device (to measure air quality) turns out to be the only visible representative of the European Union in one area of inner London. In effect, part of London becomes part of Europe through an air-quality-monitoring experiment. But along with an illustration of the critical place of technology to European government,

the chapter also makes a further and more important argument. This is that a concern to produce continuous and *precise* information on the part of the public authorities displaces the concern of scientists to tell the *imprecise* truth about pollution. In effect, the contemporary preoccupation with the importance of information production overrides an (older) ethical scientific order. The apparently minor episode discussed in this chapter has much wider resonances. It points to the way that scientific activity itself, in its orientation to tell the truth, may exist in a conflict with the governmental demand for technical information. It is conventional to equate oppositional politics with public protest, but political opposition can take the most scientific and technical of forms. In a technological society it could be oppositional not to call for more public information, but to defend the ethical autonomy of science. Critical reflection is not necessarily enhanced by more information than by a more nuanced sense of the strengths and weaknesses of different ways of telling the truth. The chapter calls for attention to the displacement effects of the production of information. An overproduction of information can have both anti-political and anti-scientific implications.

If scientific and technical activity can have political implications, then politics can also be technical, and inventive. In chapter eight I discuss ways of telling the truth which are not scientific. The argument here turns on the concept and practice of demonstration. In English, the term demonstration has referred both to the scientific activity of showing an object or effect and to the political activity of public protest. Here I argue that these two senses of the term are closer together than is generally imagined. Focusing on the conduct of road protests in Southern England in the mid-1990s the chapter makes two arguments. First, it argues that political demonstration involves setting up a *site* within which the truth can be shown and witnessed. The argument cautions us from drawing a clear line between forms of rule and forms of resistance.[108] Second, I argue that the road protests may be considered exemplary forms of political action not based on a fixed identity, or sense of a community. Instead, they may be seen as a political formation which is assembled through a process of action. The two arguments are not unconnected. The credibility of the road protestors to tell the truth depended, I argue, on their success in resisting attempts to fix their identity, whether through processes of internal organisation and political normalisation, or through representation by media external to the protest. Their capacity to act politically, and open up a space for contestation, relied on their

capacity and ethical commitment to resist the reduction of their activity to a given political ideology, identity or set of interests. The story has wider implications for the study of the political. Following the work of Georgio Agamben I take the political to be irreducible to politics in so far as politics is understood as a struggle between institutions, political interests or ideologies.[109].

In chapter nine ('Political Invention') I draw together the central arguments of the book. First, I return to the themes of chapters two to five and examine the central role of technological in the formation of new zones of political activity. Developing an argument first made by Bruno Latour and Michel Callon the chapter develops an account of the relation between zones and sites of scientific and technical activity. Second, the chapter extends the analysis of chapters three, seven and eight to develop an account of the relation between politics, science and technology and the political. The chapter argues that scientific and technical practices can have political and anti-political effects precisely because they are not simply expressions of political interests or ideologies. Finally, the chapter returns to the topic of invention, extending further the analysis of technology, invention and government developed in chapters one, five and six. In a technological society our models of innovation are dominated by the image of technology. In this chapter I argue that invention should not be equated with technical change, but with forms of practice which serve to open up rather than determine possibilities for further thought and action. Rather than draw a dividing line between technology and politics, sociology should be attentive to the ways in which both technical practice and political action can be both inventive and anti-inventive in their implications.

PART 1
GOVERNING TECHNOLOGY

2

TECHNOLOGICAL ZONES

TECHNOSCAPES

In his essay 'Disjuncture and difference in the global cultural economy', Arjun Appadurai makes a distinction between what he terms technoscapes, mediascapes, financescapes, ethnoscapes and ideoscapes. These refer to the spaces and lines of flow of technologies, media images, capital and persons respectively. The shape and the topology of such spaces are not objectively given. For they do not 'look the same from every angle of vision, but rather ... they are perspectival constructs, inflected very much by the historical, linguistic and political situatedness of different sorts of actors'.[1] In these circumstances any image is necessarily refracted and partial.

Appadurai's essay is intended to alert us to the complexity of such 'scapes' and the problematic character of any claim to knowledge of a global society.[2] Nonetheless, he is prepared to make two historical assertions. First, that there are significant disjunctures between such spaces. The space of flows of TV or film images is quite different to the space of flows of computer software, for example, although they may intersect and interact in diverse ways. The movements of international capital may effect the global movement of labour, and yet have their own specificity. Second, in Appadurai's account, movement within such spaces has become increasingly rapid. In short, 'people, machinery, money, images, and ideas now follow increasingly non-isomorphic paths ... the sheer speed, scale and volume of each of these flows is now so great that the disjunctures have become central to the politics of global culture'.[3]

Appadurai's distinctions between the various spaces of migration, media flow and so on are, no doubt, provisional and ideal–typical. However, his account does raise two important sets of questions. First,

how might one describe the *topology* of such spaces as they are formed through the movement of materials, practices and persons? How do such spaces figure in, and how are they formed by, the calculations and strategies of public institutions, national governments, international organisations and political movements? Historically, the notion of territory has certainly provided one of the principle ways in which global space has been both divided and imagined. However, its political importance is not invariable.[4] Appadurai suggests that spaces he is concerned with cut across and disrupt a sense of territorial boundedness, a theme which resonates with the work of Will Straw on transnational music scenes, or Paul Gilroy's notion of the *Black Atlantic*: a space of travel as well as location.[5] Rather than take the existence of geographical territory as a given, its particular historical and cultural significance needs to be investigated.

Second, to what extent are there disjunctures and connections between forms of space established technologically and those established by other means? What connections are there, for example, between the development and use of contraceptive and reproductive technologies and the employment of West Indian women caring for white middle-class children in New York;[6] or the development of the global software industry and changing forms of foreign investment in India; or the place of global intellectual property regimes in the development of the market for commercial music or film; or the relationship between the development of the Internet and changing structure of a national economy?[7] In short, what kinds of frictions, slippages and linkages exist between, in Appadurai's terms, technoscapes and ethnoscapes, between the displacement of techniques and the displacement of persons?[8] To what extent, if at all, can one talk about *national* technological territories having some kind of correspondence to the territories of nation-states? To what degree have national administrative and legal borders played a role in disrupting and channelling the flow of technology and expertise, or *vice versa*? In what ways are the borders of states and of transnational zones of governance formed and imagined technologically as well as territorially?[9]

The answers to these questions are necessarily complex. For, in practice, the distinction between the technical and the cultural, for example, between what might be considered in Appadurai's terms part of a technoscape and what is part of an ethnoscape or ideoscape, is itself related to the concept of territory. In general, those objects and practices

that are considered scientific or technical are precisely those which are thought to be able to escape territorial constraints. Scientific and technical practices form objects and inscriptions which have been made mobile. Matters of scientific fact are considered such in so far as it is considered possible in principle, or in practice, to produce visual manifestations of them elsewhere.[10] Those objects and practices that are represented as cultural are those which are more likely to be restricted by territorial and administrative borders. Making a person more 'technical' – through forming, and by calling attention, to their skills or expertise, for example – is a way of making her able to cross many social, legal or administrative barriers.[11] Making a technical practice more 'social' or 'cultural' – by locating it in relation to the specificity of its conditions of production or use for example – may serve to restrict its movement. Consider the case of indigenous medicines which may have a territorially restricted zone of value or application. Or, in some circumstances, an expanded one – if, for example, their genetic specificity itself becomes an object of value in an international market.[12] In a discussion of art markets Peter Wollen makes the observation that those objects which are able to demonstrate their 'purity' of ethnic belonging may, in some circumstances, be easier to sell in the international market than those works which draw on a variety of Western and non-Western artistic traditions.[13] In short, the question of whether an object or person is located in a territory is not independent of how and whether they have been made 'cultural' or 'technical'.

The remainder of the chapter is in two parts. In the first part, I consider the degree to which technological connections have generated technological zones with relatively well defined ends. In the generation and regeneration of a zone, technology in one place is made relatively similar to technology in another. In this way entities and places are connected together. Forms of measurement are made to take *similar* forms in different places so that comparisons between the state of one place and the state of another are considered possible.[14] If an earth observation satellite is used to observe weather conditions in one place it should be possible to compare these conditions with the weather somewhere else also observed by the same satellite.[15] If a university or a school can be evaluated using a particular technical procedure then, it is thought, a similar institution can be evaluated using more or less the same technique despite the existence of differences between them.[16] If a piece of software works on one PC it should work on a similar one somewhere else. If a

doctor knows how to perform a diagnostic test in one clinic she is expected to have few difficulties in another which uses similar procedures, and she should also be able to compare the results. It should be emphasised here that the ease with which it is possible to generate and regenerate a technological zone should not be taken for granted. Zones are not fixed structures within which action takes place. Zones are always in process. They demand regeneration, adjustment and reconfiguration: frequent maintenance work. As doctors, auditors and computer users well know it is never possible to assume that the same technical practice will work in another place in exactly the same way. For however apparently standardised a device is, or is supposed to be, there may always be a need to make adjustments to its design and use. It is common enough to equate expertise with the technical difficulty of the task. But it would be more accurate to define an expert in other terms. In the context of an analysis of technological zones, an expert should not just be thought of as somebody who knows how to use a complicated piece of equipment or perform a difficult task, but rather somebody who is able to make adjustments to this equipment, and to themselves, which take due recognition of the complexity of circumstance.[17]

In the generation of zones, space and time are reconfigured. We cannot take space and time to be a coordinate system *within which* the formation of zones occurs. On the one hand, as Bruno Latour has argued, in so far as space and time exist as a coordinate system this is the product of particular metrological devices.[18] On the other hand, zones involve the formation of a dynamic space of flows and surfaces full of creases, dislocations and intersections. Points and places which were geographically distant can be, as Michel Serres has suggested, folded together, crumpled and superimposed.[19] Indeed, with the development of electrical communications, comparison and connection may be possible between places in near real-time. Other writers, including John Law, Annmarie Mol and Jody Berland have used the metaphors of region, territory and network to describe well-defined forms of technical circulation.[20] Here I prefer the notion of zone precisely because it does *not* have such a specific metaphorical association with either information technology or land, with all their connotations of physical presence. Three points should be emphasised. First, technological zones will not, in general, be territorially continuous or uniform. They may overlap with, or contain, other zones, and they are likely to be fractured and contested. Efforts to forge a completely uniform zone are likely to reveal and create

objects and experiences which do not fit the standard.[21] Second, although they may be characterised by uniformity, they may also be marked by significant levels of differentiation and variation.[22] Zones are not structures, territories or regions, but discontinuous spaces of circulation and regulation. They are not bounded by continuous borders, but interrupted by shifting restrictions and blockages and points of conflict. Third, the term zone is intended to convey a broader sense of a field which has been marked out and mapped, measured and regulated. Zones are framed and reframed by instruments and markers. Marking out zones is often taken to be a form of political action. Consider, for example, smokeless zones, time zones, erogenous zones, danger zones, temperate zones, and demilitarized zones. Determining the existence and the character of such zones, and maintaining their existence may be a difficult matter. Zones may be more or less unstable formations and potentially contestable. They are always in process.

The second part of the chapter is concerned with the ends of such technological zones. The territorial borders of states have a clear location. States are thought to possess borders which should not be violated by others. The conditions within which persons and objects are able to cross borders are thought to be well defined, even if violations and anomalies are numerous. A whole series of legal mechanisms and architectural and technical forms, from scanners and passports, to customs forms and quarantine hospitals, exist to regulate the movement of persons, objects and organisms across borders.[23] Some similar considerations apply to the passage points between different technological zones. When accessing the Internet there may be certain places which are only accessible on the basis of knowledge of a code, or payment of a fee or the acquisition of a particular competence.[24] To be available for sale in a country it may be deemed necessary for an object to be first tested to check its quality or its point of origin or destination. When entering a danger zone the wearing of protective clothing may be demanded.

In many cases, however, it maybe difficult to establish well-defined technological zones with clear and secure separations from other zones and this difficulty may itself have certain beneficial and dangerous consequences. A number of questions arises. Is it possible, for example, to define technological and legal restrictions on the Internet that make it possible to block the circulation of racist or pornographic material, or to data bases? Can flows of pollution across national and regional borders

be monitored and measured, stopped or regulated?[25] Is it possible to ensure that knowledge about the design of nuclear, chemical or biological weapons remains contained in particular sites?[26] Moreover, in so far as they exist, how can the ends of technological zones be defined and policed? Through what legal and technical mechanisms? By what laboratories and national and international institutions? And what connection is there between the controls, restrictions and blockages that regulate the flow of technical practices and those that channel and delimit the flows of media images and persons? Is there an alignment between those conventional political–territorial borders that regulate the everyday movement of tourists, migrants and business travellers and those zones and technical and legal impediments that govern and disrupt the movement of techniques, skills and instruments?

THE TECHNOLOGICAL EMPIRE

In the modern political imagination a clear distinction is often made between the national and the international order.[27] This distinction is reflected, for example, in the continuing disciplinary separation of international relations from politics and sociology, and the distinction between foreign and domestic politics.[28] In the realist account of international relations the nation-state has a very well-defined inside and outside. The frame is thought to be clear. 'Inside' the nation-state rational and democratic government is thought to be, at least in principle, possible. Sovereignty is founded on the application of a unified system of law, public security and regulation, and the technical infrastructure of government is relatively homogeneous. With exceptions the State has a monopoly over the legitimate use of force. 'Outside' the territorial boundaries of the nation-state, however, the situation is supposed to be quite different. Rational government is said, in practice, to be impossible. Anarchy prevails. The analyst has to be content with the study of the unprincipled struggle for power between states. And technology is merely an instrument of this struggle.

The realist notion that the distinction between the inside and the outside of the nation-state can be framed in these terms has been much criticised, and rightly so. It suggests that states can be viewed as disaggregated actors. It fails to address the ways in which the formation of 'international relations' as an object of political reflection and calculation, and the consolidation of the borders of the nation-state are

themselves intimately related.[29] It provides an inadequate analysis of changing transnational and global flows, and 'the proliferation of international agreements and forms of intergovernmental cooperation to regulate the unprecedented growth of these phenomena'.[30] Moreover, it fails to examine the position of those who are marginalised in conflicts between national governments, or who suffer the side effects of these conflicts. Feminist writers, in particular, have sought to effect a transformation in the vision of international relations away from the traditional institutions of political power.[31]

The idea that there is clear distinction between the inside and the outside of the nation-state is a political fiction.[32] But it is a political fiction that has had real effects. It is one way – perhaps the dominant way – that the kinds of space discussed by Appadurai have been imagined and ordered; and this is notwithstanding such phenomena as the nineteenth-century development of the international-conference system, the historical importance of notions of imperialism and international solidarity, and the more recent emergent notions of globalisation, global governance and cosmopolitan democracy.[33] This conceptualisation has had important implications not just for the stress placed on formal territorial borders but also for the constitution of the ends of technological zones. The state or the empire has been conceived of as a geographical territory; but it has also been imagined and formed as a kind of technological zone, the ends of which may coincide with its territorial borders, or be extended beyond them. In general terms, in so far as they exist, the formation of national technological zones involves what we might call, following Bruno Latour, a double process of purification. On the one hand, the production of science and technology itself involves a process of purification. The heterogeneity and complexity of the world is reduced. Technical devices and procedures take more-or-less standard forms. Natural scientific knowledge no longer bears any obvious trace social or cultural elements.[34] On the other hand, in the nationalist political imagination, the integrity of national territory is often thought to depend on the uniformity of a legal and technological regime *not* marked by the contaminations of the international and the foreign. Seen in these terms, the formation of a national system of government is closely related to the development of science and technology. The conduct of government is thought to rely on the existence of a more or less uniform technological zone: a *striated* space in which difference is reduced.[35] In what follows, I want to examine three

dimensions of the contention that the borders of nation-states coincide with the borders of more-or-less homogeneous technological zones.

First, the problem of military security has been formulated in technological as much as in territorial terms.[36] In the post-1945 period Western military strategists have been as much concerned with the creation of zones within which military force could be projected as with the occupation of territory per se. In these circumstances, the capacity to observe and respond to a threat rapidly and accurately, and at a distance, has come to be particularly important. The conduct of war is as much a matter of mobility and logistics, and particularly the logistics of perception, as of the exercise of force in itself.[37] Today, it is the communication and imaging technologies of weapons systems that are the most expensive to develop. And the 'improvement' of new weapons systems is measured not just in terms of firepower and payload, but also in terms of accuracy, flexibility and controllability.[38] For the Western military, the utility of a force is thought to depend on the speed and the accuracy with which it can be exercised at a distance. In this context, as Mary Kaldor notes, 'the preferred technique is spectacular aerial bombing which reproduces the appearance of classical warfare for public consumption and which has very little to do with reality on the ground'.[39]

At the same time as the solutions to the problem of military security are technological, military powers have sought to maintain national defence apparatuses which were *not* dependent on foreign suppliers or governments. Administrations of the dominant powers have frequently pursued policies of what Mark Elam has termed technonationalism.[40] Here one could consider, for example, the remarkable stress placed on the value of an imperial communications network to the security of the British empire in the late nineteenth century. Imperial security depended, it was thought, on the creation of an 'all-red line', which would circumvent the problems of having to rely on the technical capacities of other countries.[41] The empire was fragile. Its internal security and stability required constant observation. It needed to be connected together by a web of communication so that any threat could be responded to rapidly and in an informed manner. Nothing would give it greater 'political reinforcement', noted one commentator, than a communications network based on the highest and most precise standards of British science and engineering.[42]

It is sometimes thought that in comparison to its allies, Britain has maintained a relatively small professional army. This may be so. But

British military thinking has been dominated as much by the desire to intervene and respond *anywhere,* as by a concern to maintain a permanent military presence. As David Edgerton has argued, the radar and the aeroplane have played a key part in British military strategy, and the military aerospace and electronics industry has been given a strategic importance despite the enormous costs of this policy both to the public purse and to the capacity of industry to compete in civil markets.[43] However, the implications of this military and political strategy are not just economic. Aerospace technology also figures as a metonym for Britain: a modern nation which accords technology a central role in maintaining national and imperial security. Edgerton suggests that British military–political thinking can be characterised as a one of 'liberal militarism' – a doctrine that sought to avoid what was regarded as the excessive state intervention associated with conscription, through the development of a more subtle technological military strategy.[44] The role of humans in military conflict has thereby, in principle, if not necessarily in practice, been minimised. Many of the key institutions of liberal militarist Britain – air bases, defence research laboratories, nuclear establishments and aerospace manufacturers – are located in southern England, a landscape which generally signifies a quite different sense of the nation: the domesticated rural idyll and the ancient cathedral or university town. Thus, the symbolic landscape of Britain is marked by a conflicting contrast between alternative visions of national identity. For the author J. G. Ballard, it was the American air bases of East Anglia which provided the necessary antidote to the traditional England of Cambridge in the period immediately following the Second World War. It is in the south, too, that some of the key political conflicts over technology have occurred in Britain in recent years: the anti-nuclear demonstrations at Aldermaston and Greenham Common[45] and, as we shall see later, the anti-road protests of Newbury, Twyford Down and the A30 bypass which occured in southern England in the 1990s.

Likewise, a concern to protect the purity of technological zones has also been a key feature of American foreign and security policy since 1945. A critical element of US military–industrial strategy in the post-war period was to minimise the degree of connectedness between their own technologies and those of its enemies, and its allies, while tying in third countries into particular client relationships. As one former White House staff member noted, in relation to the problem of national security, 'to know the technological basis of a system is to know how it

can be defeated. Thus, the provision of the technology of a crucial system to a potential adversary provides the knowledge to counter the system'.[46] The American empire has been, in part, a technological one; 'a cyborg regime' as Andy Pickering has argued.[47] During the cold war, the absence of connections between Nato and the Warsaw Pact created the conditions within which an enormous level of anxiety could develop around the imagined technological superiority of one or the other. And in the context of rapid technological change it was, no doubt, easy to imagine, and to project, entirely fictitious threats.[48] The position of NASA is significant in this context. For, in an era in which the possible consequences of military conflict had become so catastrophic that it was impossible for either super power to 'win' a nuclear war, the space programme provided the perfect platform on which this psychological drama could be played out; a place where technological weakness and superiority was most manifest, and where small technological gifts could be exchanged between the super powers in the relative safety of space. Witness the elaborate staged rituals of joint US–Soviet space missions.

However, such policies of technological nationalism have been impossible to sustain. Contemporary technological development has not resulted in pure national forms but in complex arrangements which include components from many places. In the defence sector the rapidity of technological change has produced increasingly hybrid technological systems which could not, in practice, be distilled into their 'foreign' and their 'national' components. By the 1980s 'hybridisation had reached a stage at which America could no longer wield its own weapons without the help of a friendly foreign hand. The ultimate symbols of American prowess and the world's most potent weapons systems were suddenly discovered to be cram-full of foreign parts'.[49] In these circumstances what is thought to be required by the US government is not a policy of technological nationalism, but careful management of the technological dependency of America on its allies.

A second dimension of the problem of national technological zones concerns the way that zones have been constructed in response to the problems of economic and social security. This has taken many different forms, and with different inflections. A central feature of this is the way that the nation has been imagined as a domain of *regulation*. Regulation is often intended to protect and enhance the health and security of firms, cities and individuals.[50] Consider, for example, the complex and shifting set of regulations governing standards of hygiene, cleanliness and

pollution in the city.[51] Or the diverse ways in which 'the effects' of cinema, photography and television on public health and morality have been regulated historically, both formally, through the mechanism of the law, and informally, through the regulation of the family and the school.[52] Or the methods with which relations between parents and children have become the objects of public scrutiny.[53] Such regulatory instruments operate in complex ways, for they do not act on individuals or firms as wholes, but through constituting and acting on their various parts. In the context of regulation, the individual may be represented and governed as an arrangement of different technical entities and capacities: diseases, unrealised potentials for action, or undesirable tendencies and moral infirmities that are in need of reform.[54] In principle, all of these parts may be the object of knowledge, whether by expert authorities or through self-observation. Similarly, the firm, the school, the laboratory or the hospital may be regulated in terms of a series of specific objects and outputs: their productivity and efficiency, the quality of their staff, their employment practices, their culture and ethos, and the safety of their working environment. These institutions are thereby turned into objects of forms of reflection and calculation.

Without doubt, technical regulation never has the effects it is intended to have, nor are they the same everywhere. It can have unintended consequences. As Michael Power has argued in a discussion of audit, institutions and persons may make themselves auditable at the expense of other ways of representing themselves to others.[55] Moreover, in so far as it works, regulation may simply displace problems elsewhere. Persons conduct themselves differently *off-stage*. Multinational firms operate lower safety standards in less-developed countries, sometimes with disastrous consequences.[56] And hazardous waste maybe dumped in territories which are poorly monitored.[57] However, the failures and uncertainties of technical regulation do not necessarily give rise to a crisis of legitimation. On the one hand, in so far as they are measured, failures are likely to lead to demands for a better understanding, and better forms of regulation. In this situation, one of the functions of scientific and social research has been to been to provide a basis on which improvements in regulation can be made, putting concerns with health, safety and pollution into the frame of economic calculation.[58] Research and monitoring may both reveal the need for regulation and, at the same time, serve to make visible its subsequent failures, leading to constant, if uneven, adjustments. This process may, in some circumstances, lead to real

improvements. But it can also lead regulation to develop something of an autonomous recursive momentum. The result, as we shall see, can be an excess of monitoring, and an overproduction of information. On the other hand, the very idea that regulation should be understood as a *national* matter has, for different reasons, come to be seen as problematic. In particular the development of the European Union represents an extraordinary attempt to reconfigure the technoscape, to establish a unified technological zone at a level beyond that of the nation-state. I return to discuss the complexity of this development in subsequent chapters.

A third aspect of the relation between national borders and the ends of technological zones centres on the desire to create national, regional and global zones of communication and information. Communication scholars have frequently emphasised the role of the mass media in articulating notions of national identity and in fostering certain versions of the national culture.[59] This is of continuing importance. But of equal significance in the development of the media has been the notion, held by liberals, that both markets and societies could be formed and reproduced by enhancing their connectedness through communication media. On the one hand, an efficient liberal market is one in which the speed of communication has been maximised.[60] On the other hand, a liberal society is one in which all of its members are at least potentially linked together and kept informed about what is going on elsewhere. In a society of communication the individual is *not* kept under continuous surveillance. Rather government is possible by making the individual members of the population interested, informed, and responsive. Liberal government relies on the existence of the informed citizen. Being an individual in a liberal society means being in touch, knowledgeable and informed, not least, perhaps, about oneself. Such an individual does not have a natural existence. The citizen must be formed morally and technically. She or he must develop a commitment to the truth and the value of being informed. In this respect, media production has a critical importance. For the formation of a unified zone of communication has been, in effect, taken to be a precondition for the existence of a liberal public sphere within which the whole population can participate.

This is the idealised vision. But when measured up against this ideal the practice is always likely to be found problematic. The contemporary discipline of media studies – with all its concerns with ideology, bias, audience activity and interpretation – is formed on this complex political

surface: on the multiple failures of the national media to live up to an ideal image.[61] When judged against the ideal the population may not be as interested in being informed as the ideal suggests.[62] Or, conversely, it may be shown to suffer from the demands and dependencies that an excess of communication may create.[63] Information can seem too often overproduced, when its absence would allow more time for thought and the space to think over time. Moreover, efforts to tell the truth in an objective manner may be continually shown to be compromised, whether for economic or political reasons. Historically, the idea that particular authoritative media institutions could speak for and to the whole nation, has always been problematic as divisions emerge amongst those who are addressed.[64] The particular preoccupations and values of national and political cultural institutions are revealed to be the preoccupations and values of particular national elites – resulting in the emergence of the problem of how it is possible either to promote and support a plurality of values or to meet all the demands of different audiences. In the face of these multiple problems, both public and private broadcasting institutions can become preoccupied by the anxiety that they are not getting through to large enough publics or specific publics, resulting in a demand for more market research, and more feedback.[65] Finally, the national territory and its publics may be reached by media technologies such as satellite television and the Internet which cut across national borders. This can produce profound anxieties as to the integrity and coherence of the 'national culture' that was assumed to coincide with the national mediascape.

INTELLECTUAL PROPERTIES

The idea that technological zones correspond to the formal territorial boundaries of nation-states is difficult to sustain, and arguably increasingly so. On the one hand, 'national' and imperial technological zones cut across each other in ways that national territories do not. Many international organisations and transnational institutions of governance are concerned with the negotiation and reconfiguration of transnational and global technological zones. On the other hand, capitalist industrial organisation is itself forged partly through the formation of technological zones which do not correspond to the technological zones of nation-states, however conceived.[66] Two ways in which industrial technological zones are constructed are of particular importance. First, intellectual

property ownership creates technological rights of access. For private capital this right is of enormous importance; for firms may themselves be constructed around and through the development of technological zones.[67] This is particularly true of fields such as computer software, media technology, biomedicine and genetic engineering.[68] In these areas research costs are high, and production costs relatively low. Once developed, products can be easily reproduced. In these circumstances, rewards may be earned, but only as long as the products of research and development can be owned and ownership protected, or their circulation controlled and directed. In principle, access is prohibited except on terms defined by the owners themselves. Techniques, objects and organisms can be owned, bought and sold. By turning technologies into property they become mobile, but within circuits more or less defined by the conditions and circumstances of ownership. In this way the existence of intellectual property rights can provide both a spur to innovative activity (it gives an incentive to those who wish to acquire them), and yet also serve to restrict the innovative possibilities open to others. The operation of intellectual property rights is much more complex than it might first appear. For, particularly in the development of new technologies, the legal and material basis for intellectual property claims is often uncertain and problematic. At the very least, the law must be continually readjusted to deal with new questions and situations thrown up by the development of technology. The blockages and restrictions established and defined by intellectual property law are thus themselves dynamic and open to contestation. I return to consider questions of invention and intellectual property in chapter five.

But formal claims to intellectual property are only one of the many ways in which private technological zones may be forged and the conditions for capital accumulation established. Indeed in many cases, making legal claims to intellectual property may be undesirable in so far as they involve the dissemination of knowledge about a firm's internal activities to potential competitors. In practice, more or less privatised technological zones may be forged not just through formal intellectual property claims, but through a variety of other mechanisms: the informal possession of knowledge which is not published or disseminated; the use of technical barriers (such as encryption) and other 'privacy-enhancing technologies'; and through the consolidation of technical standards.[69] As David Noble has made clear there can be a moral dimension to these practices. In the late nineteenth century one US

businessman, for example, argued that there should be a National Bureau of Standards, for:

> We are victims of looseness in our methods; of too much looseness in our ideas; of too much of that sort of spirit; born of our rapid development perhaps, of a disregard or a lack of comprehension of the binding sanction of accuracy in every relation of life ... Nothing can dignify this government more than to be the patron and establisher of absolutely correct scientific standards and such legislation as will hold our people to faithfully regard and absolutely obey the requirements of the law in adhesion to those true and correct standards.[70]

The natural laws on which standards were ultimately based were also, in this view, moral and economic goods.[71] Manufacture demanded a sound moral and technical basis.

In practice, industrial standardisation has occurred in a variety of ways. In many cases alliances have been forged and compromises made between public authorities and firms through specific forms of technological regulation or measurement, and safety and quality standards. Rigorous quality and safety standards may be of benefit to firms wishing to defend themselves against cheaper competition. In this way, social concerns and good economics can sometimes be drawn together and national and regional markets protected. In Europe and North America there is a fine line between promoting safety, environmental and quality standards in the interests of health and social justice, and a concern to cut access to national or continental technological zones. But private capital may also forge standards more or less autonomously from the public authorities. Firms may give away products or selectively relinquish intellectual property rights to other firms or users through licensing in order to create a de facto industrial standard.[72] They may exploit dominant market positions in order to impose their standards on users and consumers, and having done so firms may update standards, thereby locking persons and devices into ever new configurations.[73]

Of course, many technological zones are not contained within national or regional boundaries, nor defined by the property rights or de facto standards of individual firms or particular industries. Nor is their development intended to create the kinds of imperial or global zone associated with the development of contemporary military or media

communications networks. Technological zones are often quite localised, although not generally localised in any one place. As Alberto Cambrosio and Paul Keating note, scientific practice routinely involves the establishment of voluntary standards and 'the enforcement of definitions of *good* or *state-of-the-art* science'.[74] In her study of high-energy physicists, for example, Sharon Traweek notes the absence of connections between Japanese high-energy physicists and their colleagues in other areas of research in Japan. Experimental work in high-energy physics takes place in a handful of establishments in North America, Europe and Japan. The technological zone formed by these laboratories is not confined to any particular nation or region; but rather it is, nonetheless, strongly tied to specific institutions, persons and devices which have been the object of huge technical and financial investments.[75] High-energy physics, which is often taken to be the most fundamental and 'general' of disciplines, is also one of the most dispersed and concentrated. The technological zone of high-energy physics is a network of points.

UNCERTAIN ENDS

But at the ends of zones everything may be more problematic. It may not be possible to read an essay written on my PC on my friend's Apple Mac, even though we are working in the same city or the same building. It is an open question whether 'European' industrial practices associated with the new 'post-fordist' regime of production developing in Japan, North America and Western Europe can be reproduced in Latin America, India or Turkey.[76] It becomes unclear to what extent, or on what basis, the Anglo-American desire to audit and evaluate scientific research can take hold in the institutions of the European Community, despite the desire of some national governments to adapt the values of efficiency and accountability.[77] The side effects of a drug, or a pesticide, at other times and places, on others, or on other parts of the body, may be unknown and unmonitored. And it is uncertain whether the demands made on African countries to implement European and North American intellectual property regimes can be realised in practice. From the middle, a technological zone may often seem well defined and continuous. It may be imagined to have clear ends, or no ends at all. But at the ends of the zone there will be different perspectives, and uncertainties and anxieties about what may be possible or desirable, and different accounts of where

the ends exist and whether or not they are solid or permeable, contestable or non-negotiable.

Blocking all the points of access to a technological zone is no doubt impossible, and undesirable. Trying to prevent all access would be a costly business. Indeed liberal economic thought demands that blockages should be reduced as far as possible. Those concerned with the undesirable social and environmental consequences of technological development argue that connections must be made between what goes on within technological zones (such those defined by the activities of the nuclear industry) and what goes on outside. Blockages are frequently contested, and there is a demand to make them more permeable. A reduction in restrictions and the eradication of impediments is a common demand supported by different political rationales. Yet making it possible to cross between technological zones with ease also requires work, and often specialist tools. The economist Paul David uses the term 'gateway' to refer to those devices which make it possible to pass between different networks.[78] David himself conceives of gateways as material objects or software. The adaptor which allows the journalist to plug in her laptop when working in another country, the piece of software which translates a document written using one package into another, and the transformer which makes it possible to connect a device requiring a low voltage input to the mains: these are all gateways. They make it possible to cross technological borders at more or less time and cost. But gateways do not necessarily open as smoothly as one might hope. And they are rarely so simple. Persons, or parts of persons, may often be required to act as gateways, connecting together apparently distinct zones or separate parts of a zone. Connecting technologies together may involve configuring human as well as non-human components.[79] Indeed, as those concerned with science and technology studies have long argued, it is extraordinarily difficult to make skills and practices mobile without the mediation of persons. Machines may be designed in order to enhance the capacities of persons. But persons also embody techniques.

Often, however, there are no gateways, no filters or adapters, and no possible points of translation between technological zones. Entry to a zone may be prohibitively costly and difficult. Fitting components together manufactured by different firms can be a frustrating business. Bringing people together who are used to working in different ways may cause enormous problems of mediation, or the points of access may temporarily be blocked. Qualifications may not be recognised. Persons

may be barred from participating in technical discussions on the basis of their sex or their lack of the necessary social, familial or professional connections or qualifications. Software and hardware may not be compatible.[80] It may be quite unclear whether and how a technique developed in one place, in relation to one situation, can be deployed elsewhere. It may be extraordinarily difficult, politically and technically, to measure the side effects of a drug or a pollutant and thereby to make it the object of regulation and control. The 'overflows' or 'externalities' of a technological zone may not be visible or manageable.[81] Like the translation of language, the translation of technique between different locations and situations is often a problematic and a political matter. It is underdetermined by narrowly 'technical' requirements; different kinds and designs of gateway are always possible. The form in which translation occurs may have to be negotiated, and may often be contested or imposed, whether by law or political action. It is not surprising that transnational political and scientific organisations have developed, in part, as ways of managing, containing and controlling this politics.

It is true that technological zones may look democratic from the inside, to those who participate within them. Part of their attractiveness, no doubt, is the liberal way in which associations are created between different kinds of human and non-human entities which cut across existing social divisions and geographical boundaries, continually reconfiguring the social. Consider, in particular, the new technological zone created by the Internet. The Internet is often imagined by many to be a kind of perfect democratic space within which communities are thought to be no longer marked by traditional forms of social distinction. Some commentators imagine the internet as if it were a 'virtual space' within which identities can be freely played with, and novel kinds of 'collectivity' may be imagined and formed through with the various media of the Internet (usenet groups, electronic mail, the world wide web).[82]

But in creating connections across space and time, new kinds of boundaries may have to be established. As Marilyn Strathern has argued, 'behind the democratising concepts of impure cultures and hybrid networks ... lie new asymmetries'.[83] In experiments in electronic democracy, for example, it has been found that informal and formal rules and boundaries are necessary precisely in order to ensure the widest possible participation. Completely unregulated access to on-line discussion groups, for example, can lead to the domination of a few and the possibility of racist, sexist and other forms of abusive communication. Some form of formal or informal regulation may be necessary if the freedom of the majority is to be ensured.[84] Indeed, one should expect that the forms of association that technological zones make possible always also create distinctions and separations, and produce the conditions within which new forms of distinction and separation can emerge. Such distinctions mark persons, devices and institutions. Persons and objects will be partially excluded, or be excluded altogether. Techniques, bodies and practices will be modified and remoulded in an effort to pass through narrow gateways, and to work in different situations. Entering into a technological zone may be a difficult and a costly exercise, generating the conditions for conflict. Sociologists have often contended that there are only a small number of fundamental political antagonisms. But this desire to reduce political conflict to an unchanging logic is not just anti-political; it is an historical error. In part this is because the development and reconfiguration of technological zones creates new possible sites of political contestation and potentially novel forms of conflict and identification, at the same time as it may reconfigure old ones. Social research can not necessarily predict where those antagonisms may emerge; but it should be alert to the possibility of their emergence.

FLEXIBLE ZONES

Is it possible to conceive of scientific and technological zones when there are no precise technological standards, or rigidly enforced rules of access? In thinking about how more flexible scientific and technological zones are created and imagined I want to turn to medicine, to journalism and to ethnography: forms of expertise in which the values of standardisation and precision are less emphasised than in the exact sciences and technologies. In such disciplines movement is possible in ways that do not rely on the development of highly standardised devices or procedures, clear channels of circulation and relatively well-defined policed borders. In such fields, expertise is marked by a capacity to adapt to circumstance, and to be alert to specificity.

The origins of modern ethnography are often traced back to the work of Bronislaw Malinowski, who developed the genre of ethnographic text that privileged an account of lengthy fieldwork experience.[85] Simon Schaffer presents a different account of the genealogy of anthropology,

drawing attention to the importance of the expedition by Alfred Haddon and William Halse Pitt Rivers to the Torres Straits in 1898 as well as the work of their American contemporary Franz Boas. While at the Straits, Haddon and Rivers sought to make a precise assessment of the islanders' perceptual capacities in order to compare them with English subjects. They imagined that this was going to require considerable work. 'Rivers made much of the specialist training required for effective fieldwork' and he and Boas both laboured to 'calibrate and standardise the results of their experience in order to produce reliable accounts of what they found and make them count back home'.[86] But there were some advantages in carrying out research away from home for, according to Rivers, Melanesians would give more reliable results than the English students he was used to, because the islanders would never 'speculate about what they are being asked to do' .[87] The Torres Straits could, in Rivers view, be turned into something like an experimental laboratory for psychological science.

Without doubt Rivers and Boas projected some of their own categories onto the social worlds of their subjects. Indeed, at the time, critics reckoned that the Cambridge researchers had simply imposed their techniques on their Melanesian subjects.[88] But, in Schaffer's account, what is interesting and important about Rivers's and Boas's work is that they did *not* follow the rule book of late-Victorian science to the letter. For despite their prior adherence to the value of formal procedures, standardised techniques and hard facts, they were forced to be more pragmatic in the field. In this way 'the experience of fieldwork in the 1890s challenged these hierarchies'.[89] In consequence, Rivers and Boas learned to think otherwise about their own traditions. '"Boas" break with the American Natural History Museum was part of a ferocious reaction against the hierarchies of condescending populism and racist evolutionism.'[90]

Michel Foucault's account of the *le regard* in *The Birth of the Clinic* has all too often been read simply as a prelude to his analysis of panoptic surveillance and discipline in *Discipline and Punish*. The notion of *le regard* has been translated as 'the gaze'. This conveys something of its sense; but it is also misleading, for Foucault uses the term to refer to the process of making things visible rather than the act of looking as such.[91] Nor does he clearly link the gaze with the concept of discipline. Here, one might make a connection between Foucault's account of the figure of the doctor and the scientists described by Schaffer in the late nineteenth

century. In *The Birth of the Clinic* Foucault noted how the doctor's capacity to make disease visible is, in a certain sense, *not* highly formalised. Foucault's doctor deploys a clinical gaze that relies on a great deal of subjective judgment. But subjective judgment is not unscientific. It can be learnt, although perhaps less in the laboratory or the lecture theatre than, as Thomas Osborne reminds us, at the bedside or in the field.[92] The doctor has to adjust himself to the reality which he has to confront. He has to learn to work in different situations. He requires training. In this way the nineteenth-century doctor is an exemplary 'specialist of space' operating not just in the enclosed spaces of the hospital, operating theatre and lecture room but in the open spaces of the city.[93]

Schaffer's and Foucault's analyses can be drawn together with that of Annemarie Mol and John Law. They describe the experience of the twentieth-century tropical doctor also having to learn and adapt in the field. Laboratory tests for haemoglobin do not necessarily work in the tropics, whether because the equipment is unavailable or the technicians are not trained. Medical measurement does not travel well across time and space. In these circumstances, tropical doctors rely on interpreting a complex set of signs to be able by which to 'see' anaemia. When the patient arrives 'the doctor looks at her eyelids, gums and nail beds. These should be all pink. If they're pale, then the patient is anaemic. It's a rough and ready technique. But if the haemoglobin level is low enough, it works'.[94] For Mol and Law argue, 'there are no clear boundaries, no lines of fracture where one variant [of medical practice] stops and the other begins'. Laboratories are sometimes to be found in Africa and the tropical doctor may be more attentive to directly visible symptoms of anaemia when she returns to the Netherlands. In these circumstances, they suggest that one might think of the differences in medical practice between Africa and the Netherlands less in terms of clear regions and borders and well-defined connections than in terms of continuous variations and in terms of the metaphor of fluidity.[95]

These accounts of different kinds of spaces of scientific and technical practice are important. They are correctives to the view that scientific practice necessarily involves the application of a particular well-defined and precise technical procedure. In some cases it may do – although this is not feature that is universal to science and technology but rather something which is culturally and historically specific. Standardisation and precision are cultural values.[96] The application of a standardised practice may have both benefits and dangers. Benefits: because in so far

as it is possible, standardised practice produces a homogeneous space which cuts across geographical and social divisions. Dangers: because by applying the same procedure everywhere, much that is important and valuable may be missed, significantly transformed or destroyed. In research, the entities that can be visualised through standardised measuring techniques may be mistaken for the complex reality from which they are abstractions. This is what Whitehead calls the fallacy of 'misplaced concreteness'.[97] The abstraction is confused with concrete reality. Knowledge *is* produced, but at the expense of a reduction in what it may be possible to know.

But along with the development of scientific forms of visualisation and calibration, less exact ways of comparing observations made in different places have persisted and continued to develop. From the eighteenth century onwards, quite different although no less technical forms of expertise have emerged based not so much on calibration and standardisation but on the cultivation of apparently quite subjective and aesthetic capacities. One could refer not just to anthropology and medicine, but to the reliance placed in journalism and travel writing on the testimony of the individual who is uncalibrated, yet nonetheless considered reliable, moral, disciplined and disinterested. One could point to the way that, as Chloe Chard has argued, the way that personal testimony became, in the eighteenth century, treated as a source of authority in accounts of the foreign.[98] Or, in the more recent past, one could trace the important and productive association between journalism and sociology that occurred, for example, in the work of Robert E. Park and the Chicago School in the 1920s, resulting in the significant development of an ethnography of the city; a form of investigation of the urban that depended on a prolonged period of personal involvement.[99] Thus, anthropology, along with some forms of sociology and non-fiction writing, has involved the development of a kind of expertise which could not be straightforwardly copied by another, but could only be acquired gradually through practice and experience.[100] In conjunction with discipline and precision, it seems, human personality and ethics have provided the means by which distant events and objects can be visualised. Personal vision has not been entirely displaced by the development of standardised and precise technical methods. Rather it has been formed into a remarkable instrument in itself.[101]

This implies a methodological point concerning the sociology and anthropology of science and technology. Namely, that in relation to the study of the exact sciences the place of sociology and anthropology is one neither of opposition nor replication. The sociology and anthropology of science and technology does not require an explanation of the development of science and technology in causal terms. Nor does it necessitate a denial or denunication of the knowledge that the exact sciences produce. Rather, it involves an analytical repositioning of the arguments and techniques of the natural sciences as situated practices – understanding scientific and technical activity as part of, rather than apart from, a complex and contested reality. It requires us to introduce into the study of science and technology a concern with politics, geography and history, while recognising that the identities of these disciplines may also need to be rethought.

GLOBALISATION

The idea that a nation or an empire could or should be drawn together technologically has, no doubt, been a political aspiration, although it is one that is likely to have been spoken about as much by bureaucrats, engineers, activists and academics as by national political figures. As much as there has been a desire to extend the reach of scientific and technological networks, there has also been a demand to determine their limits, their points of application and their accessibility, whether on moral, financial or political grounds. Technological networks may, and very often do, cut across formal territorial borders as well as established boundaries between public and private space. But this does not necessarily lead to the eradication of borders as such. New ones are produced.

In so far as technological circulations and blockages exist they may be more uncertain, unstable and contestable than is sometimes imagined. Here the controversy over the conduct of the French nuclear weapons tests in the Pacific in 1995 may be exemplary. As far as President Chirac's government were concerned the tests were apparently uncontroversial. On the one hand they were purely technical, designed to gather data for future computer simulations of nuclear tests. They were, in this way, linked to the work of government laboratories and defence establishments in France and possibly elsewhere.[102] On the other hand, the tests were conducted on a territory over which, in the view of the French government, France held sovereignty. The technological and territorial borders of the tests were, for the authorities, absolutely clear. Local activists, a number of South Pacific governments and the environmental

organisation Greenpeace, however, suggested a different frame, one that gave the tests political, cultural and environmental significance. The boundaries of the tests were expanded by these parties to include not just a consideration of the effectiveness of nuclear-weapons equipment, but a whole array of other issues and objects including the rights of local populations, the possibility of radioactive releases and the health of the surrounding environment. For one politician from the Cook Islands, 500 miles from the test site, 'the easterly trade winds come from the direction of Mururoa. The sea current travels to our waters. Any nuclear waste or seepage, will reach us first.' Some European governments and EU officials suggested another frame which defined the tests as coming within the technological zone governed by the Euratom treaty, one of the founding articles of the European Communities.[103] The French government rejected both of these frames, refusing entry to the EU scientists and confiscating Greenpeace ships. Having lost the argument in public, although not in the courts, the military–technological boundaries of the colonies were defended by law and by force. Elsewhere, in Europe, as we shall see, efforts to move, rethink, defend and redraw technological connections and boundaries have sometimes been more gradual and less spectacular and violent, but no less significant.

In recent years there has been much debate over the extent and importance of globalisation. At one extreme, there are those who argue that the globalisation of economic and cultural forms has undermined the political significance of the nation-state. For many others, the nation-state continues to be an important object of analysis.[104] For, in so far as there is an increasing degree of global interconnectedness today, this has not necessarily diminished the significance of the nation-state, or the importance of national regulations in channelling and transforming global flows. The nation-state may not have lost its general viability; 'rather, there is an insistent tension between the project of the modern nation-state and its ideological control over the circulation of both its citizens and their capital in diaspora'.[105]

In this chapter, I have suggested that what I have termed technological zones may not coincide with national boundaries, but neither are they global in their extension. There is no inherent tendency in the development of technological zones that they should necessarily become globalised. A distinction must be made between the idealised image of globalisation as an imaginary space in which *everything* is connected, and a global technological zone – a global technoscape – in which only

certain places and practices are connected together, and many others are excluded. A network of laboratories conducting research in a particular area of science may form a global technological zone in so far as individual laboratories are situated in different continents. But from another perspective the spatial extension of that zone may be very small indeed; confined within the laboratories' walls.

Technological zones take varied spatial forms which may both reinforce or cut across and subvert formal political boundaries; they may even create new ones. Their ends are in principle contestable; and due to the importance with which they are invested, they may be contested and reconfigured. They serve both to prevent and to establish sites for political conflict, and they reinforce and undermine zones of military domination. As we shall see, technological zones are the objects of developing forms of transnational regulation. In what follows I examine a series of remarkable attempts to reconfigure different technological zones: those associated with environmental and health and safety regulation, communication and information technologies, and security and defence. This has been the process of European integration.

3

HARMONISED STATES

STANDARDS

Prior to the twentieth century, standards of measurement were often set by reference to a physical object. When, in 1785, General Roy began his systematic geographical survey of the United Kingdom at Hampton Poor House ten miles south-west of London he purchased a 42 inch brass measure which originally had been divided into inches in 1742. The length of the first 36 inches of Roy's scale were calibrated against a yard measure maintained by the Royal Society in Westminster at exactly 65 degrees Fahrenheit.[1] The Royal Society yard was in effect the standard on which the geographical coordinates of the Kingdom were determined. Roy's interest in geographical measurement stemmed from his experience of military service in Scotland during the Jacobite war in 1745. He reckoned that the existence of a common and precise system of geographical coordinates would make it possible for the Kingdom to be ruled more effectively and for its territory to be made secure. Roy was not alone in his recognition of the importance of precision measurement. As the work of Norton Wise, Ian Hacking and other historians of science suggests, measurement and quantification were viewed increasingly as a critical instrument for government in the late eighteenth and nineteenth centuries.[2]

Today, measurement standards are established on a different basis. Contemporary measurement standards do not refer to an object, but to an event which can be replicated under specified experimental conditions.[3] The introduction of this system has political implications. For whereas General Roy juxtaposed his brass measure against an object held at the offices of Royal Society, the deployment of the new experimental standard redistributes the competencies of relevant parties. The contemporary equivalents of General Roy do not need to go to the Royal Society to inspect the Royal yard. They refer to the work of particular

recognised laboratories not because they maintain a particular artefact, but because they possess the specific resources, authority and skills to reproduce the experimental conditions defined by the standard. The effect of this movement is analogous to the effect in government of dispersing political power away from the sovereign. No longer is there a sovereign power, and no longer is there a Royal yard. Instead there are many laboratories, the authority of which derives from their technical capacities and the trust of others in the reliability of their results, and their rigour of their practices. The values of precision are now spread wide.[4] Standardisation is dispersed; it is manifested as series of political and technical projects which do not derive from any single centre of authority.

Today we are used to the idea that technologies come in relatively standard forms. Technologies of *measurement* such as the ruler, the scales or the thermometer are calibrated against a global (metric) system. *Interconnecting* technologies such as plug sockets, phone cables and railways lines work because interconnections are standardised. And many industrial parts are *interchangeable* making it possible for new components to be obtained when old ones are broken. For much of the time we take technological standardisation for granted. Standardisation is reckoned to be a technical matter which can be best left to specialists, and is of little interest to students of politics and government.

In this chapter I make two arguments. First, standardisation is critical to the formation of what I have called technological zones, and the generation of new spaces of political rule. Far from being of a marginal importance to students of politics, standardisation has played, and continues to play, a critical part in political and economic life. Standardisation is both expected to reduce blockages and restrictions in the circulation of technology and to create new more secure technological zones with clear and well-policed points of access. Second, while many standards are fixed and accepted, standardisation is never a completed process.[5] On the one hand, the development of technology continually destabilises existing standards, thereby creating the conditions for new standards to emerge. On the other hand, the process of standardisation serves to create new sites and objects of political conflict. The ideal of standardisation is the fantasy of a smooth and homogeneous technological zone in which the speed of circulation is maximised. In practice, standardisation may produce new fractures and dislocations which may act as catalytic points for further political conflict.

This chapter centres on the European Union. Along with other international organisations, technical standardisation has a critical place in the politics of the European Union. For outsiders one of the difficulties of understanding the politics of the European Union is the extraordinary technicality of many of the problems which its institutions tend to address. The institutions of the European Union do not do what the governments of most traditional nation-states do. They do not run and pay for hospitals, schools, armies and local-government bureaucracies. They do not rely on the service of a vast number of public employees. But one of the principle things that the European Union does do is set the conditions within which a limited degreee of standardisation (so-called 'harmonisation') is expected to occur. In effect, the European Union establishes a frame within which a vast array of quite disparate technological activities take a more or less standardised form. The European Union should not be understood as 'a state', but as a series of imperfect zones of circulation. Harmonisation plays a key part in their formation.

EUROPE'S MISSING MASSES

Brussels. In thinking about the European Union it is tempting to start with an account of its central political institutions. It would be possible to describe the complex institutional processes of the European Union, such as the principles of codecision, qualified majority voting and so on; to examine the forms of representation available to different member states and the formal relations between the different institutions of the Union: the Council of ministers, the European Commission, the European Parliament, the Court of Justice and the Court of Auditors; to trace the history of the European Union from the early days of the Treaty of Rome, through the Single European Act to the Maastricht treaty and its subsequent further modifications;[6] to analyse the history of the main policy areas of the Union from enlargement to competition and trade, from agriculture and the environment to monetary union; to examine also the vexed question of the shifting balance between European and national sovereignty.[7]

Of course, formal accounts of institutions frequently tell us very little about what actually goes on inside. The public images of institutions are invariably different from their internal complexities. This is above all in the case of the institutions of the European Union; institutions in which so many aspirations and anxieties have been invested. The notion of

bureaucracy – with all its negative connotations in English – is closely associated with the European Commission: 'Brussels' is above all, for its critics, a bureaucracy. Yet reports from inside the European institutions notice, for example, that the European Commission is, in a certain sense, not (yet) a particularly bureaucratic institution although, according to some commentators, it 'may be moving towards a more "mature" form of bureaucratic behaviour which emphasizes a more regularized and predictable relationship with organized interests'.[8] It is open to all kinds of lobbies and special interests. There are an extraordinary range and forms of other institutions with which it deals, and the political alliances with which it is involved. Necessarily so, given its small size in comparison, for example, to the bureaucracies of the major European nation-states. Moreover, its *fonctionnaires* are marked by a commitment to a subtle form of political militancy (in favour of the European project) which one would not find in national administrations in which such commitments may be more understated, or repressed.[9] There are also significant questions concerning the internal politics of language, of national identity and patronage which suggest that its officials cannot be thought of as rational administrators in the Weberian sense.[10] Why is French the dominant language of the Commission?[11] Do particular nationalities dominate specific Commission or Parliament directorates? Or, indeed, even minor elements of their *organigram*, such as the cafés in the Parliament used by the parliamentarians, officials, academics and the official *navette* service which ferries parliamentary papers continually between the main European institutions at Brussels, Strasbourg and Luxembourg?[12]

But the European Union should be approached from other directions as well.[13] One different approach would be to attend to the question of culture. Indeed, in criticising traditional emphases on political institutions and formal political process, sociologists and anthropologists have tended to focus on the issue of culture and the neglect of cultural policy by mainstream political scientists and economists. Certainly an attention to culture suggests the possibility of a broader account of what politics might be.[14] It also indicates the evident weaknesses of the European institutions' official statements, not least in their tendency to articulate a reductive sense of the unity of European culture. At their best, such statements tend to understand cultural difference in the context of an overall sense of the cohesion of European culture. At their worst, they project an absolute sense of the difference between Europe and its Others.[15]

In thinking about the question of culture in the European Union, however, it would be a mistake to confine attention to, for example, the promotion of the arts and language and with the field of cultural policy. On the one hand, these are of somewhat marginal importance to the everyday work of the European institutions. The Culture Directorate (formerly DG-X), after all, is a relatively small part of the Commission when compared, for example, to the directorates concerned with, for example, industrial, technology or competition policy. Almost as if an effort not to be seen as agents of a quasi-nationalist political project, the European institutions have *not* invested heavily in cultural policy, perhaps ultimately to their own disadvantage. At one level, the European institutions are preoccupied with what are conventionally understood to be 'technical' and 'legal' rather than 'cultural' matters. In short, the EU has been much less concerned, in the words of Friedrich Engels, with the 'government of persons', than with the 'administration of things and the direction of the processes of production'.[16] At another level, if we wish to understand the cultural policy of the European Union we need to look not so much or not just at the products of the cultural industries or statements of cultural policy, as they are narrowly conceived, but at the politics of regulation and technology; at material culture. Indeed it is significant that, in Europe, debates about the possible threat of integration to national traditions and identities have revolved less around explicit elements of cultural policy and formal declarations of European citizenship, than around experiences and fears of technical regulation, centralised bureaucratic interference, and the loss of national currencies and regional food products. In Britain, in particular, a sense of 'the threat' of the European Union to national sovereignty was articulated in terms of, for example, the 'ludicrous' and 'irrational' regulation of such objects as bananas, chocolate and beef. For those opposed to the project of further European integration the 'irrationalities' and 'excesses' of the European regulation of material culture were important signs. For they indicated how it was possible to reconcile a nationalist and neo-liberal opposition to further political integration.[17]

In this chapter and the next, I focus on one dimension of this: the remarkable effort to forge what might be termed, following the discussion in chapter two, a European technological zone. I examine the European project, not through its formal political institutions, nor just through its legal system, although these are important, but through the vast array of technical instruments, expert practices and material objects

which are associated with them. If we are to understand contemporary European government, I suggest, it is helpful to think of the European Union not just in terms of notions of political or monetary union, nor simply as a geographical entity (although the geography of Europe needs to be interrogated further) or as a political arrangement between nation-states, but in terms of the array of technologies and objects which form it, and are formed in relation to it.[18] It is by focusing on technology, and on the non-human as well as the human elements of the European Union that we might make sense of the accurate observation of Meny et al.: 'If the overall picture is taken into account it is remarkable how much the Community has been able to do in so many fields, with such limited resources, with so few instruments of control, and without customs officials, policemen or enforcement agencies.'[19]

Certainly, Europe is often imagined as something of a bureaucratic Leviathan – the epitome of a Kafkaesque bureaucracy.[20] It is represented as monolithic and powerful. As such the development of the European Community has been sometimes greeted by evident ambivalence, by hostility and confusion. The image is misleading. Europe is difficult to understand not just because of the complex division of powers that exists between its bureaucracy, its judiciary, its parliament and the governments of its member states. Nor due to the impenetrability of its bureaucracy – which is in many ways easier for outsiders to navigate into and through than many other public or private institutions.[21] Nor due to the inadequacies of its publicity machine, or the lack of photo-opportunities it presents to the mass media. Rather, the difficulty in understanding the European economy and the European political system has been, at least in part, a function of the critical part played by a vast array of objects and technical devices in its make up.

Two terms should figure in any analysis of the technological formation of Europe. The first is 'harmonisation'; the second is the 'network'. The ideas of harmonisation and the network have been key terms in the everyday talk in the European institutions; figuring in large numbers of policy documents. In their constant repetition they link together a whole series of apparently disparate policy areas: environmental protection, film, competition, innovation, regional and social policy. They are also both evidence of *spatialising projects*: efforts to establish links which cut across and disrupt national boundaries. In different ways, the various projects of harmonisation and networking are intended to forge technical connections across Europe; to integrate Europe through the formation of

a series of European technological zones. This chapter and the next are concerned with the complexity of that integration.

This sense of Europe as a technological formation resonates with the work of those political scientists who have rightly stressed the importance of regulation to European integration. In an insightful analysis Giandomenico Majone, in particular, has argued that the European Union should be regarded as something of a regulatory state, acting not through public ownership (as has been the case in Europe in the past), nor through deregulation, but through the development of a complex and expanding regulatory system. As Majone argues, the European economy has undergone a process of re-regulation rather than the kind of pure deregulation demanded by neo-liberalism. In this respect, European government has moved closer to an American model in which regulatory institutions have historically played an important role.[22] Moreover, Europe has not merely provided a space within which the regulatory systems of different member states have come together, it has also established a set of institutions which have encouraged a certain degree of regulatory innovation.[23] The focus of this book on technology is certainly not the same as Majone's focus on regulation. The concerns here are both narrower – there is little here about the instruments of social or financial regulation, for example, although these might be addressed in similar terms. But also different, in so far as the governance of technical change, and the place of technology in government, cannot be understood simply in terms of regulation, as narrowly conceived, but must also address, as we shall see, a much broader range of practices and artefacts. The formation of Europe entails not just the development of European laws, markets and regulations, but also the formation of European objects and practices. The lack of attention to technology is a serious weakness of Majone's analysis. Majone presents us with an image of Europe as a more or less functioning regulatory system. As we shall see, the formation of Europe as a unified technological zone is much more complex, contested and problematic than this image suggests.

HARMONISATIONS

Historians might note that the idea of harmonisation has been understood in broadly one of two ways in Europe.[24] First, harmonisation has been associated not so much with an absence of technological connections but with the problem of social and geographical difference.

A reduction in the socio-economic discrepancies between the Union's regions has been a formal objective of European government since the late 1950s. The founding Treaty of Rome recognised, in principle, the need to reduce gross inequalities in the economic development of the different regions and nations of the community. 'Member states are anxious to strengthen the unity of their economies and to ensure their harmonious development by reducing the differences existing between the various regions and by mitigating the backwardness of the less favoured regions.'[25] Despite this bold declaration, however, the Community paid little attention to this interpretation of harmonisation. Individual national governments may themselves have directed their attentions to the reduction of socio-geographical inequalities, but this was not the overriding concern of the Community. With the important exception of agriculture, the Community did not seek to act upon a problem conceived of in social and geographical terms. Only since the mid-1970s has the issue of 'regional harmonisation' acquire greater prominence. More recently, the Maastricht Treaty renewed the call for the Union to 'aim at reducing disparities between the levels of development of various regions and the backwardness of the least-favoured regions, including rural areas'.[26] To this end the European Regional Development Fund would be strengthened in order 'to help redress the main imbalances in the Community through participation in the development and structural adjustment of regions whose development is lagging behind and in the conversion of declining industrial regions'.[27] Economists dispute whether such efforts will be adequate.[28]

Europe can be thought of as a space divided, economically, administratively, culturally and geographically. It can be represented as a map with different regions, each marked by their own levels of unemployment, industrial productivity and wealth; a series of social and economic differences waiting to be reduced, or even eradicated. This is an idea of Europe addressed by this first sense of the notion of harmonisation. It is a representation of Europe which you will find on the desks and walls of many European officials. It is the object of an increasing quantity of European statistics and an increasing variety of objects of measurements. Instant comparisons and calculations are possible. In short, Europe has been translated into what Peter Miller has termed a 'calculable space'.[29] The evident differences between the income of its populations, the quality of its beaches and the productivity of its various regions have, thus, been turned into a visible problem.

However, Europe could also be represented as a space not just marked by socio-geographical differences but also by differential flows, by lines along which movement is more or less possible or desirable, and blockages and impediments across which movement is more or less easy. The problem addressed by the second (and perhaps more common) sense of the term harmonisation concerns the problem of *mobility*; the problem of ensuring that mobility within Europe is productive, integrative and intensified. This sense of harmonisation is also found in the Treaty of Rome. As early as 1958 it was seen as important for workers from different nations and regions to assimilate 'thereby contributing to the formation of a "socio-psychological" foundation for the European Community.'[30] In the 1960s and 1970s, however, the issue of mobility was not prioritised. It proved too difficult to remove many of the so-called non-tariff barriers (local customs, laws, public procurement practices, technical standards and so on) which restricted movement across Europe. The European institutional procedures were too slow to cope with the work involved and the need for unanimity in the Council of Ministers made it difficult to reach agreement.[31] Far from harmonisation, divergencies in technical standards actually *increased* as national governments and standards' institutions developed a vast range of new regulations and standards particularly in relation to issues of environmental and consumer protection.[32] However, the problem of harmonisation became a central theme of European Community policy in the 1980s. Against the background of the neo-liberal project of the single-market programme, Europe was acted on as an economic space fractured by a vast array of legal, administrative, technical and linguistic barriers. Individuals, objects and information were all inhibited from moving across Europe due to what was said to be excessive bureaucratic interference, unfair government subsidy, and divergencies in national technical regulations. It was seen as divided in a way which reflected national indiosyncracies and interests and petty bureaucratic rules; a space littered with 'obstacles and impurities' which were the consequences of the excesses of earlier modes of governance.[33] The '1992' project would eradicate the *striations* of national-state capitalism and create the entirely smooth space of multinational capitalism.[34] In the vision of '1992', Europe would be deterritorialised; transformed into a purely economic zone without any internal political boundaries or cultural identity. As the publicity produced by the UK Department of Trade and Industry expressed it, Europe would be 'open for business'. It was in this context that Prime Minister

Margaret Thatcher, signed the Single European Act which was supposed to provide the legal and political framework for the Single Market programme. The Conservative government, which proved so hostile to public support for science in Britain, were committed to the formation of a European scientific and technological zone.[35]

The project of harmonisation was not the only element of the single-market programme, but it was certainly one of the most important. According to the team of economists who wrote the European Commission's own report on the single market, the existence of divergencies in technical regulations and standards across Europe was 'rated by companies as one of the most acute problems they face in their European operations'.[36] German beers had different purity standards to beers in other member states, Italian transport companies carried livestock for longer than in Britain, Denmark required soft drinks and beers to be sold in recyclable bottles whereas other member states did not, and engineering companies across Europe manufactured components to different specifications and measurements. Drivers wishing to use a car telephone on a trip from Germany to the UK via Belgium had to install no less than three different systems.[37] Suddenly it seemed that technical regulations and standards, a subject which had hitherto been widely regarded as 'arcane' or 'tedious' acquired a political significance which they had not possessed since the end of the nineteenth century.[38] Economists, who had managed to ignore the existence of standards, institutions and technical regulations, finally began to recognise their extraordinary economic importance.[39] All the costs were added up. According to the Commission's own analysis the annual cost of content and ingredient regulations to European industry on just four items (chocolate, ice-cream, beer and pasta) was 1 billion ecu.[40] Undoubtedly, in all the attention to the costs of a lack of harmonisation less attention was paid to measuring the costs and difficulties of harmonisation itself.[41]

But even if the technical details are complex, and the costs difficult to calculate, it is tempting to think that harmonisation is conceptually, and indeed politically, straightforward; a process which would happen over a short period of time in order to meet a deadline ('1992') and then be forgotten. Common standards of measurement need to be accepted. Common regulatory standards dealing with, for example, the safety of electrical appliances and toys need to be agreed upon. And standards which allow network technologies such as mobile telephones to be connected together have to be laid down. In one reading of the situation,

the European institutions simply laid down new standards and regulations and the nations and regions of Europe have come to accept them. Europe would be gradually *cleared* for business, and the Commission, which was at the centre of this process, would become an ever-expanding bureaucracy defining an ever-greater number of standards and regulations. The Commission would develop into the administrative centre of an increasingly regulated economic and social space. Harmonisation would serve not just to increase mobility of objects and persons across Europe; it also would increase the extent to which they could be acted on in a *European* way. Possibly contrary to the aspirations of the neo-liberals the ordering of Europe would involve, as Majone observes, a process of re-regulation rather than a process of deregulation per se.[42]

But this is not exactly what has happened. First, because the European institutions are not at 'the centre' of the process of harmonisation, for the process does not have a single centre. In so far as the European Union is able to act, it can only do so by devolving responsibility to a whole variety of other actors and accepting that many European standards have to be voluntary. The process of harmonisation does not create a huge centralised European state, but relies on a much more dispersed set of governmental institutions which exist as much within the so-called 'private' as the 'public' sector and take the form of laboratories, expert committees and testing stations as much as conventional administrative offices. In effect, the logic of harmonisation cuts across the distinctions between the 'state' and the 'market', and between 'science and technology' and 'administration'.[43] Second, because the space that is created can never be the pure smooth space of the neo-liberal political imagination. To be sure, some of the earlier national boundaries have been reduced, but a whole new series of complex divisions have been created. Indeed, in rendering Europe's uneven technological surface visible to further and more detailed scrutiny, further fractures are revealed and produced. Chocolate, the object of the European economists' studies, is a good example. Efforts to harmonise chocolate quality standards highlighted differences between 'pure' continental chocolate and British chocolate which contained vegetable fat. For one French chocolate-maker the difference was clear: 'We produce a noble product, like wine. Our chocolate is an international icon, and like wine it is made entirely of natural products given to us by the good God. Why let bad alchemists [British producers] disrupt this natural cycle and turn it into a product of horror?'[44]

DELEGATION AND DISPERSION

Harmonization depends on *delegation*. This is true in Europe and elsewhere. After all, the Commission is only a small bureaucracy ('only enough to run the government of a small city'). The Commission itself simply does not possess the competence to define European regulations, or to check that an object or an action complies with existing regulations.[45] Indeed its own laboratories have not generally been highly regarded. They were locked into, for too long, the development of nuclear power. Until recently, they have remained isolated and unproductive. Their location has all too often been a matter, along with other European institutions, of political deals between the governments of member states, which have very little do to with any objective assessment of where they would be able to work most effectively. Outsiders may be forgiven for not knowing precisely from where the whole process is organised.[46]

But in the context of the project of harmonisation the small scale of the Commission is not surprising. For, as an agent of government, the Commission seeks to operate not by administering anything directly, but rather by aligning the diverse powers of existing national professional, private and public organisations. The European institutions are only able to lay out general directives which delegate responsibility *for others to act*. In so far as harmonisation has occurred, it is because Europe delegates to an array of relatively unknown organisations with acronyms like ETSI, CEN, CENELEC, Afnor and BSI.[47] These institutions perform the difficult task of coordinating the activities of private firms and public organisations across the continent gradually getting them to agree on the appropriate safety standards for machine-tools, the properties of electrical components, and so on. In turn a vast complex of other governmental and private organisations are entrusted to perform the task of measuring the degree with which the regulations are complied. In this way, the EU acts 'at a distance', regulating, but not directing, activity within its borders. The Union is an extraordinarily technical political institution; but it is not an absolutist regime. It is at *the middle*, but not the centre, of movements and flows.

But although harmonisation is made easier through delegation, complete uniformity is impossible. Harmonisation is not equivalent to standardisation: to the complete eradication of difference. This was resisted for a variety of more or less principled reasons. Firms which have invested huge amounts in making objects of a particular quality refuse to

change over to another standard. Newspapers claimed that their readers would resent not being able to eat and drink the substances they have done in the past. Objects and devices which have been used for a long time can not easily be changed without a vast amount of work. As a result, it either proves impossible to agree in Europe, or it if it is possible to agree, it can take too long. In 1969 the Community had adopted a General Programme for the Removal of Technical Trade Barriers. However, from the very beginning the process was slow. In 1984, fifteen harmonisation directives passed had taken an average of 9.5 years to process. Private and semi-private standardisation bodies were accumulating often divergent national standards at a much faster rate.[48] To get around this problem, the European Community agreed in 1987 to dilute its policy of harmonisation. 'Mutual recognition' of national standards and regulations would be a sufficient basis for objects and processes to be able to move across frontiers. As part of this 'new strategy', the Community did not seek to establish European standards, but merely to lay down general terms and 'essential requirements' in relation to which a range of different standards may be possible.[49] Earlier the critical *Cassis de Dijon* judgement of the European Court had paved the way for this movement. According to the judgement, member states of the Community could not prohibit the sale of a product which was produced according to regulations governing products in other member states except when considerations of environmental protection or public health legitimately applied.[50] In the frame established by these shifts in law and policy, precise targets and the instruments to achieve them could be left in the hands of member states, or even local authorities. Full harmonisation remained, however, a political aspiration. As one of drafters of the Commission white paper on the internal market noted, 'mutual recognition achieves [the] objective [of creating a single market], but it does not satisfy all aspirations of consumers and producers ... only harmonisation can implement effective Community policies'.[51]

But even in so far as common regulations and standards are agreed upon, there is a problem of reception. A technical standard or a regulation is a text. It attempts to define a certain arrangement of objects, processes and persons. It says, for example, that all European lorries must conform to at least these safety standards, and carry this maximum load. It may suggest that its requirements are tested in a certain way, but it may leave open scope for widely differing interpretations. In the end, however, the meaning of a technical standard or regulation, its use and its political significance are, as reception theorists would say, in the hands of its readers. If it is a regulation it is backed by the law, but it may be unclear what it means, local authorities may chose to ignore it, or simply fail to put the procedures in place which would make it work. There are sometimes great differences between what a European regulation implies in one part of Europe in comparison to another. If it is merely a voluntary standard, firms may chose to act only if they are forced to by their suppliers or their customers. A standard or a regulation does not have any natural force or intrinsic momentum. It requires agents who are prepared to *make* it into a reality. It is an authority which may be obeyed, ignored or opposed. It can be accepted as an authority or subverted. Informed commentators argue that European regulations are more likely to have force when the national regulatory bodies are tied together in the form of a network connected to a central European regulatory agency.[52] Others point to a growing recognition that the development and implementation of stringent standards has costs as well as benefits.[53]

BATHING WATER AND THE 'LABORATORY EFFECT'

In considering the process of harmonisation in practice, the example of bathing water is a good one. Bathing water was, after all, one of the first objects of European environmental regulation. A directive on bathing water quality was issued in 1975, a time when, formally, the European Community did *not* have the competence to legislate in relation to environmental matters.[54] The directive demands that individual member states monitor water quality near bathing beaches according to common standards.

Bathing water is not a marginal issue for the European Union. Since 1991 the Commission has been required to publish an annual report on bathing-water quality thoughout Europe, detailing the success or failure of nearly 20,000 individual beaches, rivers and lakes in meeting quality standards.[55] The report is publicly available, its contents appear in full colour on the European Commission web-site, and its results are widely reported in the press. Indeed, maps of bathing-water quality are perhaps the most public image of Europe as a technological zone – a zone which has been made comparable by measurement. On this basis the differences between different regions of Europe are immediately visible. The information is said to have a large influence on tourism in particular regions, and it may raise questions about the safety of eating local shellfish.[56]

The monitoring of bathing water does not merely represent Europe; it has effects.

But despite the remarkable interest in measuring the quality of bathing water, and displaying these measurements as widely as possible, the comparability of such measurements across Europe has been limited. This was made clear in a study made by scientists from the *Institut Louis Pasteur de Lille* in France.[57] According to the study, the tests and procedures used by different laboratories across Europe for measuring were not comparable. Perhaps not surprisingly, for the original EC directive had not specified how they could be made comparable. According to the report's authors the commercially available culture media within which samples are prepared were dissimilar. And there was no agreement of what size of sample of bathing water would be sufficient to make an estimate of the quality in general. There was, moreover, no common quality-assurance system between different European laboratories. Different European laboratories simply did different things. Their work, which hitherto had been viewed as comparable by many, was not. The authors of the report made a statistical analysis.[58] They made the important point thus.

> Real interlaboratory trials, like those organized by the RIVM together with the European Commission using reference materials, have demonstrated greater dispersion of the results (R varying 1.5 and 6.5). The differences in results between laboratories can sometimes be associated with a particular method, incubator or transportation period. *However, they can usually only be attributed to the 'laboratory effect'. This stresses the need for further attention to quality assurance based on internal controls (use of reference materials) and through external controls (participation in interlaboratory trials).*[59]

Although the observation is a statistical and an experimental, and not an ethnographic, one, the conclusion should be immediately recognisable to historians and anthropologists of science. Making skills and places comparable is a difficult process, and the degree of comparability of different technical procedures is always potentially controversial. There was, as the authors of the Belgium report noted, a 'laboratory effect'. When different measurements of different laboratories were carried out on a standardised sample of artificially contaminated sea water different results were obtained. 'Experienced microbiologists analyzing natural sea water enriched with pure strains of faecal coliforms and faecal streptococci obtain equivalent results when using a common method and significantly different results using their own method.'[60]

In short, laboratory practices are extraordinarily variable, even when broadly similar procedures and equipment were used (that is, similar according to current EC regulations). Effective harmonisation would, according to the research report, require not just the standardisation of instruments and materials ('reference materials'), but also the standardisation of practices (through 'interlaboratory trials'). When displayed in reports and published diagrams, harmonisation seemed to have been successful: Europe was a calculable zone. But when the practices of harmonisation were examined in the laboratory, the smooth surface of Europe's technological zone was remarkably uneven. The conclusion could have become politically controversial. It did not. Whereas 'the public', as users of beaches, were the appropriate readers of the Commission's annual report on beach water quality, the audience for the French laboratory's report were specialists. This was not a case of concealing information: some campaigning organisations were well aware of how poor 'the scientific base' of European standards was.[61] But there was no attempt to turn this minor (although typical) problem into a public political issue. The implication was that the standards should be drawn tighter, and more tightly disciplined and regulated. But this did not happen quickly. Decisions could not be reached. Over twenty years after beginning the harmonisation of beach-water-quality measurement it was still not completed. For one British official 'it makes you despair of the whole process [of harmonisation]'.[62]

The problem of replicating experimental practice across Europe is certainly not a new one. Steven Shapin and Simon Schaffer examine in detail the difficulties of replicating the experimental apparatus of the air-pump in the1660s, and determining what counted as a working air-pump.[63] Jim Bennett has written of what we might call the harmonisation of practices in different European astronomical observatories in the eighteenth century. According to Bennett: 'It was the instrument industry that made [the observatories'] identity of astronomical purpose possible. This spread of an instrument technology and accompanying research programme illustrates some of the features detected by Shapin and Schaffer in the case of the air-pump. For the instrument successfully to replicate the programme of work requires more than the dissemination of written accounts – observers must themselves transfer a practical

facility.'[64] The contemporary lesson of this story is clear: harmonisation depends not just on written statements and procedures, but also the transfer and monitoring of practical skills. Harmonisation is apparently a rationalistic and legalistic enterprise; but to be successful it demands the presence of persons. The politics of the European Union which are so often associated with the activities of the Commission, the Parliament and the Council of Ministers are to be found in the most detailed and technical of laboratory procedures.

A EUROPEAN TECHNOLOGICAL ZONE?

If it is accepted that national differences do need to be eradicated or reduced, why does this need to occur at a *European* level? The logic behind the formation of the single European market is clear. But two reasons are sometimes given for thinking otherwise. First, there is the evident disjuncture between Europe and the spaces of flow established by transnational industries. Although it may make sense to establish common European environmental regulations, why bother establishing European standards in some areas of advanced technology when, de facto, the standards are established through the operation of a global market, and in the design labs of Japan and the United States. In the end, European standards can never be merely *European* standards.[65] In so far as there is an ambition to establish Europe as a technological fortress it is a mistake. The technological borders of Europe must be flexible and negotiable. At the very least there must be a complex effort of coordination at a global level. In these circumstances, regulatory organisations such as the international telecommunications union (ITU) and the World Trade Organisation (WTO), which have previously been regarded as having a narrowly 'technical' function have become the sites of an extraordinary level of political conflict. As Puay Tang observes, such organisations are undergoing a period of instability in their attempt to re-establish a international regime for the governance of technology.[66] In so far as Europe has become something of a technological empire, then it can be forced to negotiate and compromise over what blockages and impediments it wants to maintain around this empire and for what reasons.[67]

Second, there is a problem of *timing*. Harmonisation is a spatial and a political project. The ambition of harmonisation is to make it possible for technical devices and regulations to work across an extended area.

But as a political project, the success of harmonisation can depend crucially on *when* it occurs. Paul David gives us the example of the development of the QWERTY typewriter keyboard into a standard.[68] As a keyboard standard, QWERTY is certainly not the best one possible. Typing would be easier if the keys were rearranged. However, due to the effectiveness of the business strategy of its manufacturers, QWERTY became the industry standard just as, more recently, VHS has become the standard for video cassette recorders. In other cases a number of more or less incompatible standards can be created which may require more or less costly or complex devices to convert from one standard to another. Think of the difference between the Personal Computer and the Apple Mac, the imperial and the metric system of measurement, and the varieties of leaded and unleaded petrol. In short, once a standard or a regulation has been established it may be difficult for anyone to change. There may be a very short space of time for anyone to influence the outcome before the use of the standard becomes widespread.[69] The European Union, or its delegates, may be simply too slow to act at the right time to have any effect.

Consider the example of High Definition Television (HDTV). In Europe, the French government led a remarkable campaign along with Europe's large electronics firms to make sure that the Community should back a particular standard, HD-MAC. Yet little was done to ensure that broadcasters would adopt this standard, or to consider whether backing was justified in comparison to potential rival standards emerging in Japan and the United States, or to consider whether the European institutions were subsidising research programmes which were going nowhere. Leading 'European manufacturers went hand-in-hand with the European bureaucrats, whose political prestige was partly embodied in the MAC policy'.[70] Inside the Commission, some officials and engineers were sceptical.[71]

> ... the norms and standards which are so praised in Europe have, like everything, positive and negative effects. One positive result is interconnectivity... that's nice for the customer and it would normally reduce the cost. But it is completely rigidifies commerce! It blocks commerce! You have a fantastic example with high definition television. They were imposing a standard which was already obsolete. Because of timing you need to agree politically on a standard which in ten years or so will be old.[72]

In the face of such speed, some would claim that public institutions should simply move out of the way. Capital can be delegated to achieve the necessary process of harmonisation and deterritorialisation on its own. All that the public authorities should do is to make sure that public safety is ensured and that business does not form and exploit its own empires, bounded by its *private* technological standards. Instead of trying actively trying to create common standards based on consensus, the public authorities should concentrate on regulating the conditions within which industry can develop and own its own standards, while at the same time fostering mutual recognition of differences in standards globally. If maximising trade is the sole ambition it is argued that the principle of harmonisation, 'mutual recognition', should be extended beyond Europe's borders to include North America.[73]

THE POLITICS OF HARMONISATION

Social and political theorists have often drawn, as I have noted, an opposition between technology and politics. The development of a democratic public sphere is inhibited by the commercialisation of the cultural industries and the scientisation of political decision making. Politics has 'been transformed by the objective exigencies of new technologies and strategies'.[74] Certainly, it is possible to see harmonisation in these terms. The process of harmonisation has, after all, been largely removed from any public political scrutiny. For two reasons. First, because it occurs in international bodies which, despite their critical importance to government, are still viewed by the mass media as if they belonged to another country. Europe is *foreign* news, and the mobilisation of the mass media or the political parties at an international level remains limited.[75] Brussels, as a foreign and a bureaucratic body, is doubly Other to the nation. Second, because the process concerns matters which are largely delegated to technical experts, or debated by restricted groups of bureaucrats and lobbyists. As one political scientist has noted following a detailed study of EU water policy 'one cannot fail to be struck by the importance of scientific evidence and counter evidence, and scientific dispute, as one analyses documentary sources'.[76] The point is an important one. For it is precisely because of the extraordinary attention paid to scientific and technical evidence in the formulation of European regulation, that it is impossible to understand the conduct of the European institutions solely in terms of the actions of

political parties, interests, networks and lobbies. In its preoccupation with such conventionally 'political' actors, political science fails to recognise the political agency of scientific and technical materials. Consider, for example, the case of the scientists of the *Institut Pasteur* who criticised the current state of beach-water-quality measurement. This is a political intervention; albeit one which is not made in public. It not only makes claims about the quality of bathing water (which may be relatively uncontroversial) it also makes claims about the competencies of laboratories, the actions of firms and the direction of European policy. In this case the technical is political, but cannot be conceived of just in terms of the motives and interests of conventional political actors, or in terms of the conventional political tactics of lobbies. It is political argument which is articulated by technical means and concerns matters of fact.

Yet such an account of harmonisation only tells part of the story. For, as a political project, harmonisation can open up other spaces for public political contestation. Of course, one could point to a rather conventional political split on the *scope* of harmonisation. For example, there are many who have argued that the principle of harmonisation should be extended to the social domain, and be concerned with questions of employees' rights, environmental protection, taxation and so on.[77] Certainly, the idea that Europe has a *social* dimension has provided the basis on which the support of social-democratic organisations for the European project has been enlisted. Moreover, to a limited extent the arguments in favour of social harmonisation have been successful, although generally only in so far as it could be argued that an absence of such harmonisation would lead to unfair competition in the single market,[78] or there was shown to be a clear *scientific* basis to it. According to the judgement of the European Commission of Human Rights, for example, the age of consent for homosexuals should be sixteen across Europe. It cited the evidence of a medical report which claimed that 'most researchers now believe that sexual orientation is usually established before puberty'.[79]

Yet the forms of political contestation which surround harmonisation do not just take such forms. After all, harmonisation is concerned as much with the regulation of objects and technical procedures, as with the regulation of persons and social institutions. It is, moreover, extraordinarily dispersed and specific in its implications.[80] It has far-reaching effects, but it achieves these through the most mundane and material of

mechanisms. Revealing differences in the quality of bathing water across Europe, helps to make the quality of bathing water calculable and comparable, but it also helps to make it more visible. The same could be said of all the efforts to develop common standards of abattoir hygiene following the development of bovine spongiform encephalopathy (BSE). The existence of European competence over the health and safety standards of abattoirs was said to reveal differences in standards and practices across Europe. The procedures of British abattoirs were found inadequate. What appears to be a technical matter can become a political event with unexpected ramifications and 'untechnocratizable consequences'.[81] Technical practices can open up the space of political contestation, without being reducible to politics as it is conventionally conceived.

A TECHNOLOGICAL MARKET

How is it possible to form a market? Economists have sometimes thought that markets have a kind of natural existence. That all that was required was the eradication of impediments: whether they are due to tradition, to culture or to legal differences. But as Michel Callon has argued, there is nothing natural about a marketplace, or about the rational economic actors that are expected to inhabit one. The agents of rational economic calculation, in the way that is to be understood by economists, have to be *made*. Moreover, they have to have the instruments, sites and techniques with which economic calculation is possible. Graham Burchell has made a similar point. For neo-liberalism, Burchell argues, 'the rational principle for regulating and limiting governmental activity must be determined by reference to *artificially* arranged or contrived forms of the free, entrepreneurial and competitive conduct of economic-rational individuals'.[82] Callon himself uses the example of the table-strawberry market in a rural area of France to demonstrate the extraordinary attention which must be paid, for example, to the architecture of a trading floor if something like the free market of the economists' imagination is to be formed. Such a market is one in which, in Callon's terms, personal relationships between buyers and sellers are placed outside of the *frame*.[83] Europe has a much more complex architecture than a rural French marketplace. There has been the fantasy that 'Europe' could be transformed into a smooth space in which the mobility of capital and labour would be maximised. Europe would be in reality,

and not just in political rhetoric, a single market and a technological community. Technologies in all their various forms, appear to be both potential instruments and real impediments to the realisation of this objective. Harmonisation is, seen from this perspective, a necessary prerequisite to the formation of a market: one in which rational economic behaviour is possible.

Yet the harmonisation of Europe is not as easy as one might imagine, nor does it result in the formation of the frictionless space of the neo-liberal political imagination. To be sure, many connections and comparisons between previously divergent technical practices across Europe are made possible. It becomes possible to compare measurements of the quality of beaches across the continent, and to assume that, given the right technical specification, it is possible to make a call on a mobile telephone from Naples to London. Yet these connections are frequently less exact, and stable, than one might imagine. There are connections, but the lines crackle. The devices and procedures which are used in different places may be similar, but not identical. For the connections to be made, or at least appear to be made, there has to a certain amount of flexibility. There is necessarily a degree of *play* in the network.[84] Harmonisation is necessarily an on-going process. The situation should be immediately recognisable to students of thermodynamics. Reducing complexity and noise is costly. Achieving complete uniformity is impossible.[85]

In her book *After Nature*, Marilyn Strathern reminds us that the idea of building a tunnel between England and France has been a fantasy since 1856.[86] As she remarks, one of the reasons why the tunnel has been built is simply that the enabling technology now exists. In this way the construction of the tunnel is indicative of our contemporary attitude towards technology. If it is possible then it should be done. The tunnel is also indicative of the political logic of the contemporary European project in two ways. On the other hand, there is a sense that harmonisation should occur because, at least in principle, it can. On the other hand, if we are to understand Europe today, we need to think of it as an entity which is being united as much by instruments, lines and devices as by more conventional political associations.[87] We might expect the technological unification of Europe to be a relatively unproblematic exercise. But, in practice, this isn't the case. While it has finally been possible to build the Channel tunnel, Europe can not be so easily connected together in other ways. The ends of Europe's technological

zones have been surprisingly difficult to define and police. And far from being established as a smooth technological zone, the boundaries of Europe remain internally and externally fractured. Technological edifices may need to be continually built and ripped apart. They are full of imperfections which may be noticed only when attempts are made to remove them.[88] Mrs Thatcher, who signed the Single European Act, which gave such great impetus to the harmonisation process at the end of the 1980s, thought she was ensuring that Europe would not be dominated by a huge central state and a large Brussels. At one level she was right. Brussels has not developed into a large bureaucracy. She, along with other European national leaders, ensured that the Commission remained small and could never grow to the scale of a national administration. But at another level she was wrong. For the strategy of harmonisation allowed the European insitutions to knit together, in an imperfect way, a vast array of quite diverse technical practices across Europe and beyond.

European integration is certainly an extreme example. It is an international political project in which harmonisation has been a central preoccupation. But if it is an extreme case it is none the less exemplary of the critical part played by technical standards in contemporary political and economic life. States are judged on the basis of whether they are able to meet certain environmental and safety standards. In recent years the British and Belgian governments have been engulfed by scandal because of their failure to regulate the production of food. Companies use and develop technical standards to create, however briefly, monopolistic positions in new technology markets. Consider, above all, the example of Microsoft. Political conflicts and international trade disputes develop around the form, scope, legitimacy and ethics of standardisation. Consider whether the arguments about whether it is possible, for example, for a government to prevent the import of Genetically Modified organisms because they fail to meet food safety standards? Or to restrict the import of commodities from factories which systematically exploit child labour? The process of standardisation is intended as a process of deterritorialisation in which the mobility of capital or labour is unimpeeded and across which uniform forms of social and environmental regulation are possible. But it is also a process which simultaneously forms new zones of control and regulation and creates new sites, objects and forms of political conflict.

4

ON THE NETWORK

A NETWORK SOCIETY

The network has become a critical term in contemporary political and economic life. Firms and bureaucratic organisations are reckoned to be increasingly connected through networks.[1] Scientific research is said to be conducted less and less in autonomous institutions of pure research or vast centralised public facilities, and more and more in collaborative networks which cut across the distinctions between the pure and the applied, the public and the private, the academic and the commercial.[2] The organisation of local and central government is said to take an increasingly network form.[3] Professionals no longer work within single organisations over long periods of time but manage a network of relations with many. Social movements and 'life-style' groups are thought to act as networks.[4] And technical devices from electronic personal organisers, to mobile phones, to the Internet are expected to help individuals and organisations to manage the networks they inhabit and create. How can we account for the prevalence of the network, as a metaphor and a model of individual and collective life today? With which political doctrines is it associated? What political problems is the term intended to address? What objects and agents does it draw together and to what purpose?

In responding to these questions this chapter develops three arguments. First, I argue that it would be a mistake to view the network as the symbol of a particular political project. For the network model has become common across a broad range of political opinion, and deployed in association with what might appear to be quite contradictory political strategies.[5] Networks are thought to provide, for example, the conceptual and organisational basis of a mode of government which does not

revolve around the opposition between the state and the market: the network is said to be both more organised than the market and yet less centralised and less bureaucratic than the state; thus providing an appropriate balance between control, commitment and flexibility.[6] They serve, whether for the post-Marxist 'left', for feminists or for management gurus, to define a form of organisation which avoids the old centralised bureaucratic models of the party, the trade union, the firm or the state.[7] Consider, for example, the development of a whole literature in management studies on the firm as a network organisation,[8] or the notion that innovation is the product of 'knowledge-creating network[s]',[9] or the disbandment of the UK communist party, and its refoundation as an agency for political networking. Or the stress placed on the importance of networks and networking for some intellectuals of the centre left or the 'radical centre'.[10] At the same time they provide a sense, for political scientists, of the intricacy of relations developing between different political actors in the context of new forms of national and transnational governance which cannot be captured in terms of the older concepts of state power.[11] Lacking any single meaning or reference, networks have a complex political function. On the one hand, both the model of the network and the instruments of networking can appear as merely technical solutions to the problems of government, which can be accepted or rejected on scientific or technical grounds and investigated using the methods of economic and political science. On the other hand, along with the notion 'community', the network has come to be seen by many to be the basis for a 'third way' beyond the opposition between statist social democracy and free-market capitalism.[12] Certainly, in referring to the model of the network, many authors wish to indicate a break with what are regarded as the old centralised models of commercial and political organisation and older collective models of society and class. Seen in these terms networks are markers of a 'new' politics; a new politics which is frequently associated with the new networked information and media technology. Networking is reckoned to be an economic and political imperative in the face of the double impact of new technology and globalisation.

Second, the extraordinary significance and prevalence of the concept of the network today cannot be accounted for simply by pointing to the existence of networks in the real world. For the function of the concept of the network is not merely 'cognitive' or representational; the use of the concept, and the various practices, social scientific disciplines, policies and technologies with which it is associated, entail an effort to reconstitute and reorganize the social field.[13] The discourse of networks and networking has a performative and technological as much as a representational function.[14] Networks do not so much reflect social, political and technological reality; they provide a diagram on the basis of which reality might be refashioned and reimagined: they are models of the political future.[15] Indeed, the prevalence of the network effects a transformation in those objects which have always been thought of as networks. A mobile telecommunications or computing network may function as nothing more than an instrument for long-distance communication and control. But when understood as part of a 'network society', a 'networked firm', or a 'networking organisation', the same technology is reckoned to be the basis for a whole new social or political order. The shift in the political connotations of technological devices is often signified by the invention of further concepts such as teleworking, 'the virtual society', e-commerce or cyberdemocracy.[16]

Third, although the common use of the network model is indicative of an extraordinary political preoccupation with new media and information technology, it would be wrong to assume any simple one-way link between the development and use of new technology and the use of the concept and the model of the network. Indeed, as we shall see, the model of social and political networks (of kinship and patronage) may equally inform our models of media and information technology. The social acts as a metaphor and a model for the technical as well as vice versa.[17] Michel Callon, John Law and Arie Rip have defined the notion of *problematisation* to be 'a form of translation that posits an equivalence between two problems that require those who wish to solve one to accept a proposed solution for the other'.[18] A key part of the attractiveness of the network model is the way that it can *simultaneously* serve as a response to two intersecting problematisations of the present. On the one hand, networks, conceived of as technologies, are thought of as solutions to a whole series of problems concerning the fragmentation of communities, the problem of empowerment, the decline in democratic participation[19], the crisis in scientific and technical literacy,[20] and the need to foster new forms of entrepreneurial activity and freedom.[21] On the other hand, networks, conceived of as social and political relations, are reckoned to be solutions to many of the economic problems of society such as fostering a culture of invention and innovation and meeting the challenges of globalisation. In this view, the development of a 'network

society' or a 'network state' is an appropriate and functional response to the demands of an information and knowledge-based economy. Many of the conflicts over the significance and function of the network model cannot be understood in terms of a political conflict between 'right' and 'left'. Rather, they are conflicts between different problematisations of the relations between 'technology' and 'society', and alternative understandings of the complexity of these relations.

The remainder of this chapter is in two parts. In the first part, I examine how the idea and the model of the network has been developed in the institutions of the European Union. As we shall see, the model is both a technological one (conceived of as a solution to social and political problems) and a social and organisational one (which is represented as a solution to the problems of an innovative and technological economy). In the second part, I examine how political opposition to dominant formulations of the network model within the Commission bureaucracy has invoked understandings of socio-technical networks which cut across the distinction between the 'social' and 'technical' senses of the term. In sociology and political science, the concept of the network is often used as a purely analytical device. Here we see the notion of the network in an *impure* form, enmired in current political controversies, and subject to conflicting uses and interpretations. The analyses of networks developed by economists, political scientists and sociologists themselves play a significant part in the struggles to define what Europe is to become. The social sciences play their part in helping form the object we wish to analyse.[22]

PARTNERS

The network has become one of a number of dominant terms in contemporary political discourse in the West, but there are specific reasons why it should have particular resonances in the European institutions. One was the way it came to be seen as a response to the dominance of neo-liberalism during the period of the single-market programme which had led to the intensive programme of harmonisation discussed in the previous chapter. In the Commission President Jacques Delors's own response to the neo-liberalism of the 1980s, the 1993 white paper on *Growth, Competitiveness and Employment*, great stress was placed on the political and economic importance of so-called network industries such as telecommunications, energy and transport, the construction

of which required coordinated action at a European level.[23] This was a traditional sense of technological network which, since the nineteenth century, had provided a justification for action by the authorities in the national and international public interest. Europe, in this view, required an information and communication infrastructure – an information motorway – in a way which was analogous to the national public interest in the telegraph and railway networks of a century earlier, and which also would be able to compete with information superhighways of North America.[24]

But elsewhere the idea of the network was used in quite different ways and referred to different objects. For, in the European institutions, it also came to signify decentralised forms of organisation and intervention which were less organised, and yet more coordinated than the invisible hand of the market. A network in this sense was a more or less loose socio-technical association, not a technological infrastructure at all. To participate in this kind of network required *partners*.[25] The metaphor of an unformalised marriage is an appropriate one. For, operating as if it were a huge dating agency, the European Union sought to provide the conditions and resources within which persons and organisations can get together with others. Networks were formed amongst professionals and practitioners and supported by programmes with names like MEDIA, MONITOR, ESPRIT and SCIENCE. Such networking activities did not provide large levels of financial support to participants but they were expected to create more or less loose associations of experts who would meet, collaborate and participate in the development of European projects.[26] Partners could be found on the World Wide Web through a computer database, arranged via a specialist partnership agency, fixed by Commission officials, or encountered at European 'Information days' in Brussels.[27] Europe provided the framework and the rationale for such cosmopolitan relationships to develop. There was a sense in which the network was used in the European Union as a way of both transcending the political conflict between social democracy and neo-liberalism, and as a way of developing a form of public intervention which would animate social and economic actors instead of creating a dependent or protective relation between the state and its clients. They were, in this sense, an instrument of what Jacques Delors called, drawing on the theoretical vocabulary of Jacques Donzelot, an 'animator state'.[28] Networks were reckoned to be particularly important both in innovative and 'information intensive' industries such as human genome and climate research,

as well as those industries, such as film, which had become dominated by what some had called a 'subsidy mentality'.[29] In short, they had a central role in fostering a more innovative culture in Europe.

There were sceptics, and anxious onlookers. The British Prime Minister, Mrs Thatcher had once confided her concern to European Parliamentarians about the promiscuity of European contacts, and the dangers to health that this posed in the era of AIDS.[30] But the enthusiasm for networks and networking in Europe was enormous. By May 1994 it was possible for a European Commissioner to announce that the notion of the 'network is the underlying principle of the Commission's activities in research and technology'.[31] At this time little was known about how such 'networks of expertise' worked or whether they were effective in achieving the goals that were set for them, or whether they corresponded to the kinds of informal networks increasingly subject to the investigations of sociologists and management scientists.[32] Moreover, despite the centrality of technical harmonisation to the European project, discussed in the previous chapter, there was little attempt to coordinate harmonisation policy with the rapidly developing support for networks or to justify support for networks in terms of the demands of the broader policy of harmonisation.[33]

A second reason for the dominance of the network model in Europe was the way that it made it possible to rethink the political structure of Europe. For it suggested, for some, the possibility of an ordering of political space which bypassed the nation-state. In effect, by becoming part of a network an entity (firm, device, person, region) might, in principle, become 'European' without first having to locate themselves in a national context. This was, and remains, of considerable importance. For, according to the Maastricht treaty on European Union, the division of powers and competencies between European and national institutions was determined by the concept of subsidiarity. In the formulation of the principle provided by Altiero Spinelli: 'The Union only acts for effecting tasks which may be undertaken in common in a more efficient way than if Member States were to act separately'.[34] The principle is open to negotiation, depending upon whether it is viewed largely as a restriction on common action, or a statement of when common action might be necessary. For many in the Commission it suggested the latter. Whereas for others, it implied that the Community's powers should be restricted considerably, as there was little that the Community could do, apart from establishing the framework for a single market. By revealing and supporting networks this argument could, however, be subverted. For by cutting across national boundaries, networks formed new entities which could not be encompassed by the territory of any one nation-state. Thus, the network model could displace the territorial model of sovereignty.[35]

The third reason for the dominance of the network model was the increasing importance of a certain view of the 'information society' in the European Commission.[36] The notion of a European 'information society' was elaborated in a series of documents in the early 1990s. In these accounts, notions of information technology, industrial and administrative decentralization, interactive organisational structures, human potential, the idea of the 'European information society' and accounts of European history were articulated into an single political project.[37] In the Commission's view the world was in the midst of an epochal historical movement which would have revolutionary consequences both at the level of the individual, and at the level of the state. For the individual, human relations were being transformed. At the same time, 'hierarchical and linear empires are gradually giving way to interactive organisations' and 'decentralisation'; an historical movement 'supported by the new technologies'.[38]

The emergence of such a society was inevitable according to the Commission, but why should this society be *European* rather than national or global? The political forces surrounding the European institutions pulled in a number of different directions and several justifications emerged. One was that the direct link that was thought to exist between the formation of information technological zones and the creation of a political community.[39] The new information networks would be, it was argued, the perfect material infrastructure for a European society of consumers and citizens, increasing the density of flow of information and services, thereby creating 'a more caring European society with a significantly higher quality of life and a wider choice of services and entertainment'.[40] The risk, according to the Commission, was that only some individuals would wish, or be able, to participate in the information society. Training would be required to transform non-participants in the information society into participating citizens. Individuals had to be convinced that the advent of such a society would transform Europe into a dynamic culture. To support this, the creation of a European information infrastructure would unleash 'unlimited potential for acquiring knowledge, innovation and creativity'.[41] Information technology, coupled with training, would foster the formation of an

active European citizen.[42] In this way, information technology was at the centre of a broader vision of Europe's future. For with a shrinking proportion of the planet's population, and a high cost workforce, the European economy would have to compete on the basis of its 'added value'. Europe would have to be a 'knowledge-based' economy and a 'knowledge-based' society.[43] As participants in such a society Europeans would need to be continuously up-dated and retrained.

A second dimension of the Commission's project for the European information society marked a more complex departure. Up until the 1980s the European institutions' concern with the existence of social and cultural differences had been limited, articulating a commitment to diversity, but in reality doing little to support it. The role of the European institutions was to reduce difference, eradicate barriers, even if this meant restricting the flow of commodities and persons from outside of Europe. In these circumstances, 'cultural diversity and heterogeneity have been circumscribed by the forces of centralisation, standardisation and unity'.[44] Indeed, inside the Commission, the idea of 'unity in diversity' had moved, according to one observer 'from optimistic ideal to virtual self-irony'.[45] As we have noted, culture was considered marginal to a political project built around legal regulation and economic and technological harmonisation. Within the European institutions, cultural policy remained impoverished and underdeveloped.[46]

Increasingly, however, the Commission's position became more complex, if not contradictory. In relation to technology, 'diversity' was, at least in principle, considered a resource as much as a problem. It was something that the Commission should promote and not just reduce. After all, it was part of the essence of Europe that it was diverse, and part of the role of the European institutions to foster and develop this diversity in so far as it was valuable to do so. According to the former Commissioner for Research and Education, Antonio Ruberti, 'although it is a handicap in some respects, for the most part European diversity represents a trump card'.[47] The new concern with diversity was, moreover, in the Commission's public view, intimately connected to the convergence of the media, telecommunication and information technology.[48] Articulating a mechanistic view of the consequences of technological change, the Commission's public prediction that the development of the new communication networks would serve to support rather than to threaten cultural diversity. Europe's regions 'can expect', the Commission stated confidently, 'new opportunities to express their cultural traditions and identities and, for those standing on the geographical periphery of the Union, a minimizing of distance and remoteness'.[49] In this problematisation, the development of networked information and media technologies would become the solution to the absence of a sense of a *European* community.

MILITANTS

There are many specific different stories that could be told about networks and networking in Europe today. One might write, for example, about the mismatch between the image of a fully networked Europe and the implementation of Trans-European Networks in different settings, or the ways in which European collaborative research networks have developed in practice. I want to tell one specific story about networks – about a particular part of the European Commission's bureaucracy in Brussels, a section (Directorate A) of DG-XII (the Directorate General for the Science, Research and Development)[50] which, when I visited it in 1994–95, was devoted to research strategy and supporting measures: 'which basically means studies, evaluations, reports and foresight studies and so on'.[51] Here, the idea of the network figured as one element of a broader story told by some researchers about the complexity of science, technology and their relations to the economy. For some in DG-XIIA the assessment of science and technology policy was necessarily a complex matter and talk about networks and complexity figured in opposition to two reductionist ways of talking about the value of technology that were common in the Commission and elsewhere. On the one hand, an assessment of the value of technology should not be reduced to a consideration of the technical quality of the scientific or technical work (and therefore left to scientists themselves). Value was always something more than a technical matter.[52] On the other hand, it could not be reduced to a consideration of market value, and therefore assessed in narrowly 'economic' terms. It had to involve, amongst other things, a concern with societal needs, with geography, with regulation, with the role of users in innovation, and with the details of technical design. In this view any assessment of the value of technology was potentially open-ended. This was a view which opposed the ideas that 'technology', 'economy', 'management' and 'society' were distinct fields. The details of scientific and technical practice were themselves matters of managerial, social and economic importance.

Bureaucracy may be an inappropriate word to describe some of the work of Directorate A, if by bureaucracy we mean an organisation which is governed by a commitment to political neutrality and the impartial execution of formal procedures. For at least a few members of this Directorate did not identify themselves as bureaucrats, but as intellectual outsiders seeking to act on the workings of the Commission from the inside, through the deployment of expertise. One researcher, who worked for a unit called FAST (Forecasting and assessment of science and technology) in DG-XIIA had been interested in labour-process theory, in Gramsci and in ethnomethodology. He expressed his institutional position in the following terms: '[Individually] we have an awful lot of autonomy, which makes it important for us to go through the whole hierarchy and especially to jump between institutions and promote the viewpoints of each of us [in FAST]. We have our own networks, and we write our syntheses and we promote our own recommendations for Community policies ...'[53] Another senior figure's intellectual and political position derived, in part, from Marxism and systems theory, but was also, in his view, comparable to the position adopted by some scientists. FAST was a 'scientific militant about the human and social utility of science ... a scientific militant like Prigogine is [a] militant for the new alliances ...'[54] Its function was to open up controversy about the social dimensions of science and technology in the Commission and to conduct a 'resistance' against dominant positions including, above all, the 'competitiveness ideology' which conceived of the function of scientific and technological activity in narrowly economic terms. Elsewhere in the Commission the role of the intellectual existed even at the highest levels of the organisation. A senior official in the research unit working under the then Commission President Jacques Delors, the Cellule de Prospective, suggested that his group functioned as an intellectual animator operating through inter-service discussion groups which cut across the formal boundaries of the Commission bureaucracy.[55]

The sense of 'militancy' and autonomy of FAST and the Cellule and their commitment to certain intellectual doctrines was, as Pierre Bourdieu would say, a strategy of social distinction within the Commission bureaucracy.[56] It allowed them to take a long-term view of the significance of their work. But it was also intended to have effects. The proposals and research reports written by DG-XIIA did not function just as a form of legitimation, nor were they merely ideological or 'intellectual'. They were intended to bring the 'social' and the 'technological'

elements of the European project together. Although the members of the Cellule and FAST did not consider themselves future researchers they were concerned with *la prospective* – an orientation toward the future. But what was the justification for the particular orientations they adopted? What problems did they pose and what were the problems that an attention to the complexity of science and technology might be expected to address?

Bruno Latour has written of the perfect symmetry between the dismantling of the Berlin Wall in 1989 and the first conferences on the global environment in the same year. Both indicate a need to rethink the binary oppositions which informed the twentieth century political imagination: between nature and culture, between the material and the social, and between liberal market economies and state socialism.[57] This observation had some resonances in the European Commission. For one justification for the need for work on the complexity of science and technology was the structural position of the European Community itself – or rather its *shifting* position in the New World Order. One DG-XIIA official, Jean, framed his understanding of the position of Europe in terms of an historical sociology which explicitly drew on the actor–network theory of Bruno Latour and Michel Callon.[58] The problem, for Europe, in his view, was to replace the highly organised network of allies created in the period after 1945, by a much more complex set of connections demanded by a new historical situation. Science policy was, in his view, not so much about taking decisions but, in actor–network terms, mobilising alliances to take account of new social and environmental realities. In this context, science policy had to be seen as a *process* of reconstructing networks – a process of reordering – not a decision which somehow determined how everything else should develop. He expressed his view of the changing position of Europe in these terms:

Jean: ... I would say the decision [about science policy] is not a decision, it's how you can make so many allies, and this process [in Europe] which has been very successful up to now, is maybe less successful right now ...
Andrew: So how have the allies been created or mobilised in the past?
Jean: One of the major solutions was the East–West direction. The second one was space. And the third one was with the help of a strong national industrial policy: big support and organisation of market and prices. So you could recover a high investment in all these cases quite

> easily. Today, things are moving. Things are more complex. We are not in a protected market ... we're losing allies, [but] we still have a budget and the solution will be how we will adjust to globalisation [and] the interaction of many more actors in the process, societal needs and so on

But if the European Commission had to confront the complex reality of Europe in the period after 1989 it also had to confront the legacy of its own institutional and technological history: the marks and residues left by earlier interventions. Historically, the European institutions had once displayed a remarkable commitment to nuclear power in general, and nuclear fusion in particular. Indeed, the Commission's own laboratories, run by DG-XII, had once been primarily devoted to civil nuclear research.[59] For in terms of the emerging interest in Europe in the complexity of the social and the technical, such a commitment was misguided. For nuclear-fusion research was highly centralised, and the generation of power by nuclear fusion, if it ever proved possible, would necessarily be concentrated in a few facilities. Michel Foucault had once noted that social and political thought had yet to cut off the king's head. But in political terms, nuclear fusion was undoubtedly an absolutist solution: a technology in which all power flowed from a central source, *outwards*. It was the antithesis of the kind of politico-technical regime favoured by the proponents of complexity in DG-XIIA. One FAST researcher expressed the opposition between the economists and sociologists of DG-XIIA and the view of others in DG-XII thus: 'None of us love nuclear power. You will find people here [in DG-XII] that live for nuclear power or for big machines: they find them beautiful. Technology can have that fetish aspect ...'[60] The problem, however, was not just one of fetishism. The fixation of DG-XII on *advanced* technological research could lead to neglect of the different ways in which technologies may be used, and a neglect too of the more mundane but perhaps more critical role of technical standards and regulations to the European political project.[61] While the European Community was committed to harmonisation, its research programmes were not necessarily oriented to the pursuit of this objective or, if they were, it was sometimes in an inappropriate way.[62] In effect, there was a disjuncture between the technological project of European integration which had, as we have seen, come to involve the harmonisation of a whole series of mundane and technical instruments (such as procedures and devices for

assessing the safety of toys, or the quality of river water), and the direction of research policy which had been geared towards the development of the most prestigious and most 'advanced' technologies.[63] In Raymond Williams's terms there was a conflict between an *emergent* culture in the Commission, which emphasised the complexity of any proper socio-economic evaluation of technology, and a *dominant* culture which stressed the values of technological innovation and competitiveness above all else.[64]

In this situation, part of the problem confronting those in favour of change was the problem of changing the culture of commitment inside the Commission to such absolutist technological solutions – whether based on nuclear power or on more recent information and environmental technologies. Indeed, many Commission intellectuals and social researchers saw themselves opposed to the dominant view of officials working for DG-XII. '... for the mainstream in DG-XII believes that research on the environment should be restricted to its technological aspects'.[65] While they worked on quite specific research projects – such as examining the current state of biotechnology research in Europe – they also had a broader agenda. One which was both political and intellectual at the same time. In theoretical terms this was expressed in terms an opposition to the linear model of innovation: the idea that new products resulted from innovative technology, which in turn resulted from advanced scientific research. One framed his critique of the reductionism of the linear model by reference to the work of evolutionary economists, such as Christopher Freeman and Luc Soete: 'So now we come to a more complex view of research where there are a lot of mediations through which research can influence economic and social welfare. So it makes us more modest, if you want and it leads us to look more at the use of technology; the way that technology is incorporated into the organisational framework of companies and public institutions'.[66] Not Big Science but modest science.

The need for more attention to the complexity of the social and the technological could be further justified by a consideration of Europe's diversity. The notion of 'unity in diversity' had always been, as we have noted, a key feature of the rhetoric of European integration, but one which was not worked through in the development of policy. But an attention to the complexity of technology suggested a way of reworking the notion of diversity in a more productive way. On the one hand, the idea of a common European policy failed to recognise that research

programmes, industrial policies and technical standards simply do not have the same implications in different places. The ideal of a common policy was not sufficiently sensitive to the fact that policies and instruments have to be adjusted, to take account of the diversity of different regions and actors, and their autonomy, and to value it. It was 'paradigm shift to go from European integration despite our diversity to European integration because of our diversity'.[67] There was a clear connection to be made here for one researcher between a sociology of local actors and a reformulation of economic policy in terms of regional networks and local actions.[68] He commented:

> If you look at internationalisation and globalisation and so on then the autonomy [of different actors] is very limited ... I turn this round and say I'm not interested in globalisation and so on. Of course [such forces] influence price levels, technology and so on ... but what's interesting is how local actors or regions manage their actions within these frames. I'm Mister Bottom Up.[69]

Indeed, the diversity of Europe was one of the conditions for the emergence of the idea of the network and the new concern to bring social questions into the development of technology. Above all, it was the work of members of the Commission on the diversity of Europe which acted as a stimulus for the Community to come to realise the need 'to develop technology to meet diverse socio-cultural needs'.[70] In developing this new way of thinking, the work of DG-XIIA on socio-economics of technology was no doubt important, but it was but one input of many. *Experience* may have been just as important as *expertise*. One member of the Cellule de Prospective reckoned that the notion of the network and the concern with the importance of diversity derived as much from the experience of the Commission in regional and social policy, and in particular the work of a person in DG-V (Employment and Social Affairs) monitoring Commission programmes in relation to the issues of poverty and the family.[71] It seems that the notion of the network had simply become too pervasive in the Commission to be owned by anyone, or tied down to any one particular sense or point of reference, or to have simply one point of origin. As we have seen, for the European Commissioner responsible for Research and Development, Antonio Ruberti, the idea of networking had become the principle governing all of the Community's research activities.[72]

On the other hand, there was the issue of *scale*. Europe has always been thought to be bigger than any of its individual constituent member states – a *supra*national political entity, a *federal* political system, a *super*-state. Increasing the scale of Europe was an ambition, even if at the same time it generated hostility and anxiety from those who viewed this enterprise as a threat to local cultural differences. The concept of *subsidiarity*[73] set down in the Maastricht Treaty on European Union stipulated that the European institutions should only do things which could not be carried out effectively by the member states acting on their own. Without doubt the principle could be interpreted in different ways implying different accounts of the relation between the functions of the Community and the functions of the member states. It could suggest, for some, that the nation-state should be, and would continue to remain, at the centre of the European political system.[74] Europe was, in this view, a space marked and divided territorially.

But when seen in terms of networks, this vision could be radically changed. For a network could both cut across national borders (and hence be 'European') and yet, in containing only a few elements, be much more *localised* than any nation-state. The point is made by Marilyn Strathern: 'networks can take any scale – have the power to cross different organisational levels – precisely because each relation invokes a field of embodied [social] knowledge about relationships'.[75] Seen in these terms, spatial differences can be collapsed, and reworked. Indeed, for the intellectuals of FAST and the Cellule, the notion of the network offered a more profound account of subsidiarity than the one entertained by the heads of the member states at Maastricht. For it implied that the European Union could, in some circumstances, operate at a lower level than the national governments.[76] In comparison to the European networks identified through socio-economic research, individual nation-states could be both bigger and less well integrated. They were geographically extended, but not necessarily internally well connected. Research on the sociology of local industrial networks suggested there was sometimes a greater connectedness across national borders than within the territorial boundaries of nation-states. The structural analyses of systems theory suggested a similar view, if for different reasons. A senior figure in FAST put it thus:

> We have to get away from the linear and hierarchical model of the in-
> franational, subnational, national and international and so on. To my

> mind there are now five major spatial and temporal systems [the city, the region, the national, the regional–continental and the global] which are not in a linear–hierarchical top–down or bottom–up relation to each other – they are overlapping using different temporal scales and different systems and connections.[77]

Despite the remarkable attention paid to socio-economic accounts of technology in DG-XIIA and the Cellule, it would be misleading to suggest that they had a straightforward 'impact' on technology policy. After all, the documents coming from the research units and think tanks were only a small fraction of those that came across the desks of those officials given a responsibility for drafting or editing. All too often the interventions of the intellectuals came too late, or in an inappropriate form or language to influence debate at critical points. Or they were pitched at an extraordinarily abstract and general level. At a FAST conference held in Wiesbaden in 1993 a remarkable attempt was made, involving a hundred researchers over the space of three days, to condense the results of a vast body of research on the complexity of the global technological and economic system into five short 'bullet' points which could be presented to the Commission later that summer in an effort to influence policy.[78] The notion was that only if arguments about the complexity of technoeconomic systems were put in a simplified form would they have any chance of convincing senior political figures. This particular effort failed.[79]

Some people were clearly more successful or more skilled than others in developing the informal personal connections within the bureaucracy necessary for their work to have any chance of being translated elsewhere.[80] One university economist who had carried out contract research for DG-XII thought that his work on technology was influential because, through his father's acquaintance with Jacques Delors, he had managed to get the Commission President to sign a short preface (which he had himself written) to the book deriving from his work. He reckoned that my concern with political rationality and technology was naive in failing to address the importance of familial and social connections; a reflection of the (British) belief in the real existence of disinterested bureaucratic administration.[81] I had to agree. In any case, whatever their success in being heard or read, the degree to which officials' and researchers' projects could be turned into action was necessarily limited given the strength of earlier commitments and other alliances made by

the Commission: 'with time you have obviously many more people who have a vested interest in the ongoing actions and it's much more difficult to change the system'.[82] The Commission militants sought to effect a radical reworking of the idea of the network, but they were realistic about their possibilities for success.

A NETWORK STATE?

In the third volume of his recent study of the *Information Age*, Manuel Castells writes of the European Union as 'a network state'.[83] His argument, which draws on the work of international relations theorists, is an explicitly functionalist one. Europe has become a network state, he argues, because of the need to accomodate various centres of national and regional political authority across Europe and, at the same time, to respond to the forces of globalisation. 'Available evidence, and recent debates in political theory, seem to suggest that the network state, with its geometrically variable sovereignty, is the response of political systems to the challenges of globalization. And the European Union may be the clearest manifestation of this emerging form of state, probably characteristic of the Information age'.[84] Elsewhere, in his three-volume study, Castells is clear that the study of technology cannot be separated from the study of society: 'since technology is society, and society cannot be understood or represented without its own tools'.[85] The point is an important one; yet when he comes to the study of government, Castells conceives of networks as purely organisational and political, and as distinct from technology. The organisation of Castells' (European) 'network state' is a reflection of the forms of technological connection he finds elsewhere. Despite his own insistance that information and communication technology play a central role in political and economic life, Castells' 'network state' is a purely 'social' organisation, devoid of any technological elements. Thus, the notion of the network has a double function in Castells' analysis. On the one hand, information and media networks have played a central role in contemporary forms of economic and social restructuring: 'particularly important was the development of networking as a dynamic, self-expanding form of organization of human activty'.[86] On the other hand, political networks (conceived of as ways of sharing sovereignty) become part of the solution to the problem of globalisation, which is itself partly a technological one. Despite his continuing insistence on the importance of technology to economic and

political life, Castells splits off his analysis of politics and government from his account of technology. In Castells' account, technology and government are bound together by a functional interdependence.

In chapter one, I have already suggested why we should be cautious about using the metaphor of the network in talking about both politics and technology. However, Castells's analytical strategy is interesting because of the way that it replicates the functionalism and technological determinism of the dominant political discourse of the European institutions. In Europe and elsewhere, it is thought that the development of networks of media and information technology will solve many of the problems of democratic participation, community and empowerment. At the same time, social and organisational networks are reckoned to provide the basis for the formation of a more enterprising, innovative and competitive technological culture. Europe is not a network state. But the European Union is a political institution in which the model of the network has come to provide a dominant sense of political possibility. As we have seen, internal political opposition within the European institutions does not necessarily contest the importance of the idea of network. It has instead sought to rethink the idea in a way which cuts across the distinction between the technological and the political senses of the term, and introduces a sense of the irreducibility of problems to either 'political' or to 'technical' solutions and the complexity of the spatial forms generated through the development of technology. While I remain sceptical of the value of the network metaphor, given the way that it has become so closely associated with a certain view of new media and information technology, I remain indebted to the Commission militants' sense of the complexity of European space.

MISCONNECTIONS

The various projects of technical harmonisation and the diverse European network programmes are united by a similar ambition. In this ambition Europe is to become a more or less homogeneous set of technological zones which both maximises the mobility of persons, skills, technical procedures and scientific objects and intensifies the density of technological connections. In practice, this 'European technological zone', in so far as it can be said to exist, is far from homogeneous and well connected. First, as I have noted above, there is only a limited degree of coordination between the 'harmonisation' and 'networking'

policies of the EU. In these circumstances, one should expect that the kinds of technological zone formed through harmonisation and networking will have quite different forms, and will not necessarily be mutually supportive. Second, as I have argued in the previous chapter, harmonisation is, and is likely to remain, an imperfectly completed project. Aligning the different regulatory and scientific practices current across Europe is extraordinary difficult. Third, if 'the European technological zone' works imperfectly within the territorial boundaries of the members of the EU, it also extends beyond these boundaries. Firms and governments, whether in Korea or Turkey or the United States, who wish to do business with Europe are drawn into the web. At the same time, 'Europe's' technological zones may become more or less integrated into larger US, Japanese or global configurations.

In the next chapter I introduce a further complexity to this image of European technological zones. This is the institution of intellectual property rights (IPR). In a capitalist economy, the acquisition of IPR is of one of the key ways in which innovative activity is rewarded. IPR allow the formation of privatised technological zones, access to which requires payment. Yet as we shall see, there is a tension between the development of research networks, technical harmonisation, and the establishment of a stable framework on which to base claims to intellectual property rights.

5

INTELLECTUAL PROPERTIES

AN INVENTIVE SOCIETY

European scientists and engineers, it is often said, are very good at invention; less good at protecting and exploiting what they have invented. Europe should be both guilty and proud. Proud of the number of the Nobel prizes that have been won over the years. Guilty about the technological failure of some of its industries.[1] This common moral tale says a great deal about the importance of intellectual property in a technological society. Inventive activity has a critical place in accounts of what it is to be European. And Europeans reckon that their inventive activity should be rewarded in the future.[2] Invention is considered an investment, and the claims to intellectual property protect that investment. As such the notion that there are *rights* to intellectual property (IPR) has had a economic and a moral justification.[3] The economy benefits due to the moral activities of its individual members. In these circumstances, the acquisition of intellectual property is an increasingly key objective: whether for the industrial corporation, the nation or the university laboratory.[4] In the nineteenth century, a measure of population was often used as an indicator of national well-being.[5] By contrast, today, measures of research and development activity, innovation and intellectual capital have been turned into one of the clearest indicators of the health and creative productivity of the economy.[6] The failure to be innovative, and hence the failure to modernise, is a moral one. Measurement of innovative activity serves to reveal the failure, and establish a basis for its solution.[7]

Of course, along with other claims to property, claims to intellectual property circumscribe the conditions under which others have access: ordering and reordering technological connections and borders; establishing what can be used where, by whom, and in what situations. Rights

of way are restricted. Paths are blocked. Technological zones are established, and given the legitimacy and protection of the law. In principle, it should only be possible to copy or use something which is owned with permission. In practice, others must pay for use, or work out some way of evading such claims and border controls. This is an era of gate-crashing and piracy, hacking and cloning, encryption, cyber-crime and patent protection.[8] Gaining, protecting and evading claims to intellectual property is a business practice, and the successful acquisition and defence of intellectual property is of critical economic importance to the dynamics of inventive industries such as media, pharmaceuticals, biotechnology and software. At the same time, the protection of intellectual property is reckoned to be central to the economic well-being of technologically developed societies threatened, it is thought, by the cheaper labour costs of their developing competitors. Certainly, policing intellectual property rights has become a major concern for developing organisations of international governance. And extending the reach and effectiveness of intellectual property law has become a significant element of US and European foreign policy. According to one witness in a House committee hearing on intellectual property law held in 1980, 'innovation has become the preferred currency of foreign affairs'.[9] Sandra Thomas confirms the point: 'the US grants favoured trading-status only to those nations which have comprehensive intellectual property protection ... pressure has been applied in the form of retaliatory tariffs on imports from [those] countries [that do not have such protection]'.[10] For the World Intellectual Property Organisation (WIPO), 'the patent system is the ultimate means to disseminate technology'. The industries of less developed countries are enabled to adopt, and to benefit from, Western technologies, but not to copy them for free. Such industries have to exercise a trade-off between being able to produce goods cheaply, without having to pay the costs of licensing, and having better access to Western markets and capital. Through such pressures, the patent and copyright system may be gradually extended, thereby forming, in principle, although not yet in practice, a global legal–technological zone.[11]

This brief introduction suggests why intellectual property rights have come to be so central to government of a technological society. On the one hand, the acceptance of the importance of intellectual property rights is reckoned to be both an imperative and an incentive for those who wish to be part of an innovative culture. On the other hand, the acquisition

and contestation of claims to intellectual property has become a central part of business strategy.

If intellectual property rights play a key role in the government of a technological society, they should not be thought of as something like a stable legal framework. The ends of the technological zones associated with intellectual property rights may be difficult to define, stabilise and police. The terms in which claims to intellectual property are made may often be undermined, and may be forced to change. Marilyn Strathern has written of the ways in which Western notions of intellectual property are problematised in their encounter with Melanesian culture, with its different sense of 'persons', 'artifice' and 'nature'.[12] In this chapter, I argue that the basis of intellectual property claims may also be destabilised through political and technological developments in the West.

The chapter revolves around two arguments. The first one is about intellectual property in general. Claims to intellectual property involve a categorisation of both an (invented, created) object and a subject (owner, inventor, author). They imply a distinction and connection between the two. The social subject forms or invents the technical object which, as a technical object, is thought to be distinct and separable from the social circumstances of its production. Thus, the connection between the object and its origins needs to be asserted, but it must also be, in a certain sense, denied. Those who make claims to intellectual property must demonstrate a point of origin. Yet it must also be possible to use and to replicate the object in other places. In this way, objects can be exchanged and treated as property; in some cases as a commodity. Establishing claims to intellectual property involves work: the work of forming, separating and making connections, and distinctions, between social subjects and technical objects.

But, in so far as IPR relate to *inventive* or *creative* activities, claims to intellectual property may also be problematic and contestable. For in inventing new objects it may also be necessary to invent new kinds of *subjects* of rights. Who or what the social subject of invention is may itself be up for grabs. It may not only be possible to contest whether the object is novel – and the result of the work of an individual subject (whether this subject be a person or a firm, for example). It may also be possible to contest the classification of the subject as an appropriate subject of rights. To what extent can the categories applied to the subjects of intellectual property rights (authorship, invention and so on) be reused in different situations? On what basis, and with what economic and

moral justification, is it desirable that new technical objects should be considered as properties to be exchanged and bought and sold? How is it possible to reconcile the economic or social justification for intellectual property (private intellectual property is a public good) with a natural and 'moral' justification (an author has natural rights to the products of his or her creative activity)?[13] Consider a number of contemporary examples, some of which I discuss in further detail later. Is writing computer software a form of authorship, or does it involve design or invention? Is it desirable for intellectual property claims to be made in relation to so-called indigenous knowledges?[14] How is it possible to define the subject of rights within the context of a complex division of labour? And should it be possible to claim ownership over parts of the human body, or sequences of the human genome? Intellectual property, a field of extraordinary technical complexity, is potentially a fertile zone for political controversy.

Intellectual property rights are said to exist in order to secure the future of an inventive economy and a creative society. But what if that society and that economy are themselves being invented? What if the political as well as the technical order are in a state of flux? The second theme of this chapter is the intersection between the problem of defining intellectual property rights and the development of technical standards and research networks. The intersection is a complex one, appearing in different situations, and constantly changing. In this chapter I focus again on the European Union, although similar arguments could be made in relation to other global international organisations. Here, I argue that the European Union cannot be seen as something like a 'political and economic order' *within which* the development of intellectual property rights occur. Rather, Europe is, as we have seen, something of a technological invention itself; still in the *process of ordering*.[15] And intellectual property rights themselves play a critical part in the invention of Europe and in the constitution of the European Market. Conflicts and controversies over what intellectual property rights are, and what they can be applied to, are also controversies about what Europe should become and what form of unity it should have. Consider, for example, the debate over the design of patent protection in the EU. Seven years after the so-called 'completion' of the Single European Market in January 1993 there remained no common Community Patent.[16] In these circumstances, patentees are required to pay substantial costs to translate patents into the different languages of the Union, and it has been quite possible for

national courts to come to different rulings concerning infringements of the 'same' patent.[17] A Community patent would be economically desirable for patentees, dramatically reducing the costs of translation, and increasing the effectiveness of the law in protecting their rights. It would, however, serve to undermine the principle that citizens should be able to have recourse to the law in their own language.[18]

Similar arguments could be made about the global economy and the formation of a global regime of intellectual property rights. Conflicts and controversies over what intellectual property rights are, how they should be established and policed, and what they can be applied to, are also controversies about the organisation of the global economic and political order. I return to the issue of globalisation later. Here, however, I focus on Europe, and take three case studies. The first, computer software, raises questions both about the instability of the categories of intellectual property law, and their effectiveness in relation to a particular medium. The second example, human-genome research, raises questions about the relation between intellectual property and ethics. The third example, basic research in high-energy physics and X-ray astronomy, demonstrates how, even in non-commercial fields, the development of European scientific networks is bound up with transformations in IPR. In all three cases, the development of IP produces new subjects of rights, but also new objects of rights. The notion of IPR is much more than a legal or administrative frame within which innovation occurs. It is associated with the formation of new subjects and objects of innovative activity.

WRITING SOFTWARE

Computer software has always had an uncertain and problematic status in the law. Intellectual property rights over technology have historically been governed by patent law. Patents protect inventions. However, there has been reluctance to accept that patent law could ever be applied to software.[19] A computer program has been regarded as a way of issuing instructions to a machine, which itself can be the object of a patent. Intellectual property law is framed around an opposition between objects and techniques which may be *invented*, and immutable literary or artistic works which may be *created* and inscribed. In effect, the application of patent law has tended to assume that technology had to be something like a physical object or a technique.[20] Yet in its immateriality, mutability and technicality, computer software operates across and outside the

terms of this opposition, making legal attempts to fit it either into the category of technical invention or 'literary work' problematic, both in principle and in practice. So if software is not a machine, can it be conceived of as a literary work and hence governed by copyright? Perhaps. But only after some considerable modifications are made to many of the basic assumptions underpinning the idea of the literary work. And even then the law may not be effective.

Consider three problems. First, there is a problem about the *originality* of software. What makes software original, and hence the possible object of IPR?[21] In this respect there has been a difference between different national legal systems. In UK law, the term originality simply meant that a text has not been copied, whatever its actual merits. In France, by contrast, *orginalité* has been taken to imply some individual effort 'beyond a mere expression of automatic and constraining logic'.[22] As David Saunders notes, French law did not conceive of software in exactly the same terms as literature, there was nonetheless a continuing concern with the link between creativity and the notion of *droit d'auteur* in the French legal system.[23] For the continental European tradition copyright law has been based on the notion that the author has a special bond with his or her work which is not reducible to the relationship between a work and its owner. In this formulation, which is closely associated with a Romantic conception of the creative act, the author is an aesthetic subject whose creativity is expressed in the work of art.[24] This fuelled the emergence in continental Europe of regimes of moral rights – which protect the personality of the author as embedded in the work – alongside or in conjunction with regimes of copyright, which protects the economic interest of the author in exploiting the work as a commodity. In effect, the law presupposed and supported a certain version of creative subjectivity, albeit one which, historically, has had to be modified in order to account for the problems posed by an earlier generation of media technologies such photography and film.[25] In 1985 the law was modified further and the ideal of *droit moral* weakened in order to incorporate software. The shift was a significant one. As Edelman notes, 'we are no longer in the "purity" of the *droit moral*, but heading towards a "*copyright à la française*"'[26] in which intellectual property is ascribed not to an individual person but to a corporate body. In German law the position was different still. For the criteria for the award of copyright relied on an estimation of the quality of the software in comparison to the average produced by the market. Estimates suggested that 90 or

95 per cent of commercial software could not be granted copyright protection under German law.[27]

Second, there is a problem about how to distinguish between idea and expression. For copyright law has protected the particular form of *expression* of the author but not the *ideas* which are expressed which, according to a liberal conception of the public sphere, could and should be reproduced and contested by anyone. It should be possible to debate ideas, but not to plagiarise the manner in which they are debated. But the existence of a clear distinction between idea and expression is always potentially problematic, not least in the development of software. For computer software contains a complex hierarchy of interconnected codes which range between mechanical operations (machine code, assembler program) and more or less relatively sophisticated programming languages. As Georgina Born argues, 'even in the latter, there is a question as to how mechanically initial ideas are inscribed in design or program, and how much this process is itself creative translation ... the difficulty, then is to define which codes may legitimately be protected and licensed since creatively "authored", and which copied without payment since mechanical process or simply "idea"'.[28]

Third, there is the problem of the *mutability* of software: the difficulty of defining its identity and boundaries. For as a particular piece of software may evolve as it passes through the machines of different programmers and users, it may be difficult to create an authoritative and stabilised piece of work. Continual translations and retranslations may occur.[29] In an interconnected system it may be difficult to establish the location of the author or the original artefact. Moreover, although much scientific and technical work is oriented towards the stabilisation of facts or artefacts in particular forms, this goal may be difficult to achieve in the case of software and, indeed, in some cases may not even be desired.[30] The standardisation of software in the form of well-defined packages is difficult. There may often be the temptation, the possibility and the economic incentive to make minor modifications. The problem then is to define what the possible subject and what the possible object of the law is, and to stabilise the subject and object at a particular moment.

In Europe, the effort to find a resolution to these problems has taken a particular form. At the root of this resolution was a tension between the ideal of Europe as a zone which is *connected*, discussed in previous chapters, and the protection of intellectual property. For although the possibility of gaining intellectual property rights was and is expected to act as a spur to creative endeavour, the defence of such rights could serve to create local monopolies which, in the longer term, either inhibit competition or prevent connections being made. IPR may encourage inventiveness, but not connectivity. Europe needs both. Intellectual property rights may be a critical feature of a liberal capitalist economy in the abstract, but they may prohibit the formation of unified technological zones in practice. In effect, the topology of the technoscape may be locked into certain forms which inhibit further movement. Firms may create their own technological zones by making claims to intellectual property, inhibiting the activities of others. Europe might itself be conceived of as a technological zone. But it would be like a feudal state: unable to unify its many (commercial) principalities. How could the European institutions avert dangers of (commercial) feudalism without resorting to absolutist political solutions?

One of the key problems here concerns interfaces between different programs. Without interoperability firms can very effectively circumscribe and defend their own technological borders.[31] This danger is recognised in the 1991 European directive on the legal protection of computer programs. Article 6 defends the right to de-compile a copyright program in order to obtain information which is necessary in order to make another program interoperable.[32] Thus, 'even if a limited group decided not to reveal the standard information to others, certain acts will nevertheless be available to all third parties in case they want to develop (competitive) products that are inter-operable with the standard'.[33] In effect, the European directive asserts that some way must exist to cross between different technological zones. In the terms of the law, the goal of creating a unified European zone has precedence over the commercial interest of some companies to police their own technological borders.

This does not mean, of course, that competitors will simply be able to copy a program, however widespread it has become.[34] Nor is it clear whether a law which deals with what is and what is not a legitimate act of decompilation can be made to work in practice.[35] Nor does it mean that the law is the only way in which intellectual property can be maintained and boundaries policed. In practice, programmers and manufacturers use technical as well as legal solutions in order to defend what they claim as their intellectual property and to define the ends of their own technological zones. Such technical methods include programs which only allow access to networked information on the basis of electronic payment, encryption techniques and forms of 'fingerprinting' which

identify the owners of images or data even after the original data has been modified by others.[36] The vast social machine of the law is supplemented, it seems, by certain less costly technical devices. Indeed, according to one commentator, 'copyright as it is known today, will become increasingly obsolete ... replaced by a combination of various system-based mechanisms – cybercops – to effectively deter and reduce copying and manipulation of information'.[37] The law will be seen as an inadequate defence of property in an interconnected and mutable technological environment.[38] Commercial enterprises and public institutions are building their own electronic fortifications, which may act as barriers to legitimate as well as illegitimate forms of external scrutiny. To what extent such technical defences will be adequate, can be relied upon, or remain effective for significant periods of time, is uncertain. Certainly, the difficulties of protecting intellectual property through the law are encouraging the development of a new industry – of electronic defence.[39]

Of course, very often, the defence of property is not the only strategy available – or indeed the most effective one. Like Machiavellian princes, firms maybe ruthless and perverse in their technological practices. Often connection is made all too easy. Borders are opened up, at least for a time. Software is simply given away, made available over the Internet, or licensed to others at a low price. In this way, everyone and anything is enlisted into the network. Witness the practices of Microsoft, News Corporation and Netscape. In this way, the troublesome problem of defending intellectual property may be partially avoided. Competitors who choose to vigorously defend their own property, such as Apple, are outflanked. They simply fail to gather together sufficient allies in their preoccupation with possession and their narrow concern with intellectual property rights. Moreover, a certain software package can very rapidly become the de facto standard, avoiding the troublesome process and time-consuming process of public approval.[40] In these circumstances, the technologically marginalised are not necessarily outsiders. They are those who have been *compulsorily included*. The continual demand to update follows. In this way a technological empire is reproduced, even if its ends are never the same again.

OWNING GENES

Europeans are concerned to defend their investments and define their rights to property. It is said that they need financial incentives to be

inventive.[41] This certainly has implications for how persons relate to other entities. If Europe is to be networked together *and* property rights are to be defined then novel arrangements have to be made, and possibly remade. If new technologies are developed, then new definitions of intellectual property rights may be necessary.

But intellectual property is not just critical to the ordering and reordering of Europe as an economic and technological zone. It also has a critical role in international relations. As I have noted, intellectual property has become one measure of, and a means of defence of, a nation's or a trading bloc's competitiveness. It is an indicator of intellectual capital, along with others: numbers of papers produced; numbers of citations in recognised journals; numbers of PhDs; balances of trade in high-technology product and so on. At the same time, intellectual property law has become a key site of conflict between the major world blocs. Institutions such as the International Telecommunications Union (ITU), the General Agreement on Tariffs and Trade (GATT) and the World Intellectual Property Organisation (WIPO) are some of the fora in which these conflicts are played out. Not surprisingly, such organisations of international governance are undergoing a period of considerable institutional instability.[42]

A key area of conflict centres around the human-genome project, a massive worldwide scientific undertaking to map and sequence all the DNA in human chromosomes which began in the mid 1980s. In the United States it has been called 'biology's moonshot'.[43] Perhaps. But the differences between the two projects are considerable. For whereas the Apollo programme was directed at claiming the symbolic and frozen zone of the moon's surface, the genome project has been directed at the more politically and ethically charged and commercially exploitable space of the human body. And whereas the moon-landing programme was concentrated in one organisation, NASA, and in a few laboratories, the human-genome project is a more dispersed endeavour. Donna Haraway's comparison between the development of transgenetic organisms today, and the generation of non-naturally occurring transuranic elements such as plutonium during the cold war is probably more suggestive.[44] For, as Haraway notes, nuclear research also problematised the distinction between natural and artificial material while, at the same time, playing a key role in the formation of the post-war world order. The unstable stability of the cold war was underpinned and formed around the instability of artificial atomic nuclei.

Should it be possible to own elements of the genetic material of humans or other animals? In Europe, as elsewhere, environmental organisations have argued that genetic material should never be patented. 'The challenge is to place these questions [about the patenting of "life"] before our legislators to stop the "brave new world" of biotechnology spinning out of democratic control.'[45] But these attempts to establish an ethical European technoscientific zone is said by industry and governments to be problematic. The European Patent Office, considered to be a 'technical' rather than a political agency, has operated largely outside the discursive space of public politics. Elsewhere, in the United States, companies will be vigorously engaged in patenting genome research whatever the European Union decides to do. After all, since 1980, the American Patent and Trademark Office permitted patents on living organisms which led to a 'flood of biotechnology applications and generally stimulated the economic development of the technology'.[46] In comparison, if Europe does not have a sufficiently rigorous protection for intellectual property then European venture capital will simply not have the incentive to invest in this technology. Europe, which is already lagging behind in the race to patent the human genome, will fall further behind and be invaded by the products of others. In 1996, 70 per cent of all patents deriving from the human-genome project, in particular, have been awarded to US or Japanese companies and public laboratories.[47] In this context, intellectual property rights are necessary to defend the European economy against foreign invasion.[48] Their absence represents a 'a dangerous void in the European scene'.[49]

In an effort to establish a legal basis for intellectual property in biotechnology the European Commission sought to make a distinction between *body parts* and *biological material*. Body parts and human beings are considered as *natural* and therefore cannot be owned; they can only be discovered. Whereas biological material which can only be visible through the technical procedures of research, and is therefore *artificial*, can be. The distinction was represented by one member of the European Parliament, thus:

> Genes belong to the human body. They are not patentable as such, in other words in their natural state. On the other hand, an invention that makes use of elements that are suitable for industrial application and are obtained by a technical process from the human body, in such a way they can no longer be attributed to a given individual, is still patentable. This applies, in particular, in the case of the isolated gene, the usefulness of which has been proved and demonstrated.[50]

The distinction is a sophisticated one. In order to make it possible for biological material to be patented, the directive draws a line between an object in its natural environment (i.e. an individual body) and 'the same' object in an artificial environment (extracted from the body and placed in relation to different elements and objects). In this way the biological object acquires a different *parallel materiality*.[51] According to the final Directive adopted by the European institutions:

> Inventions which are new, involve an inventive step and are susceptible of industrial application are patentable even if they concern a product consisting of biological material ('biological material' means any material containing genetic information and capable of reproducing itself or being reproduced in a biological system). Biological material which is isolated from its natural environment or produced by means of a technical process may be the subject of an invention.[52]

Yet this apparently 'technical' distinction between the 'natural' and the 'artificial' is further complicated by an ethical distinction. For, according to the terms of the Directive, the boundaries of the (natural) body are protected by the laws of *human rights*, by a common sense of public morality and human dignity. Indeed, the operative part of the Directive came to include an 'illustrative list of inventions excluded from patentability' which offend against human dignity, following European Parliament intervention.[53] This list includes, 'processes for cloning human beings', 'processes for modifying the germ-line identity of human beings', 'uses of human embryos for industrial or commercial purposes' and 'processes for modifying the genetic identity of animals which are likely to cause them suffering'.[54] The ethical judgement is not made on the basis of distinction between the natural and the artificial, but between the human and the non-human. When what was once considered essentially natural can be made artificial, the realm of the natural is defended on the basis of its proximity to what is considered human.[55] Two conclusions follow. One is that the intellectual property regime governing the invention of genetic materials has yet to stabilise. It remains a key focus for debates concerning both the ethics of biotechnology, and the economic relations between the EU and United States. The

second is that economic competition between firms and economic blocs is played out in debates concerning technical, legal and philosophical distinctions between what is, and is not, human.

ASTRONOMICAL OBJECTS

My third story comes from basic research. In comparison to the industrial and ethical complexities of biotechnology and software development, the case of basic research may seem straightforward and uncontroversial. In general, it is thought that only those scientists responsible for carrying out particular pieces of research are entitled to lay claim to intellectual ownership of the results of this research. Once published, such results circulate freely in the public domain.

In practice, however, the basis of claims to intellectual property in basic research is much less clear-cut than this account suggests. Two interrelated issues arise. First, who is the subject of intellectual property rights? How, in other words, does one make a distinction between those persons whose creativity led to the discovery or the result, and those who 'merely' provided support?[56] The distinction is more complex than it first appears. For new instrumentation may often play a critical role in the generation and production of new experimental objects and phenomena.[57] At the same time, the distinction between 'technicians' or 'creative workers' can become ambiguous.[58] Many individual scientists spend a significant fraction of their working life designing, repairing and perfecting instrumentation, but nonetheless consider themselves as creative workers. In practice, the activity of using a ready-made piece of instrumentation to produce new results may be much less 'creative' than the activity of developing instrumentation. In these circumstances how is it possible to mark or register a clear distinction between creative and uncreative labour which is so central to contemporary notions of intellectual property? And on what basis is technical labour denigrated as 'merely' technical?

The second issue concerns the *object* of intellectual property claims. Experimentation does not discover objects in their natural state. Rather, it abstracts them from their environment and renders them in a new form in which they can be visualised as objects of science. Experimentation is a form of intervention in nature which *creates* new objects.[59] But if this is so what kind of thing is a suitable object for an intellectual property

claim? Are the electronic impulses resulting from the activity of an electromagnetic radiation detector and subsequently recorded on a computer suitable objects for an intellectual claim? Or does this record have to be rendered in a 'clean' and standardised form from which various sources of noise, pollution or systematic error have been erased? Or does it have to be interpreted and placed in relation to a wider set of issues and debates? How abstracted must the new object be from its original environment to become the object of an intellectual property claim?

Consider two examples: nuclear and high-energy physics and space research. In post-war Europe both of these disciplines registered significant shifts in the ways in which questions of intellectual property were managed. In nuclear and high-energy physics this shift coincided with the development of the Centre for European Nuclear Research (CERN). As John Krige and his colleagues note CERN had come to dominate the world of fundamental particle physics in Europe by the 1960s. Its work came to revolve around the design and production of huge new pieces of instrumentation, including complex and elaborate detectors and involving large collaborative teams. In these circumstances, scientific-journal articles listed dozens of scientific team members, irrespective of their individual contributions, while excluding the contributions of engineers. In order to establish their individual reputation, scientists preferred conference presentations, for which they could be the sole author.[60]

In space research a shift in the intellectual property regime occured in a different way and revolved around the design and production of individual satellites. The development of the European X-ray Observatory Satellite (EXOSAT) which was funded by the European Space Agency in the 1970s is illustrative of the issues involved, and has played a significant part in the emergence of a new intellectual property regime. Historically, *prior* to the development of EXOSAT, space scientists in Europe who had designed equipment such as X-ray detectors and 'telescopes' for space missions had also interpreted, presented and published the data deriving from these missions.[61] There was no question as to who owned the rights to the results of the observations of the equipment they designed. The design of instruments and the interpretation of data were, in terms of public recognition, carried out by the same people. Within this regime of intellectual property, laboratory technicians and secretaries were largely invisible, as were the aerospace, defence and electronic firms involved in designing and building and the managers who brought together this complex network.[62] But the development of

increasingly large and expensive satellites such as EXOSAT introduced a complication. In order to be funded such large satellites needed to be seen as *observatories* for many astronomers and not merely as platforms for the astronomical detectors of a few.[63] Observatories were open to the use of many in a way which mere experiments were not.

The distinction between an 'observatory' and a detector platform was a critical one. Whereas, in the past, the designers of X-ray detectors were considered as creative workers with rights, the notion of the observatory implied a radically different division of labour, and a different intellectual property regime. In this division of labour, according to the Space Agency, the detector designers (the 'hardware groups') had no privileged rights to the data. In effect they were considered to be merely technicians. Data were owned by 'observers' who put in proposals to be awarded time using EXOSAT's detectors after its launch.[64] Such 'observers' were, in principle, drawn from the whole of the astronomical community of Europe, and not only from the departments of the university 'hardware groups'.[65]

Following a dispute between the 'hardware groups' and the Space Agency a different justification for some preferential rights for the instrument designers was found. However, this did not rely on a notion that instrument designers had privileged moral rights to data on the basis of their contribution as creative individuals. Rather rights were justifiable on *utilitarian* grounds: because they served the interests of the (European) community of scientists as a whole. Time was needed by the instrument designers 'for functional checkout of spacecraft and experiments, assessment of inflight calibrations, occultation etc.'. In other words, if EXOSAT instruments were to be useful to the wider community of 'observers' they would first need to be calibrated against a common standard: made into a form which would be usable by many others. And this process of calibration would best be done by those who had designed them. Even though the instrumentation of EXOSAT would produce useful data, this data would not be useful without the mediation of calibrators.[66] In effect, the ambition, implicit in the notion of the observatory, to give equal rights of access to the satellite to all interested scientists, would not work because the experiment designers could not, or would not, communicate their own tacit knowledge of the instrumentation to others. The limited formal rights that the instrument designers came to acquire as a result of this argument depended on their knowledge as designers.[67]

Thus, the distinction between an astronomical observatory and a platform for astronomical experiments implied a distinction between different regimes of intellectual property. In an *experiment,* a particular entity (typically a small number of scientists or research groups) had rights over the data derived from experiments they have designed irrespective of the role of technicians and technical-support institutions in the division of labour. In an *observatory,* the interested scientific community could, in principle, acquire access to the data and the experiment designers are demoted to the position of technicians. Changes in regimes of ownership have effects on the identity of persons.

However, this shift in the intellectual property regime of space research not only had implications for the subjects of intellectual property rights (the university scientists) but also for the artefacts of their investigations. In the earlier regime, instrument designers maintained control over most aspects of the research process. They received relatively raw data derived from the signals coming from a satellite's instruments. They only relinquished ownership of data once it was published in the form of a scientific-journal article. By this time, the original data would have undergone several further processes of mediation within the university laboratory. However, within the new regime this was no longer possible. For the individual scientists who were successful in gaining the status of 'observers' could not be expected to understand all the idiosyncracies of the satellite's instrumentation or remove all the noise from the crude data sets which could be derived directly from the signals coming from the satellite. In these circumstances, a new intermediate form of mediation was required. The European Space Agency laboratory themselves cleaned up the data and disseminated it in a standardised format to the 'observers'.[68] The development of the astronomical observatory not only implied a new division of scientific labour and a new intellectual property regime. It also produced new objects (standardised data sets) which could circulate between the Space Agency laboratories and the many 'observers'' laboratories scattered across Europe and beyond. Such objects were more mobile and durable than the graphs and tables which had, until that time, lain on the desks of scientists working in individual laboratories.[69] In effect, the development of EXOSAT served, temporarily at least, to constitute a more or less European technological zone.[70] New (European) objects ('data about stars') began to circulate in more or less standardised form. In thinking about the process of European integration, social scientists have tended to focus their attention on the

implications of integration for the conduct of administration and politics and the problematic attempts to forge a sense of European identity or a collective model of government. Here we have seen that the transformation of Europe also has implications for non-human artefacts such as computer software, genetic materials and astronomical data. While it may be extraordinarily difficult to foster a sense of European citizenship and identity it has certainly been possible to make non-human artefacts with European characteristics. At the same time, these new 'European' artefacts play their part in the construction and reconstruction of Europe.

GATHERING

The idea of ownership is a way in which the boundaries of entities are constituted and their conditions of access determined. As Marilyn Strathern has argued, 'ownership gathers things momentarily to a point by locating them in the owner, halting endless dissemination, effecting an identity'.[71] This is equally true of technology as it is of housing or land. However, what is specific about technology is that what might be owned may be continually emerging. Its identity and its potential are initially unclear, or may become so. Equally importantly, the ways in which technological zones may be demarcated and protected and their ends and points of access determined are uncertain and contestable. The law, which has become the principle way in which ownership is fixed, is continually failing to adjust to the demands made on it. The exercise of the law demands that the boundaries and identities of subjects and objects need to be defined and identified. But the development of technology and science do not easily fit in relation to the legal fictions that individual subjects are sovereign, and that objects have clear and distinct identities. Technical and scientific developments create too many connections between previously distinct entities and places – as they are intended to do. And they disrupt existing conceptual distinctions – as they are also intended to do. At the same time these failures create sites on which new disputes can emerge and new conflicts be made visible.

No doubt very few of these conflicts are made public. Awarding rights to intellectual property can itself be an extraordinarily technical practice, and intellectual property questions define themselves as being outside the domain of politics. Prior to any extensive deliberation by the European

Community institutions, it was possible for the European Patent Office to accept a patent application for OncoMouse™, a genetically modified mouse which provides an experimental model for the simulation of breast cancer.[72] This is a reminder of how difficult it may be to turn a technical issue into a matter of public politics. To establish institutional and discursive spaces within which political debate can take place often requires considerable work. The act of creating such public sites of debate is a political act. In the case of EXOSAT, a controversy over the allocation of intellectual property rights emerged, but only within and between the European Space Agency and senior university scientists. There was no question of any wider debate about the necessity of a radical shift in the intellectual property regime and the scientific division of labour whatever its implications for the working lives of many laboratory workers. In the case of software copyright, some political questions could be raised in public in institutions of representative democracy such as the European Parliament. Indeed, with some considerable difficulty the Parliament itself has acquired a small support office to help it intervene in such areas, with all the complex questions that they raise.[73] In the case of biotechnology and human-genome research, by contrast, controversy has become a public issue, despite considerable efforts by governments to keep this issue out of the public domain.[74] The moral basis for intellectual property claims and the status of objects of research have, to varying degrees, become a matter of public political controversy. Making claims to intellectual property entails disentangling an object from the original circumstances of its production.[75] In this way an object is placed in a new restricted zone of circulation. By contrast, making an object into an object of political controversy involves a new process of entanglement. As a result of such a political process technological circulation may be stopped or more tightly regulated. I return to consider questions of politics, political circulation and political entanglement in chapters eight and nine.

Here I have written largely of European developments. Yet the issues are common. Debates over intellectual property rights may not be obviously political because of their technical and legal form. Yet it is precisely *in* debates over technical detail, over the legal or administrative status of particular subjects and objects of rights, and over the moral and ethical legitimacy of particular claims to rights, that international political conflicts are played out, whether in formal international organisations or otherwise. The politics of the New World Order does not just occur in

relation to specific territorial conflicts – although these remain important. It also occurs in relation to the place of intellectual property rights in the formation and regulation of technological zones and the markets with which they are associated. Indeed the European Commission has itself called for a 'A New Order for Global Communication' which would establish an international charter for the harmonisation of global standards and intellectual property law.[76] In this chapter I have shown how problematic the basis of intellectual property claims may be in relation to the development of new bio- and information technologies and the development of basic research. This is not just because there is rapid technological innovation in these fields. It is also because the development of technologies has come to disrupt the conventional framework of intellectual property, with its assumptions about the existence of single discrete origins and clear distinctions between what is public and what is private, what is natural and what is artificial, and what is creative and what is merely technical. The consequence is that conflict over intellectual property today does not just occur over specific claims to intellectual property rights. It also occurs over the basis of such claims, and their ethical justification.

Here I have only begun to explore the complexity of the kinds of relation that might exist between technical standards, collaborative research networks and intellectual property. In general, one might expect tensions between the logic of technical standardisation and claims to intellectual property rights. Technical standardisation fosters connectedness; claims to intellectual property may restrict the circulation of objects and practices. In discussing the development of European intellectual property law regarding computer-software development we saw some of these tensions in play. However, the relation between intellectual property rights and standardisation is far from straightforward. Intellectual property law is often used to create technological monopolies built around proprietary standards, which may foster a wider circulation. This has been a common business practice since the nineteenth century. And, as we have seen, in the field of basic research, a shift in the regime of intellectual property can be associated with new forms and objects of standardisation and new zones of technological circulation. In chapter two, I defined a technological zone to be a space of circulation within which technologies take more or less standardised forms. Thinking about intellectual property is critical if we are to understand the complexity of such spaces, and the identity and characteristics of the objects and

practices which constitute them. Intellectual property is more than merely a matter of ownership. It also implies the formation and reconstruction of new objects and subjects of technical practice.

A TECHNOLOGICAL SOCIETY

Thus far I have been concerned with the centrality of technology to the configuration of political and economic space. On the one hand, technological development may involve the formation of zones of circulation which are not contained within the territorial boundaries of nation-states. Objects and practices are transformed, manipulated, standardised and disentangled in order that they be made mobile. On the other hand, technological development itself becomes a problem to be solved. The demand to be technologically competitive and innovative is also thought to have implications for the organisation of research, the development of intellectual property law and the regulation of objects and practices.

The following chapters involve a shift in focus. In the first half of this book I have been concerned with how technologies have come to play a critical part in the reconfiguration of political and economic space, and how this has had implications for the form that technological artefacts take. In the second half of the book, I am not concerned only with the material artefacts of a technological society, but also with the citizens who expect and are expected to participate in it. In today's technological society there is a demand and an expectation that citizens themselves must acquire a certain degree of knowledge and skill about scientific and technological matters. They must become governable scientific and technological citizens. The next two chapters examine how this might be achieved. The government of a technological society entails both the creation of new material and immaterial objects, and the formation of new kinds of persons.

PART 2
TECHNOLOGY, POLITICS AND CITIZENSHIP

6

ON INTERACTIVITY

TECHNOLOGICAL CITIZENSHIP

Much has been said in recent years about the declining rates of political participation to be found in Western liberal democracies, whether on the basis of measures of voting or the membership of political parties or civic associations. In this context, many intellectuals and politicians have called for a revival and a reworking of a classical ideal of citizenship; an idea which is taken to imply not just a set of political and social rights, but also a set of responsibilities and duties. According to political philosophers and sociologists to be a citizen today entails accepting a moral demand to be active in, and informed about, public life.[1] However, such a tough morality does not come naturally. Active, responsible and informed citizens have to be made. As David Burchell has argued, modern political philosophy, 'neglects the positive construction of the *persona* of the citizen, both as an historical process and a social fact'.[2]

In this chapter I argue that the relation between technology and contemporary forms of active and responsible citizenship has two dimensions. On the one hand, as I argue later in the chapter, interactive and networked technologies have come to be seen as a key resource in the making up of citizens. New technology is reckoned by many to play a critical part in the revitalisation of democracy, in its various forms. This is a period of a remarkable investment by many political and educational organisations in new technology. Interactive technology is expected to produce active citizens.[3] On the other hand, along with a reinvention of ideal of active political citizenship and the technological investment with which it has come to be associated, one can also talk about a moral preoccupation with the importance of *scientific and technological citizenship*. Today, the individual citizen is increasingly expected, and increasingly expects, to make his or her own judgements about scientific

and technological matters. These expectations have come from a variety of directions and obey no simple logic. They are neither straightforwardly pro- nor anti-science. For politicians, business leaders and some educationalists, the problem is often diagnosed as one of the poor quality of science and maths education and a lack of flexibility in the workforce to adapt to new technological demands.[4] For many scientists there is a weakness in 'the public understanding of science'.[5] For a few, this weakness is compounded by the effects of Romantic, 'postmodern', 'relativist' and 'anti-scientific' currents in intellectual and political life.[6] For some consumer groups the problem may be with science itself, its forms of knowledge and organisation. Patients campaign for more access to medical records, or more choice concerning treatments. Pregnant mothers and their supporters argue for the importance of natural birth techniques. Others argue that the public would understand the virtues of organic farming not on the basis of a romantic attachment to nature, but on the basis of a scientific understanding of the risks of other methods. Still others call for a form of scientific citizenship which would be knowledgeable about the social relations of science and technology and the politics of expertise.[7] Such demands and concerns are not new, even if they now take a new and more urgent form. Writing in the late 1930s, the biologist and socialist, J. B. S. Haldane argued:

> I am convinced that is the duty of those scientists who have a gift for writing to make their subject intelligible to the ordinary man or woman. Without a much broader knowledge of science, democracy cannot be effective in an age when science affects all our lives continually.[8]

Today, few would believe that scientific writing, on its own, will be a sufficient instrument with which to produce the kind of citizen required to meet the political requirements of a modern technological democracy. Citizens and consumers have too many other demands on their time, and too many other readily available forms of self-improvement and entertainment, and above all too many other available media to gain all they need to know from books. In this multimedia context, the idea of 'interactive' technology has acquired particular importance in discussions of public knowledge in general, and public knowledge of science, in particular. There is no doubt, as Mark Poster notes, that the usage of the

idea of interactivity can 'float and be applied in countless contexts having little to do with telecommunications'.[9] Yet in relation to discussions of scientific and technological citizenship, interactivity can have a remarkable significance, drawing together concerns both with, for example, public 'participation', 'active citizenship' and 'empowerment' and with more specific questions and anxieties about the proper way to bridge the gulf between popular culture and the esoteric worlds of technical expertise.[10] If the health of advanced industrial economies is to be measured, in part, in terms of their possession and acquisition of intellectual and scientific capital, then at least one of the functions of interactive techniques has been to improve and maintain this capital. Citizens, consumers, students and school children need to be actively engaged with science.

In exploring the contemporary politics of interactivity, this chapter focuses on the modern museum of science. To many this institution may seem somewhat marginal to the discussion of interactivity, which is primarily associated today with the development of digital technologies. However, I argue that an analysis of the museum of science may have some considerable significance for those concerned with understanding the wider phenomenon of interactivity. First, as we shall see, science museums have played a significant part in the history of interactive technique and the idea of interactivity. Second, and more importantly, an analysis of the museum of science is suggestive of the way in which interactivity is actually much more than a particular possibility inherent in the development of media. For the museum of science, putting the interactive model into practice promises to turn the unfocused visitor–consumer into the interested, engaged and informed technological citizen. Interactivity is more than a particular technological form. It provides what Deleuze calls a diagram for organising the relations between objects and persons.[11] Today, interactivity has come to be a dominant model of how objects can be used to produce subjects. In an interactive model, subjects are not disciplined, they are *allowed*.

The second subsidiary theme of the chapter concerns what might call the historical geography of interactivity in science museums. This takes us from the Exploratorium in San Francisco to the National Museum of Science and Industry in London and the Cité des Sciences et de l'Industrie at la Villette in Paris.[12] My focus here is less on the details of interactive exhibits, or the abstract concept of interactivity, than on the ways in which the concern with interactivity circulates across different museums,

and how it becomes associated with quite distinct and local preoccupations, political rationalities and institutional forms.[13] There are continual movements of persons and devices between American and European museums. Here, the movement of the idea and the techniques of interactivity between institutions and countries tells us something about the complexity of its invention. The 'invention' of interactivity was not a sudden discovery, but was rather a history of episodes, in which the techniques acquired ever-new forms and resonances.[14] The story also provides an indication of the shape of the kinds of global ideoscapes and technoscapes suggested by Arjun Appadurai's theory of global culture discussed in chapter two. In this case, the idea and the techniques of interactivity link together diverse projects in the public display of science and technology across national boundaries forming an international technological zone. Interest in interactives is, to use Will Straw's terms, a global *scene*.[15] Yet, at the same time, there is a marked disjuncture, to use Appadurai's term, between the technological zones of European integration discussed in earlier chapters and the absence of an account of this technological formation in the major European science museums.[16] There is no *European* museum of science.

One way of understanding how a connection came to be forged between interactivity, government and the agency and body of the museum visitor might be in terms of the place of interactivity in cybernetics and communications theory. Historically, the idea of interactivity is one of a number of terms (including noise, feedback and network) which have acquired particular significance since the development of communications theory, cybernetics and related fields in the 1940s with the work of, amongst others, Norbert Wiener. In the cybernetic account there is no essential distinction between the capacities of the human and the non-human actor. Both the human and the machine act as sources and receivers of information, thereby functioning as part of an interacting system. As Peter Galison reminds us, 'according to the cyberneticist, the world is nothing more than the internal relations of these incoming and outgoing messages'.[17] Certainly, within the contemporary science museum, the technology of interactivity can be intended, if not necessarily to obliterate, at least to reconfigure the distinction between the human visitor and the non-human exhibit.

Cybernetics does figure in this story. But I focus on a different theme. One which connects to a rather more long-standing concern with the body as a source of experimental knowledge and with what we might

call, following Foucault, the *political anatomy* of the museum visitor.[18] As Simon Schaffer notes, in the eighteenth and early nineteenth centuries the body of the natural philosopher, or of his audience, frequently functioned as an essential part of the experimental apparatus. The eighteenth-century Parisian lecturer Jean Antoine Nollet, for example, 'described "beatifying electricity", when sparks were drawn from victims' hair'.[19] In 1800 the English chemist Humphry Davy reported on his experiments with the inhalation of gas. Davy 'lost all connection with external things ... I existed in a world of newly connected and newly modified ideas. I theorised – I imagined that I made discoveries.'[20]

Since the late nineteenth century, however, the significance of scientist's body to experiment has changed. The body of the practising scientist has become disciplined; capable of performing meticulous practical tasks and making exact observations but no longer serving as an experimental instrument in itself. The process of science education is, at least in part, a matter of turning the untutored body of the student into that of a reliable technician. As John Law observes, the discipline of the scientist's body can play an important role in laboratory work.[21] Experimental events are no longer *experienced* by the scientist; they are *recorded* by the scientist's instruments. By contrast, the relatively undisciplined body of the visitor has an increasingly important part to play both in the contemporary science museum and what is often called 'the science centre'.[22] Today, the visitor to the museum or the science centre is often encouraged to interact or to 'play' with an exhibit. In effect, the visitor is expected to make scientific principles visible to themselves through the use of touch, smell, hearing or the sense of physical effects on their own bodies.[23] In a manner foreign to the practice of contemporary experimental science, the body is itself a source of knowledge.[24] As we shall see, interactivity is expected to turn the visitor into an experimental self. Self-experimentation becomes part of the solution to the anxiety of government.

SPIRIT AND ECONOMY

In the first annual A. W. Franks lecture given at the British Museum in London in 1997, the former chair of the London stock exchange, and the then chair of the National Art Collections Fund, Sir Nicholas Goodison, defended the importance of objects. Quoting Phillipe de Montebello, Director of the Metropolitan Museum in New York, Goodison urged his

audience not to take 'a headlong plunge into the still somewhat murky waters of the new technologies'. The interactive touchscreens which have become an increasingly ubiquitous feature of many contemporary museums were to be shunned. The desire of the public to engage with exhibits hands-on was, he thought, problematic. For Goodison, objects 'should be allowed to speak for themselves and not be debased'. 'The object is at the hub of a museum's purpose ... it is not the role of the museum to ape Madame Tussaud's or Disneyland'. Rather it has a spiritual purpose: to 'inspire those who are receptive to inspiration'.[25]

But Goodison was not simply a cultural conservative. An equally powerful theme in his lecture was a concern that museums should conceive of themselves as businesses. At one level, there was a need to develop 'clear objectives, identify long-term liabilities, capital needs ... develop robust management, measurements of success and on-going monitoring of standards'. Evidently museums needed to become further embedded in what Michael Power has termed the audit society.[26] At another level, there was a need for a coherent national framework both for management and for funding agreements. Even university-funded museums might want to come under the same organisational umbrella as those that were under the control of the then Department of National Heritage. Indeed, recognising them both as a spiritual resource *and* as a business could be, Goodison reckoned, an appropriate agenda for the New Labour government – whose election he warmly welcomed. He hoped that the arts ministers of the new government could develop a bold approach towards museums – and develop a new relationship between the *spiritual* and the *economic* which Goodison saw in the vision of Prime Minister Tony Blair.[27]

Goodison's attacks against interactivity and his proposals for museum management are perhaps an indication of what might be at stake in the museum world today – not just in Britain. They might be contrasted with a statement put out in a different setting – the web site of the British Interactives Group (BiG) – the organisation for individuals involved in all aspects of *hands-on* exhibitions and activities. At the time of Goodison's speech the BiG web site listed more than twenty projects related to interactivity in the UK receiving funding of no less than £500 million from the National Lottery. These included the new Wellcome gallery at the Science Museum; what is said to be the world's first geological visitor centre The Dynamic Earth, in Edinburgh and the Newcastle International Centre for Life which is said to incorporate a

huge structure modelled on the DNA helix. In addition, Bristol 2000 would involve a complex which will include amongst other things Science world (a hands-on presentation of science and technology) and an 'electronic zoo' called Widescreen world.[28] Goodison drew a line between interactivity and the business of museums. Elsewhere, as he recognised, this line was blurred. Goodison's remarks provoked a lively response from interactives designers. One questioned Goodison's distinction between interactives and art. Clear rather than murky water was an appropriate image: 'Like some paintings and sculptures, the best interactive exhibits are, literally, wonderful and making them is an art. Try cupping your hands to divert a real tornado of water vapours, eight feet high, or touch the image of your own hand, out in the air in front of a real image mirror.'[29]

In Britain the debate on 'interactivity' intensified in the context of huge sums of money made available through the National Lottery.[30] But the debate is more than of local interest. For it can also be understood, in part, in relation to earlier changes in the public function of the museum. The modern science museum originally developed in the nineteenth century as a place where the successes of the imperial state could be displayed and where 'European productive prowess was typically explained as a justification for empire'.[31] But it was also intended to be a liberal space within which a bourgeois public would participate, and be seen to participate, in their own cultural and moral improvement. Thus, the population would be managed, as Tony Bennett argues, 'by providing it with the resources and contexts in which it might become self-educating and self-regulating'.[32] As an institution of government, the museum would act not so much through controlling and disciplining the public, but by enlisting its active support for liberal values and objectives. 'Museums and expositions, in drawing on ... techniques and rhetorics of display and pedagogic relations ... provided a context in which working- and middle-class publics could be brought together and the former – having been tutored into forms of behaviour to suit them for the occasion – could be exposed to the improving influence of the latter'.[33] The complex of museums developed at South Kensington in the 1850s became the paradigm of this liberal exhibitionary strategy.

In recent years, however, the liberal conception of culture as a means of individual improvement has had to run alongside – if not compete with – neo-liberal notions of culture as a consumer product.[34] The traditional museum has been accused of being too paternalist, too dominated

by the concerns of curators and the fetishism of the artefact, and too dependent upon public subsidy.[35] What is said to be required is a new recognition of the competitive character of the visitor business in addition to the older preoccupations with scholarship and public education. The museum is but a 'part of the leisure and tourist industries'.[36] For Neil Cossons, the director of the London Science Museum in the late 1980s and 1990s, this was a challenge that should be welcomed for, with the decline of state funding, 'spending power, and therefore choice, [would be put] into the hands of the people'. The implications for the museums he reckoned were clear: 'The battlefield will be the marketplace and the casualties will be those museums that fail to adapt'.[37] Such rhetoric created enemies. One former curator resented the accusation of being called a dinosaur.[38]

Seen in this context, 'interactivity' was to have a double function. First, it is one of a range of a range of technical methods – along with cost control, visitor research, quality assurance, marketing and customer relations – which would enable the museum to forge a more 'economic' relation both with its visitors, and with private industry.[39] At the level of the institution, the museum was increasingly expected to respond to the public's demands rather than simply tell the public what it needs to know – the public needed to understand science but, before this is possible, the museum must first understand what the public wants.[40] At the level of the gallery, museum staff aimed to design exhibits which enable visitors to make choices and to experience a gallery 'in their own way'.[41] And at the level of the individual display, the museum sought to develop and employ techniques which encourage greater dialogue with the visitor. As an influential Management Plan for London's Science Museum noted:

> Passive and poorly interpreted attractions will suffer at the expense of those that develop live demonstrations, provide participation, interactive displays, and give a quality of personal rather than institutional service to their visitors. Informality and friendliness will be valuable attractions. [42]

For one commentator interactive media had a particular role to play in such a reorientation:

> ... for interactive media the combination of: 1. multiplexing as a delivery mode; 2. interactivity as an intrinsically engaging form of media; 3. niche marketing as an advertising strategy; 4. the affluent status of museum visitors as a demographic group; 5. museums' status as pillars of respectability on scientific, environmental and heritage issues ... will greatly increase the attractiveness of museums to sponsors.[43]

Second, the technology of interactivity had a function in the context of broader changes in political thinking on both the left and the right. Contemporary political thinking is sceptical of the political and economic competence of the state and, in its stead, relies on the self-governing capacities of the individual, the family, the enterprise or the community. As Nikolas Rose observes, the subject of what he calls 'advanced' liberal forms of government is given unprecedented responsibility for governing his or her own affairs. For advanced liberalism, the task of the public authorities is not to direct or provide for the citizen but to establish the conditions within which the citizen could become an active and responsible agent in his or her own government.[44] Seen in this context, interactive devices had a function, for they might foster agency, experimentation and enterprise, thus enhancing the self-governing capacities of the citizen. Interactivity promised, in other words, to turn the museum visitor into a more active self.[45]

EMPOWERMENT

The association of the idea and techniques of interactivity with a broader conception of the public function of the science museum was not new. In 1969, the nuclear physicist Frank Oppenheimer, who had been blacklisted from practising as a scientist by the House Un-American Activities Committee, established the Exploratorium in San Francisco as an alternative to the traditional science museum. For Oppenheimer, existing museums in the United States often glorified the achievements of earlier scientists at the expense of enabling visitors to engage in a process of discovery themselves. The radical message of the Exploratorium was one of *democratic empowerment*.[46] The public would be empowered through being able to interact with objects as an experimental scientist does in the natural world of the laboratory, an idea which had been suggested to him following earlier visits to the Children's gallery at the Science Museum and the Palais de la Découverte in Paris.[47] According to Hilde Hein 'interactive pedagogic technique contains a key to empowerment that

could transform education on a broad scale and make an avenue of general self-determination'.[48] In short, visitors would be participants rather than mere observers. Increasingly concerned about the growing interest in mysticism, drugs and Eastern religions in the younger generation, Oppenheimer himself expressed the intellectual and political aspirations of the Exploratorium in these terms:

> The whole point of the Exploratorium is to make it possible for people to believe that they can understand the world around them. I think a lot of people have given up trying to comprehend things, and *when they give up with the physical world they give up with the social and political world as well.*[49]

If the idea of interaction was central to what the Exploratorium was trying to do, how was it possible to realise this in practice? What was an interactive technique and how could interactivity *empower*? In the early years, the Exploratorium's attempts to develop participatory and interactive exhibits were, no doubt, rudimentary. The Exploratorium staff had, themselves, to learn how to embody Oppenheimer's radical philosophy in a technical form. However, the centre was able draw on and translate other models of interactivity. One was a temporary exhibition of 'Cybernetic Serendipity' which had originally been shown at the Institute of Contemporary Arts (ICA) in London from August to October 1968 and which was designed to explore the relations between creativity and 'cybernetic' technologies such as computers, robots and mechanical feedback systems. For Oppenheimer and the Exploratorium the origins of the 'Cybernetic Serendipity' as an art exhibition accorded with the centre's modernist philosophy. First, neither Oppenheimer nor the exhibition organisers perceived a fundamental distinction between art and science. For Oppenheimer, science had an 'aesthetic dimension' and art and science were united in the 'human quest for understanding'.[50] According to the exhibition organisers, 'at no point was it clear to any of the visitors walking around the exhibition, which of the various drawings, objects and machines were made by artists and which made by engineers; or, whether the photographic blow-ups of texts mounted on the walls were the works of poets or scientists'.[51] Blurring the boundaries of art and science was an important part of the Exploratorium's pedagogic strategy for by doing so it was hoped that the centre's visitor might begin to understand that science was a *creative* activity.

In terms of the Exploratorium philosophy, a second positive feature of the ICA exhibition was that it engaged with science at the level of material practice rather than merely at the level of metaphorical association. Visitors could have a practical as well as visual experience of technology. The instructions to one of exhibits of 'Cybernetic Serendipity', for example, invited the museum visitor to interact with a machine by turning knobs that adjusted the phase and frequency of two wave oscillations relative to one another in order to produce a variety of patterns.[52] Thus, the relationship between scientific or mathematical truth and art would, through a process of interaction, be revealed to the uninitiated. This philosophy still persists. Addressing what he perceived to be the 'crisis in science education' the director of the Exploratorium, Dr Goéry Délacôte has created a 'Center for Public Exhibition' which 'provides informal science education through interactive exhibits which address and explore the relationship between science, art and human perception'.[53]

A further intellectual rationale for the idea of the interactive exhibit in the Exploratorium was found in the work of the psychologist, Richard Gregory. In his Royal Institution Christmas lectures of 1967–1968, Gregory had expounded a theory which held that visual perception entailed a complex integration of the perceiver's interpretative dispositions with external stimuli. According to Gregory, 'perception is not a matter of sensory information giving perception and guiding behaviour directly, but rather the perceptual system is a "look up" system; in which sensory information is used to build gradually, and to select from, an internal repertoire of "perceptual hypotheses"'.[54] Translating this into practical terms, the Exploratorium 'let the visitor be the laboratory subjects of their own perceptual experiments'.[55] The intended effect of this pedagogic strategy was not just to teach perceptual theory, but to encourage the visitor to experience the process of discovery and thus to become an experimenter.

The extraordinary enthusiasm for interactivity, which had been initiated by the Exploratorium in the late 1960s and subsequently spread across the United States, finally arrived in Europe in the mid-1980s with the opening of Launch Pad gallery at the London Science Museum, the Cité des Sciences et de l'Industrie in Paris and Richard Gregory's own Exploratory in Bristol. One key figure in this movement was Gillian Thomas, who set up the Cité des Enfants at La Villette, subsequently became the head of education at the Science Museum and

then moved to lead the Bristol 2000 project. For Thomas, particular historical objects such as a lunar-landing vehicle could have an iconic value – as signifiers of technological progress in particular fields – but were of secondary importance to the development of interactives. In galleries such as the Earth Gallery of the Natural History Museum (1996) and the Materials Gallery (1997) at the Science Museum, individual iconic objects form a part of a display which is substantially interactive. Hands-on experiments communicate scientific truths. Iconic objects merely signify the importance and beauty of science. Background information is largely provided through interactive touchscreen computer terminals.

Certainly, by the early 1990s the growth of interactive science exhibits in Britain had been phenomenal.[56] Indeed, a veritable interactives movement had emerged with the formation of associations such as BiG and the European Collaborative for Science, Industry and Technology Exhibitions (ECSITE). Curators, educationalists and museum managers began to share their ideas about the function and design of interactives and encourage the use of interactives in exhibition spaces in which they had previously not been found, such as art galleries. Crudely, two tendencies in this movement might be identified. On the one hand, at least one strand of the interactives movement extolled the virtues of the kind of experimental culture fostered by the Exploratorium. The Exploratorium's own three-volume guide to the development of interactives is called the 'cookbook' – stressing the informality of interactives design. The first BiG workshop for interactive fabricators held at the former home of the Royal Greenwich Observatory at Herstmonceux castle had at least some Californian resonances: 'If you've done hands-on and brains-on but want to try souls-on (whatever that may or may not be) this is the forum for you.' 'Mind, body and soul: the holistic approach to hands-on learning.' On the other hand, in conjunction with the use of new media technologies, interactives design has become highly professionalised and extraordinarily sophisticated and correspondingly expensive. Indeed, the Science Museum considered selling its professional services in interactives design to many of the other museums and centres in receipt of funding who do not have any well-developed expertise in this area. Interactivity may become an industry and a commodity. One of the ways that the Science Museum distinguishes itself as a national museum from other well-funded science centres is as a centre of excellence in interactive-exhibit design.

If the Exploratorium provided a model for the interactives movement in Britain, it would be a mistake to imagine that interactivity in Britain was simply a copy of the American original. As sociologists of technology have been at pains to argue, the process whereby a technology is 'transferred' from one place to another should be thought of as a form of translation or reinterpretation rather than merely a form of diffusion.[57] In the UK, the radical concerns of the American centre with the issue of empowerment and freedom were marginalised and, with exceptions, Oppenheimer's interests in the links between science and art were ignored. Some existing boundaries needed to be maintained. Instead, interactivity came to operate in relation to the failure of the traditional science museum to address a rather more mundane set of concerns with the public understanding of science and the attractiveness of the museum to visitors.[58]

Criticism of the traditional science museum was most forcefully made by Richard Gregory, founder of the Bristol Exploratory and former advisor to the Exploratorium. For Gregory, 'looking at the traditional museums of science we find remarkably little science'.[59] For Gregory, the essential feature of science was experimentation, so that in order to enable the public to get an 'intuitive feel for... the principles of science' hands-on interactive experiences were, he believed, critical. 'I suggest', wrote Gregory, 'that the major aim of interactive science centres, after stimulating interest and curiosity, should be setting up hand-waving explanations giving useful intuitive accounts'.[60] There was a particular need for such interest and curiosity. For the public were thought to be ambivalent about the authority of science and, at the same time, were said to be uninformed.[61] The promotion of the public understanding of science was, in this context, a necessary but insufficient solution.[62]

The new interactive science centres were certainly popular. 'Science centres attract visitors like magnets' noted the education officer at the Science Museum responsible for Launch Pad.[63] Interactive exhibits, whether located within science centres or in more traditional object-centred exhibitionary spaces were also consistently rated highly by the public according to visitor research. According to the Science Museum's own internal audit, Launch Pad received 714 visitors per square metre of gallery space per year, while the entire museum received only 44 visitors per square metre per year.[64] This popularity has proved both a benefit and problem for the development of interactive exhibitions. Certainly the fact that interactives are popular is of considerable commercial and

political significance in a period when the museum or the science centre is increasingly understood as one part of a broader leisure industry and when the traditional curatorial concern with collection has been down played. Accusations that interactive science centres are merely expensive playgrounds which convey little of the tedious and difficult reality of science can be met with the response that this is what the public wants.[65] If interactive galleries enable visitors to have fun and to enjoy some kind of experience of science then, in this view, that is sufficient justification for their development. In a period when visitor numbers are taken to be one of the key performance indicators used in museums, and an important source of revenue, then the case for increasing the space given to interactive exhibits within the museum can appear unanswerable.[66]

However, the recognition that visitors came to interactive science centres and exhibitions to enjoy themselves created a problem for proponents of interactivity.[67] In the view of their designers, interactive exhibits were always expected to be as much instruments of informal education as a means of entertainment. The museum visitor was conceived of as an active learner and not just as a consumer. In this context, critics pointed to the lack of historical or industrial contextualisation of many interactive exhibits and the frequent absence of any explanation of what scientific principles were supposed to be revealed through the process of interaction. Some exhibits, it was said, can be interpreted in ways which lead museum visitors to *false* conclusions.[68] Indeed, it was unclear whether any of the scientific principles that many interactives were meant to demonstrate would be grasped by any except those already possessing a good scientific education.[69] Moreover, some questioned whether many interactive devices are really interactive. Many so-called interactive touch screen computers, for example, simply allowed the visitor to select from a predetermined set of options. Far from providing the possibilities for experimentation such interactive devices merely serve to create the illusion of choice.[70] Indeed, interactivity may, in practice, be associated with what Slavoj Zizek has called *interpassivity*. The user of the interactive device allows the machine to be active on the user's behalf, thereby *displacing* any creative activity of his or her own. The activity of the user is projected into the machine, but the machine's 'activity' is largely predictable.[71] We can contrast this with the possibility of a more creative relation to museum exhibitions (or to works of art) in general. In such a relation, the museum visitor may not be visibly 'active' at all, but will be open to the imaginary experience

which allows the museum to act on her behalf. This is a different kind of pleasure to the pleasure of interacting with a quasi-interactive device; it is 'a pleasure in anticipating that the anticipation that expectations will be simply be met will be confounded'. This is a 'creative passivity'.[72]

There have been many different responses to such criticisms. At the London Science Museum large numbers of human 'explainers' are employed to make sure that the interactive exhibits do the job they are intended to do. New galleries such as Health Matters and the temporary exhibition space, Science Box, incorporated increasingly sophisticated interactive exhibits as a matter of course. On the other hand, one new gallery came to be marked by the *absence* of any interactives. The new gallery devoted to the remarkable scientific-instrument collection of King George III, for example, was accompanied by an exquisitely produced, well-researched book, but did not incorporate any interactives. Senior museum managers determined that interactives would be inappropriate.[73] In this way the purity of the original objects would be preserved. The lesson is a familiar one. The body is reckoned to be the site of education and popular entertainment. But, as Bourdieu reminds us, serious forms of aesthetic contemplation and historical appreciation are only thought to be possible at a distance.[74] The historical object is thus fetishised. Ironically, George III's instruments were, in their day, interactive, and it may have been particularly instructive to make a working model for visitors to use. Interactivity is not a new development in the history of science and technology, but has been *made* new. What is involved here is not so much the invention of a tradition, but a denial of the connections that can and should be made between the past and the present.

But along with the remarkable emphasis on interactivity in galleries of *contemporary* science, what is perhaps striking is the diversity of forms new galleries came to take. Internally, the museum has come to as something like a television station producing *different* programmes for *different* audiences – a post-Fordist industrial organisation to use the terminology of contemporary sociology.[75] Different galleries take different forms depending on their intended audience, their subject matter, the availability of commercial sponsorship and the philosophy and experience of their designers. There is more emphasis on tailoring interactives to particular age ranges so that it is possible to act on the specific technical competencies and interests of the young visitor. In these circumstances, gallery designers increasingly draw on the diverse insights of

visitor research, ergonomics, sociology, developmental psychology and educational theory to ensure that the new interactive galleries prove to be educational as well as entertaining *and* meet their *specific objectives*.[76] This has implications for the relation between the museum and its visitors. To an extent unparalleled in the past, the museum visitor has become the object of investigation and an element of the museum's internal audit. If interactive technologies are expected to enhance the agency of the visitor and to channel it in the most productive direction, then the specific dynamic of this agency must itself be known. The visitor, it seems, has been increasingly called on to interact with exhibits and respond to the growing number of explainers, actors and researchers who also inhabit the museum. Constant *feedback* is a requirement of the new regime.[77]

A CYBORG REGIME

In what follows I want to look at a museum where 'interactivity' has a rather different set of resonances. At La Cité des Sciences et de l'Industrie at La Villette in Paris, 'interactivity' functions not just in relation to notions of the visitor as active consumer and learner, but in terms of a project which centres around a particular vision of the relation between humans and machines. Opened in 1986, La Villette was one of a number of other major construction projects – including the Bastille opera house and the Beaubourg – which dominated Parisian cultural policy in the 1970s and 1980s. Whereas in the UK, the imperatives of cultural policy became increasingly understood in terms of notions of consumer demand and commercial viability, the ostensible objective of the developments in Paris was to broaden public participation in culture. As Nathalie Heinich has noted, one goal of the Beaubourg project was to 'democratise culture' and to somehow 'reconcile the imperatives of mass consumption with "higher" cultural production'.[78] Likewise, a key aim of the development of the site at La Villette was to enable a larger public to recognise the value and experience the excitement of science. Thus, the public would come to place as much value in science and technology as the French State itself.[79]

In practice, the techniques used at La Villette to encourage public interest in science have obeyed no simple logic and are, no doubt, contradictory. On the one hand, the Cité tries to go to meet the wider public's taste not just through *vulgarisation*, but, by blurring the

traditional boundaries between education and popular culture. Echoing the philosophy of many late nineteenth-century exhibitions, science is presented not just as knowledge but also as spectacle and entertainment:

> Above all the Cité des Sciences et de l'Industrie is a place to learn and a place to have fun.
>
> La Villette: a new way of seeing, listening, learning of amazement and emotion! A place for creativity and leisure, for discovery and play.[80]

On the other hand, La Villette is not entirely without its own marks of cultural capital. In the park outside the Cité, there are a number of 'deconstructionist' architectural follies designed by Bernard Tschumi,[81] an experimental postmodern garden, a research centre for the history of science and technology, as well the new national conservatory of music – 'a complex conceived as a stimulating environment and meeting place for the arts, sciences and music'.[82] Even in the Cité itself there is a multimedia library, an international conference centre and associated information services. In addition, mirroring the philosophy of the Exploratorium, there is the 'Experimental gallery' which exhibits 'initiatives in art'.

> ... the Experimental gallery exhibits artwork closely related to the fields of science, technology and industry. Though these works are neither illustrative nor educational in nature, they do represent a certain poetry, myth, humour and even criticism. The artists do not share the same views on the world as do scientists but instead provide an answer to these views.[83]

At first sight, La Villette's gestures towards art and its flirtations with postmodernism appear to mirror the Beaubourg's enthusiasm for technology. Since its opening, for example, the Beaubourg has been associated with Pierre Boulez's Institut de Recherche et de Coordination Acoustique/Musique (IRCAM), a centre which carries out research in avant-garde computer music.[84] And in 1984 to 1985 the Beaubourg supported experiments in collective computer writing in an exhibit entitled 'Les Immatériaux' which provided a vehicle for the philosopher, Jean-François Lyotard, to speculate about the impossibility of consensus through communication.[85]

Yet despite the apparent parallels between the cultural strategies of the two institutions their broader ideological resonances are quite different. In the case of the Beaubourg, the centre's close relation to technology serves to legitimise its identity as an innovative cultural institution – reinforcing the image given to it by Richard Rogers's bold architectural design. By comparison, in the case of the Cité, 'art' will always remain at the margins of an establishment which is dominated by a vision of the information age, and which tries too hard to be futuristic. Ironically, it is the Cité which appears to be the more conventional of the two institutions: its high-tech structure immediately conjuring up not so much an image of innovation and creativity, but a history of so many earlier exhibitions and philosophies in which progress has been equated with technological change.

Although the Cité's relation to the future is only too familiar, its representation of technology is nonetheless distinctive. Whereas the museums of the nineteenth and early twentieth centuries articulated the evolutionary metaphors of biology and political economy, the Cité's taxonomies draw on the new ahistorical sciences of communications theory, cybernetics, psychology and ecology.[86] Exhibit areas are devoted to whole series of topics concerned with the bodily and perceptual capacities of humans: sound, vision, light games, the representation of space, expression and behaviour. Moreover, although the Cité does possess the shiny rockets and cars to be found in all traditional science museums, its dominant images are those associated, not so much with hardware, but with language, software and the metaphors of the 'information society'. This is a museum of information, networks, environment, multimedia, interfaces and participation.[87]

In practice, these ideas are manifested in a number of different ways. At the most basic level, the Cité is full of 'interactive exhibits and audiovisual presentations', 'computer-based displays and games', 'participative, hands-on displays' and 'state-of-the-art museum technology'. Each of these devices has, no doubt, a specific didactic function and entertainment value. But collectively, the museum's interactive media also have a metonymic effect. As one curator put it to me, alluding to McLuhan, 'the medium *is* the message'. At La Villette, the future *is* interactive. Visitors to the museum do not purchase a ticket, but a machine readable smart card on which is written the demand 'Découvrez!'.[88]

However, interactive technologies do not simply function as rhetorical tropes. They also serve to organise the internal space of the museum.

As Roger Silverstone has argued, the visitor's experience of a museum may be understood as a narrative in space, the structure of which is governed, but not determined, by the spatial organisation of the museum itself. This idea, derived from the work of Michel de Certeau, 'encourages us ... to begin to analyse the rhetorical and narrative strategies which are present both in an exhibition's layout and in the routes which individuals construct through it'.[89] In the case of the Cité, the internal space of the museum apparently takes a quite conventional form: the visitor is guided around a three-dimensional space divided into exhibitions, shops, galleries and cafés. However, the existence of 'interactive' devices and technologies creates discontinuities in this space, puncturing the visitor's route and establishing a further 'fourth' audiovisual dimension within which the visitor is encouraged to place herself, to participate and to interact. Thus, the visitor is not simply an observer of the museum's machines – she is positioned within them. In the 'Sound' exhibit area, for example, a computer game called a 'voice-actuated note-gobbler' serves to display the tone of a person's voice. The 'Light games' area includes a section devoted to the explanation of interference which brings together a number of 'hands-on' displays. In the 'Aeronautics' area some of the most popular exhibits are flight simulators. In the 'Environment' area computer based interactive multimedia allow the visitor to explore topics such as greenery, air and trees. Interaction is compulsory and compulsive.[90]

Just outside of the Cité, the position of the museum visitor in the museum's exhibitionary strategy is dramatically symbolised by a huge 3-D Omnimax cinema – La Géode – in which 'visual effects combine with sound effects to transport the spectators into the midst of the action surrounding them'.[91] Reflecting on the significance of La Géode, Paul Virilio reminds us that 'the fusion/confusion of camera, projection system and auditorium in the Imax/Omnimax process, is part of a long tradition of "mobile framing" in cinema, dating from the invention of the tracking shot in 1898'.[92] Placing the Omnimax in relation to the early history of cinema is certainly appropriate. Like the cinema of the 1890s and 1900s, contemporary Imax/Omnimax cinema is less concerned with narrative than with exhibition, spectacle and affect.[93] However, the economic conditions of Imax and early cinema are quite different. Whereas small-scale production companies played an important role in the development of early cinema, the relative scarcity of Imax/Omnimax auditoria and the expense of film production has meant that the development

of Imax/Omnimax depends on corporate sponsorship.[94] In La Géode, one popular programme is a film of the Space Shuttle produced by NASA and the Lockheed Corporation. The Space Shuttle is a particularly appropriate subject at the Cité for its design is based on the view that it *matters* that research in space depends on the involvement of humans and does not just rely on the operation of remote controlled instruments. In the Shuttle, humans are 'explorers' pushing back the final frontier of space; they have the *Right Stuff*. However, equally significantly, the physical and perceptual capacities of their own bodies are the objects of the Shuttle scientists' experiments. Thus, at least some of the experiments performed in the Shuttle bear some comparison to those that might be found in the main body of the museum.

In the Cité, the idea that science and technology reconfigure the boundaries between humans and non-humans is a pervasive one – represented not just in the ubiquity of 'interactive' techniques but in the vocabulary and taxonomy of the museum's exhibits. The Earth is understood as a 'machine' and as a 'spaceship'. Computers can 'talk'.[95] 'Animal and vegetable kingdoms come to life in the form of automatons.' Robots and humans live in a 'cybernetic zoo'. And marriage is presented in terms of notions of 'trade' and 'system'. The contrast between La Villette, on the one hand, and the Exploratorium and the Science Museum, on the other, is considerable. For whereas all three institutions use a mixture of mechanical, made-up and computer-based interactives, it is only La Villette which fully embraces the vision of an interactive information society. For the other two institutions, however, interactivity does not primarily connote information technology, but rather a more wide-ranging attempt to reinvent the contemporary museum

Have there been explicit contestations of the interactive model? At one level, a series of questions has properly been asked about the use and effectiveness of interactives, not least by museum professionals and interactive designers themselves. Experimentation in interactives design was, after all, a central feature of the Exploratorium philosophy. Do they possibly convey the scientific principles that they are intended to? Are they really cost effective given the wear and tear to which they may be subjected? How do visitors use them? Can they be brought together with objects from the museum's collections? However, the force of such questioning has not been any decline in interest in interactives. On the contrary, criticism has provoked professionals to improve the design of interactive devices, tailoring their design more closely to the needs,

capacities and behaviour of *real* museum visitors, and integrating them more carefully with the more traditional text- and object-based exhibits. In brief, the notion of interactivity has come to be the centre of a rapidly expanding cycle of intellectual, financial and psychological investments in the public presentation of science and technology.

At another level, a few historians and sociologists of science have proposed a very different model of the future of the museum of science. For many proponents of interactivity, museum collections are reckoned to have primarily an iconic value. In comparison to the cluttered display cabinets of an earlier period in the history of museums, there are relatively few historical objects in the interactive museum of science. In the model proposed by some historians of science, however, museum collections acquire new significance for they are illustrative of the critical importance of technical devices in scientific practice.[96] The task of the museum curator, in this view, is not to design ever-more-sophisticated interactives, but to forge a new political rhetoric of display. The purpose of such a rhetoric would not necessarily be to encourage the visitor to experiment or interact with custom-made interactive devices. Rather it would be to try to use the particular advantages of the museum as a medium to tell stories about the complexity and technicality of scientific practice, and the radical differences between science as it is encountered in textbooks, school experiments, political arena and exhibitions and science as it encountered in the laboratory and the field.[97] Rather than excite interaction, such an approach might encourage visitors to map some of the paths which lead between the messy imprecision and uncertainty of technical scientific work and the critical importance of notions of scientific precision and certainty in public political and cultural life. Such an approach is certainly not the only one available for the contemporary museum of science. Yet, in its difference, it brings into focus the remarkable preoccupation with the virtues of the interactive model today.

POLITICAL ANATOMY

Is the science centre and the museum of science an isolated case, only of interest to specialists in the history and sociology of museums? I do not think so. Although science centres and science museums were one of the first institutions to develop an explicit programme of interactive

technological development, the interactive model can be, and has been, generalised to other sites and situations: to education and broadcasting, marketing and the workplace. Today, the promise of interactivity, is at the centre of of a whole series of attempts to reinvent educational, political and broadcasting institutions.[98] We can now speak of the importance of interactive devices and methods in the classroom, in marketing and in the mass media.[99] At the same time, in the field of party politics and public service, an array of new technical methods such as focus-group research and electronic democracy also take some elements of the interactive model, in so far as they emphasise the importance of *working with* rather than directing the political imagination of ordinary citizens. In this model of political life, intensive interaction with 'the public' in carefully managed environments is expected both to maximise and intensify feedback between government and the governed and to minimise the possibilities for unexpected political controversies and conflicts at a later date.[100]

In his discussion of 'docile bodies' in *Discipline and Punish*, Foucault notes the importance of what he terms 'body-object articulation' for the exercise of disciplinary power. 'Discipline defines each of the relations that the body must have with the object that it manipulates'.[101] Reflecting on an eighteenth-century set of instructions for handling a rifle, he speaks of the way in which the body and the rifle are brought into one functioning arrangement: 'over the whole surface of contact between the body and the object it handles, power is introduced, fastening one to another'. In this way, Foucault argues, the body is reconstituted as a 'body-weapon, body-tool, body-machine complex'.[102] Discipline operates by fixing the relations between body and tool to form a unified apparatus.

In comparison to the instruments and codes of discipline, the various techniques of interactivity imply a much less rigid articulation of bodies and objects, coupled with a liberal sense of the limits of permissable control. There is a degree of play and flexibility between the interactive device and the user's body. Above all, the use of interactives is not intended to regiment the body, but to turn it into a source of pleasure and experiment. 'Present-day hands-on interactive science centres are delightful, full of the fun of surprises, and discovering new phenomena and seeing how things work'.[103] Whereas discipline is exhaustive in its application, interactivity is specific, instantaneous and intensive. Whereas disciplinary technology manipulates and manages the body in detail,

interactive technology is intended to channel and excite the curiousity of the body and its senses; resulting in anticipated effects on the intellectual productivity, questioning and creativity of those who interact. Whereas discipline is direct and authorative, interactivity is intended to turn the user (visitor, school child, citizen or consumer) into a more creative, participative or active subject *without* the imposition of a direct form of control or the judgement of an expert authority.[104] Discipline implies normalisation; the injunction is 'You must!' Interactivity, by contrast, is associated with the expectation of activity; the injunction is, 'You may!'[105] We may draw up an ideal–typical set of contrasts:

Discipline[106]	Interactivity
The time-table: 'Precision and application are, with regularity, the fundamental virtues of disciplinary time'	**Flexible time:** interactivity depends on the choice of the user
The correlation of the body and the gesture: 'a well-disciplined body forms the operational context of the slightest gesture'	**An orientation of creative capacity:** Interactivity does not depend on discipline but on the potential of the undisciplined body and the unfocused mind. 'For the child, or the aware but not especially knowledgeable adult, failed predictions can signal the need for further experiment or to see the phenomenon in a fresh way'[107]
Body–object articulation: through rules and codes. The constitution of **'a body-weapon, body-tool, body-machine complex'** which persists over time.	**Body–object articulation:** through guidance rather than rules. The constitution of a **brief 'body-machine interaction'.**
Exhaustive use: 'Discipline ... arranges a positive economy; it poses the principle of a theoretically ever-growing use of time, ever more available moments and, from each moment, ever more useful forces'	**Intensive use:** the value of brief interactions must be maximised. Exhaustive use is likely to be impossible

Discipline[106]	Interactivity
The authority of the expert: the scientist who lectures and who acts as an authority	**The concealment of expertise:** the authority of expertise is partially hidden in order to maximise the possibilities for interaction. The imagination and expertise of the ordinary citizen is worked with rather than contradicted by the voice of authority.
Injunctions: **Learn!** **You must!**	Injunctions: **Discover!** **You may!**

In studying the relations between technology and government there is the temptation to take one of two approaches. One temptation is to write the history of technology as simply an adjunct to the history of political doctrines or ideas. Such an approach would focus our attention on the texts of political theorists, intellectuals and politicians. It would concern itself with the great statements of liberalism and socialism, republicanism, communitarianism and conservatism concerning the conduct of government. A second temptation would be to associate grand transformations in politics and government with significant developments in the history of technology. Seen in this context, writers such as Jean-François Lyotard and Mark Poster, at particular moments in their writing, have placed the emergence of new information sciences and technologies at the centre of their analysis of the political present. For Lyotard, 'the postmodern condition' was intimately associated with the emergence of the new cybernetic and information sciences.[108] For Poster, the present era is marked by a movement from the mode of production to the mode of information.[109]

One of the virtues of focusing on the topic of interactivity is that it displaces both 'political ideas' and information technology from the centre of our analyses. On the one hand, interactivity is both much less and yet, in a certain sense, much more than media and information technology.[110] It is a diagram for the exercise of power which will have many different technical manifestations, which may or may not involve

the use of new media and information technologies. In this way, interactivity provides the model for a whole series of specific elaborations, innovations and investments across a range of media and institutions. On the other hand, a focus on interactivity cuts across the conventional terms of political theory, with all its endless preoccupation with the differences between liberalism, neo-liberalism and social democracy, pluralism, authoritarianism and conservatism. As we have seen, in order to account for the significance of interactivity in different locations one must examine how the idea and the technology becomes associated with particular political strategies and ideas in specific circumstances. Through the use of interactive devices, political doctrine can be rendered into technical form. Yet interactivity is also both much less and much more than simply a political idea or doctrine. It is much less in so far as interactivity is not, in general, the subject of any political manifesto, nor is it the object of political controversy. Explicit attacks on the idea of interactivity are rare. The public intervention of the Director of the British Museum was exceptional in this respect. Yet it is political in the sense that it has become a model for the exercise of political power which does not take a disciplinary form. Although the interactive model is not, as we have seen, a recent invention, it has acquired a remarkable political currency today.[111] Politics does not circulate just through the flow of ideologies or rationalities of government, but through diagrams, instruments and practices.

FROM ANATOMY TO CHEMISTRY

In the museum of science, interactivity has promised to forge a new political anatomy for the new museum visitor. The activity of the visitor or consumer has come to be governed through fostering the experimental capacities of the untutored body rather than through direct and authorative instruction. In this way, it is hoped, interactivity will provide part of the solution to the problems of what I have called technological citizenship. In the next chapter I am also concerned with the problem of technological citizenship. Here I focus on the contemporary concern with the provision of technical information for citizens who are expected, and sometimes demand, such information. The story here centres on the preoccupation with air-quality monitoring in major European and North American cities. The story is illustrative of a much wider

contemporary preoccupation with the value of precise scientific information in producing a more informed population. As we shall see, the story is about how the (over)production of precise information displaces both science *and* politics, leading to a depoliticisation of science. But it is also a story, as we shall see, about the political chemistry of the air itself.

7

POLITICAL CHEMISTRY

INFORMATION

One of the characteristic features of contemporary government is the extraordinary range and quantity of information that citizens and institutions are expected to process: information on the likely effects of common drugs and foods on the body; information on the benefits of certain courses of treatment or forms of education; information on the state of the roads, the airports and public transport; information on the quality of services provided by hospitals and schools. The citizen or the consumer is expected to be continuously informed, updated on developments and potential difficulties and possibilities.

Such information is much more than raw scientific data. First, the production of information is often linked to practices of government and self-government. As Marilyn Strathern argues, information generally has *regulatory* effects.[1] Its existence is thought to imply a transformation in the conduct of those who are, or who should be, informed. Information does not merely exist; it *demands* (immediate) attention. Ignoring information which is made available is reckoned to be either misjudged or willful. Information is practical and technical in its form and performative in its function. Information is never merely scientific data, if by scientific data we mean sets of numbers and facts about the natural or social world which have been abstracted from their specific conditions of production and reception. The very concept of information implies a reader who *should* be informed. It is a moral as well as a technical concept.

Second, the production of information has complex and often unexpected implications for those engaged in its *production*. To render an object in the specific form of information is likely to involve a multitude of different scientific procedures and innovations, political negotiations and compromises, regulatory arrangements, technical standardisations,

financial investments and institutional resources. In doing so, as we shall see, the production of information may precipitate new forms of political conflict (what forms of information should be produced, for what reasons, and with what instruments?) while displacing or silencing others. It will serve to create new objects of scientific investigation while marginalising other lines of inquiry which do not feed directly into the process of information production.

Third, information entails a transformation in the *object* which is informed about. Information does not merely represent an object which independently pre-exists it. Natural and social objects such as water pollution, weather conditions, economic performance, public opinion and research productivity do not naturally exist in a state in which they can be the object of information. Necessarily, the production of information involves the manipulation of an object into more or less standardised form in which its properties can be measured, recorded and made visible. It entails placing the object in a calibrated grid with which it may be compared to an ideal or normative standard, giving it a *new* reality.[2] Information is a reality which is placed in circulation. The circulation of information may be more or less public or restricted.

In thinking about the production of scientific information, Alfred North Whitehead's philosophy of organic mechanism is suggestive. For Whitehead, objects (which he terms 'actual entities') are always in the process of becoming: 'The actual world is a process, and that process is a becoming of actual entities.'[3] In this view, objects are historical realities, the properties of which are determined by their changing relations to other entities: 'an individual entity, whose own life-history is a part within the life-history of some larger, deeper and more complete pattern, is liable to have aspects of that larger pattern dominating its own being, and to experience modifications of that larger pattern reflected in itself as modifications of its own being.'[4] The identity and properties of an object are not given, but dependent on the changing environment of which they are a part. The endurance of an object over time cannot be assumed, but depends on the endurance, density and strength of its relations with other entities.

In the context of this philosophy, information cannot be understood either as a realistic representation of an external world, nor merely as a social construction.[5] It is more than just a social construction because the object which is represented plays its part in the production of information. Reality is not a blank screen onto which social categories can be

projected: 'there is nothing in the real world which is merely an inert fact. Every reality is there for feeling: it promotes feeling; and is felt.'[6] At the same time, scientific information is both more and less than a realistic representation of the world, because to produce information demands a practical and technical intervention in the world which necessarily abstracts an object from the complexity of its environment. In this view, information can be true in the sense it can be accurate, but it cannot be True, if by Truth we mean a representation of an essence which exists independently of a more or less standardised and socially sanctioned set of practices of measurement or experiment.[7] The production of scientific information does not mirror the world as it is, but forges something new, with more or less inventive consequences. It multiplies realities.[8]

In this chapter, I focus on one apparently mundane example of scientific information: information about the quality of urban air. The chapter has two themes. One is a story of a political and scientific event. This a story of how the European Union figures as an event in the history of the air, and how urban air plays a remarkable part in the history of the European Union as it unfolds in a small area of south London. It is a story about how the chemistry of the air becomes political, and how 'air quality' becomes part of a transnational technological zone. The second theme of the chapter is an argument about information, science and politics. Here, I argue that the production of information can displace other forms of political and scientific activity. In this case, there is a conflict between an ethic of scientific conduct with an orientation towards truth, and a political project which emphasises the importance of information dissemination and active citizenship. Here, the imprecise and uncertain truths of scientific research are displaced by the far more numerous and precise measurements produced by monitoring the quality of the air. If the European Union can be seen as an event in the history of the air it is one which, I argue, has had *anti-political* effects.

MONITORING ZONE

Drivers travelling along the congested main road from the West End of London towards south-east England and the Channel tunnel (the Old Kent Road) pass a small sign 'You are now entering an air quality monitoring zone.' Below this text there are the emblems of the European Union and the local authority, the London Borough of Southwark, and a logo in the middle of which are the words 'air aware'.[9] On the other

side and a little further along the road from the monitoring-zone sign, next to one of the few green spaces in this deprived inner-city area, is a much larger electronic noticeboard which gives information about the quality of the local air 'in real time'. Elsewhere in the borough there are smaller noticeboards (in hospitals, neighbourhood centres and public libraries) which carry similar news. Interspersed between public housing estates and petrol stations are a few large stores (Toys 'Я' Us, Tesco, B&Q), drive-in McDonalds and KFC, and local shops which advertise cheap international telephone calls. This is an area marked by multiple lines of flow and forms of regulation. The traffic to and from France and Belgium rarely stops in Southwark. The air-conditioned interiors of McDonalds and Tesco are insulated from circulation of exhaust fumes. And beyond subsidising the efforts of the local authority to monitor air quality, the European Union has no visible presence in this part of London. Here, in south London, movements of capital, commodities, persons, exhaust chemicals and pollution measurements have the same coordinates in Cartesian space and time, but they do not necessarily interact. In Arjun Appadurai's terms there is a marked disjuncture between the scapes or zones formed through the circulation of technology, finance, media and persons.[10] In these circumstances, as Paul Virilio has suggested, the technological zone formed through the production and circulation of common forms of environment measurement appears to function as a system which exists more or less autonomously from its immediate urban environment.[11]

The sign on the Old Kent Road is the only visible manifestation of the presence of the European Union in this area of London. But it is also one indicator of what has become a remarkable transnational political project. Air, along with a whole host of other objects, from sea water to meat, are subjected to increasing levels of *continuous* monitoring. To be sure air quality has been, in London and elsewhere, a concern for some time. As early as 1821 a bill was put before the House of Commons to facilitate local prosecutions of owners of steam engines by parties suffering damage from their smoke.[12] And following the infamous 'smog' episodes of the early 1950s which resulted, it is thought, in thousands of deaths, research on air pollution and its effects acquired a higher profile than it had hitherto.[13] Yet the intensity of interest in monitoring, and the extraordinary level of public information which has resulted from it, is a more recent phenomenon. Monitoring stations have been established across London, and, by the early 1990s, had begun to form part of

a series of both London-wide and national monitoring networks.[14] In Paris, by 1991, there were no less than eighteen-air-quality monitoring stations which could measure up to fifteen pollutants in 'real time' and thirty more on specific projects.[15] In Berlin, there were nearly forty stations.[16] In the UK, the environmental pressure group Friends of the Earth (FoE) has continued to call for an increase in monitoring work, as well as putting in question some of the ways monitoring has been done. Moreover, encouraged by FoE and other groups, an increasingly environment-conscious press criticised the Department of the Environment for its failure to maintain an adequate monitoring programme despite an annual budget of £5 million.[17] More monitoring, it seems, led to greater political visibility of the 'air quality problem', particularly following the notorious smog episode of December 1991, during which extraordinarily high levels of air pollution were recorded across the capital. In turn, this visibility contributed to the case for more monitoring. In 1995 the UK government, following a European directive, demanded that all local authorities set up their own local air-quality-management strategies and establish air-quality-management zones. Both in order to promote public awareness and in the interests of open government, Department of the Environment air-quality data became freely available, in a frequently updated form, from the Department's own web site and telephone information line.[18] The public needed to know both the good and the bad news. George Myerson and Yvonne Rydin note that a form of 'reassuring realism' is a common feature of official pollution texts.[19] The realism is both scientific and moral, although it is framed in a discourse which maintains a distinction between the scientific and the moral. Because the information is realistic it *has* to be taken seriously.

The concern to monitor, assess and inform was not just the product of a national political initiative, even if it has taken quite specific forms in different countries. Indeed, the recent surge in political interest in urban air quality may have begun in the state of California which, as Wyn Grant reminds us, 'has been a global pioneer in the development of urban air quality management strategies'.[20] But in the wake of the electoral performance of green parties in the 1989 European elections, such North American concerns became quickly translated across the Atlantic. The European Community, in particular, made the quality of the urban environment an object of a whole series of policy interventions and regulations with research programmes being established in areas

such as epidemiology and environmental telematics.[21] This would lead, as one Commission official put it, to '*empowerment through information*'.[22] In this vein, the Commission's 1990 Green Paper on the Urban Environment called for more comparative information on the state of the urban environment in Europe, and for more effort to be put into informing the 'different sectors of the population of the Community's policies and measures' through setting up a 'network of urban local initiative centres'.[23] In this way, the environmental concerns of Europe's urban populations and Europe's urban administrations would be connected together. Increasingly the World Health Organisation also took a more active and influential concern with the state of the air,[24] establishing a succession of guidelines for Europe, as well other parts of the world. In short, air – and the *urban air* in particular – became the object of a vast, if not necessarily integrated, global zone of monitoring and research.[25]

The 'air quality monitoring zone' in south-east London was established originally as part of the European Union LIFE programme.[26] It is true that, prior to this, Southwark Council 'had already invested in "state of the art" automated pollution analysers to monitor *background* concentrations of significant pollutants (nitrogen oxides, carbon monoxide, sulphur dioxide, ozone and radiation)'.[27] There is no doubt the reasons for the remarkable interest in air quality in south London was the result of a complex set of quite specific local circumstances, actions and motivations. In particular, the Labour Party in Southwark were, unlike in most other areas of east and south London, faced by a strong Liberal Democrat group in the council, and promoting 'air quality' provided one way of outflanking the traditional Liberal concern with environmental matters.[28] But air quality was more than just an object of local party politics. For LIFE money would put Southwark not just ahead of other London local authorities in the development of air-quality monitoring, but at the leading edge of current European thinking. It would demonstrate the usefulness of 'advanced technology' to reduce air pollution *and* increase 'public awareness'.[29] Indeed, the monitoring zone was just part of larger project funded by LIFE in Southwark. There was, for example, an exhibition at the Council's Livesey Museum on the Old Kent Road and videos and an interactive CD-ROM produced with the intention of fostering a new culture of environmental awareness amongst local schoolchildren. There was also a sophisticated system for real-time air-quality information to be networked, via computer, to a local public

research organisation: the South-East Institute for Public Health, which coordinated and compared air-quality data from local authorities from across the capital. It was the pride of local Labour councillors. 'Southwark Council wanted to do something positive for our residents' reported Councillor Nick Dolezal at an impressive conference held jointly by Southwark and the European Commission to demonstrate the achievements of LIFE at the recently opened Rotherhithe Holiday Inn. The conference was attended by local-authority representatives from throughout the UK, Commission officials and one Member of the European Parliament and hosted by the presenter of the early evening popular TV show, *London Tonight*.[30] The setting and the presence of a 'television personality' was not just incidental, for if pollution-monitoring data was to exist in the form of public information it required publicity. Information is much more than data; it demands an audience. Spectacle, advertising and publicity have long had, and continue to have, an important place in the history of science.[31]

EXPERIMENTAL DEVICES

The monitoring zone and the publicity surrounding it were important. They were indicative of the extraordinary significance accorded to 'air quality' in forging a connection between a local authority, Europe and the citizens of London. But perhaps one of the most remarkable features of the local council's effort to put itself at the forefront of the new air-quality movement, were two experimental devices called FEAT and SMOG DOG™. Whether it was due to their lack of any awareness of European developments, or the weakness of the European environmental-technology industries, Southwark officials had been drawn to the work of US manufacturers. The Fuel Efficiency Automobile Test (FEAT) was promoted by its designer Don Stedman from the University of Denver, Colorado, who met with Southwark Council officials at an Edinburgh hotel on a visit to Europe in 1993.[32] SMOG DOG™, which was similar in design, was developed and marketed by the American defence and aerospace firm Hughes Corporation at its Santa Barbara Research Center, and applied 'advanced technology developed for environmental monitoring from space'.[33] FEAT and SMOG DOG™ promised to identify individual polluting vehicles and, moreover, to report the results in real time. An infrared source made it possible to gain

data on instantaneous emissions of carbon monoxide, nitrogen oxides and hydrocarbons as the vehicle passed by the detector, and an automatic licence plate reader (ALPR) could 'translate and digitally record a vehicle's alphanumeric licence plate number from the video image'.[34] According to its manufacturers, SMOG DOG™ had already proved highly successful in the US. Indeed, in April 1996 it was selected for the Association of Commuter Transportation *Best Product Award* at their annual western regional conference in Los Angeles.[35]

US remote-sensing technology certainly played a critical part Southwark's bid for LIFE money. It was, according to Council officials and scientists associated with the project, the feature of the bid which made Southwark's project innovative at a *European* level. At a time when Southwark had almost no contact with the European Commission of whatever kind, and no European strategy, and no track record as a participant in European programmes, Southwark's interest in experimentation was considered to be crucial to the success of the bid . By being able to claim that it could monitor the polluting emissions of cars *in real time*, Southwark could contribute to the emergence of an environmental (and technologically advanced) Europe at the same time as Europe could contribute to the health of Southwark. In short, through using the most advanced instrumentation Southwark could demonstrate that it was part of a European project in which technology played a central role. It could become part of what I have termed a technological society.

To be sure, the novelty of remote sensing was not the only distinctive feature of the Southwark bid. Another was the Old Kent Road itself. The Old Kent Road was the entry point for a significant proportion of road traffic from continental Europe coming into central London. It was the beginning of the A2 trunk road which brought visitors to Britain from Dover, the Channel tunnel and the French and Belgian ports. It was a journey which, no doubt, some Commission advisors and officials may have experienced: a continuous traffic jam for five miles. In maps produced by Southwark Council, the Old Kent Road is represented as a line running from London to the Channel, yet in its evident congestion and pollution it was certainly an unsatisfactory link to the Continent.[36] Viewed in this particular frame, remote sensing could, at more than one level, at least ameliorate the impoverished connections between England and 'Europe'.[37] Elsewhere on the road, different networks were being maintained by private financial means. A few local business people had taken advantage of the deregulation of telecommunications and opened

up shops from which local residents could make cheap international phone calls: to the Caribbean, the USA, Turkey and the Phillipines. Here there was a disjuncture between the ethnoscapes marked out by the frequency and destination of international phone calls, and the technoscape which was to be established through the development of a European network of environmental monitoring.[38]

In Southwark, remote-sensing technology was actually used in a quite specific way. In principle, FEAT and SMOG DOG™ made it possible to monitor the emissions from individual vehicles. To this end, the first experiments were conducted outside Pursers, the local Volkswagen main dealer, situated roughly half way along the Old Kent Road, between the Elephant and Castle and New Cross, as well as on a number of smaller roads nearby.[39] As cars passed the infrared sensor, readings were taken of the levels of emissions of carbon monoxide and hydrocarbons. At the same time, speed measurements were taken together with an estimate of the age of the vehicle read from a frozen video image of the plate. In this way, the data collected formed one input into a series of studies concerning both the effectiveness of the monitoring and the polluting effects of motor vehicles.

Yet the objects of Southwark's studies were not just the motor vehicles or the behaviour of remote-sensing devices but the consciousness and behaviour of the *drivers themselves*. In a speech, the then British Prime Minister, John Major, had once declared that 'every individual and every group will in future have access to the information they need, *in order to act as an environmental watchdog*'.[40] At a very immediate and practical level, remote sensing promised to help motorists acquire the information to do just that. Following a high reading by the remote-sensing equipment a policeman would be instructed to stop the vehicle further down the road. As a local metropolitan police superintendent noted, apparently reworking the Prime Minister's canine metaphor, the police 'added teeth' to Southwark's activities, even if they were not as sharp as they would like.[41]

After it had stopped, the vehicle was then subjected to a road-side test, with an idling engine, which took the same form as the 'MOT test', which is required to be carried out on motor vehicles once per year by law. At the same time, the driver was given an information pack 'explaining the "polluter pays" principle and the aims and objectives of the road-side emissions testing scheme'.[42] In this way, it was hoped that the driver would become 'exhaust aware', and hence be motivated to modify his or

her behaviour. The Southwark watchdog, observing the constraints of the existing law, was intended to be benign in its behaviour to the motorist, however sharp its teeth might be. Indeed, the operation of the remote-sensing device, it seemed, provided the basis for the driver to be 'hailed' or interpellated, as Althusser would say, as a free and environmentally responsible citizen.[43]

How effective could remote sensing be, in realising the complex set of expectations to which it was subjected? There was no single answer. In the United States it was said to have performed well and, indeed, to be in operational use in the state of California. Certainly, in its early publicity Southwark Council had extolled the virtues of the new devices. The transport minister, Stephen Norris had launched what was called the 'air pollution machine' on 23 June 1994 at an event which was reported in the national press and national and local radio networks. And in 1995, a reporter from the BBC popular consumer affairs programme, WATCHDOG, was convinced enough to state that the Southwark initiative 'was arguably the number one consumer story of the year... because every consumer has to breathe this air'. Many more local and national press reports followed.[44] This publicity was not just a by-product of the project, but an integral feature of it. For it was intended that remote sensing would not just alert the *individual* driver, but increase *public* awareness of the air-quality problem and, hence it was hoped, contribute to a shift in public behaviour in general. A small experimental device was not just an instrument for the insertion of a London borough into Europe, but also for a much more far-reaching political project directed at the problem of changing popular environmental consciousness.

Yet would remote sensing really prove as effective in the UK as it was said to be in United States? There were two reasons for thinking otherwise. On the one hand, in North America most vehicles were fitted with catalytic converters which were extremely polluting when the catalyst failed. In these circumstances, remote sensing might be a good way of spotting failed catalysts, but would it be of any use when applied in the UK where catalysts were less common? Second, in the UK, the MOT test, which was performed on a stationary vehicle produced quite different results to the remote-sensing device. However, when the device was used, many vehicles 'failed' the remote-sensing test, but passed the MOT test, or vice versa. This was not surprising, for the two tests measured different things. In effect, the MOT test measured a particular vehicle, but in a way which could not correspond to the emissions of that

vehicle on the road. Remote sensing only measured the concentrations of gasses being emitted from a vehicle on the road at a particular moment in time. The results of a remote-sensing test did not refer to a vehicle, but to *a moment*. Given this limitation, could an image of a machine-moment be translated into an image of a machine at every moment? Was the idea that remote sensing actually detects polluting vehicles (and not just polluting events) an illusion which could be sprung on an unsuspecting public? Would the doubtless dramatic effects of remote sensing subsequently pale when subjected to further illumination by science or the law?

In the UK, a public controversy over the utility or otherwise remote sensing had developed as early as 1994. The issue emerged during the inquiry by the House of Commons transport select committee into 'transport-related air pollution in London' in June 1994. Prior to the Commons committee inquiry the government's own Transport Research Laboratory (TRL) had already begun to test the new remote-sensing technology, seeking to find out whether there was any correlation between the results of remote sensing tests and the (legally significant) measurements taken by the MOT test. According the Department of Transport the results of the TRL research, at the time, were not encouraging and 'we see no immediate prospects of such a device becoming a practical reality'.[45] But, in their memorandum to the committee the motoring organisation, the Royal Automobile Club, claimed that the whole approach of the government research project was 'misguided'. RAC researchers had themselves used American remote-sensing technology as 'a research tool ... to create the largest bank of information on emissions in Europe' which 'identified very clearly the existence of "gross polluters"' for over 'half the emissions of carbon monoxide comes from only 12 per cent of the vehicle parc'.[46] In the RAC view there was not likely to be any exact correlation between the remote sensing and the MOT test (because they measured different things) but this did not mean that the remote-sensing test was without value. On the contrary. 'We see clear potential for the remote sensing of vehicle emissions within a roadside regime targeted at gross polluters'.[47] In short, remote sensing could be used by the police to stop and to fine drivers who failed to maintain their cars properly. To be sure, it was not a 'technological panacea' but it was one of a number of measures which could make motoring more environmentally friendly.

The select committee agreed with the RAC. Stopping cars randomly was expensive, and in any case, despite the existence of the appropriate

legal powers, had not been tried to any significant extent. Moreover, the committee had noted the desire of the Metropolitan police to have a 'suitable emissions detector' which would provide a reliable basis for stopping polluting motorists, for as the police had observed 'people who fail to maintain their engine also [frequently] fail to maintain other parts of the vehicle'.[48] Far from being a device with little prospect of becoming a practical reality, Members of Parliament pressed for a vigorous programme of research into remote-sensing technology in order to '*permit the Metropolitan Police to receive an early answer to their request for approval of an emissions detector*'.[49] This was essential. For with only 'a purely visual test of excessive emissions' (by the police) it would be difficult to fulfil the promise made by the Transport Minister at the 1994 Conservative Party conference who, adapting the traditional vocabulary of law and order, had called for a 'high profile national city centre crackdown on vehicles exceeding prescribed [emission] limits'.[50] If the government was going to be tough on pollution and tough on the causes of pollution, then it would need the appropriate scientific, as well as legal, instruments. This was completely at odds with the cautious conclusions of the TRL scientists. But the government scientists were unaware of the implicit criticism that had been made of their conclusions. Perhaps not surprisingly. For the duty of the government scientist was simply to give technical advice to ministers, not to engage in public debates about policy. Moreover, increasingly government scientists were seen as something like commercial contractors.[51] They simply carried out the terms of a contract to government. They were not responsible for the fate of their work subsequently. The domains of the scientific and the political were, in this arrangement, clearly distinguished. In effect the imprecise truth articulated by the government scientists ('emission detectors do not work in the ways that are claimed . . .') was displaced by a desire for an exact, precise and automatic instrument on the part of the public authorities.

In Southwark, these political and scientific positions were given a new twist, and different resonances. Southwark, along with most local authorities, did not possess specialist scientific expertise in air-quality monitoring.[52] They therefore contracted a physicist from the University of Greenwich to conduct her postgraduate research work on the remote-sensing device, although they were also able to draw on some support from the TRL. The Southwark researcher was sceptical of the value of the remote-sensing device. On the one hand, the figure of 12 per cent 'gross polluters' was highly misleading and had to be given a 'health warning'.[53] To be sure 50 per cent of emissions measured by the detector did come from 10.9 per cent of measurements, but this did not imply that 10.9 per cent of cars caused 50 per cent of the emissions. For the emissions measured by remote sensing depended on a complex series of factors, including the speed of the car, whether the engine was cold and whether the road was congested or freely moving. In these circumstances it was quite difficult to determine whether any particular car was a 'gross polluter'.[54] This was clear when measurements of the same car were taken on a number of occasions. For according to the Southwark data, approximately 80 per cent of vehicles which exceeded a given threshold for high emissions on two occasions have a third emissions reading that is below the threshold.[55] A car which appears to be a 'gross polluter' on one or even two occasions is not necessarily likely to be one on a subsequent occasion. There was some correlation between the results of tests on the same vehicle, but not that much. There was no doubt that some vehicles were more polluting than others, but it was unclear whether a particular fraction could be classified as 'gross polluters'.[56]

In their official report on the project, however, Southwark Council refrained from these rather sceptical conclusions. The various studies of SMOG DOG™ and FEAT were classified as either 'successful' (of which nine were) or 'unsuccessful' (as one was). Whereas the researcher appears to have expressed considerable doubts about the utility and cost-effectiveness of remote sensing, these concerns were down played in the official report which argued that remote-sensing devices are 'the most promising screening tools currently available' enabling them 'to be used as a "green" equivalent to the speed or "gatzo" camera' which had already become a common feature of London's roadsides. At the same time, remote sensing could provide an effective means of acting on the elusive problem of bad driving through raising awareness amongst polluting drivers of the effects of their behaviour.[57] Moreover, in publicity produced by the European Commission's Task force on priority information projects, the inaccurate interpretation of the statistics of remote-sensing experiments was repeated. 'Research suggests that a minority of vehicles contribute a disproportionate amount of pollution, with perhaps 10 per cent of cars generating 50 per cent of emissions'.[58]

Moreover, whatever its costs, remote sensing had one further advantage over other methods. It was remote. It did not discriminate on the basis of any *visible* feature of the vehicle and its occupants. Informally, it was remarked, by some, that SMOG DOG™ and FEAT could not be

subject to the accusation of racism sometimes levelled at local police officers. Racism was a problem. Two years after the air-quality experiments, British National Party posters were placed on top of Labour Party election posters on the same stretch of the road. Officially, Southwark Council simply noted that although stopping older cars on sight might be a cost-effective way of finding polluting cars, 'it would lead to poor relations with drivers reducing the prospect of being able to work positively with motorists to improve awareness and change behaviour'.[59] Remote sensing was not just at the cutting edge of European environmental technology, it was democratic in its *indifference* to surface appearances.

It might be said, from this account, that Southwark (and before them the RAC) were guilty of a kind of cover-up, whether deliberate or unconconscious, by hiding the real deficiencies of remote sensing. Perhaps. But from a certain perspective such devices could work better than alternatives, especially given the financial costs of using expensive human policemen for environmental policing and the political dangers of discriminating against motorists simply because their cars were old. However unsatisfactory it was when scrutinised by physicists, the remote-sensing device looked impressive in public. When given its role as an environmental watchdog, it looked as if it could *perform*. It is sometimes suggested that scientists and experts dominate public debate. But the situation here was that scientists *did not* have sufficient voice to question in public the enthusiasm for remote sensing, even if they so wished.[60] The desire (and the availability of funding) to be part of a European technological society displaced a scientific concern for truth.

In any case, now that the environment was becoming an increasingly European and not just a national political problem, the situation was different. When seen in *European* terms the cars in London could look rather unusual. They caused pollution when they were old, poorly serviced, badly driven, sitting in a traffic jams or accelerating rapidly. But elsewhere in Europe, cars were increasingly similar to American cars. Many had catalytic converters. Unlike British vehicles, perhaps they could be classified into 'gross polluters' and others. Moreover, in its continuing, and no doubt over-determined, enthusiasm for environmental telematics, the European Commission pressed ahead with its research and development programme. Whether it was needed or not, Europe would be connected together by a dispersed network of real-time monitoring devices. Remote sensing could supplement this fixed monitoring network. In this way it might have a practical role in improving the European environment after all.[61]

PUBLIC CONSCIOUSNESS

In what form should the information generated by all the various forms of monitoring be presented? What was its real audience? For Friends of the Earth, the immediate audience of monitoring was clear: the mass media. For the environmental organisation, monitoring provided a critical way of both raising public consciousness of the problem and of putting pressure on the political authorities. Of course, FoE did not have, and could not afford to have, the scientific expertise to carry out a continuous monitoring programme or, for that matter, the more experimental form of remote sensing tested in Southwark. But for many years the organisation had prided itself on the *scientificity* of its analyses.[62] Science was regarded as an effective political means of visualising environmental problems in the public arena. In this context, FoE would periodically commission what we might term spectacular measurements of pollution which were intended not so much to be part of any sustained scientific programme of measurement, but to simply display the existence of the problem.[63] As we shall see in chapter nine, FoE was ambivalent about any form of association with militant forms of political demonstration. Instead, it delegated commercial and public scientific institutions to form scientific and technical demonstrations on its behalf.

But if the audience for the occasional monitoring performances of the FoE was clear, what was the audience which desired the regular, detailed and, without doubt, tedious information which could now be produced by the network of monitoring stations currently operated by national and local government? There was no certain answer. To be sure, various governments had conducted surveys on 'public awareness' of the problem of smog, finding it, according to one local-authority commentator, second only to dog fouling in the popular consciousness of environmental problems. In a telephone survey commissioned by the Department of the Environment no less than 40 per cent of interviewees had heard or read news about traffic pollution problems 'recently'.[64] But knowledge of how, or whether, pollution information figured in the decisions and calculations of everyday life was very limited. The public authorities knew little about the conditions within which information was received or in what way it might be used by individuals to take

responsibility for their actions. 'Market research studies after summer smog episodes ... suggested that, respectively, 10 per cent and 18 per cent of drivers surveyed said that they had decided not to use their cars on at least one occasion during the high levels of pollution'.[65]

In any case there were reasons to doubt whether 'the public' could become *interested* in the monitoring project, at least as it had been first conceived.[66] In the first place, according to one report, the chemical terms used to express the results of monitoring were, for the most part, meaningless or misunderstood except by specialists. The public did not classify pollution in terms of entities such as SO_2, NO_x, ozone, particulates, PM_{10} or VOCs. Detached from their network of connections to specific concepts and devices in the scientific literature, the reference of these terms disappeared. Or drifted onto other objects such as the ozone layer. This did not mean, of course, that the lay public had no knowledge of pollution. Indeed, in a certain sense, public knowledge of pollution was as complex as – if not more than – that expressed by government agencies.[67] It referred to a whole series of causes (traffic, aircraft, sprays, fires, government policy and power stations), to effects (coughs, asthma, headaches, fatigue and irritability) and to visible forms (dust, haziness, fumes). Set against this complex body of understanding, official statements on air quality seemed to have limited value. Indeed, far from being induced into action by up-to-date air-quality information, the predominant response was one of 'fatalism'. Even asthmatics and bronchitis sufferers were, according to the report, often indifferent to information: for they knew anyway and could not do anything more.[68] Perhaps all the efforts to increase the speed of information flow could have the opposite effect to that intended. Far from fostering a sense of agency and self-government, it seemed it could lead either to passivity, or worse, to a sense of panic.[69]

Despite the expression of such doubts about the engagement of 'the public' with the air-quality problem, they did not undermine the support for more monitoring and public information in policy circles. On the contrary. For in so far as such arguments are listened to they lead, if anything, to a search for more comprehensible and *user-friendly* ways of presenting the data, and the development of approaches which are attentive to the needs and understandings of specific publics. Anthony Giddens has argued that there has been a general sense of a loss of public trust in abstract systems during what he has termed 'radical modernity', although he presents no empirical evidence for this assertion.[70] In this

case there is no clear sense of a lack of trust in technical information, even though one would be justified, merely an indifference.

A FRAGILE ARRANGEMENT

What is remarkable about the story of air quality is the extraordinary level of political investment in the chemistry and 'quality' of the air. A few chemicals (NO_x, SO_2, CO, etc.) are placed at the centre of a rapidly expanding arrangement of political alliances, policy directives, technological transfers, financial flows and measurements and assessments of 'public opinion' involving, amongst other bodies, local authorities, environmental groups, the Environment Directorate of the European Commission, the Metropolitan Police and the World Health Organisation. The concentrations of chemicals which make up 'air quality' are not merely of common interest to these organisations. They have a critical place in forging a network of connections between them.

But can this extraordinary political and technological alliance be maintained. Are the links between 'air quality' and 'public health' firm enough? Can information on air quality produce subjects who are capable of making calculations of the health risks of living, driving and walking in the city? Can it lead to rational action?[71] There are two sets of reasons for thinking otherwise. One reason is that 'air quality' is not just a property of the urban air in general, or even a property of the air at a particular time and place (such as behind a moving vehicle), it is an expression of a relation between air and the government of an urban population. Records of air quality were public information. The political strategy of the political authorities was based on the idea that scientific techniques could provide precise and irrefutable accounts of the links between polluting chemicals and the health of the population. For only on the basis of such guidelines concerning 'safe' levels of pollution could the authorities, and the public, *act*. Yet the basis on which precise guidelines could be established was contestable.[72] Potentially at least, these scientific foundations of political action could be undermined. At the very least they would have to be constantly repaired and replaced.[73] Why? First, because in the case of some pollutants there were reckoned to be no 'safe' levels, and in the case of others the existence of particular 'safe' levels was simply an artefact of existing measuring techniques. Inevitably any estimate of what was 'safe' in the present, would have to be changed in the future. Actions which were once thought safe, would

become dangerous. Second, because the link between measurable forms of air pollution and the incidence of some health problems (such as asthma) was difficult to establish or may even not exist, suggesting perhaps that increasing levels of asthma may be caused by 'invisible' increases in allergens.[74] Third, because existing ways of monitoring pollution do not measure the pollution which individual citizens have to breathe. Pollution is monitored at particular *points* in the city, yet the level of pollution will give a very misleading idea of levels of pollution in the city as a whole, for such levels could vary 'radically within metres of each other'.[75] Necessarily, an individual wandering through the city, driving a car or working on the streets, would experience a quite different level of pollution to that measured by an electrical device operating in one place. The ways in which persons breathe, cough and cover their faces with masks was unrecorded. The ways in which individuals negotiate the city streets in different ways are never tracked, and probably never could be. But the value of current practices of air-quality monitoring would be undermined by an experiment which would estimate not pollution in one place, but which would measure the concentration of chemicals which might be absorbed into a *moving* body. The electrical device would move with the experimental body. In this arrangement, the exposure of bodies to the chemistry of the urban air would have to be continuously monitored. In such an experiment, the body of the citizen would be integrated into what we might call, following Elizabeth Grosz, an urban 'information machine'.[76]

Yet there is a second set of problems. For not only is the topology of urban space much more complex and multi-layered than one might imagine: so is the space of international scientific relations which sustains the existence of 'air quality'. Decisions about what should be taken to be 'good quality' air are made at a whole variety of levels – the national, the regional, and the global – and in a complex set of institutions from the World Health Organisation to the European Environment Agency.[77] Moreover, air-quality standards rely on assessments derived from a series of scientific disciplines and techniques (air-pollution chemistry, epidemiology and toxicology), the claims of which are controversial and uncertain in themselves, and extraordinarily difficult to draw together. Chemists, epidemiologists and toxicologists will have different answers to the question of what is 'good' quality air. In these circumstances, there is always a possibility that differences in the position taken at an international level may be used to undermine the authority of a national

or local body, or vice versa. Of course, considerable efforts are taken to ensure that there is international *harmonisation*. But this is difficult to achieve. Different administrations have different political cultures and priorities, and different ways of deploying and drawing together the claims of different forms of scientific expertise. They face different political pressures, which may have little to do with a concern for the environment.[78] It would be extremely surprising if there were any coincidental agreement between the approaches taken by different political bodies. At the Southwark LIFE conference in 1996, an official and a scientist from Paris outlined the extraordinary sensitivity of the city's classification of air quality which was reported in no less than ten bands ranging from 'excellent' to 'very poor'.[79] For the majority of the audience it seemed that this seemed to confirm the existing British classification of air quality. But there was also, perhaps, a certain defensive amusement. For the extent of the difference between what good quality air meant in Paris and London seemed to undermine the possibility of making the kinds of distinctions which, in Paris at least, were thought possible. In the UK the idea of distinguishing between ten air-quality bands was too precise. *The* quality of the air, and its effects on the population, has appeared remarkably elusive. 'Air quality' has multiple realities depending upon the conditions and circumstances within which it circulates.

SCIENCE, INFORMATION, POLITICS

In writing about the relations between science and politics, many writers have been drawn to one of two positions. One view, which seems common-sensical, is simply to keep science and politics separate. In this view, scientists convey neutral advice, on the basis of which it is possible to act or not. The chief threat to science, in this view, is its politicisation. A second, which has become increasingly fashionable, is to reduce science to politics, and to read into scientific controversies the play of social and political interests. The chief threat to politics, in this view, is a failure to recognise the political interests which inform scientific judgements.

Here, I have argued there is nothing mysterious about the relation between science and politics. The production of scientific information involves a double movement. On the one hand, the production of knowledge is a creative act. Reality is not merely reflected in the form of information or knowledge: it is creatively worked with and acted

upon. In this case, measurements of 'air quality' do not reflect the essence of real air prior to the activity of measurement, yet they can be produced from it. This abstraction can be seen as an event in the history of the air; an event which establishes a new relation between 'air quality' and the conduct of citizens, scientists and public authorities.[80] Second, in order for the new object of information ('air quality') to be produced it must be sustained and circulated. This necessarily depends not just on the use of scientific procedures and techniques, but also on political negotiations and bargains, government grants, financial deals and publicity. The survival of scientific information *as information* relies on the existence of a vast and increasingly transnational arrangement of technical, political and economic resources and agreements as well as more localised and 'dirty' forms of political bargaining. The existence of 'air quality' depends on whether a series of connections can be maintained between air and the institutions which measure it and finance this measurement.

Seen in these terms, scientific information always has the potential of becoming recognised as political. First, its existence places demands on those who know, or who are expected to know, it. The very idea of information implies a relation between a set of natural or social entitities which are objects of knowledge and a set of actors who are or should be informed or knowledgeable. In the case of air quality, its existence as information has created extraordinary (and unrealised) expectations on the part of those political authorities who support its production.[81] In this particular case, the production of information has had an *anti-political* effect, serving to displace the problem of air pollution, and deflect other problematisations and other demands for other forms of action. As Yvonne Rydin has argued: 'the policy area of urban air quality management has been marked by the attempt of the state to resist pressure to act, to withdraw from responsibility, to turn away from the impossible problem without losing face'.[82] Nonetheless, this anti-political solution may be undermined by scientific research itself, which may open up the question of the particular way in which 'air quality' is defined and measured. Scientific research often serves to disentangle objects from the complexity of the social and political situation of which they are part. But in raising questions about the production of scientific information, it may also serve to reinscribe and re-entangle such objects in a political situation.[83]

Second, scientific information can become recognised as political given its necessary reliance on a set of technical procedures, financial resources,

disciplinary formations and legal regulations which sustain particular historical forms of its existence. There is no single solution to the question of how the resources and devices necessary for scientific research should be organised and managed. Historically, philosophers and sociologists have sometimes imagined a clear distinction between an autonomous scientific community and a realm of public politics. In practice, this distinction between 'science' and 'politics' takes different historical forms, and is uncertain, negotiable and in process.[84] In the particular case discussed here the distinction is essentially a contractural one: scientists are contracted to carry out research for the political authorities but have no direct responsibility for its public presentation.[85] The effect of this contractual relation is to create a tension between a scientific ethic and a political project. Here, the former stresses the importance of telling the truth about the limitations and imprecision of instruments and the uncertainty of scientific knowledge claims. The latter emphasises the strategic importance of information production for the government of a technological society. Given their contractual dependence on the public authorities, and their marginal presence in public space, scientists have little opportunity to question this strategy. In this context, the realisation of the political project has anti-political effects, in opposition to which scientific arguments can become a form of political intervention. Sociologists and political theorists tend to draw an opposition between the certainties of science and the undecidability of politics. But the opposite can equally be true. The uncertainties of science can have political effect in opposition to the rigidities of what we call politics.

As we have seen, the government of a technological society has implications for those who are governed. It implies the need to be knowledgeable, up-to-date, adaptive and inventive. It is thought to demand not just new cognitive capacities but a more experimental body and a more informed mind. In an analysis of the sociology of markets Michel Callon has argued that 'the true question concerning the state is this: how and with what methods and efficiency does it contribute to the performation of calculative agencies and the organisation of their relations?'[86] In this case, we must equally ask the question of the effectiveness and efficiency of the local state in producing agencies who calculate the consequences of their behaviour on the basis of environmental information.

But if the government of a technological society has implications for its citizens it also has consequences for its non-human objects. Today it may be impossible to identify a realm of 'nature' which is distinct from

human intervention. Air, water, grass, persons and animals are all artefacts, made up of interacting and mutating complexes of 'natural' and 'manufactured' elements. Whitehead speaks of the plasticity of the environment resulting from advances in scientific technology.[87] Yet the government of a technological society introduces a further order of artificiality. Its substances and political preoccupations ('air quality', 'genetic material', 'software') are themselves *artefacts of artefacts*. The political demands of a technological society constantly put new objects into circulation.

8

DEMONSTRATIONS: SIGHTS AND SITES

GOVERNMENT AND OPPOSITION

In this book I have sought to be irreductionist about the conduct of government. First, following the work of Michel Foucault, I have not sought to reduce the study of government to the question of the state, but rather understood government as a set of practices and technologies of governing which operate across distinctions between state and market. Second, following the arguments of Bruno Latour, Michel Callon and others I have sought to be irreductionist about the materiality of government. Government does not rely just on the conduct and properties of persons, but on the actions of a whole array of technical objects from pollution-monitoring devices to interactive media. Today, government has come to take a particular technical form, and many political, economic and cultural institutions have become preoccupied by the potential of new technologies. The production of new technologies and artefacts has come to be seen to be an increasing part of the solution to the problems of government, and the very language of governing has increasingly drawn freely from the conceptual vocabulary of new technology.

But if government is such a technical matter then what of contemporary political protest? If we need to rethink what is involved in government today, then how might we rethink the conduct of political action and 'resistance'? Is resistance simply opposed to power? One of the accusations often directed against the work of Foucault and Callon and Latour is that whereas their analyses have much to tell us about the importance of technology to the exercise of political power, they have little to say about political action or political conflict, or the actions of those who are excluded. In responding to these accusations, this chapter aims to show how might one be irreductionist not just about the conduct

of government, and the dynamics of science and technology, but about the conduct of political protest as well. In what way can one talk not just of the materiality of practices of government, but also the materiality of political conflict?

In this chapter, I address the question of political protest through an analysis of public demonstrations. The chapter develops two interrelated arguments. First, I argue that there are significant similarities between political demonstrations and scientific and technical demonstrations, and many of the questions addressed by those concerned with the study of scientific demonstrations can also be raised by those involved in the study of politics. In interrogating the conduct of scientific demonstrations, historians have sought to understand the complex relations between the social site of demonstration and the kinds of persons and devices deemed necessary for a demonstration to be performed. Likewise, an analysis of the conduct of a political demonstration may demand careful attention to the technology and ethics of telling and witnessing the truth and the ways in which sites of demonstration are made. Demonstration is a technical, ethical and spatial practice.

Second, I suggest that if we are to understand such actions and to take them seriously as political *events*, we should not look for the existence of political identities or ideologies or social movements which lie behind such actions, but rather look to the actions themselves.[1] In political sociology, political action is often viewed as merely an expression of something else which lies behind it whether this something else is conceived of as a social movement, or a political ideology or an identity.[2] Yet in its preoccupation with social movements and ideological conflict, political sociology neglects to analyse the objects, technologies and practices of political action. Moreover, it has tended to assume that social and political identities can be taken as given prior to the conduct of political action.[3] In effect, political sociology tends to oversocialise the political actor.[4] This argument parallels recent earlier work in the sociology of scientific knowledge which shifted the focus of analysis from the study of scientific communities and theories to the ethnographic study of the empirical practices and objects of science.[5] Just as sociologists of science argued that we cannot account for the conduct of science in the laboratory in terms of the play of wider social and economic interests, or the cognitive interests of 'scientific communities', we should also not see the conduct of political actions as simply an expression of external political and social forces. To put it in other terms, the political is irreducible to politics.[6] Just as we should be irreductionist about government, so, too, should we be irreductionist about the political. As Judith Butler has argued we should recognise 'that politics has a character and contingency and context to it that cannot be predicted at the level of theory'.[7] Relativist arguments within the philosophy of science once pointed towards the value of ethnographic studies of science. Today, arguments in political theory point to the value of an ethnography of politics which is attentive to the specificity of the event.[8]

DEMONSTRATION

It is commonplace to think of a demonstrator as a political actor: a protestor against an injustice, the breaking of a promise, a threat (or the absence) of violence, or an intolerable situation. Demonstrators, in this sense, are markers of the unacceptability of another's actions, expressions of whether the exercise of power should be limited, or intensified. They claim to display that subjects have a stake in government. This political sense of the term emerged the nineteenth century in connection with the Chartists and the revolutions of 1848, a manifestation of the emergence of the masses as a political subject.

But the notion of demonstration also has an earlier historical sense. In the Middle Ages the demonstrator had a particular function in the anatomy lecture theatre. He pointed out the feature of the body which was being shown and about which the lecturer was speaking. The demonstrator made visible to the audience the object of which the lecturer spoke, and thereby made a significant contribution to the production and dissemination of anatomical knowledge in public.[9] To be in the presence of a demonstration was a matter of *witnessing* a technical practice. The truth of the lecturer's knowledge was established through observing a demonstration. This sense of the term still exists, in some form, today. In the university science laboratory, a demonstrator is one (usually a graduate student) who assists undergraduates in their practical classes, pointing out the objects they are expected to discover and understand. The truths of laboratory science are proved to the novice, in part, through demonstration. In the twentieth century the technical meaning of the demonstrator and the demonstration acquired a further sense. If the older scientific or mathematical notion of demonstration implies proof, the idea of *the demo* can also imply provisionality. A demo

model is a display of the possibility of a real object, rather than its actualisation. It is a way of showing what can or might be done.

Demonstration, whether it is understood in a technical or a political sense is, or can be made to be, a political matter. On the one hand, because there is a politics to who can, and who should be allowed and trusted to witness a demonstration – under what conditions and in what ways. Being a witness is to adopt an ethical stance.[10] As Stephen Shapin has argued, the development of 'science' in the seventeenth century involved an effort to regulate who could and who could not be properly called upon as witnesses to matters of fact about the natural world.[11] On the other hand, public demonstration is political, because the telling of a truth in public can never be described as disinterested – it is always intended to have effects on, or challenge the minds or effect the conduct of others.

My account focuses on a particular story of demonstration. It concerns the conduct of direct action against the construction of roads in Britain in the mid-1990s.[12] What is remarkable about the anti-road protests, I argue, is the absence of any well-developed ideological project, and the absence of a well-defined political constituency on which they are based. Indeed, the intended effect of the protests was as much a technical as a political one: to demonstrate a truth which it has been otherwise impossible to demonstrate in public by other means. The history of science can inform our understanding of the contemporary art of politics. For to conduct a political demonstration can be a matter of making visible a phenomenon to be witnessed by others.

In thinking about demonstration as a technical and ethical practice, the analysis of the suffragette movement by Barbara Green is suggestive.[13] In her account Green explores the complex and shifting ways in which the suffragettes conducted a feminist politics and engaged in what she terms a form of visibility [spectacular] politics. In part this involved street marches and parades. But as the suffragette movement evolved it developed more militant forms of demonstration which involved smashing storefront windows, burning messages on golf courses and setting fire to empty buildings and, following imprisonment, hunger strikes and other forms of passive resistance. In this way,

> Through a rejection of pageantry, the suffragettes cultivated an alternative form of spectacular politics that assaulted the public eye, or exhibited ... tortured bodies for public delectation. Thus the fluid definitions and techniques of feminist spectacular activism constantly evolved to meet the difficult task of advertising feminism.[14]

The use of the term *advertising* in this context is apposite. For part of the burden of Green's argument is to contest the view that the suffragettes simply articulated an authentic and suppressed version of women's experience. Rather than counterpose the authenticity of women's experience with the inauthenticity of advertising, Green's analysis points to the potential *creativity* of publicity and advertising for feminism in establishing both an identity for the feminist activist and a place for feminist argument in public space. In Green's account, advertising and publicity are of critical importance to the conduct of contemporary oppositional politics and of contemporary forms of political identification. In this view, the notion of advertising is not accorded the negative connotations given to it, for example, in Habermas's work on the public sphere.

> At one time publicity had to be gained in opposition to the secret politics of the monarchs; it sought to subject person or issue to rational-critical debate and to render public decisions subject to review at the court of public opinion. Today, on the contrary, publicity is achieved with the help of the secret politics of interest groups; it earns public prestige for a person or issue and thereby renders it ready for acclamatory assent in a climate of nonpublic opinion.[15]

Without doubt publicity can have this function. An excess of publicity can be used to reduce the discursive space of political debate. Through the use of commercial advertising, sophisticated forms of news management, the ceaseless circulation and updating of news and the overproduction of official information, the terms of political discourse can become extraordinarily restricted. Yet, a distinction might be made between those forms of publicity which direct, restrict and close, and those which open up and destabilize the space of politics, whether in a creative or in a destructive way. Public spheres are not just spaces within which opinions and argument can be expressed concerning matters of public importance. Nor are they to be valued for their own sake. They are, as Habermas's early work suggests, artefacts of certain, no doubt historically specific forms of practical activity.[16] They can be invented, reinvented and disinvented. The spectacular actions of the suffragette established a set of sites within which feminist political action could

be both conducted and witnessed and, at the same time, opened up a discursive space within which a more or less novel set of questions about political rights could be raised: a resiting of the political.[17]

EXPOSURE

The action against the construction of the Newbury bypass in southern England was only one of a number of anti-road protests occurring in the UK and elsewhere in Europe from 1992 onwards. Other protests were directed against the extension of the M3 motorway at Twyford Down, the development of link roads to the M11 motorway in north-east London and the development of the A30 trunk road near Honiton in Devon.[18] But in Britain Newbury came to be by far the most prominent action, gaining extensive coverage in the national broadsheet newspapers and broadcasting media. No doubt the extent of this media interest in Newbury was over-determined. Newbury was only an hour's drive from London and therefore easily reached by journalists.[19] It was in what was considered to be a beautiful part of the countryside and, as a result, the action could enlist the support of conservative opinion which would otherwise have little relation to direct action.[20] The bypass itself was moreover of considerable importance to the Conservative administration. It was, after all, one of largest single road-building projects at the time; a critical part of a proposed £23 billion roads programme. It established what the government perceived to be a strategic transport connection between the industrial West Midlands and the port at Southampton on the Channel. The significance of this link was made clear with the publication of plans for Trans-European Networks (TENs) which emerged following the Maastricht Treaty for European Union in 1992. In these plans Southampton was one of only five ports in south-east England which would be connected to the rest of the UK by a Trans-European Network. The Newbury bypass was, in effect, along with the Old Kent Road one of the main routes along which the authorities expected the traffic with the rest of Europe to go.[21] Such links were of historic importance to Britain's relations to the rest of Europe for, according to European Commissioner, Neil Kinnock, 'just as the development of efficient national transport networks was vital in the last century in what became *national* "Single Markets", so in the next century the same will have to occur *internationally*. The challenge is not so much

new in nature, as new in scale'.[22] In total 15,000 kilometres of new road would be needed to realise this ambition.[23]

Yet the attention accorded to Newbury derived equally from a rather more local consideration of politics of landscape and location. Landscape is sometimes regarded as little more than a backdrop to events and, as Eric Hirsch reminds us, accounts of landscape have often figured in anthropological writing as something of a conventional way 'which informs the way the anthropologist brings his or her study into "view"'.[24] But anthropology and sociology have, in parallel with the emergence of environmental politics, reconceived landscape as meaningful. Certainly, in Lefebvre's terms, the bypass route occupied an important place in the representational space of (English) politics.[25] Newbury was only ten miles from Aldermaston which had been a key object of anti-nuclear protest in the early 1960s. And more importantly it was near to the site of the Greenham Common airbase which had featured so centrally in feminist opposition to nuclear arms in the early 1980s. Indeed forms of spectacular protest remembered from and developed at Greenham figured in the Newbury action, and for some women at least there was clear genealogy of political activism running from the suffragettes to Greenham and to Newbury.[26] At a 'reunion rally' to mark the beginning of 'destruction work' at Newbury the name of Greenham was explicitly invoked.[27] '"They" thought the women were mad. There are no Cruise Missiles at Greenham Common now'.[28]

But if Greenham was reckoned to be one historical antecedent to Newbury, of equal importance to some activists was the experience of opposition to the Criminal Justice Act which gave the police unprecedented powers to arrest anti-hunt saboteurs, travellers and ravers.[29] At the same time as government sought to foster greater agency and self-reliance on the part of the responsible citizen, the mobility and activity of those without property was to be severely restricted. The objects of the Criminal Justice Act were represented as human pollution: dirt, noise and interference which disturbed the tranquillity of the domesticated rural idyll of southern England. If the Criminal Justice Act was intended to give the police more formal powers, it also was a suitable object against which an opposition could materialise. The rural landscape became, for the protestors *a battleground*.[30] The bypass protest itself was termed the *The Third Battle of Newbury*, a reference to earlier conflicts which occurred near the town during the civil war of the seventeenth century, an event which, in the radical English nationalist imagination,

has sometimes figured as part of a historical narrative of popular conflict against an authoritarian state.[31]

But if the historical associations of Newbury itself were to the wars of the seventeenth century, the conduct of the protest and the clearance of the land by the contractors summoned up more contemporary conflicts. The struggle between protestors and the contractors and the police was a struggle in which images and machines played a key part. Police and security routinely used video and still photography in order to track the movements of protestors as well as to secure convictions for trespass and other offences.[32] The physical lines of conflict were relatively static, moving only slowly from day to day as the contractors cleared the bypass route and the bailiffs gradually evicted the protestors from their occupation of the trees and tunnels. One day at Newbury, when it was getting dark and the security men and contractors had departed leaving behind them hundreds of tree stumps, one protestor, Alan, frozen from a day spent at the top of a tree, expanded on the metaphor of the battle. 'It's like a graveyard – after the world war'. Poorly armed, spending winter in the mud, tunnels and trees, the protestors' actions hinted, however obscurely, to the conduct of an earlier conflict. Not just a demonstration, but an exposure. The protestors were just ordinary soldiers: squaddies, popular heroes. No wonder it was difficult for the authorities to contest the legitimacy of the protestors' action, despite its illegality.[33]

SITES

The location of the anti-road protests was, however, not merely of symbolic importance. The actions at Newbury, along with those at the A30 and other sites, were political demonstrations: attempts to say no to the actions of the public authorities and private enterprises. But as demonstrations they took a certain form. They occurred in particular places: not at the centre of public administration but at the place where others are seeking to act or which others own or control. They were, after all, protests against the construction of specific roads. As political actions they were directed not so much at the icons of 'the state' (parliament, the offices of the Prime Minister), but at the dispersed actions of the authorities, and the consequences of their actions.

In being conducted at such places, the road protest could be viewed as something like a demonstration in the technical sense: an act of *pointing out* to others the likelihood, that environmental destruction would

occur.[34] The actions were directed not at a potential risk, but at an emerging reality. The truth of the protestors point of view was to be shown not just by argument (the arguments were well rehearsed, if not necessarily widely known), nor by a display of force or numbers (the numbers of protestors was generally only a few dozen at any one time or place) but by attracting and directing others to take notice of a particular action on the part of the others. The demonstrations worked not by representing the views of a group or a constituency but by showing damage and destruction. By pointing directly to what they perceived as the indifference of the road-builders to the land and the lives of its human and animal inhabitants, they sought to demonstrate through their action a different truth: that the existence of humans, animals and the land were, in whatever way, mutually implicated.[35]

Here, the conduct of a public site-specific 'art' event at Newbury organised by Friends of the Earth is instructive. The event, *Artbypass*, involved the construction of more than twenty artworks on the site of the bypass and occurred several months after the route of the bypass had been cleared by the contractors, although many protestors continued to live in camps adjacent to it. It included pieces by well-known artists such Christo, Simon English and Peter Mountain, performances by the Cholmondeleys and a film of a stage production of *A Midsummer Night's Dream* by the German film director Werner Herzog, all of which were intended to 'bear creative witness' to 'our relationship with the car and the cultural myths that cement it'. In deploying works of art in this way the organisers of the event paid tribute to 'Joseph Beuys, the inventor of the avant-garde art action as a vehicle for ethical protest'.[36] They hoped not to be didactic nor to instruct people how to think, but to open up a space for reflection at a time when the main period of media interest in Newbury had passed.[37]

Artbypass was unusual, for as a number of observers have pointed out, Friends of the Earth and many other environmental organisations have tended to deploy primarily scientific forms of demonstration. Witness their excessive faith in the importance of monitoring the quality of urban air despite the enormous degree of uncertainty in the significance of air quality measurements. But whatever the success of the event in gaining continuing national publicity for the action at Newbury, and in providing a way for Friends of the Earth to articulate opposition to road-building in *other than* scientific or administrative terms, *Artbypass* also revealed the gap between the tactics of the environmental organisation

and the activities of the protestors. This was not just because the art of the protestors was not included in the official event, nor because FoE remained ambivalent about the legitimacy and dangers of direct action. It was because, in a sense, the commissioned art – although intended to be site specific – was *not site-specific enough*.[38] For it was by living on and off the land, that the protestors had sought to demonstrate the complex connections between people and land.[39] For one commentator involved with the protest movement: 'the issues simply speak for themselves – merely in pointing things out you are being political'.[40] Being there over a long period of time was critical to the politics. In this view, the truth of the protestor's actions was both self-evident to them, and was to be made evident to others through self-evidence – the evidence of the self.[41]

BECOMING

It would be tempting to think that the anti-road protest movement was marked by a clear ideological programme – nationalist, anarchist, feminist, ecological or otherwise – which might be supported or opposed at this level. But for many protestors if anything, the opposite was the case.[42] For in so far as it was legitimised for individual protestors at an intellectual level, it was by reference to a complex mix of doctrines coming from a variety of sources. The idea that there should be a common political doctrine was denied or resisted. The object of protesting was not to construct a common identity around a single ideological project. 'There is no ideology'.[43] 'In one respect at least the [environmental direct action] movement is more like a religion than a political campaign: its origins are discrete'.[44] It was associated with a demand for public access and control over rural and urban land in opposition to the pursuit of private profit.[45] 'To "reclaim the streets" is to act in defence of and for "common ground" ... the Street Party – far from being just anti-car – is an explosion of our suppressed potential, a celebration of our diversity and a chorus of voices of solidarity. A festival of resistance!'[46] It could involve an internationalist defence of the 'global environment', but also a nationalist rejection of European or global integration. It involved a few who had been involved in far-right organisations such as the BNP, implying perhaps a defence of the purity of nature, and of England. 'Some of the pagans are really right-wing'.[47] 'We are', noted one veteran

of Greenham Common, 'an island race'. It could draw on the authority of Celtic religion, but also, at the same time, and for the same person, on chaos theory. It involved references to the technical failures of government environmental impact assessment or the costs of private road building for future generations, but connections could also be made to the work of the situationists or Michel Foucault.[48] It could be associated with displays of ethical seriousness. '[At Newbury] if you said you wanted to stop the bypass because of the Kennett [the local river] then you would be asked why you wanted to save [that] river'.[49] But also the carnivalesque. 'Bishops, senior police officers, government ministers, construction company directors and of course anti-road activists, are being sent invitations, sealed with a lip-stick laden kiss, to attend the Flim-flam festival'.[50]

The diversity of expression involved here seems to have been important to its effectiveness. For in not being dominated by a particular 'analysis' or line, the road protest movement could accommodate a surprising range of views and practices.[51] It could draw in many different persons and, no doubt, different elements of the same person.[52] Myself included. In this context, although there were many romantic anti-industrial elements in the protestors' discourse, the protests were not marked by displays of what might be termed political romanticism. As Paul Hirst has argued, for political romantics 'the consequences of [their] aestheticizing posture are always avoidable because the romantic is careful not to act. The romantic strikes political poses in a politically safe world of stabilized bourgeois norms'.[53] But, in the case of the road protest, the fantasy of a utopia-to-be did not generally divert attention from the practicalities and hazards of action in the present.[54] Indeed, in certain respects, the road protests were thoroughly unromantic events. Exclusions of individuals from the road protests, in particular, seem to have involved less questions of political ideology (although these did occur), than an adherence to the more mundane ethical codes which governed communal life.[55] The 'community' of road protests was not grounded in a well-defined sense of identity, but forged and reforged around a mutating and proliferating set of on-going conflicts. It was united, if anything, less by an adherence to a body of doctrine, than by a common belief in the necessity of direct action. The problem of the appropriate balance between work and hedonism was one concern in the earlier M11 protest. According one group of participants and commentators:

> ... if the special ambience of our free space was not guaranteed simply by single-minded barricading, nor was it guaranteed by its opposite – pure hedonism ... do-nothings were called the 'lunch outs', and drinking strong lager came to be associated with parasitic laziness, internal violence and making a mess of the street. The solution to this was deemed to be forced expulsion ...[56]

Similar concerns were expressed at the Fairmile camp during the A30 protest:

> Up-and-together camps usually carry a number of slackers and shirkers, but not so with the Fairmile – they rarely last a week. The approach is subtle at first with camp-members working feverishly around the miscreant and offering them things to do until their inactivity becomes painful. If the subtle approach doesn't work then the blatant will, and they are told where to go. The result is a camp that works and looks good.[57]

Literature produced by the *Third Battle of Newbury* also placed emphasis on the practical and psychological demands made on the road protestor. What was required of the protestor according to the authors of the *The Battle*'s own guide to activism was less an adherence to highly theorised political programme than the practice and the *ethos* of non-violent civil disobedience. Crucially this implied the acquisition of knowledge and skill: of the Criminal Justice Act, the movements and likely behaviour of police, of how to build a tree platform, a tunnel or a bender, and of what to do if one is arrested.[58] But it also depended on the capacity to set one's own limits, to open up communication with one's opponents, to display humour, to know how to look after oneself and others, and to stay calm. The body, as a bundle of different capacities, materials and propensities, had to become, if not highly disciplined, able to act in appropriate ways at the right time.[59] To develop, in practice, an intensely active form of passive behaviour – which is not to say that everyone accepted or lived up to this norm.[60] Nonetheless, the everyday behaviour of protestors, their work within the camp, their dress and the particular character of exchanges with the police and other authorities were not incidental.[61] They were considered to be important for the protest, but also for the protestors. On the one hand, excessive displays

of anger could mark the failure and the end of protest. Humour and parody were, after all, sometimes the best weapons to contest the authority of the authorities, drawing them into the game of clowning.[62] A pantomime cow breaches the line of security men at Newbury in order to get arrested. A woman protestor helps the security men to write the lyrics to their own protest song. Another tickles climbers trying to drag her from a tree: 'does this tickle your conscience?' On the other hand, living and working for long periods on camp was, at least for some, a way of transforming *themselves* – whether 'materially' or 'spiritually', or both. Being a protestor required, in principle at least, a demanding attention to an art of existence.[63] A diffraction of an earlier feminist slogan. The political, in a certain sense, had become personal.

MEDIA

> Along with about fifty protestors and 300 security, contractors and police there were maybe twenty to thirty people observing the protest and taking some record. A crew from the local independent TV company Meridian who turned up early along with a photographer working for the magazine of the *New York Times;* one or two freelance photographers hoping something might happen; an observer from Friends of the Earth as well as several independent legal observers working on behalf of the protestors; police photographers and a video cameraman and various cameramen belonging to the private security firm (with yellow hard hats) who were working on behalf of the contractors; a BBC crew with a reporter (Margaret Gilmore) who arrived rather late in the day and approached me for an interview after one protestor fell off a tree and had to be taken to hospital. The video crew from Oxford who had given me a lift out to the site from the station. I had my notebook and my camera. In addition the police were in radio contact with each other and others on all sides carried mobile telephones. Many of the protestors' camps were linked together by radio.
>
> (From my diary. On the site of the Newbury bypass, Berkshire, England, 23 January 1996)

Demonstrating in public today may involve some attention to ethics and art of demonstration, and the need for a transformation in the body and its capacities. But it also requires an attention to the electronic media

which may be used to witness and to monitor a demonstration taking place. How do electronic and photographic media figure in the conduct of a political demonstration? Does the development of electronic media necessarily lead to an overproduction of information, in which any sense of the point of the action is lost? What place do new media technologies have in oppositional forms of demonstration?

In considering the importance of electronic media to political movements, many critical accounts have tended to posit a distinction between official or corporate mass media and radical media. In an analysis of broadcast media, for example, one model is suggested by Oskar Negt and Alexander Kluge. In their book *Public Sphere and Experience*, they draw a distinction between a bourgeois and a proletarian public sphere; a distinction which broadly corresponds to one in which political and cultural life is governed from 'above' through the activities of public institutions – or from below, through the experience of subjects themselves, through their everyday life. As Miriam Hansen observes, the 'proletarian' public is not so much an empirical category in Negt and Kluge's work but a category of negation. It is that complex set of spaces which are both suppressed in the interests of government, and yet emerge, in Hansen's terms, 'in the fissures, overlaps and interstices of a nonlinear historical process'.[64] In this context, experimental and independent media occupy, according to Negt and Kluge, a critical role in the continual regeneration of a proletarian public sphere and the exploitation of the complex political opportunities and problems that develop from it.[65]

Perhaps. The example of the road protests suggests, however, that while Negt and Kluge's sense of the 'overlaps and interstices of nonlinear' processes is very suggestive, their bimodal model of experimental and independent media and state media is too crude, or simply historically specific to the German 1970s. Certainly, the sociological distinction between 'state' media and civil society which Negt and Kluge rely on does not do justice to the complexity of the position occupied and created by media institutions, nor was it a distinction which protestors themselves would, in this instance, have necessarily recognised.[66] To be sure, for many protestors the relation to the mass media was an ambivalent one: 'The frightening extent of the media's monopoly on the public's consciousness has been demonstrated in their ability to put public opinion on our side!'[67] But for others the presence of corporate media are to be welcomed: 'If I wrote a letter to my MP would you lot be here, well would you?'[68]

The form in which public broadcast news media are able to witness a demonstration is, of course, fairly well-defined. The truth of news is not underpinned by the development of a complex multi-layered account of events, but in the capacity of news reporters to continually update their account on the basis of 'live' coverage and the ethical commitment of the reporter to impartiality and truth.[69] The capacity of broadcast news media to report the truth is based not just on a technical achievement, but on an achievement of a certain form of institutionalised subjectivity, however imperfectly developed.[70] Evidence must, in principle, be gathered from all sides, and immediately. The reporter is expected to maintain a position *in the middle* of the action, yet report the action as if she were not there – as if her presence, and the presence of technology, did not influence the course of events[71] – even when she is aware of her influence. 'The action is going to be slow because the police have learnt the lessons of Newbury – they don't want bad publicity' (ITN reporter, A30 protest, from the eviction of Fairmile camp 1.30pm). The presence of the news media places a premium on news management, for all sides. In these circumstances events are likely to occur *off* camera: '[where the press were kept out] various incidents took place including two women being sexually assaulted and one man being stretched by his waist on a steel cable and left for over 30 minutes'.[72]

Yet if this method of telling the truth about a public event is well-developed and its strengths and weaknesses have been extensively interrogated, the existence of independent commercial media does not guarantee the production of any other form of representation. For many independent media the act of witnessing a demonstration is a commercial activity. The image of a demonstration is a commodity, the market value of which is determined, in part, by the capacity to transmit it rapidly at a distance. In so doing, commercial media may be able to deploy technological resources unavailable to the protestors and publish reports or images of events without ever witnessing events in person. Reporting in the manner of public-service news media may be too time consuming and costly. Distant from the events, commercial media can abandon the ethical commitment of public service broadcast media not just to impartiality, but to direct observation as well.[73] Consider the following:

A freelance photographer (Peter MacDiarmid) with a Power Mac and a digital camera is editing and selecting photos directly on the screen in

the middle of a field. Then transmitting them using a modem and a mobile phone to the *Evening Standard* in London although he hasn't spoken to them yet. One or two freelancers with less sophisticated equipment cluster round to have a look, impressed. At the bottom of the hill a protester (Pixie Pete) is sitting in a van with a CB radio which he can communicate with another CB in the tunnel system two hundred yards away in which five protestors had managed to escape into when the police and security came to evict them the previous night.

(8.40 a.m. 24 January 1997; from my diary the morning after police and security came to evict protestors from Fairmile camp, A30 protest).

On the other hand, media professionals working for national private or public media may be able to produce more complex accounts of the events, in which a premium is not put on the values of impartiality and immediacy, and the restrictions they place on what can and cannot be said and witnessed. The resources available from public and private corporations can, in principle, provide the conditions within which other kinds of technical practice and ethical commitment are possible. 'Absolute independence' may be neither necessary, nor often desirable. Andrew, a freelance photographer working for the *Observer* and the *Guardian* is able, at some financial cost to himself, to return constantly to the protest camps over a period of a year, thus gaining much closer access to the everyday work of the protestors. Jay, another freelance reporter hoping to write a feature for the *Observer* spends some days living in a tunnel at a camp but is only sure to sell her story when the eviction at the camp occurs which makes it possible to turn her experience into the background feature for a news item. Liz, a road protestor herself and an employee of BBC local radio, makes a low-budget film for BBC2 for an independent production company. In considering the position of such professionals the distinction between 'independent' and 'state' media is a problematic one. On the one hand, 'independent' radical political media may be predictable and financially exploitative, understanding events only in the terms of their own predetermined 'analysis' and failing to pay a proper wage for the work of reporting: 'There shouldn't be a magazine which represents the road protestors ... *Red Pepper* [a socialist magazine associated with the new left] still babbles on about a red-green coalition which has no touch with reality.'[74] On the other hand, working for corporate media organisations such as the BBC was not, in itself, compromised. On the contrary, perhaps. For such organisations could provide a space, however limited, within which it is possible for a larger audience to witness a demonstration, in a different way. Political demonstration was an exercise in publicity.

But what of the role of small-scale non-professional media? Certainly, they had a role in providing a vehicle for communication between different actions, as well as representing events which might otherwise be unreported; as an instrument of counter-surveillance. 'If you are using your camcorder at actions and community events, please contact us because your footage could make it onto *Undercurrents* as complete film or part of a film, be used to defend people in court, or make it on to mainstream TV' (from statement by *Undercurrents* 'alternative news service').[75] 'It has been the primary concern of *Squall* that, despite being a voluntary "underground" magazine with very limited resources, *the accuracy of its research* should combine with a *quality of writing, observation and presentation second to none*' (my emphasis).[76] If accurate reporting and information was important, propaganda was not. Nor was there an attempt to use alternative media to direct the movement from the centre. *Schnews* operated as an information sheet. And the *Earth First! Action Update*, acted primarily as an information resource for the direct action movement, available on the Internet and in hard copy and edited by different groups in rotation. The direct-action movement, it seems, was marked by a remarkable effort to *prevent* organisation or hierarchy emerging. 'There are no leaders (although there are many individuals who are ready to stamp on emerging ones) and no single philosophy other than that in the slogan itself'.[77] In comparison, the role of institutionalised environmental organisations such as Friends of the Earth was a problematic one. On the one hand, such organisations have highly developed networks of contacts with the mass media and the institutions of political administration. In this way they can operate to effect changes in policy in a manner unavailable to those engaged in direct action. They are part of what Klaus Eder has called the 'Social Movement Industry'.[78] On the other hand, the FoE offices in London could operate as an effective instrument of news management and publicity. At Newbury, it was FoE who produced regular press releases on the course of the action, displacing the position of the less well-resourced direct-action organisation The Third Battle of Newbury. By contrast to those formed through the practices of direction, the FoE networks were intended to be ordered and centred. Its position was clear.

TELLING THE TRUTH

Telling the truth is always going to be a difficult matter. It is difficult even when the technical and financial resources are readily to hand. It requires work to set up a site where the truth can be demonstrated. It requires the appropriate witnesses to be present. It involves the development of instruments with which the truth can be made visible. The history of scientific laboratories can be viewed as a history of ways in which such problems have been addressed, with all the costs and benefits, strengths and weaknesses, that this particular set of solutions to the production of truth has involved. The gradual emergence of the statistical and ethnographic methods of the social sciences in the nineteenth and twentieth centuries is another.

In thinking about the role of political demonstrations in telling the truth it is tempting to engage in a form of sociological reduction. The claims articulated through (political) demonstration might simply be seen as a manifestation of certain limited social interests or narrow political ideologies. The public presentation of political demonstration through the (impartial) gaze of television may, perhaps, encourage such a reductive exercise. For in so far as it treats political disputes impartially, as a clash of parties, ideologies or interests, televisual news and current affairs may simply avoid the complexity of what is being demonstrated about: in this case, the relations of people and land. The pessimistic Habermasian view that a concern with style and news management has come to triumph over a concern with substance may often be borne out. The viewer, along with the broadcaster, and along with a certain kind of sociologist, comes simply to see different claims as instruments of the interests of different political actors or the manifestation of a certain kind of subculture.

But perhaps what is striking about the demonstrations against road building, was the extent to which such reductive accounts were always not so easy to make. The objects of the road protest came to be taken seriously, no doubt for bad as well as good reasons. Directing attention to the object involved an extraordinary attention to the technical practice of demonstration, and to the ethics of protest. In a double sense, the anti-road protests, along with some other recent forms of direct action, involved a dispersion of politics. On the one hand, political activity was spatially dispersed. Action took place not so much in certain centres of political authority, but in a diverse set of sites; sites which themselves have to be made into places of political activity. In this way, the frame

within which road building could be understood was expanded to include other elements. The terms within which it was possible to assess the consequences of building a road were contested and enlarged. On the other hand, the road protests were dispersed, in the sense that the protests could not so easily be reduced to a certain political logic or social interest. Their success, however limited and momentary, in telling the truth about what was happening to the land was itself a product and a manifestation of this dispersion. A dispersion of political and intellectual activity is sometimes labelled as postmodern: as an indicator of the decline in the possibility of telling the truth. This need not be the case, nor was it the case here. For by developing an inventive form of demonstration, it was possible, however imperfectly and momentarily, to reveal something which would have been otherwise unknown to others.

Seen in these terms, what is particularly significant about the anti-road protests is not that they were about 'the environment' (indeed the protestors seldom talk about 'the environment'); nor that they were representative of a new social movement or subculture; nor that they articulated a radical political programme (their political programme, in so far as it existed, had many conventionally conservative and nationalist elements). Rather it is that such direct actions reworked and *reinvented* a form of public demonstration. The demonstrators were visible and they successfully managed the form of their visibility. The links with feminist politics were not coincidental. For, as Donna Haraway and others have argued, the form, degree and place of visibility of the demonstrator are gendered.[79] The conduct of scientific demonstration historically served to both produce and reproduce differences between the modesty and reliability of the male witness and the invisibility of the female. The history of political demonstrations has, in part, been a history of ways in which women have contested such gender differences.

THE POLITICAL OBJECT OF DEMONSTRATION

In this chapter I have argued that there are significant parallels between the conduct of scientific and political demonstrations. The study of scientific and political demonstrations raises questions concerning the constitution of the sites of demonstration, the technical devices deployed in demonstration, and the kinds of persons and instruments involved in demonstrative practice. In recent years sociologists have tended to want to find the manifestations of political power everywhere. A certain

reading of Marx's concept of ideology or Foucault's notion of power/knowledge has suggested that we might find politics behind every gesture or sign. While I have some sympathy with this desire, the topic of demonstration suggests that what is recognised as political action actually tends to be a rather confined and localised enterprise. It takes a lot of work to make an object into an object of scientific knowledge in the laboratory. Likewise it takes a lot of work to make an object political, and to create the kinds of sites within which political action can happen. Rather than find politics everywhere, sociologists should find that political action is a rather rare and, in a certain sense, a rather specialised activity.[80]

If political demonstrations are technical activities, they are also intended to have political effects. In thinking about the politics of demonstration, I make a distinction between politics and the political. By politics I mean a way of codifying particular forms of contestation – particularly associated with the activities of political parties and the state. Politics, in this sense, refers to the conventional forms in which the term is used. These political forms are themselves objects of contestation. The boundaries of what we call politics are the objects of political action. This sense of politics can be contrasted with a notion of the *political* which I take here to be an index of the space of contestation. Thus an action is political in this latter sense to the degree to which it opens up new sites and objects of contestation. And it is *anti-political* to the extent that it closes down the space of contestation. In making this distinction between politics and the political, and applying it to the analysis of demonstrations, my account parallels Georgio Agamben's analysis of the events of Tiananmen Square. In his book *The Coming Community*, Agamben draws the following conclusion about Tiananmen:

> What was most striking about the demonstrations of the Chinese May was the *relative absence of determinate contents in their demands* (democracy and freedom are notions too generic and broadly defined to constitute the real object of a conflict, and only the real concrete demand, the rehabilitation of Hu Yao-Bang, was immediately granted).[81]

According to Agamben the actions of Tiananmen were important, and potentially subversive, precisely because the demonstrators did *not* possess any clear identity, political interests or programme. 'What the State cannot tolerate in any way', Agamben argues, 'is that singularities form a community without affirming an identity, that humans co-belong without any representable conditions of belonging'.[82]

For Agamben what makes Tiananmen a political event is the way that it manages to escape the logic of the existing ways of organising and codifying political antagonism. The actions of Tiananmen demonstrate a political collectivity not by expressing an identity which pre-exists the action, but by forging an association marked by difference. As with the case of the road protestors this escape was partly a function of the organisation of the protest (there was little formal organisation), partly a function of the object of the protest (its concern with concrete demands) and partly a function of the identity and behaviour of the protestors (their conduct in the face of violence). The actions of Tiananmen were political, in this account, in so far as they were able to resist and subvert the then accepted logic of politics. Agamben's argument, and my analysis of the actions at Newbury and Fairmile, emphasise the importance of attending to the specificity of political action and originality of political events. Two further points follow from this way of understanding the relation between political action and the political.

First, what we take to be politics in the first sense is often anti-political in the second. Indeed, it is a feature of parliamentary party politics (with its concern for party discipline, for example) that it will have anti-political elements. Successful party politics and government demand as much attention to the formulation of anti-political as to political strategies. Politicians are experts in anti-politics. To say this is not to denounce party politics or to draw a false opposition between the anti-political nature of party politics and the political character of alternative forms of direct action. Extra-parliamentary political action can, itself, have anti-political effects. And, as we saw in chapter three, in considering the actions of intellectuals operating within the European Commission, even the most bureaucratic of institutions may contain spaces of political inventiveness. Moreover, anti-political forms of politics may be a necessary and desirable feature of political life. To call an action political or anti-political is not, in itself, to offer an evaluation.

Second, it is often the case that the act of naming something as political (as being motivated by certain political interests and so on) is an anti-political one. In the case of demonstrations such as Tiananmen, the naming of the demonstration by the Chinese Government as being motivated by political interests, or suggesting that it was the product of a particular social group was precisely a way of closing down the space of

political possibility that they might open up. In the case of the anti-road protests of Newbury and Fairmile, the protestors successfully resisted efforts by both the government and by leftist political groupings to define their 'politics' in specific terms, but were united nonetheless by a toleration of difference and a commitment to action. By contrast, for Agamben an action can become a political event, in the second sense, in so far as its politics cannot be located and fixed. His approach seeks to open up a space for the political, without trying to determine the logic of political contestation. To have political effects, in the second sense, an action must *not* be reducible to a given politics. Agamben's argument here resonates with Judith Butler's contention referred to earlier. In analysing the conduct of politics, we must be attentive to the contingency, specificity and rarity of political action, rather than assume that it is merely the most visible expression of an underlying clash of, for example, economic interests, state powers or social movements.

Here it is possible also to return to consider the relation between scientific demonstration and certain forms of political demonstration – such as those at Tiananmen and Newbury. For one of the ways in which scientific research has a political effect is precisely because the objects of scientific and technical research (such as genes, pollution and antibiotics, virtual reality) may disrupt the discursive and institutional boundaries of 'politics' and, in this way, *open up* as well as close down the space of the political. Likewise, in the concreteness of their demands, and in their inventiveness, political demonstrations may have political effects, precisely in so far as they are not reducible to 'politics'.

9

CONCLUSIONS: POLITICAL INVENTION

REVOLUTION

In his study of the significance of engineering in the French Revolution, Ken Alder notes that the relation between engineering and revolution is in one sense unsurprising. For 'after all, in the broadest sense, engineering is perhaps the quintessential revolutionary activity'. 'In principle', he notes, 'engineering operates on a simple but radical assumption: that the present is nothing more than the raw material from which to construct the future.' The French Revolution can itself, according to Alder, be 'understood as a vast engineering project'.[1]

One of the preoccupations of engineers in late eighteenth-century France was with what Alder calls the 'uniformity project'. This was not just manifested in the interest of the technocratic elite in the promotion of the standardised metric system of measurement, a system which, as Alder notes elsewhere, was 'deliberately crafted' in order to break the political economy of the Old Regime.[2] It was also expressed in the detailed design of technical artefacts and their process of manufacture. Alder himself focuses on one important example, the artillery cannon, and the attempt by engineers to promote novel methods of production involving the design of interchangeable parts. This was a challenge to contemporary artisanal modes of manufacture. The attempt, which long-predated the twentieth century 'Fordist' system of production, failed. Technical change was resisted. The French State, which had 'initiated the program of interchangeable production at the end of the eighteenth century, repudiated it in the early nineteenth century'.[3]

Alder's study is a timely reminder of the critical part that has been played by technology in modern political enterprise. Technology is not merely one subdivision of government, to be studied by specialists in science and technology policy and historians of technology. Rather,

government is itself a highly technical matter, and the recognition of this character of government is a corrective to three contemporary accounts of government and politics, all of which I have drawn on in this book. In one account, associated with contemporary political science, government is equated primarily with political institutions and their relations, and the development of public policy and regulation in relation to the law, public services, taxation and the rights of citizens. Some of the best political science is particularly attentive to the specificity of contemporary forms of political regulation and the emergence of new forms of political organisation. Here, I have been particularly indebted to the work of Giandomenico Majone and others for their work on the development of the 'regulatory state'.[4] Yet from the perspective of political science, technology barely figures except as a topic for specialists, or is simply treated as an external factor to politics. Government is considered to be the government of persons, of 'society', in abstraction from a discussion of technology and science. In this way, clear demarcations are sustained and reproduced between the history of political institutions and the history of science and technology, and between political philosophy and political theory and the philosophy and sociology of science. Science and technology, which have become so central to the conduct of government for both the nation-state and the person, are rendered external to the political process.

In a second account of politics, associated with cultural studies and poststructuralist political theory and the work of writers such as Ernesto Laclau, Chantal Mouffe and Slavoj Zizek, the study of conventional political institutions is displaced from the centre of analysis. Instead, the focus of research is on the constitution of civil society and the dynamics of ideological struggles. In such a perspective, cultural politics and the politics of discourse become the objects of investigation.[5] There are strengths in this form of analysis too, not least in its awareness of the ambivalences and complexities of political identification, and its effort to think the possibility of a politics which is neither grounded in universal norms or essential identities. In such a perspective, politics is not something that should be grounded. On the contrary, a radical democratic politics is one which has to live with the fact that the grounds of politics are not given. Thomas Keenan has summarised this position thus: 'we have politics because we have no grounds, no reliable standpoints – in other words, responsibility and rights, the answers and the claims we make as foundations disintegrate, are constitutive of politics'.[6]

Yet if political science can too often become narrowly empirical in its focus on formal political institutions and its positivist concern with political decisions and public policy, analyses of political discourse and cultural politics can become lost in the study of ideology at the expense of attention to the conduct and tactics of politics and the specificity of institutions,[7] let alone the complexity of the role of science and technology in contemporary political life. Responding to her critics who have accused her of having no concern with the material realities of political economy, Judith Butler has rightly argued that studies of political discourse and political identification need not and do not deal with 'merely cultural' questions or reduce the study of politics to the study of political discourse. The politics of identity have quite real economic and material dimensions.[8] This book aims to respond to those who accuse poststructuralist theory for its lack of political and economic realism, in a different way. Here I have sought to show that there is also a need to rethink what is meant by politics and government not just in relation to the analysis of radical politics, but even in relation to the study of the most conventionally bureaucratic, economic and technocratic of institutions. In the end, it is impossible for political analysis to avoid an attention to the specificity of institutions. What is required is a rethinking of what we mean by institution.

A third account of politics and government which has informed the writing of this book is associated with the work of Michel Foucault and, in particular, his later work on government. One of the key strengths of Foucault's work on government was to challenge the equation of political power with a concrete object: the sovereign, the government or the state.[9] In this way the notion of government opened a space for thinking about the historical specificity of particular forms of rule, and the ways in which they figured in political discourse. In particular, post-Foucaultian studies drew attention to the historical formation of 'the individual', 'community' and 'society' as subjects and objects of government.[10] Yet, while the notion of government indicated the existence of a neglected field of empirical research and political analysis, there are two weaknesses in post-Foucaultian accounts addressed in this book. First, following Foucault's own work, there has been a lack of interest in the analysis of study of political conflict, and a tendency to resort, in the absence of any developed account, to the notion of 'resistance' to understand such conflicts.[11] Second, there has little attempt, with a few exceptions, to integrate some of insights of Foucaultian approaches to the study of

government with the work of the anthropologists, sociologists and historians of science and technology.[12] In this book, I have shown one way in which different registers of post-Foucaultian political analysis and recent work in science and technology studies can be drawn together. On the one hand, this has involved a concern with the importance of concepts and technologies of interactivity and networking to contemporary forms of political rule. Interactivity and networking have come to provide, to use Deleuze's terms, diagrams of the relations between persons and non-human artefacts.[13] On the other hand, it has demanded an attention, following the work of sociologists of science and technology, to the dynamics of scientific and technological development. Foucault's analysis of *dispositifs* or apparatuses is too static to reveal the dynamic instability of socio-technical arrangements. In turn, as I have argued through a discussion of political demonstrations, historical and social studies of science have implications for our understanding of the conduct of protest.

In questioning this disciplinary division of labour between the study of science and technology and studies of contemporary politics, this book has developed three lines of argument, which I expand on in the remainder of this chapter. The first is a geographical–political one, which develops from the early work of Michel Callon and Bruno Latour.[14] This is that in thinking about the relation between science, technology and politics one cannot assume an opposition between the universal applicability of scientific knowledge and technical instrumentation, on the one hand, and the local specifities of politics, on the other. On the contrary: scientific and technical practices have come to play a critical part in the development of new spaces of circulation which may be more or less global or local, more or less continuous, and more or less subject to forms of political regulation and contestation. There is nothing necessarily global about science and technology. At the same time, political action may itself take more and less technical forms which may be replicated between different sites. Politics may itself form extended zones, despite the boundedness of the nation-state and national political institutions.

The second argument is political and philosophical. It is that in thinking of the relation between politics and science one cannot assume an opposition either between a science which is rational and objective and a politics guided by passion and interest, as the work of many philosophers of science would suggest,[15] or an opposition between a science which is oriented towards instrumental control and a domain of politics

oriented towards public debate, as suggested by Habermas and his followers.[16] On the one hand, as we have seen, many political strategies can have anti-political effects, in so far as they can close down the space for political contestation and judgement, effecting a displacement of the political.[17] On the other hand, some scientific arguments can open up the space of the political, raising questions both about matters of fact, and questions concerning the capacity of laboratories, firms and governments to determine such facts. In this context, it is necessary to make a distinction between politics conceived as ways of codifying particular institutional and technical practices, and the political conceived as an index of contestation and experiment. In this latter sense scientific enterprise may be political or anti-political in its implications, irrespective of the extent to which it is autonomous from direct control by organised political interests.

The third argument is about technology, invention and time.[18] In the government of what I have called a technological society, technology is reckoned to be central to the invention of new political and cultural institutions. Seen in these terms, a technological society should not be understood as a stage in the evolution of society, nor a particular mode of government, but rather as a particular form of orientation to the political present. Central to this orientation is the equation of invention in general with technical innovation. Here, I argue that just as it is necessary to distinguish between politics as a practice and the political as an index of contestability, it is also important to distinguish between technical change and invention. In part, this is because technical change can be *anti-inventive* as well as inventive in its effects. In part, it is because the distinction between technical change and invention opens up a space for thinking about forms of political and cultural invention which, although they may have novel technical elements, do not centre around the development of 'new technology', or indeed forms of invention which circumvent entirely the 'necessary' moment of technological change.

ZONES AND SITES

In terms of theorising the new forms of circulation, scientific research and technological development are widely understood to disrupt traditional political and cultural boundaries. Concepts of networks, cyborgs, interactivity and deterritorialisation all seem to speak of a world in which the boundaries of nation-states, persons and firms are dissolved or blurred, a

world in which connections are increasingly easy to make.[19] Certainly, in some cases, the boundaries between entities do seem difficult to draw, and may be more difficult to draw than hitherto. However, I have argued in this book that the development of technical artefacts and practices involves the formation, translation and contestation of new blockages and impediments as much as their dissolution.

In general terms, the development of science and technology involves the generation of two kinds of loci or space. In thinking about the spatialities of scientific and technical knowledge the work of Bruno Latour, Simon Schaffer and others has been particularly important. On the one hand, the production of scientific knowledge is associated with specific localised *sites of calculation*, observation, monitoring, technical practice and experiment.[20] The laboratory and the workshop are particular kinds of environment within which experimentation and monitoring can occur, and within which objects can acquire new realities. But sites of experiment and technical invention can be established in many places: in the field, in factories, homes, bureaucracies, hospitals, prisons and museum. As Ted O'Leary and Peter Miller have argued in a discussion of innovations in workshop practice and factory organisation:

> It is here on the shop floor, that new realities are created out of the dreams and schemes of diverse agents and experts based in a multiplicity of locales ... Together these disparate devices form a complex of interrelated practices for governing economic life. To adapt a phrase of Hacking's, these various initiatives that take the factory as the locus and object of intervention entitle us to analyse it as a 'space for interfering' under controllable and isolable conditions with matter and energy. As such, the factory is an intrinsically theoretical and experimental space, one where phenomena are created.[21]

Such sites of experimentation may be more or less difficult to make; they may be temporary, unstable and subject to legal challenge or political contestation. They may be mediated in more or less public view, or in more or less specialised and technical forms. The 'phenomena created' may include both non-human artefacts and persons. In chapter six, I showed how 'the museum visitor' became an object of *self-experiment* through the formation of localised sites of interactivity and forms of mediation. In chapter seven, I examined how a London street became a well-established public site of monitoring and experimentation which

served to produce the phenomenon of 'air quality'. In this example, there was a marked mismatch between the public discourse of 'air quality' and the messy artefacts of experimental practice in the field.

A second kind of space established by scientific and technological development is what Arjun Appadurai has called technoscapes[22] and I have called technological *zones of circulation*. These are spaces formed when technical devices, practices, artefacts and experimental materials are made more or less comparable or connectable. They therefore link together different sites of scientific and technical practice. Such zones take different forms. The points of access to the zones may be more or less clearly marked, with more or less well-defined and functioning gateways. They may be privatised, or open to the access of many. They are variably homogeneous or stable. In chapters three and four, I outlined the remarkable attempt to unify Europe through the formation of European technological zones; and in chapter six, I discussed the loose but nonetheless real connections established between the various sites of interactive experiment to be found in North America and Europe. In this case, different museums adopted the same interactive diagram, but developed it in quite distinct technical forms in relation to specific localised political problems.

Not only do technological zones take different shapes and forms, but there may also be considerable disjunctures between the homogeneity and unity of a zone as it is represented in public discourse and its rigidities, instabilities and blockages in practice. As it is represented, 'Europe' is a perfectly smooth and well-connected technological zone in which the movements of capital and labour are unimpeded by irregularities in the technical materials out of which Europe is formed. In practice, Europe's multiple technological zones are full of fractures and discontinuities and overlapping and intersecting strata. In some cases, these technological zones extend well beyond the territorial boundaries of Europe; in other cases they exist only in the minds of a few bureaucrats, politicians and economists in London, Paris and Brussels.

In analysing the government and politics of these zones and sites it is important to consider two sets of practices. First, practices of demonstration, testing and calibration are critical to the process of augmentation by which technologies move from one scientific or technological site to generate a zone containing many such sites. The kind of extension or augmentation inherent in zones depends therefore on particular, localised forms of work which are often extraordinarily technical. In general,

debates concerning these practices of demonstration and testing have not been held in public but have been contained within specialised committees and laboratories. Indeed, since the nineteenth century, a series of scientific and technical organisations has emerged around the problem of how to govern the formation, extension and development of transnational technological zones. In the European Union today the effort to establish an extended technological zone is manifest in the remarkable preoccupation with networking and harmonisation. In other cases, efforts to translate material artefacts and scientific and technical practices from one site to other sites can become the object of intense public political controversy. In recent years there have been protests against the testing of genetically modified crops in specified experimental sites in Britain and elsewhere in Europe. For firms, these sites are expected to be the first points in the formation of transnational agricultural–technological zones. For protestors, such experimental sites are identified with the incursions of polluting artefacts and (American) multinational capital and become, therefore, sites of contestation.[23]

A second set of practices critical to the politics and government of technology is that concerned with technical and regulatory standards and intellectual property rights. These practices play a key part in the configuration and reconfiguration of technological zones, channelling and restricting the flows of objects and persons along particular routes, forming particular lines of circulation. In chapter five, I examined the importance of intellectual property in marking the ends of technological zones or the places where movement is restricted. However, as I argued, claims to intellectual property are much more uncertain, problematic and unstable than they might at first appear. They imply the formation of both a connection and a separation between a subject and an object of such rights. In key areas of contemporary research and development such as information technology and biotechnology neither object nor subject may have a stable identity. Legal and political disputes over intellectual property rights and the subjects and objects of such rights are also conflicts over the configuration and reconfiguration of technological zones and the properties and capacities of the actors that produce them.[24]

If scientific and technical practices are much more localised and contained than is often imagined, then what of politics? Historically, politics has developed its own privileged, localised and highly regulated sites of action such as the party caucus or conference, the executive committee of the local party, the parliament, the photo opportunity and the radio and television studio. The occasions when political action, in the conventional sense of the term, moves outside these sites are rare. In general, these sites have been organised on a national basis and located in the capital. In response, sometimes conditioned by the centralisation of communications and the desire to attract publicity, many oppositional political actions have themselves been sited in the capital, often on the streets surrounding the buildings occupied by the central institutions of government. Thus, political circulation has been contained within a very restricted set of sites.

However, it is a characteristic feature of political conflicts over scientific and technological developments that they are *not* always directed towards the centres of political authority. To be sure, there are many political conflicts over science and technology that do involve the activities of parliaments and government bureaucracies. Most of these, however, are obscured from public view. While they may be crucial in the contemporary configuration of government, the development of technical standards, environmental regulations and intellectual property law are, with a few exceptions, conducted between technical specialists, bureaucrats and industrial lobbyists.[25] In these circumstances the oppositional politics of a technological society are displaced elsewhere, emerging, often unexpectedly, at the many sites of scientific and technical practice: the factory with its automated machinery; the laboratory conducting animal experiments; the construction site of a road or a dam; the experimental farm; the psychiatric ward; or the polluting chemical plant.[26] In a technological society, students of politics need to focus their attention not just on the formal centres of political authority but on the many sites where political action comes to circulate. It is from such sites, as Ulrich Beck has suggested, that politics may come to *flood* across many other fields.[27]

In chapter eight, I examined how one such location was made into a site of political demonstration. Unlike sites of scientific and technical activity, these sites tend to be temporary. They emerge in restricted circumstances and make use of available energies and opportunities. But despite these conditions, sites of demonstation may also be tied together to form fluid zones of politics. For although each action is necessarily unique, it is common for those engaged in them to try to replicate some of the tactics, practices and techniques used elsewhere, and in earlier periods. Political technique has its own geography, history and memory.[28] Consider, for example, the techniques of the anti-road protestors discussed in chapter

eight which were reproduced on a large number of potential construction sites across the UK and beyond; or the tactics of Greenpeace which have been replicated world wide. Just as there are zones of scientific and technical practice, so there may also be more or less discontinuous, temporary, fluid and fragmented zones of oppositional political action. Extra-parliamentatry political protest is undoubtedly less formal and less standardised than conventional forms of scientific and political practice. But it also has its own characteristic tactics, sites, rhetorics and organisational forms that may be replicated in different locations and situations.

THE POLITICAL AND THE ANTI-POLITICAL

In writing about contemporary forms of extra-parliamentary radical politics it would be a mistake to romanticise this politics or to set up an opposition between examples of political 'resistance' and the 'power' and 'instrumental rationality' of bureaucratic and scientific institutions. First, this would not do justice to the productivity of radical forms of extra-parliamentary political actions, and the complexity of their *own* historical formations. Radical political action can not be opposed, in any obvious way, to scientific truth. As we have seen in chapter eight, the function of action may be to reveal a truth which would otherwise be unrecognised in public. The truths such radical actions demonstrate cannot simply be proved or disproved by scientific means. They are, in a Wittgensteinian sense, simply there to be *shown*.[29] In this context, the stance of radical movements is not necessarily in opposition to scientific expertise, but rather to take on a political function which expertise has failed to, or cannot, fulfill. Second, it is partly an empirical question whether scientific work opens up or closes down the space of political contestation. The notion that scientific practice is simply a form of instrumental rationality obscures the ways in which experiments may question, and make uncertain, assumptions about the instrumental capacities of technologies, or the effects of material objects on their environments, or the capacities and competencies of laboratories and governments. In chapter three, we saw how research on beach-water-quality measurement raised questions both about the competence and practice of laboratories and the effects of polluted beach water on the instruments which measured it.

In these circumstances, as I argued in chapter eight, it is necessary to distinguish between politics and the political. Georgio Agamben's analysis of the irreducibility of the political to political interests and ideologies in his book *The Coming Community* is important here.[30] Here, I define politics as a way of marking and coding a certain cluster of historically specific practices. In this sense politics refers to a range of forms of action and practice which include organising election campaigns, networking and lobbying, decision management, party organisation and public debating. At various historical moments, trade unions, feminists and environmentalists have all sought to broaden the institutional and discursive space of what we call politics. But if politics is a way of coding a historically variable cluster of practices, then the *political* can, following Agamben, be understood as a space of dissensus and contestation which is not reducible to politics. Indeed, one of the key functions of established political institutions has always been to place limits on the possibilities for dissensus and restrictions on the sites in which political contestation can occur. What we generally term politics thus always has something of an anti-political impulse. The role of politics, in the first sense, is not generally to produce dissensus and controversy, but to contain and channel it in particular directions. Parliamentary politics can be extraordinarily anti-political in so far as its contours are carefully managed and defined. To say this is not to denounce parliamentary politics or to celebrate a culture of permanent political invention.

If politics, in the first sense, often has an anti-political logic, scientific practice can be politically productive in three ways. First, scientific practice can have political effects because it involves assigning tasks and competencies to the producers and audiences who are given the responsibility of judging or accepting matters of scientific fact. In many cases there is nothing controversial about this, for both the producers and audiences of scientific practice are well contained within specific specialist 'communities' or 'core sets'.[31] Indeed, in so far as this is the case, scientific practice restricts the space of the political. However, in a technological society there is a general expectation that non-experts are also potential audiences and that matters of scientific fact have implications for them. As we have seen, the citizen of a technological society is expected to accept or understand science itself.[32] This raises the question of whether a person should or should not adopt this role, explicitly reject it, or adopt an ambivalent relation to it.[33]

Second, scientific research creates new objects and artefacts, thereby disrupting the discursive boundaries of contemporary politics, and opening up new sites of political contestation. Of particular importance today, for example, is the creation of new genetic objects and new ways of conceptualising human capacities and tendencies in the fields of brain research, genetics and molecular biology. The objects of these areas of research are not in themselves either inherently political or unpolitical. Rather, the question of whether they open up political questions depends on the forms in which they are materialised and the sites within which they circulate. When contained within a laboratory experiment, for example, a particular sample of genetic material may pass a relatively uncontroversial existence, monitored only by a handful of scientists and laboratory assistants and circulating between a small number of laboratories. However, once circulated across other sites, and materialised in other more visible forms, such material can become the centre of political contestation. Witness, for example, the way in which cloning techniques became an object of political controversy once they were applied to something as visible and as 'human' as a sheep, whereas they had not been a political problem when vegetable samples were cloned in the laboratory. As we have seen in chapter five, political institutions have sought to close down the space of political controversy by making a clear distinction between sites and forms in which genetic material could pass an uncontroversial existence, and the sites and forms in which its existence would either be legally impossible or tightly regulated. Given the outbreak of extra-parliamentary action in Europe over the subject of genetic modification, this attempt to restrict the space of the political has only been partially successful. Instead of supposing that genetic material has inherently political properties, we could trace the ways in which it is made more or less political as it circulates and is transformed across a range of 'scientific' and 'political' sites.

Third, scientific practices can become political in so far as they raise questions about the properties and capacities of technical objects and devices. While it is commonly thought that science is a process of discovery, many of the activities of professional scientists and engineers are not innovative in the way that many people would think of as innovative. They are about testing and measuring the properties of technologies, and demonstrating such properties to others, whether for the purposes of connecting them together, or for the purpose of regulation, or in order

to market and sell them.[34] In general, the work of testing and demonstrating has anti-political effects. It is intended precisely to contain the potential space of contestation of the properties of new technologies within particular institutional and discursive limits. It is conducted prior to the release of an object or artefact into general circulation in order to anticipate the effects of the release. However, in some cases the implications of testing and monitoring work are more complex. In chapters three and seven, I showed how tests of pollution-monitoring technologies raised serious questions about the capacity of the technologies to do what they were supposed to do, yet I showed also how the political implications of such findings were contained. In a few cases, testing and demonstration can have an immediate political effect, raising questions about the safety, security, properties or effectiveness of an artefact, a process or a device or the competence of those who use it. In chapter one, for example, I discussed the implications of taking measurements of pollution outside of a chemical plant. Although there is nothing inherently unpolitical or political about a particular chemical composition of the soil, once such an object takes the discursive form of 'pollution' it may become political – a site of contestation. Whether this does actually happen depends a great deal on the spaces within which such objects circulate. Measurements of 'pollution' simply recorded by a government or private laboratory are not likely to become political matters. But they can easily become political once they are found in the press release of an environmental organisation or circulated in public documents.

Seen in these terms we should not speak of the *inherent* political properties of scientific objects but the ways in which objects may become more or less political. In general, scientific research is expected to disentangle an object from the complexity of the environment from which it becomes extracted. Pollution as measured by a detector is not the same as the molecules in the air with all its interactions with people, cars, wind and other chemicals. Scientific practice disentangles an object from its relations, translating the object into a new form. Yet in doing so, it may serve to create new forms of entanglement. Suddenly, as we saw in chapter seven, polluting chemicals enter into a whole series of new relations with citizens and governments which had never previously existed. In this case, the air ceases to be something we merely breathe in. It becomes an element in a transnational political project with all the unpredictable consequences this implies.

INVENTION AND ANTI-INVENTION

In what I have called a technological society, the concept of invention is often equated with technical invention. Today, the idea of political revolution is seldom spoken of, except as an historical event. But perhaps more than ever before technology is expected to carry the promise, or the threat, of radical social and political change in the future. Technical change is reckoned to be innovative. By contrast the social and political realm is thought be a source of resistance, of inertia. The relation between the two is often represented using the metaphor of potential. Technologies have certain potentials. But in practice all kinds of social, cultural and economic factors prevent this potential being achieved. Skills and human capital are poorly developed; knowledge about the capacities of technology is not sufficiently disseminated; the public understanding of science is said to be impoverished; or there is political or commercial or corporate resistance to new technologies. For a few fundamentalist defenders of the rationality of 'Science', public and academic irrationality is simply opposed to the rationality of scientific and technical method.[35] Society fails to realise the potential of technology, and therefore to realise its own potential.

As I argued in chapter five, the contemporary equation of technology with invention and innovation is a sentiment echoed in official statistics. Whereas, in the nineteenth century and before, a measure of population was often taken to be a good indicator of a nation's vitality, today this role is more likely be taken by indicators of technical inventiveness and literacy such as the numbers of patents awarded to national laboratories by different national patent offices, research and development expenditures, or the numbers of graduate scientists and engineers and students with computer literacy skills.[36] Ironically, given the connectedness of scientific and technical activity across institutional and national boundaries, and the difficulties of defining what research and knowledge actually are, the technical problems of obtaining reliable data and making comparisons between different national sets of data on these matters are enormous. Scientific research and technical innovation does not occur only in a *national* context.[37] And technological activities are both localised and dispersed. But in Britain and North America, the activity of measuring invention and inventiveness has itself become a small industry. Governments are anxious to ensure that economies are performing technologically and that measures exist to monitor their performance, in order that it might be improved.

At the same time, as we have seen, technology is reckoned to be central to innovation in government and to the invention of new political forms. For the European Union, standardised technical devices have provided part of the solution to the difficulties of establishing common European institutions. If it is difficult to form European citizens or to support a European public service, there has been remarkable investment in the formation of 'European' technical instruments and practices. As I showed in chapters three and four this project has had a partial success. At the same time, as I showed in chapters four and six, for many political and cultural organisations, interactive technologies and new media are expected to provide the solution to a range of contemporary problems concerning education, economic development, citizenship and democratic empowerment.[38] Interactivity and networking are considered central to the solution of many of the problems of governing what is variously called a 'knowledge-based society' or a 'knowledge economy'.[39]

But is the development of new technologies synonymous with invention? And can we take indicators of scientific and technical activity (such as dollars spent, patents or papers produced, or citations generated) as indicators of inventiveness, *however* imperfect such indicators maybe? Drawing on certain traditions of work on technology that include Marx, Deleuze and research in the history and anthropology of material culture, one might suggest a different account of invention; one that does not equate technical novelty with inventiveness. Within these traditions, the notion that technology can be understood as something like an isolated artefact is problematic.[40] Technology is viewed not so much as an artefact, but as a series of relations and connections between artefacts, physical and mental skills, desires and interests, concepts and information.[41] Seen in these terms, inventiveness should not be equated with the development of novel artefacts, or indeed with novelty and innovation in general. Rather, inventiveness can be viewed as an index of the degree to which an object or practice is associated with *opening up possibilities*. In this view, scientific and technical objects and practices are inventive precisely in so far as they are aligned with inventive ways of thinking and doing and configuring and reconfiguring relations with other actors. From this perspective, it is possible to identify forms of invention that are not technical, but rather involve the use of a devices in more creative ways.[42] In short, just because an object or device is new does not make it an invention. *What is inventive is not the novelty of artefacts and devices in themselves, but the novelty of the arrangements with other objects and*

activities within which artefacts and instruments are situated, and might be situated in the future.

Invention should not therefore be narrowly equated with technical change. Technologies change all the time, but this does not mean that technical change is always inventive. Technical changes can be conservative in their implications, maintaining or rigidifying existing arrangements between persons, activities, devices, and habits of thought; they may restrict and displace the possibility of alternative developments. Seen in these terms, rapid technical change is not necessarily inventive, nor is it necessarily revolutionary in its implications. It may indeed be a way of enforcing or sustaining a kind of socio-technical or socio-cultural stasis. The constant upgrades of computer software and hardware packages are instances of a restrictive strategy, locking users into existing configurations producing enforced obsolescence, reproducing the contours of the existing technological zone in a trivially 'new' form. But even apparently quite radical technical changes may be anti-inventive whether in their conception or their execution. More generally, there is no simple relation between the speed of technical change and inventiveness. I want to suggest the contrary hypothesis: that high levels of information production and rapid rates of technical change may occur precisely when there is a sense that inventiveness is lacking or needs to be restricted. The rapidity of the growth of information and technique may, in some circumstances, be anti-inventive. I suggest the term *defensive innovation* to refer to the way that this kind of anti-invention can be a deliberate element of industrial or cultural strategy.[43]

The same case could be made in relation to the military field and the defence industries during the cold war, in which high rates of technical change were reckoned to be necessary in order to maintain the existing structure of confrontation in place.[44] But defensive innovation is a characteristic feature of many fields of new technology. For firms, patents are acquired in order that others may not acquire them. In thinking about the distinction between invention and the speed of technical change, Paul Rabinow's recent study of the development of biotechnology, *Making PCR*, is instructive. In this study, Rabinow unfavourably compares the bureaucratic and peer-review dominated character of academia with the liberal-minded freedom he encountered in his fieldwork in the Californian biotechnology industry. Rabinow is alert to the inventiveness of the development of PCR: 'learning and making and remaking: new variants of the instruments, practices, spaces, discourses. PCR is more

than any of its specific uses – it has the distinctive quality of continuing to produce events.'[45] At the same time, however, his study points to the anti-inventive logic of the industrial development in which they are engaged: the way that unconstrained development in the field is, in part, a business of laying claims to a territory in order to ensure that others do not get there and make property claims first. 'Filing a patent application for an aspect of the work and subsequently publishing would serve as a means of establishing "prior art" and consequently barring others from obtaining a patent – especially outside the US.'[46] New products are developed in order that alternatives are not given enough breathing space to emerge. Firms invest in pure research not because they need to repay their debt to universities and to scholarship, but – amongst other things – because of a sense of the need to anticipate rival movements which may threaten to destabilise their long-term competitive position. In other words: *rapid technical change may have to occur in the present for invention by others to be anticipated in advance and therefore stifled.* So speed is not the same as invention. On the contrary. Rapid technical change can be one of the best ways of making sure that there is not an *excess* of invention, with all the unpredictable consequences for economic and political life that this might bring. Moving things rapidly may increase a general state of inertia. It may fix objects and relations in place before alternatives have the chance of developing. Frenetic pseudo-innovation may not just create a sense of boredom – everything is novel, but nothing is new – but stifle creativity. Inventiveness may occur when technical change, as it is normally measured, is slow or in places and at times when it is least expected, or most difficult. Gilles Deleuze speaks of the way in which inventiveness may occur in the most difficult and the most 'cramped' conditions.[47] Certainly we should expect that the temporality of invention (conceived of in terms of the creation of possibility) is quite different from the temporality of technical innovation as it is usually conceived. I have given two examples of these processes in this book. In chapter eight, I showed how inventive political tactics and forms relied on relatively unsophisticated technologies. Likewise, in chapter six, I argued that a preoccupation with the value of novel interactive devices and techniques in the recent development of the museum has been at the expense of efforts to rethink creatively the function and display of museum collections.

In this book I have sought to capture something of the extent of the contemporary political preoccupation with new technology through a

series of case studies. I showed how a series of institutions from the European Commission, local authorities to museums has defined the problems each faces and the solutions they should adopt in technological terms. At the same, citizens and consumers are expected and encouraged to remain up-to-date. This governmental preoccupation with new technology is also reflected in the language of politics. In this book I have also sought to give a sense of the centrality of notions of networking, feedback and interactivity to contemporary political discourse. Such language is more than merely metaphorical or representational. It is much more than simply a reflection of the proliferation of new media and information technologies in everyday life. It is indicative of the ways in which interactivity and networking have come to dominate how we think about the organisation of collective relations between persons and machines. There is nothing new in the political preoccupation with technology and the importance of technical innovation. However, in its focus on the ideas of interactivity and networking, this preoccupation has come to take a very particular historical form. We do not live in a network society. We may inhabit worlds within which the concepts and technologies of networking and interactivity have come to dominate our sense of possibility.

PROPERTY

In this political situation the anthropology and history of science and technology can make a small contribution. One way of understanding this contribution turns on the notion of property. In the received version of engineering and the natural and medical sciences, these disciplines are concerned with the properties of nature and material artefacts. Different properties are analysed by different scientific practices, theories and measurement techniques. The reality of the natural entities and the properties of technical instruments and tools are revealed through science. One task of the anthropology and history of science and technology has been to provide a different account: an account which contends that such natural properties are the products of particular localised historical practices, concepts, technical instruments and materials. Properties that appear inherent in the object depend on the object's relations with other entities. This perspective is not anti-scientific, nor is it indifferent to the claims made by scientists, engineers and doctors about the properties of objects and artefacts, and the capacities of bodies and persons. In this

book we have seen the importance of the factual claims made by environmental scientists in questioning the validity of the factual claims made by the public authorities. Scientific claims matter. They are made to matter. But the anthropology of technique need not take them simply at face value. Engineering and natural scientific research involves the manipulation of the world, and the production of novel devices, instruments and objects of knowledge. Likewise, the history and anthropology of science and technology aspires to be a productive, and an inventive, enterprise. It manipulates and enlarges natural scientific and engineering accounts of the material world – placing them in a different focus and frame, in a different space; performing a different kind of demonstration.

NOTES

1 THE TECHNICAL AND THE POLITICAL

1 See, for example, Ortega y Gasset's comments on the central importance of scientific activity to (European) civilisation [1932] 1964, pp. 81–82.

2 Cresson 1997, p. 3. Cresson's interest in the 'knowledge society' was over-determined. In the Commission she was responsible for both research and education, and the idea of the knowledge society was one good way of making a link between her different responsibilities.

3 Cresson referred, in particular, to the work of Anthony Giddens, director of the LSE, a sociologist well-known for his writings on globalisation and risk.

4 Ibid., p. 3.

5 Such as 'information society', 'postmodern society' (Harvey 1989, Kumar 1995) 'post-industrial society' (Bell 1973), 'network society' (Castells 1996), or 'radical modernity' (Giddens 1991). Peter Osborne notes that '"modernity" is routinely assumed to be an empirical category of historical sociology, used to register certain inaugural breaks or ruptures in the development of societies' (1995, p. 1). For a political critique of the notion that history passes through stages see Arendt 1964.

6 Rose 1999.

7 In this sense, the concept is a qualitative rather than a chronological category. It is a set of projects and preoccupations rather than a stage in history (cf. Osborne 1995, p. 23) Of course, there has long been preoccupation with technology in the history of political thought; see Winner 1977.

8 Barry 1996a, p. 126, Rose 1999.

9 Cf. Foucault 1997, pp. 67–71.

10 Reflecting on the contemporary preoccupation with continuous education Gilles Deleuze spoke of the emergence of what he termed a 'control society' (Deleuze 1995, p. 182).

11 On 'nature' as a matter of choice see Strathern 1992b.

12 Irwin and Wynne 1996.

13 On degeneration see Pick 1993; on evolution see Young 1985; on government as a machine see Agar 1998; on society as a machine see Wise 1988; on the state machine see Lenin [1918] 1992. On the emergence of the idea of the network in political thought see Winner 1977. 'Even Lewis Mumford, who emphasizes the idea of society as a machine, has changed his emphasis to something called a 'Power Complex'. What needs expression is the idea of a set of large-scale, complex, interdependent, functioning networks which form the basis of modern life; for this, 'the machine' will no longer suffice' (p. 193). Winner's reference is to Mumford 1970.

14 Collins 1985.

15 Burchell, Gordon and Miller 1991, Burchell 1996, Barron 1996, Cruikshank 1999.

16 Rose 1999, p. 5.

17 O'Malley et al. rightly criticise the tendency of writers who have followed Foucault's work on governmentality for focusing on programmatic forms of government, O'Malley, Weir and Shearing 1997, p. 510.

18 Barry, Bell and Rose 1995.

19 Gilroy 1993, Fuss 1995, Dean 1997.

20 Bonnie Honig distinguishes between those political theorists (including Kant and Rawls) who seek to close down the space of the political in the interests of good government and those (including Nietzsche and Arendt) who place a value on political action and dissensus (Honig 1993).

21 In particular, in the tradition of political thought following from the writings of Saint-Simon and Comte. See Winner 1977, p. 441.

22 On the relation between science and the development of international organisation see Murphy 1994.

23 On public inquiries as hybrid politico-technical institutions see Ashenden 1996.

24 This is the solution suggested by Jürgen Habermas 1971. Critical sociologists have often looked to democracy to provide a political solution to the problem of technology. See, in particular, Winner 1992 and Sclove 1995.

25 Deleuze 1988, Akrich 1992.

26 Such human elements, of course, themselves have to be assembled and fashioned. Individuals are not indivisible and autonomous, but made up of many parts, each of which is highly composite and affected by its environment in different ways.

27 Schaffer (1996, p. 80), Collins 1990.

28 Geoffrey Bennington makes the observation that reference to politics in philosophy and social theory has the effect of closing down the space of the political (Bennington 1994, p. 3). To claim that an artefact is simply the product of political interests has a similar effect. Technology may be inscribed within a political situation without being reducible to it (Joerges 1999).

29 Law 1991.

30 Cf. Habermas [1962] 1989.

31 Thompson 1995.

32 Myerson and Rydin 1996, p. 205.

33 This argument – about the politics of technology has been developed from work in two intersecting areas. One is the area of feminist theory and the history of science. The other is in the area of sociology and anthropology of science and technology (see, in particular, Shapin and Schaffer 1985, Jordonova 1989, Haraway 1989, 1991, Strathern 1992a&b, Latour 1996b, Pickering 1995b). It has longer roots in Western Marxism, in the work of, for example, Adorno and

Horkheimer, Gramsci and Castoriadis (Gramsci 1971, Adorno and Horkheimer [1944] 1979, Castoriadis 1984).

34 In the work of Hayek and Popper, for example, one of the distinguishing features of a liberal as opposed to authoritarian society is the complete autonomy of science from any political control.

35 E.g. Haraway 1991, Law 1991, Pickering 1995a & b.

36 See Cartwright 1995.

37 Pickering, 1995b, p. 7.

38 Here I prefer Deleuze's notion of arrangement (*agencement*) to Foucault's notion of apparatus (*dispositif*). As many commentators have argued, one of the weaknesses of Foucault's work is the sense of an apparatus as something like a mechanical fixed system in which everything is in place. The notion of the arrangement has the virtue of suggesting an entity which is always in process; an ordering rather than a completed order in which agency is emergent (Deleuze 1988, 1995, p. 196). Michel Callon, John Law and Bruno Latour's notion of the actor-network is similar (Callon, Law and Rip 1986). However, I prefer the notion of the arrangement to actor-network precisely because the notion of the network has become so closely associated with the idea of direct and instantaneous connection associated with information technology (Latour 1999c).

39 Strathern 1992b, p. 197.

40 Haraway 1989, 1991, 1997. For related work in critical science studies see, in particular, papers published in the journal *Science as Culture*, and in the earlier *Radical Science Journal* (Levidow 1986).

41 For a good survey of recent work on globalisation which, nonetheless, has very little to say about science and technology see Held et al. 1999.

42 Callon and Latour 1981.

43 Within historical sociology a similar point is made by Michael Mann (1986) in his remarkable study of ancient civilisations.

44 Barry 1996.

45 Habermas 1998, p. 400.

46 See Wolff 1991, Haraway 1997, ch. 2 and Spivak 1998 on the disembodied observer of modern social theory and philosophy.

47 Weber 1948, pp. 196–198.

48 Beer 1996.

49 For further discussion see Serres 1977, Johnson 1993, Tomas 1995, Pickering 1995a, Keller 1995, Hayles 1996 and Thrift 1999.

50 For influential examples of network metaphors in recent social and political thought see Latour 1993, Mulgan 1994a, Castells 1996, Melucci 1996.

51 E.g. Rhodes 1987, Dehousse 1997.

52 E.g. Charan 1991, Peters 1992, Gibbons et al. 1994, Goffee and Scase 1995.

53 Paraphrasing Myerson and Rydin 1996, p. 25 and Derrida 1978, p. 17.

54 Emily Martin (1996, p. 103) makes a similar point in a discussion of Deleuze and Guattari's notion of the rhizome which does not have the rigidity of a network.

55 This is a theme in the work of Ulrich Beck. As Beck argues, a recognition of the possible failure of technological systems, and the scientific and technical uncertainties about the form that failure will take, has become a key focus for political and scientific concern (Beck 1992, 1995, 1999).

56 Nonetheless the study of technological repair has not received the attention it deserves. Sociologists and economists of technology have tended to focus their attention either on the process of innovation or activities of consumption.

57 Collins 1985.

58 Born 1996.

59 E.g. Laplanche 1989, p. 163, Fletcher and Stanton 1992, p. 6.

60 E.g. Phillips 1995.

61 See, for example, Paul Rabinow's work on social engineering and the modern political imagination (Rabinow 1989).

62 Scott Lash makes a related point: 'In reflexive modernity one can never quite know, never quite get a grasp on objects of knowledge. The programmes of social engineering of simple modernity have brought with them their own side effects, their own unintended consequences' (Lash 1999, p. 3).

63 Strathern 1996.

64 'All social order can only affirm itself in so far as it represses a 'constitutive outside' which negates it' (Laclau 1990, p. 180). Here I make a distinction between discourse and (non-discursive) space, recognising that spatial boundaries are themselves encoded discursively, and discursive distinctions have spatial implications.

65 Callon 1998a, p. 16–17.

66 On the notion of the frame see Callon 1998b.

67 My thanks to Ann Scott for pointing out to me the psychoanalytic use of the notion of the frame. In sociology the term is developed by Goffman (1974).

68 Strathern 1996, p. 525.

69 On the notion that technology both constitutes and travels down narrow channels see, in particular, the work of Bruno Latour 1987.

70 Star and Griesemer 1989, Wise 1995.

71 See Michael Bull's work (2000) on the complexity of Walkman use.

72 See, for example, Silverstone and Hirsch 1992, Bull 2000.

73 This is a theme in the work of Harold Innis (1950,1951) and Paul Virilio (1989,1991), although the work of both authors tends towards a form of technological determinism. Virilio's work suggests that technological zones are not just spatial formations. They also govern the time between objects.

74 Deleuze expresses the relation between technique, arrangement and diagram in the following way: 'And if the techniques – in the narrow sense of the world – are caught within the arrangements, this is because the arrangements themselves, with their techniques, are selected by the diagrams: for example, prison can have a marginal existence in sovereign societies and exists as a mechanism only when a new diagram, the disciplinary diagram, makes it cross the "technical threshold"' (Deleuze 1988, p. 40).

75 Osborne and Rose 1997.

76 In drawing on Foucault, social theorists have tended simply to adopt his notion of surveillance and apply it to the study of information technology (e.g. Poster 1996). At best, this approach does not do justice to the emergence of new ways

in which the relations between persons and new information technologies have been configured. In chapter six, I argue that many of these new relations are best captured through the notion of interactivity rather than surveillance.

77 Ulrich Beck rightly criticises recent theorisations of flows and networks in terms of their lack of concern with the specificity of institutions (Beck 2000).

78 On the emergent properties of 'large' socio-technical arrangements see Pickering 1995b, 234–242.

79 Christopher Norris's various polemics against what he terms postmodernism are one version of such a moralism (eg Norris 1992).

80 Hacking 1999.

81 On the limits of social constructivism see, in particular, Haraway 1989, Butler 1993, Rabinow 1996a&b, Latour 1999a, Hacking 1999.

82 Strathern 1988, pp. 19–20.

83 'Even when we find the rule, the particular cannot be subsumed under the universal' (Lash 1999, p. 3). On empiricism see Osborne 1998.

84 On the need for conceptual inventiveness see Deleuze with Parnet 1987.

85 See, for example, Law 1994, Born 1995, Macdonald 1997, Mcdonald 1996, Rabinow 1996a&b, Latour 1999a, Knorr-Cetina 1999.

86 On branding see the work of Celia Lury 1993. On the value of Goffman for the anthropology of science see Law 1994, p. 176.

87 See, for example, Macdonald 1997.

88 On technological failure see Latour 1996a.

89 Marcus 1986, p. 170, 1994, p. 51. Marcus takes the term 'knowable community' from Williams 1981.

90 Ibid., pp. 51–52.

91 Marcus 1994.

92 On the consumption of technology see, in particular, Schwartz Cowan 1983, Silverstone and Hirsch 1992, Edgerton 1998, Bull 2000, Miller and Slater 2000.

93 'When we ask about the most general source of the desire to quantify, we find it more nearly in the requirements for regulating society and its activities than in the search for mathematical laws of nature ...' (Wise 1995, p. 5).

94 Appadurai 1990.

95 Wise 1995, Alder 1997.

96 Majone 1996b, p. 263.

97 Majone 1993a&b, 1996a&b, Caporaso 1996.

98 Castells 1998, pp. 330–332.

99 The classic statement of science as a liberal and ethical enterprise is Merton 1968. Tom Osborne and Paul Rabinow have re-emphasised the importance of a concern with ethics in studies of science in their recent work (Osborne 1998, Rabinow 1996b).

100 See, for example, Giddens 1991.

101 See, in particular, the work of Mike Michael, Michael 1992,1996a&b. Although there may be a decline in trust in specific institutions (e.g. central government, large firms, professional bodies), in specific countries, and in specific circumstances (e.g. during the BSE crisis of the 1990s).

102 Blume 1974, ch. 7 on earlier attempts to demand that scientists are socially responsible. On the public understanding of science see Irwin and Wynne 1996.

103 Irwin 1995.

104 Michael 1996a&b.

105 Hargreaves 1998, p. 49, my italics.

106 Zizek 1999.

107 Cf. Power 1997.

108 Steve Pile has made the point: '[one] effect of thinking through the geographies of resistance, ... is [that] resistance is 'uncoupled' from domination' (Pile 1997, p. 2).

109 Agamben 1993, p. 85.

2 TECHNOLOGICAL ZONES

1 Appadurai 1990, p. 296.

2 'The complexity of the current global economy has to do with certain disjunctures between economy, culture and politics which we have barely begun to theorize', (Ibid., p. 296). See also Tagg 1991 and Wolff 1991.

3 Appadurai 1990, p. 301.

4 Foucault argues, for example, that from the nineteenth century onwards, political reason became increasingly centred on the health and security of society and the economy rather than the protection of territory per se. The preoccupation of earlier political theorists with the security of territory was, in his account, although not absent, displaced and reconfigured. The notion of territory became, in particular, associated in nineteenth- and twentieth-century politics, with ideas of 'nation' and 'race' (Foucault 1997).

5 Appadurai 1986, Straw 1991, Thomas 1991, Gilroy 1993, Thrift 1996, Clifford 1997, Marcus 1986, 1996.

6 Shellee Collen in Ginsburg and Rapp 1995.

7 See, in particular, the work of Daniel Miller and Don Slater 2000.

8 Gilroy 1993, p. 7.

9 The connection between the territorial and the technological formation of the nation-state is addressed by Anthony Giddens 1985. Giddens makes the questionable assertion: 'Unlike traditional states, the nation-state is a power-container whose administrative purview *corresponds exactly to its territorial delimination*' (p. 172, my emphasis). David Held raises the critical question of the extent of the disjuncture between national state borders and other political and economic spaces (Held 1995, ch. 5 and ch. 6).

10 Collins 1985.

11 Consider, for example, the offer by the German government to offer visas (but not full citizenship) to Indian citizens who possess expertise in software to come to work in Germany, *Guardian*, 22 May 2000.

12 Parry 1999.

13 Wollen 1993.

14 O'Connell 1993, Barry 1993.

15 Berland 1996.
16 In this case a technological zone takes the form of what Peter Miller has called a 'calculable space' (Miller 1992).
17 As we shall see, different fields are marked by the value that is placed on the technically difficult and the complicated, and the value that is placed on the complex and the irreducible.
18 'Most of the difficulties we have in understanding science and technology proceeds from the belief that space and time exist independently as an unshakeable frame of reference *inside which* events and place would occur. This belief makes it impossible to understand how different spaces and different times may be produced *inside the networks* built to mobilise, cumulate and recombine the world' (Latour 1987, p. 228, emphasis in original).
19 Serres with Latour 1995, p. 60. See also Burgin 1991, Rajchman 1998.
20 Berland 1996, p. 125, Mol and Law 1994.
21 Star 1991.
22 Pickering 1995, p. 169, note 11.
23 Foucault refers to the importance of the naval hospital as a mechanism for filtering and regulating the flow of alien objects across territorial boundaries (Foucault 1977, p. 144, Deleuze 1988, p. 42). The question of the 'borders' of the nation-state have been interrogated by recent work in international relations theory (e.g. Shapiro and Alker 1996, Kuehls 1996).
24 On forms of exclusion associated with communications technologies see Virilio 1991.
25 Kuehls 1996, p. 43.
26 On chemical and biological weapons see Cole 1997 and Balmer 1997. On the spatialisation of knowledge of nuclear weapons see the work of Donald Mackenzie (1993).
27 Walker 1993.
28 Ulrich Beck has recently called for a cosmopolitan sociology which transcends these distinctions, while recognising the continuing symbolic and institutional importance of nation-states (Beck 1999, 2000).
29 Giddens 1985, p. 263.
30 Held 1995, p. 90., Ruggie 1993, p. 172.
31 See, for example, Sylvester 1994, Spivak 1998.
32 There is now a large and important body of literature in poststructuralist international relations theory which interrogates this distinction. See, in particular, Walker 1993, Campbell 1992, 1996, Campbell and Dillon 1993, Der Derian 1992, Connolly 1993, Shapiro and Alker 1996.
33 The development of the notion of globalisation reflects, in part, a concern to contest the image of bounded national societies and sovereign nation-states. On global governance see Falk 1995. On cosmopolitan democracy see Archibugi, Held and Köhler 1995, Beck 2000.
34 '"Purification" creates two entirely distinct ontological zones: that of human beings on the one hand; that of nonhumans on the other' (Latour 1993, pp. 10–11).

35 A striated space is one in which lines of comparison and movement are clearly marked. Striated space is measured and ordered: space which has been *made* relatively homogeneous. It is the space of what Deleuze and Guattari term Royal Science: those forms of knowledge which are less concerned with specificity and difference than with the formal and the general and which make rapid comparisons over a wide territorial area possible. Striated space coexists and can be contrasted with smooth space, within which lines and connections may always be in the process of transformation. By contrast to striated space, smooth space is a field without fixed channels and clear paths. 'A field, a heterogeneous smooth space, is wedded to a very particular type of multiplicity; nonmetric, acentred and [rhizomic]' (Deleuze and Guattari 1987, p. 371). Smooth space is, for Deleuze and Guattari, the space imagined and worked with by what they term the ambulant sciences: the forms of knowledge associated with local differences and variation.
36 Buzan and Herring 1998.
37 See Michael Mann's analysis of the importance of the equipment of the legionary and the technology of road building to the maintainance of the integrity of the Roman empire (Mann 1986).
38 On the logistics of perception see Virilio 1989, Der Derian 1992. On accuracy see MacKenzie 1993.
39 Kaldor 1999, p. 3.
40 Elam 1997.
41 Kennedy 1971.
42 Wise and Smith 1986, Schaffer 1992a, Barry 1996.
43 Kaldor 1982.
44 Edgerton 1991. George Orwell notes that a distinction needs to be made between an older aristocratic English ruling class which was associated with the army and the landed aristocracy and the professional orientation of the airforce, one of the key institutions of Edgerton's liberal militarist state (Orwell [1941] 1962, p. 81). In more general terms, Stefan Collini (1989, p. lxix) questions the common view, associated with C. P. Snow, that the British political establishment has been hostile to science and technology.
45 On Greenham see Sylvester 1994, Roseneil 1995.
46 The remarks are made in the context of a discussion of the proposal made during the office of President Reagan, by some senior political figures in the US, that SDI technology should, once developed, be shared with the USSR. 'The offer to provide the technology to the USSR betrays a lack of understanding of [the] underlying dynamism [of technology] and the vulnerability it creates' (Skolnikoff 1993, p. 67).
47 Pickering 1995a who draws on Haraway 1991. See also Der Derian 1992.
48 Johnson 1994, 1999.
49 Elam 1995, p. 14.
50 The significance of regulation and the forms that it has taken within different countries has, of course, varied quite widely. Majone (1996b, p. 11) reminds us that 'public ownership has been the main mode of economic regulation in

Europe'. In the contemporary European Union an explicit regulatory policy has displaced public ownership as an instrument of economic regulation.

51 Osborne 1996.

52 Kuhn 1988, Hansen 1993.

53 Bell 1993, Ashenden 1996.

54 Rose 1994, 1996a.

55 Power 1997.

56 Laughlin 1996.

57 Miller 1995.

58 Callon 1998b.

59 Anderson 1983, Schlesinger 1991, Donald 1992. In this way nationalism and liberal democracy have been closely related. Appadurai has made the point: 'States ... everywhere seeking to monopolize the moral resources of community, either by flatly claiming perfect coevality between nation and state, or by systematically museumizing and representing all the groups within them in a variety of heritage politics that seems remarkably uniform throughout the world' (Appadurai 1990, p. 304).

60 On the American experience Chandler 1977, Carey 1989. The German nationalist economist, Friedrich List, became, the 'voice of the movement demanding in 1844 that German governments create the physical infrastructure of an integrated national market and that they then agree on rules to govern that trading system' (Murphy 1994, p. 51). On the significance of List see Elam 1997.

61 Czitrom 1989 explores the relation between the emergence of the mass media and the development of empirical media research. One might say that media studies as a discipline is formed around the problem of the failure of the media to establish a perfect liberal public sphere (cf. Habermas [1962]1989). Given that part of what a liberal public sphere involves is an attention to the inevitable imperfection of government, one could say that media studies is an intrinsic part of the object which it analyses.

62 Donald 1992.

63 Adorno and Horkheimer [1944] 1979.

64 Ahiska 1999. Developing the work of Harold Innis (1950, 1951) Jody Berland notes how Canada appears at the margins of North American weather maps, produced by American and European satellites with a US audience in mind. 'Our weather forecasts are exhibited and transmitted east–west across Canada by Canadian broadcast satellites, but the information comes from American and European satellites. In other words they are maps of technoterritory as much as maps of geophysical terrain' (1996, p. 125).

65 Ang 1990.

66 Which does not mean that there is no correspondance between the kinds of technological zones formed through the activities of firms and the territorial and political boundaries of nation-states. Since the mid-1980s many economists have argued for the importance of nation-specific factors (such as public education and defence procurement) in accounting for the dynamics of technological innovation. For an excellent review of the current debate on the significance of what the economist Chris Freeman called 'national systems of innovation' see Archibugi and Michie 1997.

67 The notion of the firm, like that of the state, serves as a black box which may often obscure further analysis. Here, it is worth saying that any account of how firms are made up would have to look at the role of technical devices in establishing the unity and boundedness of the firm, in so far as these exist.

68 Jordan and Lynch 1998, p. 794. As Jordan and Lynch demonstrate the formation of such a zone does not produce complete standardisation. The technique takes different forms in different circumstances.

69 Hawkins, Mansell and Skea 1995. According to Philip Agre 'Potentially the most significant technical innovation [in the development of new digital information media] is a class of privacy-enhancing technologies (PETs) ... No longer are privacy advocates in the position of resisting technology as such' (Agre and Rotenberg 1997, p. 4).

70 Quoted in Noble 1977, p. 75.

71 Andrew Goffey (1998) notes that Nietzsche's attitude to the 'laws of chemistry' reflected his sense of their moral after-taste.

72 Stoneman 1987, ch. 9 and ch. 11.

73 The most well-known recent example of such a strategy has been by Microsoft. The ruthless pursuit of this strategy by Microsoft eventually led the US regulatory authorities to pursue an anti-trust action, *Financial Times*, 8 November 1999.

74 Cambrosio and Keating 1995, p. 82.

75 Traweek 1988, Knorr-Cetina 1999.

76 Duruiz and Yentürk 1992.

77 On the importance of accounting and evaluating research activities see Power 1996. The observation about whether evaluation has the same meaning in Britain and Europe derives from my own fieldwork in the European Commission.

78 David 1985, David and Bunn 1988. See also Paul Virilio's (1991, p. 13) discussion of the displacement of physical gateways by electronic access.

79 On this point see, for example, Akrich 1992.

80 Consider, for example, the use of the wrong software on the first launch of the Ariane 5 rocket which caused the rocket to veer off course and led to its destruction.

81 Callon 1998b, 256–264.

82 For an empirically grounded critique of the fantasy of the Internet as a 'virtual reality' which exists autonomously from reality proper, see Slater 1998 and Miller and Slater 2000.

83 Strathern 1994, p. 3.

84 Dutton 1996, pp. 283–287, Tsagarousianou et al. 1998.

85 Cf. Stocking 1983, Strathern 1987.

86 Schaffer 1994, pp. 32–33, see also Herle and Rouse 1998.

87 Schaffer 1994, p. 37.

88 Ibid., p. 45.

89 Ibid., p. 33.

90 Ibid., p. 46.

91 Foucault 1973, p. 164, Barry 1995, pp. 50–51.

92 Osborne 1992, p. 85.
93 Barry 1995.
94 Mol and Law 1994, p. 654. In practice, medical practice in Europe will also involve a great deal of 'subjective' technique. Subjective technique is a particularly important part of many applied disciplines where professionals are required to deploy their expertise in complex field situations.
95 The metaphor of the fluid is developed further in de Laet and Mol 2000.
96 Wise 1995, Schaffer 1995.
97 Whitehead [1926] 1985, 1929.
98 Chard 1999.
99 Park viewed journalism in an extremely positive light (Park 1940). My argument here draws on Barry 1995. See also Scott Lash's contrast between simple and reflexive modernity. In the latter 'individuals must innovate rules in a bricolage of their own identities' (1999, p. 3).
100 Not surprisingly, perhaps, many anthropologists have been concerned with the problem of the person of the anthropologist and how it might be possible to represent the anthropological experience (see Clifford and Marcus 1986, Rabinow 1996b).
101 See also Osborne 1998.
102 According to one report, British defence scientists were being supplied with some of the test results and had contributed financially to the costs of the French computer work (*Guardian*, 20 September 1995, p. 1).
103 'EU clash looms as Paris snubs nuclear team' (*Guardian*, 5 October 1995). According to Article 34 of the Euratom treaty, a member state that intends a '"particularly dangerous experiment" in its territory [is required] to take additional health and safety measures and to obtain permission from the European Commission on those measures' (*Guardian*, 25 October 1995, p. 25). This article, and the Euratom treaty in general, was interprated by the courts to refer to the civil use of nuclear energy. In effect, the release and geographical dispersal of radiation was regulated at a European level, but only when its origins were 'civil'. Military experiments could be conducted without reference to the effects on the health and environmental security of others. The ends of military–technological zones were considered impassable.
104 See, for example, Strange 1996 and Hirst and Thompson 1996. For an overview of the debate on globalisation and its dimensions see Held et al. 1999.
105 Mitchell 1997, p. 105.

3 HARMONISED STATES

1 The survey came to be known as the Ordnance Survey. Roy's account of his work is given in Roy 1785. Conner 1987, pp. 249–250.
2 Hacking 1990, Wise 1995.
3 The 11th General conference on weights and measures defined the metre as 'the length equal to 1,650,763.73 wavelengths of radiation corresponding to the transition between levels 2p10 and 5d5 of the atom Krypton86'. On replication in science see Collins 1985.

4 The movement towards precise standards was not inevitable. The authors of the *Values of Precision* detail how, in the nineteenth century in particular, precision was made into a value (Wise 1995). Drawing on the work of Simon Schaffer and Stephen Shapin, Norton Wise also raises the question of cultural differences in the basis for trust [in the eighteenth and nineteenth centuries], drawing a possible contrast between 'a British style in establishing standards, for example, rooted in a social order based on consensus and class (agreement among responsible 'gentlemen') rather than a society of legal uniformity' (Wise 1995, p. 11).
5 Sociologists have often written about the remarkable level of standardisation in modern industry (for example, in relation to discussions of the 'Fordist' system of manufacture). Yet it is equally striking that there are also limits to standardisation. Different firms, laboratories or states often deploy different standards. Far from reducing over time such differences may increase with the generation of new technologies.
6 CEC 1986, 1992b. On the Maastricht Treaty see Hirst 1993.
7 There is, of course, a vast literature on international relations and political science on European integration, European political institutions and the European Union, concerning which it would be impossible to do justice. Useful texts include Milward 1992 (on the early history of the European Community), Tsoukalis 1993 (on the European economy), Weatherill 1995 and Weiler 1999 (on law), Amin and Tomaney 1995 and Morarcsik 1998 (on economic integration), Majone 1993a&b, 1996a&b (on regulation), Mazey and Richardson 1993 (on lobbies), Hix 1999 (on the political system), Smith and Wright 1999 (on democracy) and Rumford 2000 (on cohesion). The institutions of the European Union themselves have played a significant part in the formation of the European Politics industry through funding university positions.
8 Sonia Mazey and Jeremy Richardson view the Commission as a 'kind of bourse, acting as a market for policy ideas and innovation in the EU policy process'. In the institution 'the most successful groups are those that exhibit the usual professional characteristics – namely sufficient resources, good advance intelligence of intended policy change, and strong contacts with bureaucrats and politicians' (Mazey and Richardson 1996, p. 41).
9 Shore 2000.
10 At the end of the 1990s the question of the existence of corruption inside the Commission became a particularly important political issue in the European institutions. One target of the allegations of the corruption was the Commissioner responsible for Education and Research, Mme Edith Cresson.
11 On the internal culture of the European Commission and the importance of language see the work of Maryon McDonald 1996. Other accounts of the inside of the Commission include Ross 1995, Abélès 1996 and Shore 2000.
12 The Parliament meets once a month for general sessions in Strasbourg. However, most smaller parliamentary committee and party group meetings are held in Brussels. The Parliament's own bureaucracy is resident in Luxembourg and has to be ferried between Brussels, Luxembourg and Strasbourg for meetings.
13 In what follows Europe refers to the European Union not to the continent of Europe.

14 Recent studies of nationalism have rightly emphasised the importance of cultural institutions to the nationalist political project questioning the earlier emphasis of scholars on political and economic history; Chaterjee 1993, Ahiska 1999.
15 Morley and Robbins 1995.
16 Engels, *Anti-Dühring*, quoted by Lenin in *State and Revolution*, [1918] 1992, p. 16.
17 This alliance was most forcefully articulated by British Prime Minister Mrs Margaret Thatcher. The possible contradictions between a neo-liberal economic programme and a nationalist political programme were central to the internal politics of the British Conservative Party from the 1980s onwards. The sense that the European Commission was obsessed with the regulation of material culture showed how it was possible to resolve this contradiction. One could be opposed to 'Europe' as a Conservative for good nationalist and neo-liberal reasons.
18 Michel Serres has made a similar point: 'A major contractual actor of the human community, on the brink of the second millenium, Europe weighs at least a quarter of a million souls. Not in body weight, but in its crossed networks of relations and the number of world-objects at its disposal' (Serres 1995, p. 16).
19 Meny et al. 1996, p. 7.
20 Mann 1996, p. 304.
21 From the author's personal experience as a researcher working for the European Parliament and the UK parliament in Westminster.
22 In Majone's analysis: 'In Europe the market system, and the structure of property rights which such a system entails, have been accepted by a large majority of voters only recently. For most of the period between the great depression of 1873–96 and the Second World War, large segments of public opinion were openly hostile to the market economy, and sceptical about the capacity of the system to survive its recurrent crises. Hence in industry after industry the response of most European governments to perceived cases of market failure was a very intrusive form of control, that is, nationalizations rather than American-style regulation.' Public ownership was, in effect, one of the main instruments of economic regulation (Majone 1996b, p. 10–11).
23 Majone 1996b, pp. 62–63.
24 For a general discussion of the scope of harmonisation and its interest to sociologists see Bryant 1991.
25 Treaty of Rome, 1958, preamble. For an excellent account of the early history of the European Community see Milward 1992.
26 CEC 1992b, Article 130a.
27 Ibid., Article 130c.
28 Many of the economic effects of further integration are likely to increase differences between regions, or increase internal differences within regions which are invisible to the regional methods of measurement available to the Commission (Amin and Tomaney 1995). For a cogent analysis of the contradictions between European integration and cohesion policy see Rumford 2000.
29 Miller 1992.
30 Teague and Grahl 1992, p. 142.
31 Church and Phinnemore 1994, pp. 516–521.

32 Pelkmans 1987, p. 251.
33 Thompson 1992, p. 140. The notion that it was the task of the public authorities to remove obstacles to foster enterprise and innovation has become firmly established. According to Commissioner Edith Cresson, 'innovation depends ultimately on people and enterprises. It's up to governments to create the environment for innovation to flourish by removing obstacles which can stifle it' *Innovation and Technology Transfer*, December 1996, p. 3.
34 'Striation ... relates primarily to the state pole of capitalism, in other words, to the role of the modern State apparatuses in the organisation of Capital. [But] at the complementary and dominant level of integrated (or rather integrating) world capitalism, a new smooth space is produced in which capital reaches its abolute speed, based on machinic components rather than the human component of labour. The multinationals fabricate a kind of deterritorialised smooth space in which points of occupation as well as poles of exchange become quite independent of the classical paths of striation" (Deleuze and Guattari 1988, p. 492).
35 Dehousse 1992. See Edgerton and Hughes 1989 on the Thatcher government's complex, if not contradictory, attitude towards science. On the one hand, the government wished to both constrain public expenditure on science and make it more useful to the economy. On the other hand, Mrs Thatcher herself supported the view of an earlier generation of neo-liberal thinkers for whom, writing in the 1940s, the freedom of scientific inquiry from state interference was a marker of a free society (Thatcher 1989, p. 4). In practice, government policy became more and more concerned that the immediate results of scientific research should become measured and monitored and that research should be more directly tied to the needs of industry. The direction of research was not, as Hayek and others had feared, directly controlled by the State. But it came to be governed through the indirect methods of evaluation and audit. Scientific research was autonomous from the formal institutions of political power, but this autonomy needed itself to be stimulated and measured, with counterproductive, unpredictable and complex consequences (Power 1996).
36 Cecchini 1988, p. 24.
37 Ibid., p. 53.
38 Noble 1977, Wise 1995.
39 See, in particular, the work of Paul David (David 1986, 1987).
40 Cecchini 1988, p. 26. At this time, 1 ecu was equal to approximately $1US.
41 On the costs of standardisation in the nineteenth century see Wise 1995, p. 226.
42 Majone 1993a, 1996a&b.
43 As Majone argues: 'Administrative regulation – economic and social regulation outside the line of hierarchical control or oversight of the central administration – is becoming the new frontier of public policy and public administration in Europe' (Majone 1993a, p. 11).
44 Quoted in 'Britain's milk chocolate not fit to bear the name, EU rules', *Guardian*, 24 October 1997, p. 2. The dispute over chocolate went on for a number of years finally resulting in a victory for the British position, 'British win a sweet victory in the EU', *Guardian*, 19 June 1999.

45 For a good summary of the position of the European institutions see Meny et al., 1996, pp. 2–9.
46 For example, as part of an effort to restructure and disperse the European Commission's own research efforts the Commission's central unit for technology policy research was transferred from the Commission's former nuclear laboratory, ISPRA, near Milan, to Seville. The deal was part of a broader effort by the local government in Spain to develop a more future-oriented technological identity (Harvey 1996). As a result, the unit was isolated from the main elements of the European Commission in Brussels.
47 CEN – European standardisation committee. BSI – British Standards Institution. ETSI – European telecommunications standards institution. CENELAC – European committee for electronic standardisation. Afnor – Association français de normalisation.
48 Majone 1996b, p. 24.
49 Pelkmans 1987, p. 114, Majone 1996b, pp. 268–269.
50 On the *Cassis de Dijon* judgement see Weatherill 1995, pp. 233–235. According to the Court: 'Obstacles to movement in the Community resulting from disparities between national laws in question must be accepted in so far as those provisions may be recognized as being necessary in order to satisfy mandatory requirements relating in particular to the effectiveness of fiscal supervision, the protection of public health, the fairness of commercial transactions and the defence of the consumer' (Case 120/78 [1979] ECR 649).
51 Schmitt von Sydow 1988, p. 97, see also Majone 1993a, pp. 16–17.
52 The European Environment Agency and the Agency for the Evaluation of Medicinal Products are examples (Majone 1996b, p. 274).
53 For an excellent account of institutional resistance to European regulation of drinking and bathing water standards in the UK see Jordan 1999.
54 The point is of some importance to those concerned with European law. Stephen Weatherill notes that the official justification for the Bathing Water Directive referred to the 'functioning of the market', while the real reason, he argues, was environmental protection. 'Spurious reasoning [of this kind] in the Bathing Water Directive makes it hard to take seriously the notion that Community competence is limited by anything other than the need to secure unanimous support in Council' (Weatherill 1995, p. 51); CEC 1976. For further details of the Bathing Water Directive see Johnson and Corcelle 1995, pp. 32–40 and Jordan 1998, 1999.
55 Quality of bathing water 1997 EUR 17629. The publication is a requirement of the ammendment made in directive 91/692/EEC. Data are made available on the Environment directorate web site, http://europa.eu.int/bathing/index.html.
56 Hernandez et al. 1995, p. 2.
57 The study was commissioned not by the environment directorate (then DG-XI) but the measurement and testing division of the research directorate (then DG-XII).
58 Demarquilly et al. 1995.
59 Hernandez et al. 1995, p. 55, my emphasis.
60 Ibid., p. 29.

61 Marine Conservation Society 1997, p. 10.
62 Interview, London, September 1997. The difficulties of harmonisation were certainly not confined to technically complex areas of regulation such as bathing-water-quality measurement. The following comments, for example, were made by a European Parliamentarian on progress towards harmonisation of European regulations on the 'Masses and dimensions of motor vehicles' nearly five years after the date of the completion of the single market. 'Some years ago we set out a Europe-wide agreement on the masses and dimensions of certain vehicles and their trailers in order to create free movement and the single market and all the advantages that this will give the citizen. We have to note that much progress has been made in this whole area ... Unfortunately the Council has not been able to bring forward specific measures that would finally complete the process' (Barton (PSE) Debates of the European Parliament 4–498/106, 8 April 1997). The problem here appears not have been the measurement of vehicle mass or safety but the expression of different interests by national governments.
63 Shapin and Schaffer 1985, ch. 6.
64 Bennett 1992.
65 Barry 1990, Tsoukalis 1993.
66 'The antecedents of organisational change by the ITU go back to the early 1980s, prompted largely by technological changes and by its members sponsored. In sum, the changes responded to (1) the changing technological environment, culminating in the merger of telecommunication and computing technologies which not only provide the means to improve public telecommunication services, but to introduce a whole range of services offered by various and discreet groups of suppliers; (2) the changing and diminishing role of governments in telecommunication development; (3) the ITU's slow mechanisms in an industry widely acknowledged to be fast moving; and (4) its technical orientation at the expense of increasingly commercial and political factors' (Tang 1995a, p. 577). For a detailed discussion of the organisation and process of standardisation in telecommunications see Schmidt and Werle 1998.
67 Consider, for example, the dispute between the US and the EU concerning the safety of animal growth hormone. Finally, the World Trade Organisation ruled that it was legitimate for the EU to prevent the import of hormone treated meat. In general, the WTO has been in favour of regulatory harmonisation in the interests of 'free trade'.
68 David 1985.
69 David 1987.
70 Dai, Cawson and Holmes 1996.
71 According to the cabinet member of Commissioner Leon Brittan, 'the standard proposed is at best *dirigiste*, at worst protectionist, and is evidently driven by Thomson and Phillips. Eventually there will have to be a standard, but there is no good reason to make one now ... let the market decide' (quoted in Ross 1995, p. 126). See also the opinion of the European Parliament Committee on the Environment, Public Health and Consumer Protection which was scathing in its criticism of the policy (EP A3–0308/91).
72 Interview, ISPRA, Italy, February 1994.

73 At a speech in London, the British Secretary of State for Trade and Industry, Margaret Beckett, suggested that this principle could be extended to relations between Europe and North America (letter from Mrs Beckett to the *Guardian*, 11 April 1998).
74 Habermas 1971, p. 62.
75 In Britain one might note the extraordinary absence of any regular reporting on events in Brussels. News media organisations understand politics as something which is not technical and occurs in national parliaments.
76 Richardson 1994, p. 162. Despite the importance of this point few political scientists have been concerned with the politics of scientific evidence.
77 On the development of a common European environmental policy see Freestone 1991. For a general discussion of the scope of harmonisation and its interest to sociology see Bryant 1991.
78 As Majone has argued: 'The growing realization that the interventionist and welfare policies had failed or could not be afforded any more, did not lead to demands for a return to laissez-faire, as the more radical advocates of privatization and deregulation seemed to expect. Instead, there was a demand for better focused and more flexible forms of public intervention, and for more attention to those areas of social regulation (environment, consumer protection, freedom of information) which were often neglected by the welfare policies of the past' (Majone 1993a, p. 12). Majone exagerrates, perhaps, the contradiction between neo-liberalism and the logic of regulation. For if we do not equate neo-liberalism simply with the political fantasies of Hayek and Friedman, then actually existing neo-liberalism has been remarkably inventive in recognising the importance of expertise and regulation for the realisation of its political project (Burchell 1996). Protecting the 'environment', for example, can be turned into an object of financial calculation through the use of techniques such as the 'polluter pays' principle.
79 Consider the judgement of the European Commission of Human Rights which ruled that the age of consent for homosexuals should be sixteen across Europe and cited the evidence of a medical report which claimed that 'most researchers now believe that sexual orientation is usually established before puberty' and that young gay men were [because of the then existing law on the age of consent] worried about seeking professional advice concerning the risks of HIV infection' (*Guardian*, 8 October 1997, p. 7).
80 One example is the promotion by the European Parliament of a European Centre for the research, development and validation of alternative testing methods in order to reduce the use of animals in cosmetics development. Parliament resolution B3–0712/92 and Energy, Research and Technology committee report PE 207.150.
81 The phrase comes from Deleuze, 1995, p. 172. See also Beck 1992, 1995, 1999. For a good empirical example of an area of regulation which has produced 'untechnocratizable consequences' consider the on-going debates about the need for controls over the development of genetically modified organisms (Levidow and Carr 1996).
82 Burchell 1996, pp. 23–24.

83 Callon 1998b. Callon draws on the work of Marie-France Garcia. According to Callon 'All of the different elements and devices [such as the way strawberries were displayed in a single hall] contributed to the framing of transactions by allowing for the rejection of networks of relations, and thus by constructing an arena in which each entity was disconnected from the others. This arena created a space of calculability: the technique of degressive bidding, the display of transactions on an electronic board, the relative qualification of batches of strawberries on their data slips, and knowledge of the national market all made the transactions calculable' (p. 20).
84 My thanks to John Law for suggesting this metaphor.
85 On the notion of complexity see Thrift 1999, Law and Mol forthcoming.
86 Strathern 1992b, p. 128.
87 For example, political parties, churches or trade unions.
88 In photographs of Brussels the Berlaymont building is taken to be the home of the European Commission, the centre of the bureaucracy. But perhaps it can also be taken as a metaphor and an index of one aspect of this enterprise. For in the early 1990s it was empty: its staff evacuated to other buildings, due to health and safety regulations.

4 ON THE NETWORK

1 See, for example, Castells 1996, pp. 160–162, *Financial Times* 27/9/99 and 15/11/99.
2 Gibbons et al. 1994, Latour 1999a.
3 Marsh and Rhodes 1993.
4 See, for example, Melluci 1996, Castells 1997.
5 'At the centre of things now are '*discourse coalitions*' that stretch across boundaries of classes, nation-states and systems' (Beck 1999, p. 29).
6 Thompson et al. 1991.
7 Castells 1998.
8 For a suggestion of the pervasiveness of the notion of the network in contemporary discussions of industrial organisation see the differing perspectives of Peters 1992 and Goffee and Scase 1995.
9 Leadbeater 1999, p. 106.
10 For an influential example of the relation between post-Marxist political analysis and management theory see, in particular, the work of Geoff Mulgan (1994a&b, 1997) who uses the term network in at least three different senses: (1) as decentralised political organisation (2) as technological infrastructure (3) as regional form of industrial organisation. In his view: 'Central to this view is a sense of the growing importance of creativity and knowledge in advanced economies: in new sectors such as biotechnology or artificial intelligence, knowledge, creativity and imagination become as important to economic success as narrowly conceived efficiency. The organizational problem is to mobilize people's commitment and mental powers rather than to exploit them more intensively. Though pyramidal bureaucracies are very good at implementing a given set of rules, they are strikingly ill-suited to creation and innovation' (Mulgan 1994, p. 119). Subsequently,

Mulgan has become an advisor to British Prime Minister, Tony Blair. The notion of the network is, of course, not a new one in accounts of left-wing organisation. See, for example, the 1926 edition of *The Socialist Network* which claims to catalogue every existing socialist and communist organisation of the period (Webster 1926).

11 See, for example, Ansell et al. 1997.

12 On the model of community see, in particular, Rose 1999, pp. 167–196.

13 As Ernesto Laclau and Chantal Mouffe argue: 'A discursive structure is not a merely 'cognitive' or 'contemplative' entity; it is articulatory practice which constitutes and organizes social relations' (Laclau and Mouffe 1985, p. 96).

14 Cf. Black's comment 'would it not be unsettling to suppose that a metaphor might be self-certifying, by generating the reality to which it seems to draw attention' quoted in Sawhney 1996, p. 293 for whom 'the metaphors that are used to study an emerging technology usually end up influencing the shape it takes'.

15 Consider the following statement by the current British Prime Minister, Tony Blair, which gives the Internet a key role in British economic development: 'Britain has a proud history as a great trading nation. We were the first industrial power – the workshop of the world. Great inventions have 'made in Britain' stamped all over them. We are a creative, innovative, adventurous people. Today we need that spririt of adventure more than ever. We need to face up to a new challenge – the challenge of the new information technologies. To succeed we have to be quick on our feet. We have to embrace the Internet now' (Blair 1999).

16 Loader 1997, Tsagarousianou et al. 1998.

17 We should not assume that there are 'real' technological or social networks to which other social or technological networks bear a metaphorical relation: 'Synonymy, metonymy, metaphor are not forms of thought that add a second sense to a primary, constitutive literality of social relations; instead, they are part of the primary terrain itself in which the social is constituted' (Laclau and Mouffe 1985, p. 110).

18 Callon 1980, Callon, Law and Rip 1986, xvii. Both Foucault and the actor–network theorists read the history of science and politics as a history of problematisations and techniques rather than a history of ideas and concepts.

19 Budge 1996, *Media, Culture and Society* 1996.

20 See chapter 6, 'On interactivity'.

21 Miller and Slater 2000.

22 Osborne and Rose 1999.

23 CEC 1993.

24 On the history of the electric telegraph and its role in imperial government see Barry 1996a. On the development of the idea of the information superhighway and the National Information Infrastructure in the United States see Wise 1997.

25 One could cite a vast number of examples. Consider the rules governing European 'support for industrial platforms to encourage networking of [media] companies'. To qualify for suppport a network 'must be made up of companies established in at least three different countries of the European Union and/or countries associated with the MEDIA programme. Priority will be given to platforms where one or more members are established in countries or regions with low audiovisual production capacity and/or restricted geographic and linguistic coverage' (CEC, Media II, Development and Distribution (1996–2000), call for proposals, 3/96).

26 According to the Director General of the research directorate DG-XII: 'in certain fields which were 'information intense' i.e. involved the production of large quantities of information by a large number of different laboratories'. Fields which were, in his view, 'information intense' included human genome and climate change research (Fasella 1997, p. 172).

27 The database is called CORDIS. Macdonald et al. 1999 discuss the 'dating' practices of European firms looking for partners with which they can form a network.

28 Delors and Clisthene 1992, cf. Donzelot 1991, p. 178, Donzelot and Estebe 1994.

29 On the subsidy mentality in the film industry see MacCabe 1992, Finney 1993, Barry 1996b, pp. 32–33. One could term such a policy postmodern in the particular sense that it sought to effect a dedifferentiation of art and industry (Lash 1990).

30 At a speech to the European Parliament in Strasbourg in December 1986.

31 Antonio Ruberti, at the launch of the European Communities 'Fourth Framework Programme for Research and Technological Development', Commonwealth Institute, London, May 1994.

32 For a comparative evaluation of some European networks see Hughes with Christie 1995. They argue that the most effective networks were diverse in their membership, not too tightly managed and involved a high level of communication between participants. In comparison to centralised facilities their studies suggest 'that networks offer substantially more flexibility....and benefits from diversity are less likely to be undermined since participants remained in their different environments', p. 112. Macdonald et al. 1999 argue that some networks come to function as clubs which are not accessible to those who have not already been members. For a useful critical analysis of the effectiveness of one networking programme see Larédo et al. 1992. For a discussion of European women's networks see Braidotti 1994. British officials, always mindful of the need to assess whether European initiatives were more cost-effective than national ones, have been particularly keen to find a method of determining the 'value-added' of European networks.

33 There are probably many reasons for this failure to coordinate different areas of policy. One has been the continuing belief that scientific and technical activity is primarily concerned with innovation rather than regulation. Another reason is the internal structure of the European Commission which is divided between various Directorates General, which function more or less autonomously from each other. In many instances regulation policy and research policy were the responsibility of different Directorates General.

34 Quoted in Delors 1991, p. 9. See also Neunreither 1993.

35 This particular implication of the network model of European integration has been commented on by a number of political scientists and international relations researchers (e.g. Keohane and Hoffmann 1991, Dehousse 1997, Ward and Williams 1997). However, as I argue later, writers from these disciplines have

tended to split off the analysis of social and organisational networks from a discussion of technological networks. In the European Union and elsewhere, these two senses of the term are intimately connected.

36 The European Community had discovered the importance of information technology in the 1980s. Prompted by assessments of the failure of Europe's industries to compete, the lobbying resources and skills of the large electronics firms, its own internal studies and, without doubt, the vast literature on the 'information technology revolution' the Commission began to support an extensive programme of research in information technology under the name ESPRIT (House of Lords 1984–1985, Cram 1997). Whereas 'America' occupied the centre of the European political imagination in the 1960s, 'Japan' came to occupy a similar position from the early 1980s. America, and subsequently, Japan, were threats to the historic place of Europe in the world system, but also potential models of what Europe might have to achieve. Europeans, who had reckoned themselves to be scientifically, if not always technologically advanced, now had to strive to stay in the race (CEC 1994b). Japan was the Other which Europe both had to emulate and to differentiate itself from if it were to maintain its historic position (Morley and Robins 1995).

37 CEC 1994b. According to Commissioner Martin Bangemann the Commission explicitly rejected Al Gore's notion of the 'information superhighway' because it did not highlight the social and political implications of the technological revolution (Seventh Charles Read memorial lecture, London, 20 June 1995). On the idea of the European 'information society' see http://europa.eu.int/dg3/.

38 CEC 1993, p. 14.

39 Cf. Anderson 1983.

40 CEC 1994b, p. 11.

41 Ibid., p. 12.

42 For further discussions of the concept of European citizenship see Tassin 1992 and Balibar 1996.

43 'Europe cannot compete with the low wage countries. Value added is the key. We are moving towards a knowledge-based economy and a knowledge-based society. Education and training will be crucial in this transition. The main areas of growth are in hardware, software and services' (Speech by Martin Bangemann, 'The European Vision of the Information Society', 10th World Congress 'Technology and services in the information society', Bilbao, 3 June 1996). On the importance of the knowledge-based society see also Cresson 1997.

44 Morley and Robins 1995.

45 McDonald 1996.

46 Pantel 1999, Shore 2000.

47 Ruberti 1993, p. 15.

48 Within the Commission the position was more complex. One Commission researcher reckoned that the movement from 'integration despite our diversity to [European] integration because of our diversity' was a paradigm shift, but it was not the result of any straightforward technological logic. It was a shift in political thinking. Interview, Brussels, 1995.

49 CEC 1994b, p. 11.

50 In 1994 to 1995, the Commission was divided into twenty-three directorates general each with responsibility for specific policy areas such as industrial affairs (DG-III), Information (DG-X) and Fisheries (DG-XIV). As part of the reform process initiated by Romano Prodi and Neil Kinnock, the Directorates lost their numerical titles: for example, DG-XII became DG-Research and DG-XIII became DG-Innovation.

51 Interview, Brussels 1994. In 1993 DG-XIIA organised a programme of research in 'the field of strategic analysis, forecasting and evaluation in matters of research and technology' (MONITOR) *Official Journal of the European Communities* 89/C 144/04.

52 One could equally say that technical quality is something that is produced through assessments made by scientists and engineers.

53 Interview, Brussels 1994. This autonomy was both an advantage and a disadvantage. An advantage in so far as it made it possible for FAST researchers to forge alliances across the Commission. A disadvantage in so far as they did not take a direct role in the routine decision-making process of DG-XII.

54 Interview, Brussels, 1994. The reference is to Ilya Prigogine, co-author of *La Nouvelle Alliance*, Prigogine and Stengers 1984.

55 The connections between the work of the various Commission services (or Directorates-General) is generally reckoned to be very poor. As far as I know, however, there has been no published in-depth study of this (see, however McDonald 1996). According to one official: 'The role of the *Cellule* is to act as an outsider...to influence those engaged in drafting[, for] the power in any bureaucracy is held by those who draft' Interview, Brussels, 1994.

56 Bourdieu 1984.

57 Latour 1993, pp. 8–9.

58 Following one discussion, Jean gave me a copy of a paper by Michel Callon (Callon 1991). On the relevance of this work for science policy see Callon, Larédo and Mustar 1997.

59 With the rundown of the European Commission's own nuclear research programme its own laboratories diversified into other areas. Some of the staff at the Commission's ISPRA laboratory, north of Milan, formed a new unit called PROMPT which also dealt with the assessment of science and technology. Unlike the intellectuals of DG-XIIA, however, the PROMPT researchers considered their work to be apolitical.

60 Interview, Brussels, 1994.

61 Interview, Brussels 1994, O'Conner 1991.

62 Witness the failure of European attempts to establish a European technical standard in High Definition Television (HDTV) in the face of American and Japanese competition.

63 There is some considerable debate as to whether the most 'advanced' technologies (from the point of view of engineers) would emerge from Commission-supported research as companies would be unlikely to want to share the results of their most commercially viable products. Of course, the debate between the sociologists and economists of DG-XIIA and others was, in part, a debate about whether what was 'advanced' should be judged by specialists alone.

64 Williams 1981, p. 204. Williams's vocabularly may imply a teleology in which the emergent culture eventually becomes the dominant culture. This should not be assumed here. Indeed, after the resignation of Mme Cresson, the Commissioner responsible for Research and Education, following charges of corruption, the importance of socio-economic considerations in the formulation of research priorities diminished. Interviews, Brussels May-June 2000.
65 Interview, Brussels, 1994.
66 Interview, Brussels, 1994. This view was also broadly supported by the Committee on Research, Technological Development and Energy of the European Parliament which noted that 'the linear model of innovation has been supplanted by the systemic model and the network model, which implies cooperation and constant and multidirectional synergies between research, marketing and development of products and processes' (EP 1996, p. 2). For accounts of the economics of innovation associated with the work of Chris Freeman, Luc Soete, Giovanni Dosi and others see Freeman (1990), Archibugi and Michie (1997).
67 Interview, Brussels, 1994.
68 Cf. Amin and Thrift 1995.
69 Interview, Brussels, 1994.
70 Interview, Brussels, 1994.
71 The distinction between the intellectual labour of DG-XIIA and the experience of DG-V mapped onto a gender distinction. In DG-XIIA all research was carried out by men and the only women employed in the offices were secretaries. The experience of DG-V was that of a woman official.
72 At the launch of the European Communities 'Fourth Framework Programme for Research and Technological Development', Commonwealth Institute, London, May 1994.
73 'In areas which do not fall within its exclusive competence, the Community shall take action, in accordance with the principle of subsidiarity, only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States and can therefore, by reason of the scale or effects of the proposed action, be better achieved by the Community' (Article 3b, Treaty on European Union).
74 According to Jacques Delors 'subsidiarity, because it assumes that society is organized into groups and not broken into individuals, rests strictly speaking on a dialectic relationship: the smaller unit's right to act is operative to the extent, and only to the extent (this is forgotten very quickly) that it alone can act better than a large unit achieving the aims being pursued' (Delors 1991, p. 9).
75 Strathern 1995, pp. 27–28.
76 Interview, Brussels, 1994.
77 Hingel 1993.
78 Interview, Brussels, 1994.
79 On bullet points see Strathern 1996/7.
80 FAST was merged into the DG-XII programme of socio-economic research.
81 This is an old story in the sociology and history of science. In the communication of science and technology, persons are important (Collins 1985, Shapin and Schaffer 1985). Rarely do written accounts suffice, however simplified.

82 Interview, Paris, 1994.
83 Interview, Brussels, 1994.
84 Castells 1998, pp. 331–332. Castells cites the work of Keohane and Hoffmann 1991 in international relations. In international relations theory there has been a long tradition of using technological metaphors to describe international forms of political organisation. In the functionalist and neo-functionalist tradition, European integration was conceived as something like an automatic process through which the various elements of the European system of government would gradually form part of a larger machine. See, for example, Deutsch et al. 1957, Lindberg 1963, Haas 1958, 1964, Monnet 1978. The development of the idea of the 'network state' reworks elements of this earlier model of integration.
85 Castells 1998, p. 332.
86 Castells 1996, p. 5.
87 Castells 1998, p. 337.

5 INTELLECTUAL PROPERTIES

1 See, for example, Patel and Pavitt 1987, CEC 1996a, CEC 2000. According to the European Commissioner for Research and Technological Development: 'This is what has been called the 'The European paradox. On a world level, Europe remains the second scientific power. Of the seven scientific Nobel prize winners this year, three were European researchers. And today Europe accounts for more than a third of the world's scientific publications. However, in industrial and technological terms, Europe's performance is much less impressive. To be persuaded of this, *one only has to look at the figures for patent filed by American, European and Japanese companies in the US and Europe*' (Cresson 1997, my emphasis). A similar sentiment was expressed in a statement of British government research and development policy in 1993 which was called *Realising our Potential* – that is realising the potential of a scientific nation – of a nation which is thought to be good at thinking – but not so good at putting things into practice. The British discover and invent – others exploit (HMSO 1993, cf. Edgerton 1991, 1996). Marilyn Strathern has made the point: 'At the least ... we should abandon the technological metaphor that imagines society is like an engine that 'makes' things out of natural resources in order to extend human potential, and lay open the issue of whether all human problems are the same ones' (Strathern 1988, p. 33).
2 Strathern 1999, ch. 8.
3 For an excellent analysis of the justification for patents see Svatos 1996.
4 On the history of intellectual property rights see MacLeod 1988, 1996, Noble 1977, pp. 84–87, Sherman and Strowel 1994. Historians point to the increasing importance of the acquisition of intellectual property rights in economic life since the late eighteenth century. However, a number of recent commentators argue that a commitment to the open publication of research findings, which was prevalent in many public laboratories and universities in the twentieth century has become displaced by an increasing orientation towards the acquisition of intellectual property rights (Nelkin 1984, Rothman, Glasner and Adams

1996, MacKenzie, Keating and Cambrosio 1990). As Dorothy Nelkin argues, 'few of the issues of official secrecy, patenting, or military security are new; indeed, similar issues emerged with the burgeoning of the research enterprise after World War II. However, they are now assuming new proportions, challenging the norms traditionally governing scientific research, the structure of academic institutions, and the nature of research relationships' (p. 7). Rabinow 1996b, pp. 19–27 argues that in the US biotechnology industry there is a tendency to publish and patent, for, in allowing scientists to patent, biotechnology firms are both able to attract high-quality scientists and protect against rival patent applications in other territories.

5 On the importance of 'population' to nineteenth-century practices of government see Foucault 1997, pp. 67–71, Porter 1986.

6 Witness the increasing tendency to measure the technological performance of firms, nations and economic blocs in terms of the numbers of successful intellectual property claims they make. e.g. 'The measure of strength', *Financial Times*, 5 August 1997, Robson 1996, HMSO 1998. Jacques Delors signed a preface to a book concerned with the problem of the technological specialisation and competitiveness of Europe's industries thus: 'Overall, this report provides vital information on national performance in innovation. It will be of particular importance for defining measures to advance the Community's scientific and technological position in the world and evaluate the results of policies already undertaken' (Archibugi and Pianta 1992, p. xiv). Making research, development and innovative activity into a measurable object is extraordinarily difficult, raising a whole series of questions, the answers to which may seem more or less arbitrary. Does 'research' include testing, patent and license work, public inspection and regulation? What is the exact distinction between the natural sciences and engineering for the purposes of measuring research? How does one count and compare indicators of innovative activity such as patents when the tendency to patent technical developments may vary widely across different countries and industries? How can one compare the performance of different laboratories and universities in terms of their research productivity? (Martin and Irvine 1983) An early attempt to provide some degree of standardisation of the measurement of research and innovative activity was arrived at by a group of OECD economists and known as the 'Frascati manual' (OECD 1981).

7 According to one European parliamentarian, in a speech promoting the need for harmonised statistical data on European research and development. 'Mr President, we are talking about scientific statistics in a Europe which is a giant in basic research, but not in technology and innovation. The reasons for this gap are being analysed. How is it possible for Europe to have the capacity for investment in basic research at this exceptional level, and lack that capacity in market applications ... Of course there are many causes. But it seems to me that *having inadequate statistics is likely to be one of the reasons why European research is not as successful as it ought to be*' (Izquierdo Callado (PSE) Debates of the EP-4–494/46, 29 January 1997, my emphasis). Responding to these and similar demands, the Commission has sought to establish a basis on which the innovative activity of Europe can be measured (Neil Kinnock, Debates of the European Parliament No 4-494/48, 29 January 1997). See also COM(96)0042 – C4-0247/96.

8 Agre and Rotenberg 1997.

9 Quoted in Kevles 1998, p. 71.

10 Thomas 1993, pp. 46–47.

11 Efforts to establish a common global framework for intellectual property developed first in the nineteenth century. The International Union for the protection of industrial property, for example, was established in 1883 and the International Union for the Protection of Literary and Artistic works in 1886 (Murphy 1994, p. 47). Commenting on the development of the intellectual property regime in the nineteenth century Murphy notes that, at this time, 'the very least industrialised were effectively exempt from the patent system, which is perhaps as it should be if the benefits of the industrial economy are to be spread as widely as possible....Yet the more industrialised a state became, the more it had an incentive to join the system and enforce the international regime in order to protect its industries' inventions' (p. 93). Despite renewed efforts, the development of a global intellectual property regime is extraordinarily uneven (Thomas 1993, ch. 5). Even where intellectual property law exists in less developed countries it may not be implemented. De Laet gives the example of the patent office set up under the auspices of the WIPO in Harare, Zimbabwe which is largely ignored by local businesses (de Laet 1997).

12 She notes that whereas in Euro-American culture a clear distinction is made between persons and things, in Melanesian culture the critical distinction is between persons, where the notion of the person is reckoned to include what Euro-Americans would call non-human elements, Strathern 1999, p. 181.

13 Carla Hesse argues that this tension was present even in the early history of copyright legislation. Observing the development of the laws of authorship during the period of the French Revolution, she notes: 'The democratic bourgeois revolution did not mark a further step in the progressive consolidation of the notion of the author. Rather, the revolutionaries explicitly intended to dethrone the absolute author, a creature of privilege, and recast him, not as a private individual (the absolute bourgeois), but rather as a public servant' (Hesse 1990, p. 130).

14 Strathern 1999.

15 On modes of ordering see Law 1994.

16 Straus 1997, p. 5; CEC 1995. In 1999–2000 the European Commission made new efforts to secure agreement on a Community patent (CEC 1999). At the time of writing it is unclear whether an agreement will be reached with the Council following the Commission's proposals.

17 Straus 1997, p. 8.

18 For more general analysis of the language question see Smith and Wright 1999.

19 S.1 (2)(c) Patents Act 1977.

20 In fact, the exclusion of software is not clear cut and, in principle, the application of patent law to computer software is possible. The first application under the terms of the 1977 Act concerned an attempt by Merrill Lynch to patent a form of computerised trading system for the stock market ((1989) RPC 561).

In this case the court ruled against Merrill Lynch, but suggested that computer programs could, in principle, be patentable if they were framed in terms relating to the novelty of the program's application (Lloyd 1993, §22.33). In 1996 the European Commission stated that it was intending to extend patent protection to the development of software (CEC 1996b, p. 11).

21 In copyright law, originality does not mean novelty: 'The criterion of originality demands no more than that the work display something irreducible, something which is one man's alone', Frow 1988, p. 7.

22 Wehlau 1993.

23 Saunders 1988.

24 Edelman 1979, Rose 1993.

25 Edelman 1978, Lury 1993, ch. 2 and ch. 3.

26 Edelman quoted in Saunders 1992, p. 199.

27 Wehlau 1994, p. 105–106, Lloyd 1993, ch. 24.

28 Born 1996, p. 102.

29 Frow 1988, p. 12, Born 1995, p. 103 Tang 1995b, p. 23.

30 On the importance of immutability and stabilisation see Latour 1987. On the lack of desire for stabilisation in the development of some forms of software see Born 1995, 1996.

31 Directive 91/250/EEC, OJ L122, 17 May 1991. See also Berkvens and Alkemade 1991, Drier 1991. Debates on the directive occurred in the Legal Affairs and Citizens Rights Committee, the Committee on Economic and Monetary affairs and industrial policy, and the Energy Research and Technology Committee of the European Parliament. See, in particular, the Salema report PE A3–173/90 & A3–0083/91 and the Turner report PE 136.025/fin/Ann.II.

32 Reed 1991, Drier 1991, pp. 323–325.

33 Prins 1994.

34 A Massachusetts court ruled in favour of Lotus in its effort to defend its copyright on the 1–2–3 spreadsheet program which had become an industry standard (*Lotus Development Corp* v *Paperback Software International*).

35 Drier 1991, p. 325.

36 Tang 1995b, pp. 24–25.

37 Tang 1997, p. 207.

38 According to Parry 1999, p. 68, despite the 'concern [of software multinationals], and the investment of millions of dollars on the development of new sophisticated encryption or other access control devices, there is little evidence of any slowdown in the unlicensed reproduction of informational products'.

39 For a good review of some of the strengths and weaknesses, and advantages and disadvantages of electronic defences see Denning 1997. As Denning notes, the protection provided by encryption can be illusory (p. 177).

40 This has led to a vigorous debate amongst some economists over the relative merits of markets and public committees in agreeing common standards (see Farrell and Saloner 1988, Shrumer and David 1996).

41 The development of the twentieth-century artistic avant garde was associated with the ideology that inventiveness depended on autonomy from the market. Today, there is the equally problematic assumption that inventiveness is most likely to be found precisely in those locations where economic incentives are greatest. I return to the subject of inventiveness in chapter nine.

42 Tang 1995a.

43 Turney 1993, p. 282. On the Human Genome Project and its implications see Fujimura and Fortum 1996, Glasner and Rothman 1998, Thackray 1998, Glasner and Rothman 1998, Wheale, von Schomberg and Glasner 1998, Turney 1998, ch. 10, Fortun 1998.

44 Haraway 1997, pp. 53–55. The reasons for Haraway's emphasis on transuranic elements rather than on artificial atomic nuclei more generally are not clear to me. Certainly it is the artificial consequences of nuclear fission and fusion which rightly invoked, and continue to invoke, the most complex ethical responses. The properties of the transuranic elements, for the most part, are largely of interest to specialists.

45 Genetics Forum, 'The case against patents in genetic engineering', London, n.d. For the case for patenting, see Poste 1995.

46 Thomas 1993, p. 41, Thomas et al. 1995. This was possible following the Supreme Court's ruling in the case of *Diamond v. Chakrabarty*. On the case and the conduct of the US debate and its relation to the political economy of the biotechnology industry, see Kevles 1998.

47 Thomas et al. 1996.

48 M. Pompidou in Debates of EP 1 March 1995 EP 4-458/40.

49 Tassy and Dambini 1997, p. 201.

50 Debates of the European Parliament, 1 March 1995, EP 4-458/40. For a response see Llewelyn 1997.

51 In the sense that it is given both a new material form *and* it is placed in relation to a different environment of other objects (Mol 1999).

52 European Directive on the legal protection of biotechnological inventions 98/44/EC of 6 July 1998.

53 OJ C 311/16 and OJ C 311/19. For further references to the debate between the Council, the Commission and the Parliament concerning the legal protection of biotechnological inventions see Abels 1998, *Bulletin of the European Union* 1/2-1998, pp. 25–26 and the web site of the European Commission dealing with questions of intellectual property http://europa.eu.int/comm/dg15/en/intprop/.

54 European Directive on the legal protection of biotechnological inventions 98/44/EC of 6 July 1998.

55 Consider the way that the rights of trees and animals are not defended on the basis that they are elements of nature but through an analogy to human rights.

56 There is a large sociological literature on the matter of 'discovery' claims (e.g. Woolgar 1976). Stephen Shapin notes how, in the seventeenth century, laboratory workers remained invisible in public despite their critical role in scientific practice, Shapin 1994, p. 358.

57 On the history of scientific instrumentation see Hankins and Silverman 1995.

58 George Marcus writes of the growing ambiguities of the contemporary scientific division of labour Marcus 1996, p. 3.

59 Hacking 1983.

60 Krige 1996, p. 267.

61 On the early history of X-ray astronomy, see Hirsh 1983.
62 The idea that a social and technical distinction could be made between the development of the *scientific instrumentation* of a satellite and the development of the rest of the technology of the satellite, which was considered as simply a platform for the instrumentation, was also reflected in contemporary government policy which, at this time, drew a clear distinction between science policy and industrial policy. See Acton 1974, Maurice 1973, Barry 1991.
63 As the European Space Agency was funded by all European governments it became increasingly difficult to justify projects which only benefitted scientists from a few countries.
64 The idea that EXOSAT users were thought of as *observers* relates to the fact that astronomy has come been considered an 'observational' rather than an 'experimental' science. EXOSAT observers, of course, could not literally see the X-rays that the satellite's instruments detected although they could generate, as one noted, 'pretty pictures' from this data. On the distinction between observational and experimental astronomy see Schaffer 1995a. On the critical importance of *pictures* in astronomy and their production see Lynch and Edgerton 1988.
65 In this way the position of the scientists working for the hardware groups was rendered ambiguous. They came to occupy two quite distinct positions within the division of labour: cf. Marcus 1996, p. 3.
66 On the importance of calibration in science see Schaffer 1995b.
67 In the context of the dispute between the hardware groups and ESA over the question of data rights, it is worth looking at the role of the ESA managers themselves. In an ethnography of Space Science Department at the central ESA laboratory (ESTEC), Stacia Zabusky mistakenly casts the scientific work of the department in an heroic light viewing it in Durkheimian terms as a realm of 'sacred cooperation' as distinct from the 'profane' work of management (Zabusky 1995). The fact that ESTEC scientists were also encouraged to do collaborative 'pure' research as well as manage was because, as it was recognised, the only way that managers could have control over the hardware groups was to acquire an equivalent level of tacit knowledge of the field. Doing pure research was a key part of a management strategy.
68 Sternberg et al. 1986.
69 Such standardised data sets are not intrinsically more mobile than other forms of data. But they are more mobile when they circulate through an arrangement of laboratories, whose activities and practices are coordinated.
70 A handful of observers came from US laboratories. The vast majority came from the UK, France, Germany, Italy and the Netherlands. Those who had failed in their proposals to become observers were excluded from participation.
71 Strathern 1996, p. 30.
72 Haraway 1997, pp. 79, 98.
73 http://europa.eu.int/.
74 Jasanoff 1996.
75 Cf. Callon 1998a, pp. 39–40.
76 Speech by Martin Bangemann 'A new world order for global communication: the need for an internal charter' at the 'Telecom Interactive 97' conference organised by the International Telecommunications Union (ITU), Geneva, September 1997.

6 ON INTERACTIVITY

1 For different accounts see Mouffe 1992, Mulgan 1994a, chapter 3, Giddens 1998. The moralism of some recent talk of citizenship is suggested by Geoff Mulgan's claim that the idea of citizenship implies a 'tough ethics' (1994, p. 68). Anthony Giddens speaks of the association of such a tough ethics and the political project of the 'third way' associated with British Prime Minister, Tony Blair. According to Giddens: 'One might suggest as a prime moto for the new politics, *no rights without responsibilities*' (1998, p. 65, emphasis in the original).
2 Burchell 1995, p. 556. On this point see also Cruikshank 1996, 1999, Donald 1999.
3 According to Philip Gould, advisor to British Prime Minister, Tony Blair, on 'public opinion', the Internet should be used prevent parliament appearing 'impotent and irrelevant' and to 'ensure the people's voice should always be heard', *Financial Times*, 15 October 1999, p. 2.
4 Since the early 1990s, the European Commission has funded periodic investigations into the state of scientific literacy in Europe. Such studies have demonstrated that 'scientific literacy in Europe is far from satisfactory and that a relation exists between an understanding [of science] and a responsible acceptance or rejection of new technologies' (Fasella 1997, p. 166).
5 Irwin and Wynne 1996.
6 This anxiety took many different forms, reflecting differences in national intellectual political cultures and preoccupations. In the United States it was manifested in the so-called 'Science Wars'. On the 'Science Wars' and their ramifications elsewhere see *Social Text* 1996, Ross 1996, Latour 1999a, Hacking 1999.
7 Alan Irwin (1995) develops the notion of scientific citizenship along these lines. For an indication of how such debates have emerged in the realm of parliamentary politics see House of Lords (2000).
8 Quoted in Irwin 1995, p. 11.
9 Poster 1995, p. 33.
10 On the notion of the 'boundary object' which forms a bridge between different worlds, see Star and Griesemer 1989.
11 Deleuze 1988, p. 40.
12 Throughout this chapter I refer to the National Museum of Science Museum (NMSI) as the Science Museum.
13 Note Appadurai's injunction: 'It is only through the analysis of ... trajectories that we can interpret the human transactions and injunctions that enliven things' (Appadurai 1986, p. 5). Although there are some specific designs of interactive exhibits shared between different museums, here I am primarily concerned with the circulation of the frame within which these diverse interactive exhibits are inscribed.

14 Cf. Foucault 1977, p. 138.
15 Straw 1991.
16 Bruno Latour and Mickes Coutouzis (1993) describe the failure of the *Euro-metrics* project which was intended to involve the various national science museums in Europe in a joint venture to represent the process of technical harmonisation. In the case of the Expo '92 exhibition studied by Penelope Harvey, different national pavilions exhibited different responses to the question of whether the importance of the nation-state could be assumed or not. The European Community was 'present as a classic example of the western egalitarian nation-state' (Harvey 1996, p. 76).
17 Galison 1994, pp. 255–256.
18 Foucault 1977, 138, see also Schaffer 1992b, p. 329.
19 Schaffer 1992b, p. 333.
20 Ibid., p. 359.
21 Law 1986, p. 21.
22 Unlike the traditional science museum, the typical science centre does not house an historical collection but is likely to rely heavily on the use of interactive exhibits. For a discussion of the difference see Durant (1992).
23 Durant 1992, p. 8.
24 Gregory 1989, p. 4.
25 In the version I obtained from the British Museum press office somebody had pencilled '?!' next to this statement.
26 Power 1997.
27 The British Prime Minister's christian education at Oxford has often been remarked on by political commentators.
28 http://www.exploratory.org.uk/big/handbook/lot-proj.html. The Science Museum received £23 million from the heritage fund out of £44 million total costs, the Dynamic Earth centre received £15 million from the heritage fund; the Newcastle Centre and Bristol 2000 each received £27 million.
29 R. Johnson, letter to the *Guardian*, 27 May 1997.
30 The weekly UK National Lottery was established during the last years of the Conservative Government in the mid-1990s. Funds deriving from the lottery are given to five good causes, primarily for capital grants. Public museums have been major recipients of lottery funding.
31 Bennett et al. 1993, p. 59. For a discussion of the history of the science museum in the eighteenth century see Hooper-Greenhill (1992). According to Schaffer the public presentation of science sometimes involved an extraordinary level of public debate: natural philosophers competed for patronage and audiences and "critics sought to subvert the status of the lecturer's enterprise" (Schaffer 1993, p. 490).
32 Bennett 1995, p. 40.
33 Ibid., p. 86.
34 Silverstone 1992, p. 41.
35 See for example the article by the Science Museum director Dr Neil Cossons in the *Listener* (1987).
36 Kirby 1988, p. 91.

37 Cossons 1987, p. 18.
38 'The inference in the article that the staff in the national museums are a load of dinosaurs with uncaring attitudes to the public was not well received' (letter to the author 30 June 1987).
39 A combination of increasing attention to marketing and the development of a public controversy about imposing museum entry charges has given the Science Museum a higher public profile (cf. Cossons 1991, p. 185). However, its activities probably draw much less public comment than other museums of comparable size. As one museum curator noted: "what is done by the National Gallery, the V&A, the Tate etc is always subject to both media hype *and* informed comment, from layman and specialist alike. Alas the same cannot be said of the Science Museum" (letter to the author 18 June 1987). The silence of the media and the public in relation to the politics of the Science Museum appears to be inversely related to the noise generated by Museum visitors. According to one Museum souvenir guide, "[The Science Museum] is somewhere where people feel free, and often excited; where they talk loudly (sometimes too loudly) and even laugh. It is different from most museums" (van Riemsdijk 1980, p. 1).
40 Here, of course, one must not imagine that 'the public' has any homogeneity or unity independently of the way that is constituted by the science museum. Recall Raymond Williams's dictum, 'there are no masses, only ways of seeing people as masses' (Williams 1989, p. 11).
41 Macdonald and Silverstone 1990, p. 184. According to one recent commentator: "Museums are ... inherently interactive multimedia. The visitor is in control of the paths along which they navigate through the artifacts, images, sounds and texts and they are under no obligation to follow the linear structure imposed by the curator" (Bearman 1993, p. 183).
42 Science Museum, 1986.
43 Nash 1992, p. 184.
44 Rose 1996b, Rose 1999, p. 139.
45 Cf. Strathern 1992a, pp. 41–43, Macdonald 1993.
46 On empowerment see Cruikshank 1996. The theme of the relation between political and scientific empowerment has been taken up by more recent US writers on science. See, for example, Richard Sclove's claim: 'If it is vital that citizens be empowered to help shape legislative or electoral agendas, it is likewise vital that they have extensive opportunity to participate in technological research and design' (Sclove 1995, p. 181).
47 According to Hein there were two important influences on Oppenheimer's thinking. One was the London Science Museum Children's Gallery (1936–1994), which contained exhibits which could be operated by the child. The other was the Palais de la Découverte, which unlike traditional science museums did not concern itself primarily with the preservation of artefacts. Created in 1937, the Palais described itself as 'a scientific cultural centre' in which a large number of scientific experiments were (and still are) demonstrated to visitors (Hudson 1987, p. 103). According to its founder, Jean Perrin, one of the objectives of the Palais was to realise the potential for scientific research which he hoped might be found in the population at large. For Perrin, those young people who hadn't

been favoured by a good education, but who had a particular aptitude for research and who had enough enthusiasm and energy to make it their vocation, should be recognised and encouraged by the National Research Service (Maury 1994, p. 24).

48 Hein 1990, p. xvi.

49 Ibid., p. xv, my emphasis.

50 Ibid., p. xvi.

51 Reichardt 1971, p. 11.

52 Hein 1990, p. 38.

53 Délacôte 1992.

54 Gregory 1970, p. 174.

55 Hein 1990, p. 72.

56 Stevenson 1994, p. 30.

57 Callon et al. 1986, de Laet and Mol 2000.

58 On the public understanding of science see Wynne 1992, Irwin and Wynne 1996, Michael 1996a.

59 Gregory 1989, p. 7.

60 Ibid., p. 5.

61 Wynne 1992, p. 281.

62 The idea that there was a crisis in the public understanding of science had become a political problem in Britain following the publication of a Royal Society report on the matter in 1985. There followed a substantial research programme on the problem and the development of a variety of initiatives (such as 'National science week') to solve it. Despite these initiatives university science departments continued to close and student interest in the natural sciences (in comparison to the social sciences and humanities) continued to decline.

63 Stevenson 1987, p. 18.

64 Thomas n.d., p. 3. For an overview of contemporary museum visitor studies see Bicknell and Farmelo 1993.

65 One widely cited example of such an accusation is Shortland 1987. One feature of this denigration of computer-based interactive museum exhibits is their association with interactive computer games. As Leslie Haddon observes 'moral panics about games, including fears of addiction, the "effects" of desensitisation and of escapism have spanned a range of political campaigns, media attention and academic, mainly psychological analysis' (Haddon 1993, p. 124).

66 Cf. Thomas n.d.

67 Gregory 1989, p. 2.

68 One member of the Science Museum education staff remembered the example of an interactive where a light signal was interpreted by many visitors as the cause rather than the effect of the phenomenon that the interactive was meant to demonstrate. Another suggested that many scientific principles which are supposed to be revealed by interactives would only be comprehensible by A-level students and above (Interviews conducted at the Science Museum, London, June 1995).

69 Macdonald 1992, p. 408.

70 Strathern 1992a, p. 42. Allucquére Rosanne Stone outlines the terms of a debate concerning what is *really* interactive which occured between programmers and managers in a research laboratory developing interactive game software. 'There are five corollaries of Lippman's definition [of interactivity]. One is interruptibility, which means that each participant must be able to interrupt the other, mutually and simultaneously. The second is graceful degradation, which means that unanswerable questions must be handled in a way which doesn't halt the conversation ... the third is limited look-ahead, which means that because both parties can be interrupted there is a limit to how much of the shape of the conversation can be anticipated by either party. The fourth is no default, which means that the conversation must not have a preplanned path, it must truly develop in an interaction. The fifth is that participants must have the impression of an infinite database ... Interactivity implied two conscious agencies in conversation ... [by contrast] to the Ashibe management ... interactivity meant taking turns, not interruption; it meant that the user pushed a button and the machine did something as a result' (Stone 1995, p. 182).

71 Zizek 1997, p. 111. Zizek poses the provocative question 'What if the "subjective" gesture, the gesture constitutive of subjectivity, is not that of autonomously "doing something" but, rather, that of the primordial substitution, of withdrawing and letting another do it for me, in my place?' (pp. 118–119). See also Zizek 1998.

72 Born 2000. A creative passivity is one that implies the possibility of learning from the other.

73 In the Science Museum there was considerable disagreement about whether the juxtaposition of historical artefacts and interactives should be considered a problem or not. Proponents of interactivity noted that the Museum had a long-standing interest in interactivity from the opening of the *Children's Gallery* (1936) onwards, and moreover disputed the rival claims to have established the interactive model made on behalf of both the Exploratorium or the Palais de la Découverte (cf. Woolgar 1976). Many others thought that integration of interactives with historical objects could be a problem as it raised questions, for example, about how to define the boundaries between objects with which the public could and could not interact. More generally, the development of interactivity in the museum not only raised questions about the function of interactive devices but also about the function of traditional objects. On these points my thanks to Sharon Macdonald, Stephen Johnston and Gillian Thomas.

74 Bourdieu 1984.

75 On post-Fordism see Amin 1994.

76 In Lash and Urry's (1994) terms the museum began to be engaged in a process of reflexive modernisation. In this process, the museum visitor was not necessarily conceptualised as an individual consumer. Many visitors came as part of family groups or in school parties and visitor research and exhibition design has to take this into account. In addition, the museum was aware that many of its adult visitors were male and middle class and, in this context, issues of class and gender have become a feature of exhibition design. A detailed examination of

the ways in which different designs of interactive exhibits addressed specific kinds of museum visitor is beyond the scope of this chapter.

77 But see Macdonald 1997 for a discussion of the difficult position of an anthropologist working in the museum. A concern with feedback is not just a feature of the contemporary museum. Witness the increasing emphasis on feedback in the operations of public service broadcasting and the universities.

78 Heinich 1988, pp.199–200.

79 The post-war French State has, at least at the level of political rhetoric, tended to place great stress on the importance of science and technology for the modernisation of France. By contrast, in the UK, interest in interactivity amongst scientists and museum staff developed at the height of what was perceived to be government hostility towards science in the mid-1980s.

80 Cité, n.d.

81 Derrida 1986.

82 Cité, n.d. The juxtaposition of scientific exhibitions and innovative architecture was not new in Paris – see Stamper 1989.

83 Cité, 1988, p.30.

84 Born 1995.

85 Poster 1990, p.114.

86 Cf. Jordonova 1989, p.23.

87 Cité 1995, p.23.

88 Slavoj Zizek argues that in comparison to repressive political regimes, a characteristic feature of contemporary liberal democratic societies is the demand to enjoy. Thou shall not is displaced by 'You may!' Zizek 1999.

89 Silverstone 1988, p. 235.

90 Donna Haraway notes the disjuncture that must be experienced by urban American children visiting the American Museum of National History in New York. 'What is the experience of New York streetwise kids wired to Walkman radios and passing the Friday afternoon cocktail bar by the lion diorama? These are the kids who came to the museum to see the high-tech Nature-Max films. But soon, for those not physically wired into the communication system of the late nineteenth century, another time begins to form' (Haraway 1989, p. 29). La Villette by contrast was built during the period which saw the introduction of the Walkman into urban culture. Its interactive exhibits are, like the Walkman, compulsive.

91 Cité 1988, p. 54.

92 Virilio 1990, p. 173.

93 Elsaesser 1990.

94 Wollen 1993.

95 As Cornelius Castoriadis notes: 'Ordinary mortals are ensnared together with Nobel laureates in the coils of a new mythology ("machines which think", or "thought as a machine")' (1984, p. 230).

96 On the technicality of scientific practice see, for example, Latour and Woolgar 1986, Gooding, Pinch and Schaffer 1989, Lynch 1993. 'Many of our former collection displays were uninspired, unimaginative and unchallenging ... [but] collections are the foundations of all great museums' and they should continue to have a central place in museum display (Bennett 1998, p. 174).

97 Bennett 1998 describes one innovative attempt to do this in the Whipple Museum of the History of Science in Cambridge. For accounts of the need to represent controversy in science museums and the difficulties of doing so, see Levidow and Young 1984, Macdonald and Silverstone 1992, M. Ross 1995 and Schaffer 1997.

98 'The new [interactive information services] represent a genuine opportunity for the competitiveness of the European economy and the diffusion of European culture, and an opportunity to take full advantage of the diversity of European society' M Monti, Member of the Commission, Debates of the European Parliament, 4-500/260, 16 May 1997.

99 On the importance of interactives in the mass media see, for example, Birt 1999, p. 5.

100 For one fantastic account of the potential for virtual democracy Budge 1996. For more nuanced analyses of the limitations as well as the advantages of new media in particular political contexts see Tsagarousianou et al. 1998.

101 Foucault 1977, pp. 152–153.

102 Ibid., p. 153.

103 Gregory 1989, p. 1.

104 According to Oppenheimer, 'We do not want people to leave with the implied feeling: "Isn't somebody else clever." Our exhibits are honest and simple ...'.

105 Zizek 1999.

106 Foucault 1977, pp. 149–156.

107 Gregory 1989, p. 6.

108 Lyotard 1984, p. 3.

109 Poster 1990.

110 Cf. Foucault 1977, pp. 224–225 quoted in Deleuze 1988, p. 40. New media and information technologies have an enormous empirical importance, and a specificity in comparison to other media such as photography and film, but it is unclear why we would should characterise our era in terms of the presence of such technologies. Interactivity is not the same as its specific technical manifestations.

111 Mulgan 1994b.

7 POLITICAL CHEMISTRY

1. Strathern 1999, p. 68. Following Searle, Strathern distinguishes between regulative and constitutive information. She makes the distinction in the context of a discussion of new reproductive technologies and kinship. '*Regulative* aims impose a duty to be well-informed: from this comes the public value put on freedom of information. At the same time, one can collect all sorts of information that need to be acted upon, a likelihood especially evident in litigation ... By contrast, kinspersons who find things out about their ancestry acquire identity by that very discovery. Parentage implies relatedness; facts about birth imply parentage. Euro-Americans cannot ignore these connections. The information forms [*constitutes*] what they know about themselves' (my emphasis). Here I am solely concerned with regulative information.

2 On the creation of public opinion see Osborne and Rose 1999.
3 Whitehead 1929, p. 30.
4 Whitehead [1926] 1985, p. 134.
5 Latour 1996b.
6 Whitehead 1929, p. 472.
7 My thanks to Mick Halewood for this formulation and for helping me understand the importance of Whitehead.
8 Mol 1999, p. 75.
9 The display of the European Union symbol is remarkable in itself. Apart from on this sign residents of Southwark are only likely to see this symbol on cars and lorries from *other* European countries driving through Southwark on their way from the Channel ports.
10 Cf. Appadurai 1990.
11 According to Virilio, the city should be represented today as much in terms of *vectors* as in terms of lines and areas. In effect, two quite distinct urban strategies and forms have come to confront each other. 'The first is primarily material, constructed of physical elements, walls, thresholds and levels, all precisely located. The other is immaterial, and hence its representations, images and messages afford neither locale nor stability, since they are the vectors of a momentary, instantaneous expression, with all the manipulated meanings and misinformation that presupposes' (Virilio 1991, p. 22). While suggestive Virilio's analysis of the place of electronic and media technologies in the urban environment tends towards a form of technological determinism. The question of whether, and to what extent, there is a disjuncture between the 'electronic' and the 'physical' environment is open to empirical investigation. Virilio presents us with an distopian and apocalyptic vision of the technological city which, while alerting us to the importance of analysing technological space, remains blind to issues of political and cultural difference.
12 Flick 1980, p. 22. On nineteenth-century concerns with that state of the urban 'environment' see Osborne 1996. On the politics of air-pollution regulation in other contexts and in relation to other problems see Ackerman and Hassler 1981 and Lundqvist 1980. On air-quality-management strategies see Elsom 1996.
13 Hall, Land, Parker and Webb 1975, DoE 1993, p. i. Measurement of atmospheric pollution on a national scale began in the UK in 1961, when a network for measuring black smoke and sulphur dioxide was established, Clark et al. 1996.
14 Clark et al. 1996.
15 CEC 1991, pp. 107–108.
16 Ibid., pp. 111–113.
17 D. J. Fisk, chief scientist to the Department of Environment, *Independent on Sunday*, 17 October 1993.
18 Of course, the increasing concern with air quality was only one aspect of a larger movement of government policy and the emergence of a new 'politics of pollution' in the 1980s. For good accounts of this process, within the political-science literature see, in particular, the work of Timothy O'Riordan and Albert Wheale (e.g. O'Riordan and Weale 1989, Weale 1992).
19 Myerson and Rydin 1996, p. 132.

20 Grant 1995, p. 74.
21 See, for example, COST 613/2 on air pollution epidemiology 'health effect assessment' E U R 14346, n.d. For documentation on European Community legislation up until 1992 see CEC 1992a. As European Parliamentarians were right to point out, the increasing efforts of the Community in promoting monitoring did not mean that any effective action was taken to reduce pollution levels in practice. See, for example, the debate that took place in the Parliament on 12 May 1992 concerning the Commission's proposal for a directive on air pollution on ozone which as the Parliament *rapporteur* noted was really a directive on 'monitoring air pollution by ozone' (EP 3-418/98, 12.5.92).
22 Boch 1997, p. 14, my emphasis. On empowerment see Cruikshank 1996, 1999.
23 CEC 1990, p. 72.
24 The UK Royal Commission on environmental pollution recommended that the UK should 'achieve full compliance by 2005 with World health Organisation health-based air quality guidelines for transport-pollutants' (Royal Commission on Environmental Pollution 1994, p. 36).
25 This existence of various levels of regulatory authority could cause political problems. For example, during a heat wave in the late spring of 1995, the UK government was criticised for failing to notify the public when European and World Health Organisation standards were breached. 'According to the commission and the WHO people's lungs are adversely effected if ozone stays above 50 parts per billion for eight hours ... a DoE spokesman conceded yesterday that "we recognise that adjustments to our warning system could be made"' (*Guardian*, 4 May 1995).
26 LIFE stands for Financial Instrument for the Environment. As is normal with EU programmes, the EU provided half of the funding for the Southwark project; the other half provided by the local authority. On LIFE see Debates of the European Parliament 4-483/52, 5 June 1996.
27 Presentation by Bill Yoxall, Head of Public Protection, London borough of Southwark, 'Breathe LIFE into Europe' conference, Rotherhithe Holiday Inn, 10 May 1996.
28 Interviews with Southwark council officials, Southwark, September 1996.
29 The full title of the Southwark project (UK/93/3098) was 'integrated environmental management scheme for air pollution in a strategic corridor' LIFE project directory, DG-X I, June 1995.
30 Presentation by Cllr Nick Dolezal, Chair, Regeneration and Environment Committee, London Borough of Southwark, Rotherhithe, 10 May 1996. It was also actively supported by local businesses including Sainsbury's which was in the process of developing a supermarket, positioned away from the main road in order to accommodate a huge car park, and Pursers, the main Volkswagen dealer in the area, and one of the larger businesses on the edge of the air-quality-monitoring zone.
31 Slater 1995.
32 Interview, Southwark Council, 20 September 1996.
33 Hughes Corporation 1996, p. 1. The involvement of US defence, electronics and aerospace firms in environmental-monitoring technology dates back at least to

the 1970s following cuts in the US defence R&D budget at the end of the Vietnam war (Bromberg 1991, p. 211).

34 Hughes Corporation 'remote emissions sensor', n.d. The detection of nitrogen oxides was, at this time, very unreliable (Lucy Sadler, personal communication).

35 *The Monitor*, September 1996, Hughes Corp., Santa Barbara Research Center.

36 As George Orwell had noted sixty years earlier in returning to London from Paris, the journey through South London seems to symbolise the worst of England (in *Down and Out in Paris and London,* Orwell 1940).

37 Cf. Strathern 1992b, p. 128.

38 Appadurai 1990.

39 In total eighteen days were spent using FEAT and thirteen days using SMOG DOG™ on four sites in 1995 to 1996. The sites were on the Old Kent Road, Abbey Street, Dog Kennel Hill and Neate Street. In addition one day was spent testing and demonstrating FEAT in Copenhagen, Solman 1996 pp. 32–40.

40 Quoted in Lees 1993, p. 110, my emphasis.

41 Southwark Council 1996.

42 Solman 1996, p. 30.

43 Althusser 1971. Although ambiguously. For, as Donna Haraway notes, interpellation has a double meaning. The subject is addressed as subject of the law. But, in doing so, the law may be asked to justify its actions. Interpellation means to hail, but it can also mean to interupt. 'With a double meaning typical of most interesting words, interpellation is also an interruption in the body politic that insists those in power justify, if they can' (Haraway 1997, p. 50). It is a political act.

44 Solman 1996, pp. 76–79.

45 DoT 1994. See also Hickman and McCrae 1995.

46 Royal Automobile Club 1994, p. 2.

47 Ibid.

48 House of Commons 1994, p. xxxix.

49 Ibid., original emphasis.

50 Ibid., p. xl.

51 During this period, the Transport Research Laboratory had acquired the status of an 'Agency'. This meant that it, along with other government laboratories such as the National Physical Laboratory effectively sold its services to government through an internal market. It was subsequently privatised.

52 In London this had been carried out by London Scientific Services (LSS) which was run down following the abolition of the Greater London Council (GLC) by the Conservative government. Aspects of the LSS's work were taken over by a new organisation, the London Research Centre (LRC). However, in the field of air quality, local authorities derived support from the South East Institute of Public Health (SEIPH).

53 Lucy Sadler, London Research Centre, personal communication.

54 The idea that there were vehicles which could be called 'gross polluters' was certainly widely accepted. According to Californian newspaper *The Sacramento Bee*, 20 per cent of vehicles on the road emit 80 per cent of smog forming hydrocarbons (Grant 1995, p. 35).

55 Sadler 1996, p. 73.

56 If remote sensing was not as effective in identifying 'gross polluters' as it had been thought then this also had implications for an assessment of its costs. Perhaps stopping cars randomly or by eye was not so uneconomic after all. The Southwark scientist reckoned that when you took into account the capital cost of SMOG DOG™ and the need for technical staff to set the equipment up, one would need to stop between 4,000 and 7,000 cars before remote sensing became any cheaper than random stopping (Sadler 1996).

57 Solman 1996, pp. xv–xvii.

58 'Environmental protection in the United Kingdom: did you know that ...', DG-X Task force on priority information projects Brussels: CEC, 1997.

59 Solman 1996, p. 68.

60 Of course this is not unique to this issue. The case of mad cow disease or BSE is much more serious in this respect. On BSE see Radford (1996) and Wynne (1996).

61 The 1992 European directive governing the harmonisation of the roadworthiness tests allowed for considerable room for divergencies in national testing regimes (CEC 1992a). Remote sensing could play a part in the forthcoming European legislation which would aim to increase the compatibility between different tests. However, at the time of the Southwark experiment there had been little development of remote sensing elsewhere in Europe.

62 Cf. Yearley 1996.

63 Interview with Tony Bosworth, Friends of the Earth, London, 5 September 1996.

64 BMRB 1994, p. 3.

65 McMullen 1996.

66 Actor–network theorists coined the term '*interressement*' to refer to the ways in which an actor is made into something like an interest (Callon et al. 1986).

67 This is supported by broad range of empirical work conducted by sociologists researching the 'public understanding of science'. See, for example, Wynne 1992b, Irwin 1995, Michael 1996a&b, Irwin and Wynne 1996. In a small study of the relation of various publics to air quality monitoring in Sheffield, Bailey et al. show that public understanding of both air quality and air quality monitoring is, in some cases, very sophisticated. According to their research, 'members of the public tried to assess not only the scientific and practical value of the model, but also its opportunity costs ... and its likely political functions' (Bailey et al. 1999, p. 300).

68 Hedges 1994.

69 The latter view was attributed to a senior government scientist. Mike Michael has documented the very different kinds of responses to their (lack of) understanding of the scientific information they are expected to understand and accept as true (Michael 1996a&b).

70 Giddens 1991.

71 Compare this with the importance of economic analyses and financial information to the formation of calculative agencies (Callon and Law 1994, Power 1996, Callon 1998a).

72 Although they are given a formulation in the 1995 National Air Quality Strategy.

73 The ways in which guidelines and regulations are modified in different countries varies considerably. For useful discussions of a growing body of work on regulatory science see Jasanoff 1990 and Wynne 1992a. As Brian Wynne notes, the UK approach has generally relied on the consensus of small groups of trustworthy experts conducting discussions generally outside of any formal or informal public scrutiny (p. 757). However, on occasions government scientific advisors do voice their concerns in the public domain. See, for example, the comments of Professor Anthony Seaton on the DoE's labelling of air-quality standards 'Air quality levels are misleading', *Guardian*, 7 December 1996. Compare this with the US case in which trust in the regulatory process is based less on persons and more on formalised and open procedures (Jasanoff 1990, 1996).
74 Interview with Professor Peter Burney, St Thomas's hospital, Lambeth, 18 October 1996.
75 Penn et al. 1996, p. i.
76 Such experiments have been performed by the Transport Research Laboratory and various other research establishments. According to Grosz, 'the subject's body will no longer be disjointedly connected to random others and objects through the city's spatio-temporal layout; it will interface with the computer, forming part of an information machine in which the body's limbs and organs will become interchangeable parts' (Grosz 1995, p. 110).
77 'New air quality warning thresholds backed by the WHO ... [are] expected to result in more warnings being given to the public', *Guardian*, 31 January 1997.
78 In a discussion of the politics of reducing vehicle emissions in Europe two commentators have noted that 'the European vehicle emissions debate was about both technology choice and commercial competition ... rather than environmental dose limits for ecosystems' (Boehmer-Christiansen and Weidner 1995).
79 Thibaut and Capporiccio 1995, p. 27.
80 Stengers 1997.
81 See, for example, the series of measures outlined in the UK government's draft 'Air Quality Strategy' which were heavily criticised (DoE 1995) and the debate in the European Parliament on air quality 4-482/80, 21 May 1996.
82 Rydin 1998.
83 Environmental organisations have developed a great deal of expertise in performing this process of political re-entanglement. However, as this case shows, they can put excessive trust in the truth and value of scientific information.
84 For an exemplary account of the emergence and defence of an autonomous space of scientific argument see Shapin and Schaffer 1985.
85 Mentioning the contractual position and funding of scientists tends to evoke one of two responses. One response is that it does not matter: it is not possible to reduce scientific arguments to political and economic interests. The other is to argue that scientific arguments reflect social and political interests or that these interests serve to construct them. Here I am making a different argument. The organisation and funding of scientific research is of crucial importance, not because it straightforwardly determines what scientific facts are produced, but because of the way it governs the ease with which scientific facts can be made political and enter into public circulation.

86 Callon 1998a, p. 41.
87 Whitehead [1926] 1985, p. 141.

8 DEMONSTRATIONS: SITES AND SIGHTS

1 Nietzsche's comment is appropriate: 'Just as the common people separates the lightning from its flash and takes the latter to be a deed, something performed by a subject, which is called lightning, popular morality separates strength from the manifestations of strength, as though there were an indifferent substratum behind the strong person which had the freedom to manifest strength or not. But there is no such substratum; there is no "being" behind the deed, its effect and what becomes of it; the "doer" is an invented as an afterthought, – the doing is everything' (Nietzsche 1994, p. 28).
2 In the work of writers such as Jürgen Habermas, Klaus Eder and Alberto Melucci the central concern is to understand the conditions within which social movements have come to mobilise. See, for example, Touraine 1981, Habermas 1987, Eder 1993, Melucci 1996. Hannah Arendt criticises the tendency of modern political philosophy to objectify political action in *On Revolution*: 'Politically, the fallacy of this new and typically modern philosophy is relatively simple. It consists in describing the whole realm of human action, not in terms of the actor or the agent, but from the standpoint of the spectator who watches a spectacle' (Arendt 1964, p. 52).
3 The argument is well developed in feminist social theory, particularly following the work of Judith Butler: 'gender is always a doing, though not a doing by a subject who might be said to preexist the deed' (Butler 1990, p. 25).
4 The argument parallels the recent work of Michel Callon who has argued that economic sociology has tended to over-socialise the economic actor and constantly wanted to look for forces of socialisation and ideology behind the market (Callon 1998a).
5 See, for example, Collins 1985, Gooding, Pinch and Schaffer 1989, Buchwald 1995, Lynch 1993, Latour 1999a.
6 Ulrich Beck makes a related point. 'Politics in the structure and rules system of the nation-state amounts to keeping and protecting the established democratic and economic rules of the game, not setting off for a new land of the political ...' (Beck 1999, p. 92).
7 Butler in Bell 1999, p. 166. For related arguments see Agamben 1993, Ashenden and Owen 1999, Barry, Bell and Rose 1995.
8 On the ethnography of political action see Butler 1996 and Berglund 1998.
9 See Hankins and Silverman who explore the complex history of the term in mathematics, medicine and experimental science. 'In the medieval schools anatomy was taught by the physician's reading aloud from the text while the barber surgeon performed the dissection, but there was also present a "demonstrator" or "ostensor" whose task it was to point out the organs as the physician read about them' (Hankins and Silverman 1995, p. 39).

10 See, in particular, Tom Osborne's work (Osborne 1998) on the importance of ethics to science. An ethical rather than a moral stance is implied here because the fact of what is witnessed should not be prejudged on moral grounds.

11 It both produced and reproduced distinctions of class and gender. Witnesses were always gentlemen. Technicians and assistants were invisible (Shapin 1994, pp. 355–407). Pierre Bourdieu makes the question of the relation between class and the disinterested ethical stance central to his work on the sociology of the intellectual field. Notwithstanding the importance of this analysis in its interrogation of the disinteredness of social theory (Bourdieu 2000), Bourdieu's work ends up being both ahistorical and sociologically reductive in its approach (cf. Born 1995, Osborne 1997). Harry Collins has examined the ways in which technical demonstrations are staged in public today, focusing on an 'experimental' collision between a train and a flask used to contain nuclear material put on by the British Central Electricity Generating Board. Collins contrasts this mere 'demonstration' in which the outcome is known (to those engaged) with a real experiment in which there is a degree of openness in the conclusions. 'The witnesses of a demonstration do not normally have access to details of preparation – the judgments and glosses, the failed rehearsals and practice runs, the *work* of science – that provide the normal levers for criticism of disputed experimental results' (Collins 1988, p. 728). The availability of such knowledge and the capacity to question the staging of a demonstration is a political matter.

12 Road building was one of a number of different objects of direct action in the mid-1990s. See McKay 1998.

13 On Green and Habermas many thanks to Vikki Bell. I draw here extensively on her unpublished discussion of the public sphere Bell 1995.

14 Green 1994–1995, p. 68.

15 Habermas [1962] 1989, p. 201.

16 Ibid. In his later work, Habermas provides an account of origins of the environmental movement in the context of an account of the distinction between the system and the life-world (Habermas 1987).

17 Jodi Dean has made the point: 'To re-site the political is to recognize the multiple terrains and spaces producing and produced by politics' Dean 1997, p. 2.

18 For their practical support in making possible my research at Newbury and Fairmile thanks to Richard Hering, Julio Etchard and Andrew Testa. On the earlier M11 action see Butler 1996, *Aufheben* 1998.

19 By contrast the parallel action at the A30 bypass which I discuss later was not covered extensively in the press, except during the final moments when protestors were evicted from the Fairmile camp. Even then only one journalist from a national daily paper (the *Guardian*'s south-west England correspondent) covered the A30 action directly. The remaining national dailies relied on reports from the Press Association reporter.

20 The correspondent for the conservative broadsheet *The Daily Telegraph* wrote extremely positively about the Newbury protest, yet had been uninterested in an earlier protest along the route of M11 which took place in a poor outer suburb of London. Other important road-protest sites, such as the A30 protest near Honiton in Devon, were less visible at a national level for much of their duration until the moment at which the protestors were evicted.

21 The Transport minister Mr Watts made this clear. 'The adoption of the TENs Guidelines will help bring about a good quality European road network which will be of substantial benefit to commerce and industry, assisting the free movement of goods and people. We have put forward the inclusion in the UK section of the Trans-European Road Network those routes which we consider of strategic importance to international road traffic' (Speech by Mr Watts, IETT conference, 30 April 1996). For maps of the European road network that developed out of the TENs proposal see CEC 1994c. Whether the development of such networks will be of benefit to the citizens of the Community is unclear. According to one commentator, 'At the EC level, the TENs decision making process is biased heavily towards building infrastructure, fueled by the political and economic and political objectives of integration and the single market ... Integration interests have dominated throughout: in the argumentation; in the setting of boundaries; in the wielding of the decision making process. The result is an overwhelming case for the ubiquity of TENs, shifting the emphasis from issues of actual costs and benefits towards removing barriers to implementation' (Richardson 1995, p. 107)

22 In a keynote address to the conference on 'creating successful public/private partnerships in trans-European Transport Networks' (Brussels, 27 February 1996). Earlier in his speech to the conference Mr Kinnock had extolled the virtues, and the necessity, of private finance for public infrastructure projects. On the policy of funding public projects through private finance see Tonkiss 1996.

23 *Guardian*, 5 April 1995.

24 Hirsch 1995, p. 1.

25 '*Representational spaces*, embodying complex symbolism, sometimes coded, sometimes not, linked to the clandestine or underground side of social life ...' (Lefebvre 1991, p. 33; emphasis in original).

26 For example, in some specific locations trees were decorated with ribbons and banners (Interviews, Newbury bypass 20 August 1996). On the Greenham Common action see Roseneil 1995.

27 Association to the suffragettes was also explicitly made by one protestor in a TV interview following the end of the A30 road protest discussed earlier. When asked by the interviewer, Jeremy Paxman, what right had they to disrupt the building of a road, she replied that there was a right to protest. 'And without the right to protest we [women] would not have the vote' (*BBC2 Newsnight*, 30 January 1997).

28 Quotation from the protest web site http://www.gn.apc.org/newbury/. Compare this with Oskar Negt and Alexander Kluge's observation of the tendency of Marxist parties to talk of the need to 'learn from defeats'. Clara Zetkin, they note, ended her speech at the congress of the Third International in 1921 after the failure of the March initiative, with the words: 'And if I demand of the congress that it undertake a thorough and conscientious examination of both theory and tactics in the March action, I am demanding this out of conviction that our analysis must be: an arming for new and severe struggles, irrespective of

either defeat or victory, for defeats too can be fruitful if they are defeats of the proletarian masses in the face of a superior enemy...' (quoted in Negt and Kluge [1972] 1993, p. 244).

29 Carey 1998.

30 On the use of the metaphor of war in radical extra-parliamentary politics see Blain 1994.

31 In contemporary politics this often involves references to the Diggers or the Levellers, which is the name of a rock band which has been closely associated with opposition to the Criminal Justice Act and with the anti-road-protest movement.

32 'Andrew, Julia, Nick and I arrive exhausted at the Fairmile at 3a.m. to be met by two protestors on patrol. The eviction is expected at any time over the next few days. Andrew's been working as a freelance covering the protests for the *Observer* and the *Guardian* for many months and we're let in to the camp and offered tea. The next day we sit round the fire talking.... But at 9p.m. in need of a change we go to a pub in Ottery St Mary, a village a couple of miles away, where we meet four of the protestors. An hour later the word comes that the police and bailiffs have moved in. We rush back to find the camp surrounded by fifty police and illuminated by searchlights and torches' (from my field diary, 24 January 1997). Later I learned that the police began eviction at that time because their surveillance cameras had picked up a significant number of 'protestors' leaving the camp for the village. The tactical surprise that the police had achieved was one of the main themes of the Sheriff of Devon's press conference at the camp site, and one of the main stories told about the events in the national press and radio coverage the day after the eviction ('Police raid camp as bypass protestors spend dole at pub', *Daily Telegraph*, January 25 1997).

33 My thanks to George Myerson for suggesting the connection between the anti-road protests and the Great War.

34 As David Goldblatt observes, criticising Beck's and Giddens's concern with the specific issue of risk, much contemporary environmental protest is directed as what is perceived as the reality of environmental damage than any notion of potential risk (Goldblatt 1996, p. 183).

35 Bruno Latour draws a contrast between what he calls ecologisation and modernisation. Modernisation involves a process of splitting off scientific questions about 'nature' from social and political questions. Ecologisation is a matter of taking care of the complexity of arrangements of humans, machines and nature (Latour 1995, 1999b).

36 FoE 1996.

37 Interview with Clare Patey, London, 5 September 1996.

38 We might compare this with the case of the Richard Serra's site-specific sculpture *Tilted Arc* which was finally removed from its site in New York precisely because of the way that its site specificity implied a political challenge to the New York city government (Weyergraf-Serra and Buskirk 1991).

39 Eric Hirsch has argued for the need to challenge the view (derived from the idea of the landscape painting) that landscape should be thought of as a fixed backdrop. 'Landscape is a process in so far as men and women attempt to realize in the foreground what can only be a potentiality and for the most part in the background. Foreground actuality and background potentiality exists in a process of mutual implication' (Hirsch 1995, p. 22).

40 Interview with George Monbiot, London, 27 February 1997.

41 This echoes Wittgenstein's remarks concerning the relation between showing and knowing: '"I know that this room is on the second floor, that behind the door a short landing leads to the stairs, and so on." One could imagine cases where I should come out with this, but they would be extremely rare. But on the other hand I show this knowledge day in, day out by my actions and also in what I say. Now does this someone else gather from these actions and words of mine? Won't it be just that I am sure of my ground? – From the fact that I have been living here for many weeks and have gone up and down the stairs every day he will gather that I know where my room is situated – I shall give him the assurance "I know" when he does not already know things which have compelled the conclusion that I knew' Wittgenstein 1969, p. 56, para. 431.

42 For discussions of this point my thanks to Julia Guest, Andrew Testa, George Monbiot, Richard Hering and others.

43 Interview with George Monbiot, London, note. Compare this with David Owen's argument, '... we should note that such substantive communities [of judgement] are contingent contextual constructs which form to address specific issues and dissolve into other communities and coalitions as struggles transform the terrain of struggle ... the question of "who are we?" [thus] remains an open arena of contestation' (Owen 1995, p. 503).

44 George Monbiot, mimeo, Oxford, n.d. Whatever its occasional insights George McKay's (1996) analysis of the road-protest movement as part of a broader 'subculture' of resistance which can be traced back to the hippies and to punk glosses over the diversity of the movements involved, their own complex relations to history, and their diverse relations to authority. Although it may be argued that 'teds' or 'punks' formed something like a subculture, I'm doubtful whether one can talk of the extraordinary range of individuals and institutions involved in the anti-road protests in these terms. McKay's preoccupation with the symbolism of the protestor's tactics goes along with a lack of concern with the practical techniques of protest (cf. *Aufheben* 5, Autumn 1996, pp. 43–44).

45 In the case of the *Land is Ours* campaign.

46 Quoted in *Squall* 14, Autumn 1996. *Squall* was one of number of magazines and newspapers written by those involved in or sympathetic to environmental direct action (Carey 1998).

47 According to one veteran of the M11 protest, who also noted that a few road protestors had been members of the far-right British National Party (BNP). Patrick Wright traces a link between right-wing ecological politics of pre-war Britain and the 'postmodern' politics of the 1960s. Rolf Gardiner, chair of the Dorset Campaign for the Preservation of Rural England, 'had metamorphosed the "new order" he had once imagined with the pre-Nazi German youth movement into the "postmodern" New Age he would announce [in 1968] in a harvest-thanks-giving sermon' (Wright 1995, p. 266).

48 The failures of government Environmental Impact Assessment procedures were identified by Friends of the Earth (FoE 1995).

49 Interview, Devon, 24 January 1997.

50 Press release from Flim-flam Events, 14 August 1996. Flim-flam events was a series of performances and 'art' events organised by the protestors which took place during the same period as the *Artbypass* event organised by Friends of the Earth discussed elsewhere.

51 Although there were a number of writers who supported and wrote sympathetically about the movement (such as George Monbiot and John Vidal of the *Guardian*) written doctrine had little importance in informing protestors of how they should act or what they should do. An antagonism to more traditional forms of left analysis had also been a feature of Greenham. 'When a group like SWP [Socialist Workers' Party] or Wages for Housework turned up and said, "This is how you should believe ..." women were just saying, "Well, hang on a minute. We want to get to the bottom of this. We want to find out what really happened"' (Rebecca Johnson quoted in Liddington 1989, p. 284 and Sylvester 1994, p. 188).

52 Cf. Singleton and Michael 1993.

53 Hirst 1990, p. 132, my emphasis.

54 As Hirst notes, 'The consequences of the political romantic's aestheticizing posture are always avoidable because the romantic is careful not to act. The romantic strikes the political poses in the politically safe world of stabilized bourgeois norms. Outside that world one pays the price for one's actions' (Hirst 1990, p. 132). According to Aronowitz, an emphasis on action rather than ideology has been a feature of contemporary gay activism in New York (Aronowitz 1995).

55 The distinction is certainly a difficult one to make. For all political ideologies contain, no doubt, an ethical element and ethical judgements may, in part, draw their strength from more or less well-articulated political ideologies. Excessively disruptive behaviour or sexual harassment were reasons why people were excluded from the road-protest camps, but the existence of some traditional forms of sexual division of labour persisted and was perhaps, to varying degrees, tolerated. Unlike the protest at Greenham Common in the early 1980s there seems to have been little interest in developing single-sex action. The relative marginality of feminism to the environmental direct-action movement in comparison to the protests of an earlier generation was noted and regretted by some women. One documentary film-maker who was contributing to a documentary of the A30 protest, and had been a teenager when she was involved in the Greenham common action commented that this was a significant difference between Greenham and the road protests.

56 *Aufheben* 1998, p. 118.

57 From the A30 protest web site http://jay.hrc.wmin.ac.uk/J's Joint/texts.FAIRMILE.html, 1996. The question of how much work was involved to take part in the activity of demonstration, and what might be considered legitimate work was an ongoing problem.

58 One commentator drew an ironic comparison between proposed official policies to develop a sense of discipline in the young with the 'training' provided in the road-protest camps. 'Besides, as youth training, the road protests could hardly be bettered – a cross between Community Service Volunteers, VSO and Operation Raleigh. Here is a genuine cadet force run without leaders, on a shoestring budget, where the coin is self-respect, self-discipline, hard work, initiative training, leadership and wit. Not all, it must be said, pass with honours' (John Vidal, 'The scum also rises', *Guardian*, 29 January 1997).

59 The notion of the body as a network of capacities and materials is suggested by John Law following the work of Goffman (Law 1994, pp. 181–183).

60 See Third Battle of Newbury 1996. As distinct from the passive forms of activity which have often been seen as a feature of contemporary consumer culture (see Slater 1997).

61 Here I focus almost exclusively on the conduct of the protestors. A full account of the protests, and the inventiveness of their particular techniques, would have to examine the complex relation between the changing tactics of protest and policing. My thanks to Robin Boast for this point.

62 This did not mean that all the protests were non-violent or that all the protestors were calm all of the time. In the year after the main confrontations between security and protestors took place at Newbury, the frustation of protestors led to violence causing, according to the contractors, £100,000 of damage (*Observer*, 12 January 1997, *Guardian*, 15 January 1997). Even on this occasion, however, anger was intermixed with a sense of carnival 'we had a great time' (Robin). On the site of the A30 bypass one protestor (Laura) remarked to me that they were there 'not for a fight [but] to make a stand, to make a statement'. Shortly before we spoke another woman had been tickling a sheriff's officer who had being trying to remove her from a tree. 'Is it tickling your conscience another remarked.' The tickling incident was reported in the national press and broadcast media. See, for example, *Daily Telegraph*, 25 January 1997. On the debate on violence amongst those demonstrating on the M11 site see *Aufheben* 1998.

63 See Third Battle of Newbury 1996. Foucault's contrast between the moralism [associated with many forms of political doctrine] and the ethical practices and 'arts of existence' seems appropriate here. According to Foucault, arts of existence are 'those intentional or voluntary actions by which men not only set themselves rules of conduct, but also seek to transform themselves in their singular being, and to make their life into an oeuvre that carries certain aesthetic values and meets certain stylistic criteria' (Foucault 1985, pp. 10–11). On Foucault's distinction between morality and ethics see Osborne 1998.

64 Hansen 1993, p. xxxi.

65 In arguing thus, Negt and Kluge were, amongst other things, trying to counter the pessimism of Adorno and the early Habermas.

66 Cf. Barry, Bell and Rose, 1995, p. 487.

67 *Earth First! action update*, 36, February 1997, p. 1.

68 Swampy talking to TV cameras on his emergence from the tunnels of Fairmile road protest camp, BBC2 *Newsnight*.

69 Work in media studies has tended to follow the work of Stuart Hall and others to view the 'objectivity' and 'impartiality' of television news media as alibi for other ideological messages (Hall 1980). But such an emphasis on the ideological connotations of the sign had two limitations. On the one hand, Hall's Barthesian interest in the denotation and connotation of the sign was accompanied by a

failure to interrogate the capacity of the media to inform. In this respect, his analysis reproduced the more general neglect of the production of truth within the Saussurean tradition of semiotics. Perhaps it was all too easy, despite Hall's intentions, to lose sight of the practicality and immediacy of politics: what issues are important at *this time*? what problems should be addressed *now*? *where* should the attention of government be directed? (cf. Barry, Bell and Rose 1995, p. 486) Second, although acting as a corrective to the economism of some forms of critical media analysis, Hall's account tended to stress the importance of the politics of reception at the expense of the politics of production. For the conduct of a demonstration, however, the politics of production are of critical importance. The presence of reliable witnesses is essential, if a demonstration is going to have credibility and effects.

70 Barry 1995.

71 Not always. In part, no doubt as a marker of distinction from the mass media some higher brow and high class forms of news reporting deliberately show the presence of ranks of reporters, microphones and cameramen in their reports. My thanks to Georgie Born for this observation.

72 From *Earth First! action update* e-mail edition, April 1997.

73 Distant observation does, of course, multiply the possibilities for errors of fact.

74 Interview with Andrew Testa, London, May 1997.

75 Although *Undercurrents* sought to expand the range of content available to oppositional groups, it was formally unadventurous, replicating the form of narrative and mode of address of mainstream news and documentary. Video activists learned how to use video in a practical sense (Harding 1997) but, with exceptions, were either not interested in, or unaware of debates concerning the politics of visual form. My thanks to Kalinka Henriksen and Richard Hering for discussion on this question.

76 'The state we're in: a notice to readers' *Squall* 14, Autumn 1996. See also Carey 1998, p. 68–69 and http://www.users.dircon.co.uk/~squall.

77 From the *Earth First!* web site http://www.wmin.ac.uk/campaigns/ef/ef/html.

78 Eder 1993, p. 55. As well as functional differentiation of international governmental organisations, there is also a functional differentiation of established organisations (FoE, Greenpeace, WWF, Amnesty) in the international social movement industry.

79 Haraway 1997. I examine the relations between the idea of demonstration, feminist politics and theory and the work of Donna Haraway in Barry 1998.

80 Specialised in the sense that it can demand the development of quite particular skills and practices which may be replicated in particular sites and remembered and reconstructed from the history of previous actions.

81 Agamben 1993, p. 84, my emphasis.

82 Ibid., p. 85.

9 POLITICAL INVENTION

1 Alder 1997, p. 15.

2 Alder 1995, p. 39.

3 Alder 1997, p. 5.

4 See, for example, Meny et al. 1996, Majone 1996a&b.

5 See, for example, Laclau and Mouffe 1985, Laclau 1990, 1994, Zizek 1997.

6 Keenan 1997, p. 3.

7 Keith 1997, p. 279.

8 Butler 1998 Indeed, Butler's own analysis of materialisation is indicative of an attempt to question social constructivism which has parallels with the work of sociologists of science such as Bruno Latour and Donna Haraway, Butler 1993, p. 4–10. I am grateful to Mick Halewood for pointing out to me the significance of materialisation in Butler's work.

9 Foucault 1977, 1997.

10 See, in particular, Burchell, Gordon and Miller 1991, Barry, Osborne and Rose 1996, Rose 1999.

11 On this point see Barry, Bell and Rose 1995, O'Malley, Weir and Shearing 1997, Ashenden 1999.

12 Exceptions include the work of Peter Miller and Mike Power on the study of practices of accounting Miller and O'Leary 1994, 1996, Power 1994, 1996, 1997 and Paul Rabinow's analysis of 'biosociality', Rabinow 1992, 1996a&b, 1999.

13. Deleuze 1988.

14 Callon and Latour 1981.

15 The idea that there was such an opposition was one of the key points of dispute in the Popper–Kuhn debates of the 1960s and 1970s. In many ways Kuhn's *Structure of Scientific Revolutions* was a very conservative book, with its assumptions about the autonomy of 'scientific communities' from politics, reproducing the dominant rhetoric of post-1945 US cold-war politics. Yet what was scandalous about his argument to many philosophers was that it raised questions about the distinction between rational justification and irrational commitment.

16 Habermas 1971. For an excellent critical discussion see Ashenden and Owen 1999.

17 On the displacement of the political in political theory see Honig 1993.

18 Spufford and Uglow 1996.

19 The idea of the networks and cyborgs as disruptive of boundaries was developed, in particular, by Donna Haraway in her well-known 'cyborg manifesto' (Haraway 1991, ch. 8). Here I would argue that while Haraway's essay did have a critical importance in the 1980s in marking a break with the essentialism and anti-technological orientation of contemporary socialist and feminist theory, it has to be read in this particular historical and political situation. The manifesto, at the time of its publication, a political event, no longer has the same significance. Fifteen years later, in a period when there is a great deal of uncritical celebration of the value of new technology, and socialist-feminism has declined as an intellectual and political force, the cyborg manifesto has quite different resonances and effects. In the work of lesser thinkers than Haraway, terms such as network, cyborg and interactivity are used, as we have seen, quite uncritically.

20 Latour 1987, Schaffer 1994, Mol and Law 1994, Barry 1995.

21 Miller and O'Leary 1996, p. 121.

22 Appadurai 1990.

23 See *Earth First! action up-date*, 60, July 1999, *Guardian* June 1, June 2, August 17, 1999.
24 Strathern 1999, ch. 9.
25 See, in particular, the work of Shiela Jasanoff on the role of regulatory agencies and scientific committees in containing both the social and discursive space of political controversy over scientific and technological developments (Jasanoff 1990, 1996).
26 Irwin 1995, Berglund 1998.
27 Beck makes the point in relation to the politics of risk: '... the BSE crisis cannot be "kept on one side" politically either and has flooded into key areas of politics – health politics, agricultural politics, foreign politics, trade politics, European politics – illustrating again the specific "and" – characteristic of risk conflicts' (Beck 1999, p. 49).
28 On the importance of thinking geographically about politics see, in particular, the work of Steve Pile, Michael Keith and Doreen Massey: Massey 1992, 1995, Pile and Keith 1997.
29 Wittgenstein 1969.
30 Agamben 1993.
31 'Core sets funnel all of their competing scientists' ambitions and favoured alliances and produce scientifically certified knowledge at the end' (Collins 1985, p. 142).
32 Irwin and Wynne 1996.
33 See Mike Michael's (1996a&b) analysis of the various stances taken by ignorant members of the public in relation to the problem of whether they should understand science.
34 The distinction between innovation, on the one hand, and testing and demonstration, on the other, is certainly not clear cut. Testing and demonstration are an essential part of the process of industrial innovation, for it is only by configuring the relation between a novel technical device and its potential users, that one will be able to decide whether a device works. As Keith Grint and Steve Woolgar have argued 'users' themselves have to be made or configured along with the devices that are to be used (Grint and Woolgar 1997, p. 74). On the sociology of testing see Pinch 1993 and Sims 1999.
35 This was one of the accusations of those who sought to defend the rationality of 'Science' in the so-called Science Wars which began in the United States and subsequently spread to Europe, e.g. Sokal and Bricmont 1998 and Koertge 1998. Good responses to such accusations include those by Latour 1999a, MacKenzie 1999 and some of the essays collected in Ross 1996.
36 Sherman 1996, Robson 1996.
37 For an excellent discussion of the issues involved see Archibugi and Michie 1997.
38 Examples of a vast literature on the value of interactivity and networking for democratic empowerment include Budge 1996. Budge, along with many others, pays scant attention to the specificity of the new media imagining that their use is relatively unproblematic. For an indication of the complexity and difficulties of 'virtual democracy' in reality see Dutton 1996, Tsagarousianou et al. 1998.

39 Leadbetter 1999.
40 Marx [1939] 1973, Callon, Law and Rip 1986, Callon 1987, 1998a, Deleuze 1988, Law 1991, Akrich 1992, Pickering 1995b, MacKenzie 1996, Ansell-Pearson 1999, Strathern 1999. Bruno Latour makes the point succinctly: 'Up to now we have believed in objects. But there are no objects, except when things go wrong or they die or turn to rust' Latour 1996a, p. 212.
41 As Donald Mackenzie, Nathan Rosenberg and others have argued, Marx is often wrongly accused of being a crude technological determinist. Better is to note his sense of the entanglement of machinery, human skill and ideology in the labour process. 'The production process has ceased to be a labour process in the sense of a process dominated by labour as its governing entity. Labour appears, rather, merely as a conscious organ, scattered among the individual living workers at numerous points of the mechanical system' (Marx [1939] 1973, p. 693).
42 See, for example, Deleuze's comments about 'invention' in tennis (Deleuze 1995, pp. 131–132).
43 For a good example of an anti-inventive cultural strategy see Georgina Born's (1995) analysis of the role of IRCAM in the development of musical modernism.
44 Including the structure of the defence industry. For an argument along these lines see the work of Mary Kaldor 1982.
45 Rabinow 1996a, p. 169. In pointing to the inventiveness of contemporary biotechnology, Rabinow implicitly criticises those sociologists of science who either have no interest in the objects of scientific research or who reduce such objects to their social context.
46 Ibid., p. 25. For a general analysis of the costs and benefits of the patent system in biotechnology see Svatos 1996.
47 'Creation takes place in choked passages ... a creator who isn't grabbed around the throat by a set of impossibilities is no creator' (Deleuze 1995, p. 133). I am grateful to Nick Thoburn for this point and for the reference (Thoburn 2000).

GLOSSARY OF TERMS

Arrangement	An ordering of social and natural entities including language, persons, money, buildings, legal rules and technical devices. Within the context of an arrangement, technologies have a value and purpose. Arrangements may be more or less stabilised or contested.
Diagram	A model for the formation of an arrangement ('disciplinary diagram', 'interactive diagram', etc.).
Entity	Any social or natural actor which has a role as part of an arrangement. Entities are historical realities in so far as their identity and properties depend on their environment (i.e. on their existence within a mutating arrangement with other entities).
Government	Except in specific cases the concept of government does not refer to an institution ('the government') but to practices of governing which may be exercised by the public authorities, institutions or individual persons on themselves or others.
Innovation	Technical change, which may be more or less evolutionary or radical.
Invention and anti-invention	An index of the degree to which a technological or political change opens up the space of possibility. Technical change may be anti-inventive in its implications to the extent that it displaces or blocks off other possibilities.
Political and anti-political	An index of the degree to which a problem or object is open to contestation and dissensus. In this sense scientific arguments can be political in the sense that they open up a space for dissensus. Conversely political projects and ideologies can be anti-political to the extent that their ambition is to close down the space of contestation.
Regulation	A specific form of government involving the use of more or less formal rules, standardised technical devices and monitoring procedures governing the conduct of, and relations between, different entities.
Site	A locale which has been made into a space of scientific practice or political action. Sites may or may not be connected together to form a zone.
(Technical) Device	A material artefact or immaterial object (such as language or software) which forms part of a technology
Technology	A method for achieving a given aim which includes the use of one or more devices, but also the knowledge and skills which make it possible for the devices to be used.
Technological Zone	A zone formed through the circulation and standardisation of technical devices and practices. Technological zones may be formally or informally regulated or organised through the use of claims to intellectual property.
Zone	A discontinuous space of circulation (of technical practices or forms of political action).

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