The Politics of Display

Museums, science, culture

Edited by
Sharon Macdonald

Chapter 1
Exhibitions of power and powers of exhibition

An introduction to the politics of display

Sharon Macdonald

In recent years politics has erupted publicly into the imagined sanctity of science and of museums on an increasing number of occasions. Two cases which have caused world-wide ripples of concern are the controversy over the representation of the *Enola Gay*—the aircraft which dropped the atomic bomb on Hiroshima in World War II—and the *Science in American Life* exhibition, both at the Smithsonian Institution in Washington (see Gieryn, this volume). Although most science exhibitions have not achieved the same notoriety, the questions that were raised in the controversies can be asked of other exhibitions too. Who decides what should be displayed? How are notions of 'science' and 'objectivity' mobilized to justify particular representations? Who gets to speak in the name of 'science', 'the public' or 'the nation'? What are the processes, interest groups and negotiations involved in constructing an exhibition? What is ironed out or silenced? And how does the content and style of an exhibition inform public understandings?

This book is concerned with these questions. It explores the political nature, uses and consequences of representations of science and technology for the public in exhibitions; and shows that exhibitions and science are productive arenas in which to investigate questions of cultural production and knowledge more generally. The focus is on museums and exhibitions that are identified as broadly scientific and are concerned with some aspect of science and technology. This includes museums of science and industry, natural history, geology, anthropology and medicine, as well as universal exhibitions (which deal with industry, technology and their own peculiar anthropology)—all of which are referred to here as either museums or exhibitions of science. The volume contains a mix of historical and present-day examples, for the aim is to show that science displays are never, and have never been, just representations of uncontestable facts. They always involve the culturally, socially and politically saturated business of negotiation and value-judgment; and they always have cultural, social and political implications. This is the case not only for recent examples which have sparked such controversy, but also for other and earlier exhibitions which have not been publicly contested.

Exploring the politics of exhibitionary selections, styles and silences is not, however, an easy matter. Exhibitions tend to be presented to the public rather as do scientific facts: as unequivocal statements rather than as the outcome of particular processes and contexts. The assumptions, rationales, compromises and accidents that lead to a finished exhibition are generally hidden from public view: they are tidied away along with the cleaning equipment, the early drafts of text and the artefacts for which no place could be found. Likewise,

exhibitions rarely seek to explain their contents in terms of a broader social and political context; and this may be something which even those involved in making exhibitions tend to overlook as they concentrate upon the intellectual, aesthetic and practical details of the task at hand. Generally invisible too, through paucity of research, are the understandings of exhibitions and science by those who visit. By analogy with the use of the term 'black box' (borrowed from cybernetics) in the sociology of science to describe those technical objects or scientific principles which are taken as given by scientists without any knowledge of their background or workings,[1] we might suggest that exhibitions tend to be presented as 'glass-cased'—that is, as objects there to be gazed upon, admired, and understood only in relation to themselves. Research, however, must seek to move beyond this.[2]

In order to move towards a more thorough understanding of the potentials, difficulties and consequences of putting science on display we need to look analytically at the contents of exhibitions in relation to their production, contexts and reception. Clearly, it is rarely possible to do all of these within any one study (evidence of what visitors thought of historical exhibitions, for example, is scant). Nevertheless, by bringing together a range of careful, probing studies which each tackle various of these dimensions, this book provides a collective vision of what is possible.

In this introduction my aim is to set out some issues involved in the analysis of the politics of the public display of science and to provide a framework in relation to which the studies might be located. I do this partly through a schematic history of the exhibition of science and technology which seeks to highlight the changing relations between museums, science, publics and power.

MUSEUMS, KNOWLEDGE AND POWER

In this book, we bring museums and science together not just to explore the politics and cultural operations of each, but also to highlight the discursive interrelationships between the two. Museums which deal with science are not simply putting science on display; they are also creating particular kinds of science for the public, and are lending to the science that is displayed their own legitimizing imprimatur. In other words, one effect of science museums is to pronounce certain practices and artefacts as belonging to the proper realm of 'science', and as being science that an educated public ought to know about. Moreover, some museums are sites of scientific research, and some collections have been formed as part of the development of particular scientific disciplines. In this way, they have played important roles in the constitution of scientific knowledge (see Allison-Bunnell, Dias, and J.Bennett, Chapters 5, 3 and 10 this volume) and have helped to define and perform scientific conceptions of 'truth' and 'objectivity'. At the same time, museums of science are widely conceived of as 'scientific' institutions in the sense that they are regarded as organized according to orderly and authoritative principles—principles conceived of as separate from power and politics.

Seeing 'truth' and 'values', 'science' and 'politics', and 'knowledge' and 'power' as divided off from one another is characteristic of ways of thinking which, in the Western tradition, have their roots in the seventeenth century, but which crystallized in the nineteenth century. From the late nineteenth century, however, with thinkers such as Nietzsche and Heidegger, and gathering pace dramatically since around the 1960s, there has been a

growing number of cultural and historical analyses which have sought to subject these divisions to critical analysis rather than take them as given. Questions have been asked about their formation and effects: how did such separations come about and what are their consequences? This has opened up many fields of research exploring the workings of power in different domains of knowledge and practice, including modern science.[3]

In this book, we are concerned with 'politics' in this broad sense of the workings of power. As Foucault has argued, power and knowledge are thoroughly mutually implicated: power is involved in the construction of truths, and knowledge has implications for power (see Foucault 1977, 1979). The production, distribution and consumption of knowledge are always political in this sense. 'Knowledge' here does not only mean that which is displayed in an exhibition as formal knowledge, of course. It also includes the knowledges (including unreflected-upon assumptions) of different parties involved in exhibition-making, their attempts to, for example, gather knowledge about visitors, and the understandings of visitors themselves.[4] These do not always work neatly with one another. Politics is, therefore, a matter of (often implicit) negotiation: a dynamic power-play of competing knowledges, intentions and interests. Moreover, if we view knowledge and power as intertwined, politics is not restricted to particular events or institutions; rather, it has ramifications throughout social life and cultural practice. Even where our concern is with what Foucault calls 'governmentality'—the administration of individuals and populations—we should look towards the detailed tactics, or 'semio-techniques', by which this may operate (Foucault 1977, 1991). Politics, in other words, lies not just in policy statements and intentions (though these are important) but also in apparently non-political and even 'minor' details, such as the architecture of buildings, the classification and juxtaposition of artefacts in an exhibition, the use of glass cases or interactives, and the presence or lack of a voice-over on a film. This is not to say that we will necessarily be able to detect the direct influence of, say, 'the State' in the design of such details; and it is likely in many cases that we will not even be able to say from where we draw our assumptions that particular display techniques are appropriate.[5] There will, however, be 'local' assumptions, claims and statements of intention—e.g. that exhibitions should 'speak to the eyes' or that labels should be designed for different 'levels' of reading skill and interest among the public. The task of the analyst, as the later chapters demonstrate, is to explore these beliefs and rationales, and to see how they are associated with—perhaps reflecting or opposing—wider historically located cultural logics and political rationalities.

The task is also to explore the consequences of particular forms of representation in terms of the distribution of power: who is empowered or disempowered by certain modes of display? Within the cultural study of museums, one of the most productive theoretical developments has been the analysis of museums as 'texts' or as 'media'; and this is an approach that can usefully be harnessed to questions of the politics of display. While sometimes focused narrowly on content, in its more interesting forms this approach has sought to open up questions about production (encoding/writing) and consumption (decoding/reading), as well as content (text) and the interrelationships between these.[6] It is an approach which leads to important questions about the determination of meaning and the distribution of the power to define in exhibitions. For example, who authors exhibitions? How much agency does an exhibition-maker have? What state political or economic interests impinge? How is the audience imagined? Who is excluded? To what extent do

visitors to an exhibition define it in their own terms? And how do certain exhibitionary forms or techniques enable certain kinds of readings? More specifically, this is an approach which can lead to questions about interrelationships between particular kinds of producers, exhibitions and audiences, and the different distributions of power these might entail and enable.

In many of the later chapters we see the interrelationship between exhibition production, content and imagined and/or actual audiences, and the positioning of these in relation to science and technology. That our focus is on museums of science is important, for it is by no means clear that the politics of production and reception necessarily work in the same ways for different media and genres of display. The strategies and techniques of, say, television, and the nature of the authority relationships that audiences have with it, are not the same as those of museums; likewise, the kinds of positioning of audiences through notions of taste, and the nature of appeals to authority, in art museums may well be different from those in museums of science. As Chapters 4 and 7 (by Teslow, and Macdonald) illustrate, a science museum trying to present an exhibition as 'art', or attempting to offer visitors choice, may easily be misunderstood. So, too, may understandings of science presented in the context of a museum differ from the understandings that the public may form in other contexts. Research into the public understanding of science has highlighted the importance to lay people of the perceived morality and trustworthiness of those who speak about science: judgments about the reliability of scientific knowledge and assessments of risk are made at least in part on the basis of estimations about the personal and institutional qualities of those providing the information (Irwin and Wynne 1996; Wynne 1996). Museums, as later chapters suggest, tend to be invested with cultural authority as trustworthy scientific witnesses—though increasingly, it seems, they have to work hard to maintain this status through rhetorical assertions of political impartiality and balance (see Gieryn, Chapter 12 this volume).

Of course, there are also variations between different types of science exhibition. Expectations of a national museum differ from those of smaller provincial museums or of universal exhibitions; assumptions about geology exhibitions may differ from those about modern technology or medical history. Likewise, certain exhibitionary styles—hands-on or hands-off, employing realism, hyperrealism, historical artefacts or reconstructions—also have consequences for the authority of producers in relation to consumers, and for the types of meanings that it is possible to inscribe. Roger Silverstone has suggested that we might explore such specificities in relation to the ways in which different media articulate time and space (1992), and in terms of their thematic, poetic and rhetorical strategies (1989). An emphasis on time and space would direct us to consideration of such matters as the authority effects of the temporal stability of most museum exhibitions, many of which are in place for years; and to the implications of their spatial fixity and the fact that visitors literally must move through them. The interest here would be in how such features might limit or expand the definitional power of institutions and of audiences. Thematics concerns genre—what are the socio-political propulsions towards, and implications of, particular representational forms? Poetics focuses on the aesthetic strategies of display, those intended to bring pleasure; and rhetoric on the mechanisms of persuasion, those intended to instruct. Of course, these may well overlap in practice, and indeed such overlap—the blurring of the aesthetic and the rhetorical, say—itself has implications for the politics of

representation as various later chapters illustrate. Nevertheless, such a framework is useful in helping analysis of museums move towards a more informed sense of the implications of particular display strategies. It will also help highlight the kinds of difficulties that might be encountered in trying to use exhibitions themselves to disrupt assumptions about, say, divisions between 'art' and 'science', and 'power' and 'knowledge'.

A SCHEMATIC HISTORY OF MUSEUMS OF SCIENCE

Museums of science can be regarded as cultural technologies which define both certain kinds of 'knowledge' (and certain knowledges as 'Knowledge' or 'science') and certain kinds of publics. Museums of science have not, however, remained constant over time: the types of science displayed, the types of public enlisted, the representational strategies and the institutional contexts, political motivations and effects have all undergone transformation. The aim of the next part of this introductory chapter is to provide a brief schematic account of some of these historical patterns and developments. There is, inevitably, much that is not touched on here, but my intention is to select examples in order to highlight some of the major continuities and shifts involved. In doing so, I divide the account into three unequal periods. The first deals with early modern museums of science, the growth of collecting during the Renaissance and the beginnings of 'scientific' ways of knowing in the seventeenth century. The next part considers the expansion of public museums of science and the development of world fairs, from the late eighteenth and more especially the nineteenth century; and the third part concerns a period, particularly since the 1960s, which has seen changing forms of display in science museums and the growth of industrial heritage and science centres.

Early modern museums of science: collecting, seeing and knowing

Histories of museums and, more specifically, of museums of science, generally trace their origins to the curiosity cabinets of Renaissance princes and scholars.[7] These were but one manifestation of a broader fascination with collecting which emerged in the fifteenth century out of 'an attempt to manage the empirical explosion of materials that wider dissemination of ancient texts, increased travel, voyages of discovery, and more systematic forms of communication and exchange had produced' (Findlen 1994:3). Such an empirical profusion posed problems for ways of knowing that had centred upon the inscribed wisdom of the Bible and of the ancients: here was material that was neither contained within nor immediately accountable by them. In response to this, collecting developed as a 'way of maintaining some degree of control over the natural world and taking its measure. If knowledge of the world could no longer be contained in a set of canonical texts, then perhaps it could be displayed in a museum' (ibid.: 4).

Although these collections often contained fanciful artefacts, such as unicorns' horns and the remains of dragons, their attempt was to represent and comprehend 'nature' through the collection and interpretation of material culture, and to this extent it is useful to consider them in relation to the emergence of conceptions of science. However, as Findlen makes clear, there was at this time no identifiable category of 'science' congruent with that which we would today label as such: Renaissance natural philosophers' understanding of

their activities was more 'expansive' and 'encyclopaedic' than this (ibid.: 9). Moreover, although their attempts to devise epistemologies based on observation of the natural world might be seen as a precursor of later scientific ideas, the ways in which they formed and ordered knowledge was also marked by major differences (ibid.; Hooper-Greenhill 1992). In the sixteenth century, according to Foucault (1970; see also Hooper-Greenhill 1992 and Prösler 1996), knowledge was based upon notions of 'similitude' and 'resemblance'. As Martin Prösler explains:

> Things as well as words were God's creation, bearing his signature at a 'deeper level'. These signs were laid down at the moment of the Creation, so that ultimately man might reveal its secrets. The form of knowing therefore corresponded to an *interpretation of signs* and of the resemblances that arose among them. Just as words and things meshed together seamlessly, so in the description of natural phenomena no distinction was made between observation, document and fable. The task of a natural historian like Aldrovandi, writing a natural history based upon his collection, was to represent this complex system—to draw together all that was known about an animal or plant and to present it in terms of the semantic relationships that connected it into the world.
>
> (Prösler 1996:30; emphasis in original)

To later observers, cabinets often appeared haphazard, so unfamiliar are the principles according to which they are ordered. Moreover, by the seventeenth century natural philosophers were dismissing the principles of similitude and resemblance, and replacing them with ideas of *comparison,* of which, Foucault argues, there were two forms: measurement and order ('mathesis' and 'taxonomia') (Foucault 1970:71). 'Henceforth, no longer did one search for signs of covert resemblance and affinity, but rather, through *observation,* isolated those characteristics whose comparison betrayed the identity, or diversity, of cosmic creations' (Prösler 1996:30; emphasis in original). This was a 'project of a general science of order' (Foucault 1970:71); and it was one in which *vision* became prioritized over other senses:

> Observation, from the seventeenth century onward, is a perceptible knowledge furnished with a series of systematically negative conditions. Hearsay is excluded…but so too are taste and smell, because their lack of certainty and their variability render impossible any analysis into distinct elements that could be universally acceptable. The sense of touch is very narrowly limited to the designation of a few fairly evident distinctions…which leaves sight with an almost exclusive privilege, being the sense by which we perceive extent and establish proof, and, in consequence, the means to an analysis *partes extra partes* acceptable to everyone.
>
> (Foucault 1970:132–3)

Museums and collections had a vital role in this new project of observation and comparison. Francis Bacon recommended that learned gentlemen should, as part of their scholarly endeavours, have at their disposal 'a goodly huge cabinet, wherein whatsoever the hand of man by exquisite art or engine has made rare in stuff, form or motion; whatsoever singularity, chance and the shuffle of things hath produced; whatsoever Nature has wrought in things that want life and may be kept; shall be sorted and included' (Bacon *Gesta Grayorum* (1594) quoted in Impey and MacGregor 1985:1). Such a cabinet would

provide 'in small compass a model of the universal nature made private' (ibid.); and on the basis of this 'world in microcosm' (Prösler 1996), the natural philosopher would be able to learn to 'read' the 'book of nature' (Findlen 1994:55). It was to this end that early modern scientific collections, such as the Repository of the Royal Society, established in London in the 1660s, were set up. However, as Eilean Hooper-Greenhill describes, such collections mostly failed in their aim to provide a complete 'visual grammar of nature' (Hooper-Greenhill 1992:157) because of the eclectic nature of collections (which were largely formed out of chance donations) and because 'The aim of cataloguing the whole of nature was too ambitious' (ibid.: 163).

The seventeenth century also saw the beginning of other changes in the criteria for authenticating and validating scientific findings. Prior to this period, the principal criterion of authenticity seems to have been the worthiness and gentlemanly status of the scientist (Shapin 1994). In other words, you could take a finding as true if it came from a noble fellow. During the seventeenth century, however, this was increasingly questioned and was partly replaced by the idea of authentication in terms of particular *methods* carried out in defined spaces, notably laboratories. These were spaces of 'observation' in which 'truth' came to be defined as flowing not from worthy persons, but from specified procedures. In theory, any person (properly equipped) would be capable of replicating these truths. However, as Steven Shapin argues, the repudiation of personal testimony as the basis for truth did not mean that the association between personal identity and truth was severed; although publicly dismissed, it remained (and remains) influential within scientific knowledge producing domains (ibid.: chapter 8).

Museums, which themselves had earlier validated their collections largely in terms of the worthiness of their donors, became important technologies for performing this new conception of truth. As Nélia Dias argues (Chapter 3 this volume), craniological collections assembled by nineteenth-century anthropological museums not only helped shape the craniological knowledge produced, they also helped to instantiate the new ideas about scientific method. In particular, what the museum offered was a site in which scientific findings were theoretically (and to a lesser extent practically) open to a general public as well as to a community of scientists: here, 'anybody' might come and survey the evidence of science.

The Repository of the Royal Society, like most other collections prior to the late eighteenth century, was not intended for the general public. It served primarily as a scientific research centre, a locus for gentlemanly scholars (Hooper-Greenhill 1992:145). There were a few exceptions to the restricted access of scientific collections at this time: collections of natural and artificial curiosities in mid-sixteenth century Florence and Bologna, and mid-seventeenth century Copenhagen (the collections of Cesalpini, Aldrovandi and Worm, respectively) were 'public' collections according to Bedini (1965), though the majority of those who visited seem to have been of high social status and had usually been preceded by a letter of introduction.[8] Indeed, it seems that such visitors were also enlisted as part of the establishment of authoritative knowledge via personal nobility. As Findlen notes, seventeenth-century visitors' books 'immortalised the fame of a museum and its creator by recording their connection to the social, political and intellectual centers of power' (1994:137); and, as such, they helped define the knowledge contained within the museum as authoritative knowledge.

The period between the Renaissance and the eighteenth century, then, sees considerable transformation in conceptions of knowledge and of museums. In the seventeenth century we see the beginnings of the growth of a particular kind of taxonomic knowledge based upon ideas of objective observation, visibility, mathematization and the ambitions of a science of order. While many of these ideas remain important, the period from the late eighteenth century sees further changes, in particular an 'opening up' of the museum to a much broader public, which is connected in part with changing conceptions of scientific authority. As we shall see in the next section, however, this is not the only impetus to the growth of the public museums, and the nineteenth century sees further changes in the nature of scientific knowledge—changes in which the museum again has an important formative role.

Modern museums of science: diagnosis, publics and progress

Particularly important to the shaping of the museum in this modern period are the following: the formation of nation-states—'imagined communities' which sought to define and enlist a bounded citizenship (Anderson 1983); colonialist expansion—which both provided 'material' for display and territories requiring governance; the further development of 'scientific' and more specifically 'museological' ways of seeing the world, and the extension of these to other domains of life. The museum is not, however, merely a product of or a site for displaying the narratives of modern developments; it is also one of the technologies through which modernity—and the democratic ideals, social differences and exclusions, and other contradictions which this has produced—is constituted.[9]

Consequent particularly to the French Revolution, many previously private collections were claimed for the public, and numerous new museums—national and provincial—were established. It was during this period, as nation-states themselves emerged and sought to define their populations as citizens, that museums came to be conceived as symbols of national identity and progress, and as sites of civic education for the masses.[10] Not only was the previously private made public, 'exhibiting' also moved beyond the confines of museums with the remarkable flourishing of 'universal' exhibitions, of which the Great International Exposition held at Crystal Palace in London in 1851 was the first.[11] At these the competitive dimension of 'national exhibitionism' was often made explicit, nations being awarded medals and ranked in ceremonies modelled on the Olympic Games (Lindqvist 1993; Harvey, Chapter 8 this volume; J.Bennett, Chapter 10 this volume).

While univeral exhibitions, which were largely concerned with industry and technology, and most museums established in this period, with the exception of art galleries, could be seen as broadly scientific (Forgan 1996:47), the nineteenth century is also characterized by the development of more specialized public museums of science. Many of the earliest of these, some of which were established in the late eighteenth century, were devoted to natural history, as was the Musée d'Histoire Naturelle, which opened in Paris in 1793 or Charles Willson Peale's Museum in Philadelphia (1784), though this also included some scientific and technological artefacts (Bedini 1965:22).[12] So too were many of the first 'scientific' museums to open in the New World (Sheets-Pyenson 1989). Anthropology collections were sometimes incorporated in the natural history museums, as in the case of the Smithsonian's Museum of Natural History, the Chicago Field Museum or the Dutch

Museum of Natural History, or as part of national self-representations as in the case of the National Museum of Denmark (1916), though from the 1830s they also began to assume distinct identities in some cases, such as the ethnographic museum of the Academy of Sciences in Petrograd (1836), the National Museum of Ethnology, Leiden (1837) and the Pitt-Rivers Museum, Oxford (1885).[13] Museums specializing in machines and technical and scientific instruments also became a distinct type in the nineteenth century, beginning with France's Conservatoire National des Arts et Métiers, established in 1794. More specialist science museums often developed out of more general collections, as did Britain's Museum of Natural History (from the British Museum collections) and the Museum of the History of Science, Oxford (from the Ashmolean collection) (Hackman 1992); or, as in the case of the Science Museum (established 1857) or the Industrial Museum of Scotland (1855), they were based on exhibits originally shown at international exhibitions (Butler 1992). By the early decades of the twentieth century, most of the first wave of nation-states, and many which were established later, could boast not simply *a* national museum, but national museums of both natural history and of science and technology, as well, perhaps, as national museums of art and other subjects.[14]

This flourishing of museums and exhibitions is bound up with the development of distinctive modern ways of seeing the world. For modern cosmopolitan Europeans, Timothy Mitchell argues, representation—particularly 'rendering things up to be viewed' (Mitchell 1991:2)—became a key means of apprehending and 'colonizing' reality. The world was to be experienced as though it were a picture—a form of apprehending that he calls, in a phrase borrowed from Heidegger, the 'world-as-exhibition' (ibid.: 13). This entailed both a detachment of the viewer—'[t]he person was now thought of as something set apart from the world, like the visitor to an exhibition' (ibid.: 19)—and a depiction of the world as 'ordered and organised' (ibid.) Even where Europeans were keen also to experience 'reality' as directly as possible, as in their ventures into unknown places or, in a rather different way through the development of highly accurate replicas (such as the 'Cairo street' at the universal exhibition in Paris in 1889), the idea of detached representation remained important. This is reflected in the desire of European travellers to photograph or paint the places they visited (preferably from a height which would set the site out as a panoroma (ibid.: 24)); and in the proliferation of texts about exhibitions—'catalogues, plans, signposts, guidebooks, instructions, educational talks and compilations of statistics' (ibid.: 20)—and the viewing platforms that were often built as part of them (T. Bennett 1995:69). This capacity of exhibitionary representation to render the world as visible and ordered was part of the instantiation of wider senses of scientific and political certainty. As Mitchell emphasizes:

> Exhibitions, museums and other spectacles were not just reflections of this certainty, however, but the means of its production, by their technique of rendering history, progress, culture and empire in 'objective' form. They were occasions for making sure of such objective truths, in a world where truth had become a question of what Heidegger calls 'the certainty of representation'.
>
> (Mitchell 1991:7)

Museums and exhibitions were thus sites in which political power could 'operate…so as to appear set apart from the real world' (ibid.: 160); they were a means of casting the newly

realized nations, and cultural, racial and class differences, as fact. In this, as later chapters suggest, museums and exhibitions were perhaps particularly effective in that they not only provided a 'picture' but also objects and other tangible 'evidences'.

The emphasis on gaining privileged vantage points from which order and objective truths might be discerned, as well as the disciplinary specialization of museums that occurred in the nineteenth century, can be seen as part of a broader epistemological development that the historian of science, John Pickstone, has called 'analytical', 'museological' or 'diagnostic' (Pickstone 1994). He is careful to emphasize that these new forms of knowing had earlier precursors and that some classical or savant forms of science, technology and medicine continue today. Nevertheless, he argues, it is useful to try to characterize a development which became much more widespread in the nineteenth century. Classical science, he suggests, tended to identify objects in terms of surface characteristics and to explain deductively according to particular natural philosophies (e.g. vitalism, mechanism) which in practice were 'rarely articulated with' the project of a general grammar of nature which the savants espoused (ibid.: 113, 117). Characteristic of the new 'analytical' or 'museological' sciences is 'that they presented their objects as *compounds,* analysable into *elements*', and that 'these elements were *domain specific*' (ibid.: 117; emphases in original). The aim was to be able, within specific types of science, to produce analytical classifications and to diagnose surface characteristics or the workings of compounds in terms of underlying *process*. This was different from the earlier idea of reading and cataloguing the 'book of nature', in that it sought to 'produce deeper, more specialized knowledge' (ibid.)—to delve beneath the surface—and thus to provide a means, ideally, of grasping 'deep structure' and process, which in turn would enable *explanation* and *prediction*. Museums, according to Pickstone, were a key site in which this new form of knowledge was articulated; and to this end universities often established museums or sought to associate themselves with existing museums (Forgan 1994, 1996), though at the same time it should be stressed that not all nineteenth-century exhibitions were 'museological' in Pickstone's sense (Pickstone 1994:123). Nevertheless, museum collections were an important research source in the nineteenth century and displays were increasingly conceptualized as a manifestation of the analysis of objects into elements, and thus as a kind of diagnosis of an underlying reality. The attempt was to arrange objects and displays in ways which would reveal profound principles. Such profound principles might be evolutionary, though there were other possibilities too, such as the analysis into chemical elements and principles. As Sophie Forgan has described, this was a matter of a good deal of consideration in the planning of the layout of many nineteenth-century museums, including the Natural History Museum, London, and Jermyn Street Geological Museum (Forgan 1994; see also T.Bennett, Chapter 2).[15] Such exhibitions were conceptualized not just as containers of scientific facts, but as themselves integral to the scientific message. This had implications for, among other things, the expertise demanded of curators, links with universities, and museum visitors.

The layout of nineteenth-century museums also differed from earlier museums in that it was expected to speak not only to fellow savants and nobles, but to a general public, many members of which could not be expected to have much prior knowledge. It was often recognized, as Tony Bennett describes in the next chapter, that the kind of deep specialist knowledge that these classifications might divulge to scientists was not necessarily that which would be of most educative value and practical use for the lay person. Considerable

effort, therefore, was directed towards making exhibitions educative for, and *legible* to, the new mass public. As Bennett argues, this was also bound up with ideas about transforming the public, and producing citizens who would themselves take on the task of self-education and improving themselves.

Ideas of improvement and progress were integral to most nineteenth-century museums and exhibitions of science. These ideas operated at a number of levels, each of which provided mutual support for the others. At the most expansive level were evolutionary narratives about the progress of humankind and of scientific knowledge; at the national level, each country sought to represent its own story of self-betterment and of civilizing influence upon the rest of the world; and at the level of individual citizens, members of the public were invited to undertake their own personal journey towards greater knowledge and mastery. Museums were sites in which these parallel narratives could converge. Exhibitions could physically knit together the universal and national or racial, and visitors could embody the progressive narratives as they moved through the orderly museum space.

Much of the nineteenth-century museum achievement is still part of our physical and symbolic landscape. However, during the course of the nineteenth century museums were to become less important as sites of scientific activity, and 'museological science', while remaining central to many areas of scientific endeavour, was to become less prestigious and authoritative than 'experimental science', which entails '*control* over phenomena in laboratories' (Pickstone 1994:132, 113; emphasis in original). While museums have continued to have an important role in validating science for the public, the legitimization of research evidence itself has increasingly become a matter of specialized expert procedures and review, carried out largely in less public spaces. Moreover, with a continued specialization of scientific knowledge, with the increased use of sophisticated technologies and with scientific attention often turned to the infinitely small or large, science has developed a greater mystique of being beyond lay understanding. Yet, while this may signal a decline in the role of the museum as a site of scientific expertise and legitimization, it also heralds a renewed significance in its role in 'the public understanding of science'. Museums of science in the twentieth century have built on their earlier emphasis on public education to present themselves as experts in the *mediation* between the esoteric world of science and that of the public. This self-perception differs somewhat, I suggest, from that predominant in the nineteenth century, in that it seeks not so much to make science legible through making evident its underlying principles, as to represent science: not simply to *show* or *tell* but to *interpret* it. Moreover, such interpretations are increasingly framed primarily in terms of the public—e.g. through categories such as 'Your Body' or 'Shopping'—rather than science.

The distinction between nineteenth- and twentieth-century exhibitions should not be exaggerated, however, for as we have noted, nineteenth-century displays were often very much concerned with public education and with finding ways of displaying science that would appeal to a lay audience. Nevertheless, I suggest that what we see in the twentieth century are moves away from the dominant nineteenth-century institutional analogy of the museum as a library (Forgan 1994), and with this a greater sense that it is only possible to display fairly limited and partial accounts of science; and a growing conviction that science needs to be embedded in other kinds of stories—and in media which were not

typically part of the museum-as-library—to make it attractive to a general public. The orderly visualism of reading—inherent in the library and book analogies, the desire to make *legible,* and the obsession with labelling exhibits (see T.Bennett, Chapter 2)—gives way to less directed and more multi-sensory approaches. Alongside these changes we also see further transformations in the conception of the public.

Recent museum transformations: contexts, interactivity and consumers

In the late twentieth century, many of the nineteenth-century triumphs—the nation-state, empire, racial and social hierarchies, progress and 'deep truth'— have come to seem much less inevitable. Particularly since the 1960s, we have seen challenges to all of these in the form of ethno-nationalist, liberationist and environmentalist movements, and the growth of interest in 'traditional' culture and heritage, 'minority', 'alternative' and 'New Age' beliefs and lifestyles. The acceleration of globalization and the transformations in capitalist production to more transnational, flexible, disorganized and consumer-led forms are also often seen both as a threat to the relevance of the nation-state and as factors involved in enabling new forms of identity and subjectivity.[16] While there has undoubtedly been a proliferation of different, particularly minority, 'voices' speaking in the public arena, the old political and cultural high ground has not simply been relinquished. On the contrary, what we have seen is an escalation of intellectual battles over the legitimacy of different kinds of representation. The 'Culture Wars' have focused especially on issues of 'political correctness' and 'intrinsic value' in relation to the literary and artistic canon;[17] the 'History Wars' on similar issues in relation to history, multiculturalism and national identity, focused partly on the *Enola Gay* episode;[18] and the 'Science Wars' have seen fierce debate over the epistemological status of science.[19]

It is in this same period that we see some marked changes in museums of science. Not only do existing museums of science come to adopt new technologies of display, new interpretive experiments and new concerns with their visitors and communities, there is also a massive expansion of two particular forms which could broadly be classified under the 'museum of science' label: industrial heritage and science centres. While there has been debate about whether these *should* be regarded as museums of science (e.g. Durant 1992), it is clear that they have posed challenges for more traditional science museums and that these have sometimes sought to borrow the strategies (and personnel) of industrial heritage developments and science centres. Intriguingly, some of the approaches that industrial heritage and science centres take to science are almost the inverse of one another. The former seek to present science entirely contextualized in a 'slice of history' in a specific community, whereas science centres are more concerned with universal laws and principles which transcend particular times and places.

Industrial heritage sites have a number of precursors, such as Skansen, a Swedish open-air museum which opened in 1891, and Henry Ford's Greenfield Village (1929).[20] Nevertheless, since the 1960s the number of these has vastly increased in an expansion which equals that of traditional museums of science and industry in the nineteenth century. In Britain, the Blists Hill development at Ironbridge Gorge (opened to the public in 1973) and the North of England Open Air Museum at Beamish (1972) are generally seen as particularly influential examples.[21] Unlike traditional science museums, these attempt to

provide a 'total environment': artefacts are presented embedded in the worlds of which they were part and visitors are invited to enter, or at least get close to, those worlds and lives. In some cases, especially in France and Scandinavia, industrial heritage developments also go under the name of 'eco-museums' and are associated with community regeneration—linking past with present—and a much greater involvement of local populations in the development of displays than is typical of most museums.[22] The development of industrial heritage, as part of a more widespread discussion of what is sometimes called the 'heritage industry' (Hewison 1988), has already been subject to a good deal of debate about its political implications.[23] Questions have been asked about how far such representations provide accounts which are emancipatory for visitors and communities. Is the movement analogous to, and part of, a claiming of history by 'the people'? Or is it simply a way of commoditizing a past in the face of a lack of alternative sources of manufacturing? As with examples we discuss here, the answers are likely to be less clear cut when it comes to dealing with specific cases and the complexities of processes and different participants than the sometimes stark terms of the debate might imply. Nevertheless, these general arguments about the politics of industrial heritage and the extent to which presenting science as part of particular places, times and social relations may enable the public to better understand the importance and/or the dangers of science have clear links with debates taking place within many museums of science; and arguments in some of the chapters here help take this debate further.

The very different strategies of science centres and the specialized hands-on galleries which have sprung up in many science museums also have pre-1960s precedents; in this case interactive exhibits in international exhibitions and museums of science (e.g. the Children's Gallery, established in the 1930s in the Science Museum, London). However, where the latter were often devoted to showing particular applications of science, the new science centres (especially the first to be developed) have concentrated more on relatively abstract scientific principles. The earliest example of a centre devoted to representing scientific principles through hands-on exhibits is the Exploratorium in San Francisco, which opened in 1969. In contrast to industrial heritage sites, science centres and their in-museum equivalents have been subject to rather scant commentary on their political motivations and effects. In many ways this is not surprising, given that such exhibits attempt to deal with 'pure' scientific principles which transcend cultural and social contexts. Yet, from the perspective of social and cultural disciplines, the emergence and rapid spread of this mode of representing science is surely also deserving of comment.

While we must certainly not assume that all science centres necessarily share identical motivations (as Andrew Barry warns in Chapter 6), the Exploratorium is an interesting and prescient case to consider, both because it has been so influential and because its founder, Frank Oppenheimer, provided very clear statements of his intentions (Hein 1990). In the document which set out the rationale for establishing the Exploratorium, Oppenheimer expressed particular concern over the fact that 'For many people science is incomprehensible and technology frightening' (ibid.: 218). The aim of the Exploratorium, as the rationale concluded, was to 'convey the understanding that science and technology have a role which is deeply rooted in human values and aspirations' (ibid.: 221). In a century in which broadly triumphalist popular perspectives on science seemed, especially after the Second World War, increasingly to be discoloured by perceptions of the dangers of

technology, there was a task, as scientists such as Oppenheimer saw it, to present positive visions of scientific potential and achievement. Indeed, the phrase which has been adopted by many science museums to describe their central activity in the late twentieth century—'public understanding of science'—is often conceptualized in terms of 'public appreciation of science' (Lewenstein 1992; see also Irwin and Wynne 1996). It was to this, in part at least, that the Exploratorium was dedicated.

Oppenheimer had personal reasons for wanting to reclaim science as a worthy and positive endeavour, for, together with his brother Robert, he had worked on the production of the atomic bomb. He had, therefore, very direct involvement in the technology which, more than any this century, has created a sense of public fear of the potential of science.[24] Oppenheimer's attempt in the Exploratorium was to represent 'pure' scientific principles unsullied by the context of their production or of their applications. While, on the one hand, he claimed that an understanding of scientific principles was important for everyday life, he also fiercely resisted any suggestion that the Exploratorium should deal with areas of science that might readily be perceived as political (such as the environment) or even that it might include any directly 'how to' exhibits (Hein 1990). Instead, the Exploratorium was to represent scientific laws as transcendent, and scientific process as a formal art. Indeed, as Barry emphasizes in Chapter 6, Oppenheimer was keen to draw analogies with art—the subtitle of the Exploratorium being 'Museum of Science, Art and Human Perception'—so pointing to the individual creative element of science rather than its social or political contexts.

If science centres may have proved attractive partly because of their potential to provide positive and relatively politically 'safe' images of science, another source of their appeal clearly lies in their hands-on interactivity—a mode of display which is becoming increasingly common in contemporary exhibitions. This is sometimes embraced by those involved as a democratizing attempt to, as Oppenheimer put it, 'bridge the gap between the experts and the laymen' (in ibid.: 17; cf. Barry, Chapter 6). Whether this is how the 'hands-on' experience is seen by visitors remains, however, an underresearched question, though several chapters in this book suggest that democratization is not *necessarily* an effect of such representations, and that, in analysing interactive and electronic technologies of display, we need also to consider the politics of the way in which the visitor is imagined.

As Andrew Barry's comparison of the use of French and English use of interactivity in national museums of science illustrates, we cannot simply infer the meanings of particular technologies of display without consideration of national cultural semantics. In Britain in the late twentieth century, for example, visitors may be conceptualized more as individualized choice-making consumers and active learners than they are in France, where the notion of citizenship and the celebration of human-machine interrelations appear more central. At the same time, however, there are also shared—though not universal—transnational conceptions of the meanings of new technologies of display, as Penelope Harvey (Chapter 8 this volume) discusses in relation to Expo '92. Here, clever reflexive use of such technologies in itself signals the capacity of nations and corporations to participate in serious world games such as trade.

In addition to the past-focused industrial heritage and the forward-looking interactive and multimedia display technologies, the late twentieth century has also seen an increased number of exhibitions in museums of science which attempt to relativize or question

scientific authority, or to reflect upon the process of exhibiting itself. This may be seen as part of a growing questioning of previous certainties and an increased willingness of cultural institutions and academic disciplines to look reflexively at their own practices. Chapters in the final part of this book describe a number of such attempts in museums of science.[25] What is clear from these accounts is that such 'experiments' can certainly produce interesting and thought-provoking displays.[26] They may, however, also provoke confusion and anger. That they do so is testament, in part at least, to the authority to sanctify science with which museums are still widely invested.

THE CHAPTERS

Chapters in this book are presented roughly chronologically. Tony Bennett and Nélia Dias focus on the nineteenth century. They describe museums of science in this critical period as they sought to open themselves up to wider publics and to inscribe social differences. Both emphasize the growing centrality of 'visibility' and 'legibility' in museum display; Bennett focusing particularly upon this in relation to museums' relationship with the public, and Dias analysing its relation to changing conceptions of science and the definition of racial difference. One important point that both make is that, despite the social divisions that exhibitions in this period might encode, those involved in the creation of museum displays were often liberal in political inclination, and the task is, therefore, to understand techniques of display not simply as attempts to sustain an existing social order. This entails, as other chapters also highlight, consideration of the alternative and contradictory political potentials of museums.

The next two chapters, by Tracy Teslow on the Field Museum of Natural History, Chicago and Steve Allison-Bunnell on the Smithsonian Museum of Natural History, both consider twentieth-century exhibitions struggling with changing scientific and social ideas. The *Races of Mankind* exhibition described by Teslow was originally created in the 1930s and entails an inscription of racial hierarchy similar to that described by Dias. By the 1960s, however, such ideas about race were scientifically and socially discredited, and Teslow describes the awkward attempt by the museum to redisplay the same exhibits in a new framework. Allison-Bunnell likewise describes a science museum finding aspects of its practice—in this case its scientific research—being defined as 'outdated' and documents the museum's struggle to justify what it does as 'relevant'. Both of these chapters, like others in the book, highlight the importance of 'textual' features of museum representations—their rhetorical and poetic strategies and their articulations of time and space—in enabling and constraining particular kinds of 'readings'. In these two chapters what is especially at issue are 'realism' and 'nature', and the mediation of art, craft and types of science.

The remaining chapters in the book examine developments since the late 1960s, focusing particularly on exhibitions created in the past 10 years. Andrew Barry analyses the development of interactivity in science museums, highlighting the alternative possible political and cultural potentials these may entail in different national contexts. I take up the related theme of visitors as 'consumers' in relation to 'public understanding of science' (and the place of interactivity within this), exploring this through a case study of an exhibition in the Science Museum, London, which opened in 1989. Penelope Harvey's analysis of Expo '92 highlights the way in which interactive and multimedia technologies of display

have also become part of a transnational competitive exhibitionary arena. Together, these chapters suggest that what we are seeing in these new exhibitionary developments are not just new ways of 'packaging' older projects, but also reconfigurations of 'the public', of 'culture' and of knowledge/power, though the chapters also suggest that there is no single 'meaning' or 'politics' encoded in such reconfigurations.

One aspect of these reconfigurations is an increasing trend towards innovative juxtaposition of styles and towards reflexivity. In the chapters by Mary Bouquet and Jim Bennett we see this trend turned to 'science' and to representation itself. Both describe exhibitions that they played a major role in creating which sought to raise questions about artefacts displayed by highlighting something of the culturally specific relations in which they were embedded. Rather than presenting science as fact, these exhibitions presented culturally and historically relativized accounts. In that both of these exhibitions also reflected on earlier, particularly nineteenth-century, exhibitionary strategies, they can also be read in relation to chapters in the first half of the book. Bouquet's exhibition, which dealt with physical anthropological remains, was intended in part as a commentary on the kind of exhibitions that Dias describes; and the exhibitions at the Whipple Museum for the History of Science, Cambridge, in which Jim Bennett was involved, sought in part to highlight the close interdependencies in the late nineteenth and early twentieth century between techniques of science, exhibition and public management, as described particularly by Tony Bennett.

Such experiments are, however, not always received as their makers hoped: Mary Bouquet found that her ideas were considered an 'insult' to science, and Jim Bennett notes that visitors did not always appreciate the intentions of *Empires of Physics* and *1900: The New Age*. This problem is explored further by Ken Arnold in his discussion of an exhibition on the history of birth control which he mounted in 1993/4 at the Wellcome Institute for the History of Medicine. As he saw it, in displaying historical material, including propaganda, concerning birth control, he was highlighting the political technologies that had been mobilized by various groups in pursuit of persuading the public to certain understandings. However, as his analysis of visitor reactions shows, visitors' expectations of 'science', of an institution such as the Wellcome Institute and of 'politics' were not always as he had predicted.

Arnold's account raises questions about the framing of debates about science representation in museums. This is pursued further by Thomas Gieryn in his analysis of the controversies over the display of the *Enola Gay* and the exhibition, *Science in American Life*. In both cases, questions over the nature of history, science and the public were at stake. As Gieryn shows, however, it would be a mistake to see such debates as a neat polarization of two sides each trying to justify their case in terms of 'the facts of the matter' or, as he puts it, 'Big Truth'. Instead, claims by both 'sides' were characterized by epistemological modesty and a rhetoric of balance, trust and public interest. The disappearance of authoritative narratives of 'Truth' might be seen as just what the cultural critics and sociologists of science ordered. However, as Gieryn suggests, there may be little comfort for them in the alternative legitimizations mobilized by those authoring science for the public.

As the studies in this book illustrate, museums are thoroughly part of society, culture and politics. As such, they are sites in which we can see wider social, cultural and political battles played out. They are not, however, simply sites, battlegrounds, terrains, zones or

spaces. Museum displays are also agencies for defining scientific knowledge for the public, and for harnessing science and technology to tell culturally authoritative stories about race, nation, progress and modernity. It is to the further understanding of such stories, their authorship, techniques, and implications that this book is dedicated.

ACKNOWLEDGMENTS

NOTES

1   The use of the term 'black box' in the sociology of science was introduced by Bruno Latour in *Science in Action* to refer to 'a well-established fact or an unproblematic object' (Latour 1987:131) or more specifically as 'an automaton…[involving] a large number of elements… made to act as one' (ibid.).

2   As is nicely implied in the title of Nick Merriman's analysis of museum visiting, *Beyond the Glass Case* (1991).

3   The sociology and anthropology of science in general, and particularly the social study of scientific knowledge and feminist analysis, have been concerned with such questions. For some overviews see Franklin (1995); Harding (1986); Law (1991); Nader (1996a); Star (1988); Traweek (1993); Woolgar (1988a).

4   A distinction is sometimes made in science studies and in the social sciences more generally between knowledge and practice. My characterization of knowledge here, however, is intended to incorporate both.

5   Foucault makes this point in a different context in *The History of Sexuality* (1979). This is not the same as saying that the State is not involved in the regulation of individuals and populations.

6   The 'encoding'/'decoding' vocabulary is from Hall's classic account of a textual approach to media (Hall 1980). For an account of a range of textual approaches to material culture see Tilley (1990); and for a brief discussion in relation to museums see Macdonald (1996).

7   See Bedini (1965); Findlen (1994); Impey and MacGregor (1985).

8   See Findlen (1994:134–46), for a fascinating discussion of visitors to these museums, particularly that of Aldrovandi.

9   For an insightful theoretical account and illustration of museums 'rid[ing] the juggernaut of modernity's contradictions' see Fyfe (1996).

10   For discussion see Bennett (1995, especially ch. 3); Duncan (1995); Hooper-Greenhill (1992: ch. 7); Kaplan (1994).

11   For discussion of the Great Exhibition see Altick (1978); Bennett (1995 *passim.*); Greenhalgh (1988); and for more general discussions of universal exhibitions see Benedict (1983), Coombes (1994), Harvey (1996) and Chapter 8 this volume, and Rydell (1993).

12   It should be noted that dates of 'establishment' are not always clear cut and these should, therefore, be taken as approximations.

13   Anthropological collections during this period generally covered both cultural ('ethnological') and physical aspects of anthropology, though some collections focused more on one aspect than the other. For discussion of anthropological museums see Ames (1992), Clifford (1997), Haraway (1989), Jenkins (1994), Jones (1992), Jordanova (1989) Stocking (1985).

14   There are, however, national differences here which deserve further research. For example, neither Spain nor Italy established national museums of scientific or technological history (Begeron 1993).

15   For other discussion of the architecture of museums and related spaces in this period see Markus (1993); Outram (1996).

16   There is a large sociological literature discussing such transformations. See, for example, Giddens (1990), Lash and Urry (1994), Waters (1995).

17   For discussion see Bolton (1992), Hunter (1991), and McGuigan (1996, ch. 1).

18   See Linenthal and Engelhardt (1996).

19   Here the book by Gross and Levitt (1994) has been central in the 'backlash' against social perspectives on science. See Gieryn (Chapter 12), Nader (1996a) and Social Text (1996) for discussion.

20   For an analysis of Greenfield Village see Staudenmaier (1993).

21   For discussion of industrial heritage see, for example, Alfrey and Putnam (1992); Bennett (1995: ch. 4); Butler (1992: ch. 4); Fowler (1992); Walsh (1992).

22   For discussion of the ecomuseum movement see Alfrey and Putnam (1992); Begeron (1993); Hoyau (1988); Poulot (1994).

23   For overviews see McGuigan (1996: ch. 6); Urry (1996); Walsh (1992).

24   He also knew first hand how political definitions could affect the course of a scientific career, having been made an outcast during the McCarthy era on account of a brief period of Communist Party membership.

25   For other examples see Ross (1995), and various examples in Karp, Kreamer and Lavine (1992), Karp and Lavine (1991) and Pearce (1996).

26   The term 'experiment' here is used to indicate the parallel with developments within anthropology to 'write culture' or present ethnographic research in new ways (for discussion see for example Clifford and Marcus (1986); James, Hockey and Dawson (1997); Rosaldo (1993)). There has also been analogous critique in other disciplines, including the sociology of science (see for example Law (1993); Woolgar (1988b)).

REFERENCES

Alfrey, J. and T.Putnam (1992) *The Industrial Heritage,* London: Routledge.

Altick, R. (1978) *The Shows of London,* Cambridge, MA and London: The Belknap Press of Harvard University Press.

Ames, M. (1992) *Cannibal Tours and Glass Boxes: The Anthropology of Museums* (2nd edition), Vancouver: University of British Columbia Press.

Anderson, B. (1983) *Imagined Communities: Reflections on the Origin and Spread of Nationalism,* London: Verso.

Bedini, S. (1965) 'The evolution of science museums', *Technology and Culture,* 6, pp. 1–29.

Begeron, L. (1993) 'The new generation of museums: technical, industrial and "ecomuseums"', in B.Schroeder-Gudehus (ed.) *Industrial Society and its Museums 1880–1990: Social Aspirations and Cultural Politics,* pp. 91–5, Chur, Switzerland: Harwood Academic/Paris: Cité des sciences et de l'industrie.

Benedict, B. (1983) *The Anthropology of World's Fairs,* London: Scolar Press.

Bennett, T. (1995) *The Birth of the Museum,* London: Routledge.

Bolton, R. (ed.) (1992) *Culture Wars: Documents from the Recent Controversies in the Arts,* New York: New Press.

Butler, S. (1992) *Science and Technology Museums,* Leicester, London and New York: Leicester University Press.

Clifford, J. (1997) *Routes,* Cambridge MA: Harvard University Press.

Clifford, J. and G.Marcus (eds) (1986) *Writing Culture: The Poetics and Politics of Ethnography,* Berkeley, CA: University of California Press.

Coombes, A.E. (1994) *Reinventing Africa: Material Culture and Popular Imagination in Late Victorian and Edwardian England,* New Haven, CT: Yale University Press.

Duncan, C. (1995) *Civilizing Rituals,* London: Routledge.

Durant, J. (1992) 'Introduction', in J.Durant (ed.) *Museums and the Public Understanding of Science,* pp. 7–11, London: Science Museum in association with the Committee on the Public Understanding of Science.

Findlen, P. (1994) *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy* Berkeley and Los Angeles, CA: California University Press.

Forgan, S. (1994) 'The architecture of display: museums, universities and objects in nineteenth-century Britain', *History of Science,* 32(2), pp. 139–62.

——(1996) '"A nightmare of incomprehensible machines": science and technology museums in the 19th and 20th centuries', in M.Pointon (ed.) *Museums and Late Twentieth Century Culture,* pp. 46–68, Manchester: Manchester University Press.

Foucault, M. (1970) *The Order of Things: An Archaeology of the Human Sciences* (trans. A.Sheridan), London: Tavistock.

——(1977) *Discipline and Punish: The Birth of the Prison* (trans. A.Sheridan), London: Allen Lane.

——(1979) *The History of Sexuality, Volume 1: An Introduction* (trans. R.Hurley), London: Allen Lane.

——(1991) 'Governmentality', in G.Burchill, C.Gordon and P.Miller (eds) *The Foucault Effect: Studies in Governmentality,* Hemel Hempstead: Harvester Wheatsheaf.

Fowler, P.J. (1992) *The Past in Contemporary Society: Then, Now,* London: Routledge.

Franklin, S. (1995) 'Science as culture, cultures of science', *Annual Review of Anthropology,* 24, pp. 163–84.

Fyfe, G. (1996) 'A Trojan Horse at the Tate: theorizing the museum as agency and structure', in S.Macdonald and G.Fyfe (eds) *Theorizing Museums,* pp. 203–28, Oxford: Blackwell.

Giddens, A. (1990) *The Consequences of Modernity,* Cambridge: Polity.

Greenhalgh, P. (1988) *Ephemeral Vistas: The Expositions Universelles, Great Exhibitions and World's Fairs, 1851–1939,* Manchester: Manchester University Press.

Gross, P.R. and N.Levitt (1994) *Higher Superstition: The Academic Left and its Quarrel with Science,* Baltimore, MD: Johns Hopkins University Press.

Hackman, W. (1992) '"Wonders in one closet shut": the educational potential of history of science museums', in J.Durant (ed.) *Museums and the Public Understanding of Science,* pp. 65–9, London: Science Museum in association with the Committee on the Public Understanding of Science.

Hall, S. (1980) 'Encoding/decoding', in S.Hall, D.Hobson, A.Lowe and P.Willis (eds) *Culture, Media, Language,* pp. 128–38, London: Hutchinson.

Haraway, D. (1989) *Private Visions,* London: Routledge.

Harding, S. (1986) *The Science Question in Feminism,* Milton Keynes: Open University Press.

Harvey, P. (1996) *Hybrids of Modernity: Anthropology, the Nation-state and the Universal Exhibition,* London: Routledge.

Hein, H. (1990) *The Exploratorium: The Museum as Laboratory,* Washington, DC: Smithsonian Institution.

Hewison, R. (1988) *The Heritage Industry,* London: Methuen.

Hooper-Greenhill, E. (1992) *Museums and the Shaping of Knowledge,* London: Routledge.

Hoyau, P. (1988) 'Heritage and "the conserver society": the French case' (trans. C. Turner), in R.Lumley (ed.) *The Museum Time-machine,* pp. 27–35, London: Comedia/Routledge.

Hunter, J.D. (1991) *Culture Wars: The Struggle to Define America,* New York: Basic Books.

Impey, O.R. and A.G.MacGregor (eds) (1985) *The Origins of Museums,* Oxford: Clarendon Press.

Irwin, A. and B.Wynne (1996) 'Introduction', in A.Irwin and B.Wynne (eds) *Misunderstanding Science? The Public Reconstruction of Science and Technology,* pp. 1–17, Cambridge: Cambridge University Press.

James, A., J.Hockey and A.Dawson (eds) (1997) *After Writing Culture,* London: Routledge.

Jenkins, D. (1994) 'Object lessons and ethnographic displays: museum exhibitions and the making of American anthropology', *Comparative Studies in Society and History,* 36(2), pp. 242–70.

Jones, D. (1992) 'Dealing with the past', *Museums Journal* (January), pp. 24–7.

Jordanova, L. (1989) 'Objects of knowledge: a historical perspective on museums,' in P.Vergo (ed.) *The New Museology,* pp. 22–40, London: Reaktion Books.

Kaplan, F.E.S. (ed.) (1994) *Museums and the Making of "Ourselves": The Role of Objects in National Identity,* Leicester and London: Leicester University Press.

Karp, I. and S.Lavine (eds) (1991) *Exhibiting Cultures: The Poetics and Politics of Museum Display,* Washington, DC: Smithsonian Institution.

Karp, L, C.M.Kreamer and S.Lavine (eds) (1992) *Museums and Communities: The Politics of Public Culture,* Washington, DC: Smithsonian Institution.

Lash, S. and J.Urry (1994) *Economies of Signs and Space,* London: Sage.

Latour, B. (1987) *Science in Action,* Cambridge, MA: Harvard University Press.

Law, J. (1991) 'Introduction: monsters, machines and sociotechnical relations', in J.Law (ed.) *A Sociology of Monsters: Essays on Power, Technology and Domination (Sociological Review monograph)*, pp. 1–23, London: Routledge.

——(1993) *Organizing Modernity: Social Ordering and Social Theory,* Oxford: Blackwell.

Lewenstein, B.V. (1992) 'The meaning of "public understanding of science" in the United States after World War II', *Public Understanding of Science,* 1, pp. 45–68.

Lindqvist, T. (1993) 'An Olympic stadium of technology: Deutsches Museum and Sweden's Tekniska Museet', in B.Schroeder-Gudehus (ed.) *Industrial Society and its Museums, 1880–1990: Social Aspirations and Cultural Politics,* pp. 37–54, Chur, Switzerland: Harwood Academic/Paris: Cité des sciences et de l'industrie.

Linenthal, E.T. and T.Engelhardt (eds) (1996) *History Wars: The* Enola Gay *and Other Battles for the American Past,* New York: Metropolitan Books/Holt.

Macdonald, S. (1996) 'Theorizing museums: an introduction', in S.Macdonald and G.Fyfe (eds) *Theorizing Museums: Representing Identity and Diversity in a Changing World (Sociological Review monograph)*, pp. 1–18, Oxford: Blackwell.

McGuigan, J. (1996) *Culture and the Public Sphere,* London: Routledge.

Markus, T. (1993) *Buildings and Power: Freedom and Control in the Origin of Modern Building Types,* London: Routledge.

Merriman, N. (1991) *Beyond the Glass Case: The Past, the Heritage and the Public in Britain,* Leicester and London: Leicester University Press.

Mitchell, T. (1991) *Colonizing Egypt,* Berkeley and Los Angeles, CA: California University Press.

Nader, L. (ed.) (1996a) *Naked Science: Anthropological Inquiry into Boundaries, Power, and Knowledge,* London: Routledge.

——(1996b) 'Preface', in L.Nader (ed.) *Naked Science: Anthropological Inquiry into Boundaries, Power, and Knowledge,* pp. xi–xv, London: Routledge.

Outram, D. (1996) 'New spaces in natural history', in N.Jardine, J.A.Secord and E.C.Spary (eds) *Cultures of Natural History,* pp. 249–65, Cambridge: Cambridge University Press.

Pearce, S. (ed.) (1996) *Exploring Science in Museums,* London and Atlantic Highlands, NJ: Athlone.

Pickstone, J. (1994) 'Museological science? The place of the analytical/comparative in nineteenth-century science, technology and medicine', *History of Science,* 32(2), pp. 111–38.

Poulot, D. (1994) 'Identity as self-discovery: the ecomuseum in France', in D.Sherman and I.Rogoff (eds) *Museum Culture,* pp. 66–84, London: Routledge.

Prösler, M. (1996) 'Museums and globalization', in S.Macdonald and G.Fyfe (eds) *Theorizing Museums* (*Sociological Review* monograph), pp. 21–44, Oxford: Blackwell.

Rosaldo, R. (1993) *Culture and Truth: The Remaking of Social Analysis,* London: Routledge.

Ross, M. (1995) '"Passive smoking": controversy at the Science Museum?', *Science as Culture,* 5(1), no. 22, pp. 147–51.

Rydell, R.W. (1984) *All the World's a Fair: Visions of Empire at American International Expositions, 1876–1916,* Chicago: Chicago University Press.

——(1993) *World of Fairs: The Century-of-Progress Expositions,* Chicago: University of Chicago Press.

Shapin, S. (1994) *A Social History of Truth: Civility and Science in Seventeenth-century England,* Chicago: Chicago University Press.

Sheets-Pyenson, S. (1989) *Cathedrals of Science: The Development of Colonial Natural History Museums during the Late Nineteenth Century,* Montreal: McGill University Press.

Silverstone, R. (1989) 'Heritage as media: some implications for research', in D.Uzzell (ed.) *Heritage Interpretation, Volume 2: The Visitor Experience,* pp. 138–48, London: Frances Pinter.

——(1992) 'The medium is the museum: on objects and logics in times and spaces', in J.Durant (ed.) *Museums and the Public Understanding of Science,* pp. 34–42, London: Science Museum in association with the Committee on the Public Understanding of Science.

Social Text (1996) (special issue on 'The Science Wars', ed. A.Ross), (Spring/Summer), 46–7.

Star, S.L. (1988) 'Introduction: the sociology of science and technology', *Social Problems,* 35, pp. 197–205.

Staudenmaier, J.M. (1993) 'Clean exhibits, messy exhibits: Henry Ford's technological aesthetic', in B.Schroeder-Gudehus (ed.) *Industrial Society and its Museums, 1880–1990: Social Aspirations and Cultural Politics,* pp. 55–65, Chur, Switzerland: Harwood Academic/Paris: Cité des sciences et de l'industrie.

Stocking, G.W. (ed.) (1985) *Objects and Others: Essays on Museums and Material Culture,* Madison, WI: Wisconsin University Press.

Tilley, C. (ed.) (1990) *Reading Material Culture,* Oxford: Blackwell.

Traweek, S. (1993) 'An introduction to cultural, gender, and social studies of science and technology', *Journal of Culture, Medicine and Psychiatry* 17, pp. 3–25.

Urry, J. (1996) 'How societies remember the past', in S.Macdonald and G.Fyfe (eds) *Theorizing Museums,* pp. 45–65, Oxford: Blackwell.

Walsh, K. (1992) *The Representation of the Past: Museums and Heritage in the Postmodern world,* London: Routledge.

Waters, M. (1995) *Globalization,* London: Routledge.

Woolgar, S. (1988a) *Science: The Very Idea,* Chichester: Ellis Horwood/London: Tavistock.

——(ed.) (1988b) *Knowledge and Reflexivity: New Frontiers in the Sociology of Knowledge,* London: Sage.

Wynne, B. (1996) 'Misunderstood misunderstandings: social identities and the public uptake of science', in A.Irwin and B.Wynne (eds) *Misunderstanding Science? The Public Reconstruction of Science and Technology,* pp. 19–46, Cambridge: Cambridge University Press.