Ausstellungen als Instrument der Wissensvermittlung

Exhibitions as a tool for transmitting knowledge

Workshop am 26. und 27. April 2002
Helmholtz-Zentrum für Kulturtechnik, Humboldt-Universität zu Berlin
Gefördert mit Mitteln der Volkswagen-Stiftung

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Exhibitions and the Public Understanding of Science Paradox

The general public today is probably more informed about science, technology and medicine than at any previous point in history. School leaving ages and numbers continuing into further and higher education are higher than at any earlier time; science and technology are subjects on the curricula of most schools; and there are ever more sources of easily accessible science information, ranging from popular science programmes on television, to health columns in newspapers and magazines, popular science books and even kits to carry out your own crystal-growing or chemical experiments at home. There are too, more museums and exhibitions of science, technology and medicine than ever before; and as the attendance figures of science centres and industrial heritage sites and recent science exhibitions, such as the theme parks at *EXPO 2000* and the *Sieben Hügeln* and *Theatrum Naturae et Artis* in Germany, have shown, there is apparently an enormous public hunger to know about science, technology and medicine (STM).[1]

Paradoxically, this growth in popular interest and the expansion of provision of popular information about science, technology and medicine, has been accompanied by increasingly vocal calls of concern about public *illiteracy* in, and popular *mis*information about, STM. (Historian of science John Pickstone calls this 'the paradox of twentieth-century STM' (2000: 190).) These calls have come especially from scientific lobbies (such as the Royal Society in Britain) and from governments, and also in some cases from environmental and alternative medicine groups. All argue that science, technology and medicine are crucial to our lives and well-being, and that we need to be properly informed about them in order to make the right decisions in relation to our own lives, both individually (for example, whether or not take vitamin pills or work long hours in front of a computer screen) and collectively (for example, whether to accept stem cell research or energy from nuclear sources). All also argue that these decisions are increasingly complex, partly because STM have in some respects become increasingly complex themselves, but also because of the proliferation of different sources of

[1] In referring to science, technology and medicine (STM) I am following John Pickstone's suggestion that considering these together rather than separately is likely to bring new insights (Pickstone 2000: 6-7). In the fields of public understanding and museological representation there are certainly many overlapping concerns that make it worthwhile to consider them together, while being mindful, of course, of areas of difference.

information. As many sociologists (for example, Giddens 1990) have pointed out, a major problem for our information societies is the question of trust: how, in the face of alternative and competing sources of information, do we know which to believe, which to accept and which to reject?[2]

Expressions of concern over public scientific 'illiteracy' are also accompanied by fears over the public succumbing to 'irrational' and 'non-scientific' ways of knowing (see, for example, Lindqvist 2000). The growth of so-called 'alternative' and 'new age' practices is seen by the scientific lobby as a symptom of a lack of proper scientific understanding and even of an underdeveloped society, which has not yet properly achieved intellectual 'adulthood'. This, together with worries about 'skills gaps', especially in the arena of technology, has contributed to the emergence in many countries of policies and initiatives directed towards improving the public understanding of science. Museums and exhibitions, which operate as voluntary or informal sources of education, which people can visit at their own leisure at any point in their lives, have often been identified as key institutions to promote the public understanding of science.

In this essay, I look at some of the exhibitionary strategies that have been adopted to deal with the perceived problem of the public understanding of science. In doing so, I look also at some other aspects of the changing landscape of STM and society - such as the decreasingly 'national' nature of contemporary scientific research - and the challenges they pose exhibitions and museums in displaying contemporary STM. The growth of emphasis on 'public understanding', which has been particularly marked since the 1980s, is itself a function of this changing landscape. However, if museums are to properly achieve their public understanding of science potential, they also need increased understanding of how the public understands and perceives science, society, and museums and exhibitions of STM themselves. To this end, I also provide some commentary from visitor research that I have carried out.

Science centres and scientific principles

One of the responses to the problem of public decision-making has been a call for better levels of education in 'basic' science and scientific principles. The first wave of public understanding of science initiatives was in many respects characterised by an attempt to provide such education. Science centres were the main 'museological' example of this.[3] Probably the first of these was Frank Oppenheimer's Exploratorium, which opened in San Francisco in 1969 (though smaller concentrations of science centre type exhibits already existed in science museums such as the Deutsches Museum and the Science Museum, especially the latter's Children's Gallery, opened in 1931). The Exploratorium certainly acted as a model for many which followed - though interestingly many ignored one aspect which Oppenheimer himself viewed as central, namely the role of art in the presentation of science (the

[2] This is not entirely a new problem. For a discussion of its history and transformations see Shapin 1994.

[3] Though whether they should or should not be viewed as akin to museums has itself been the source of considerable debate. See, for example, Durant 1992.

Exploratorium was classified by Oppenheimer himself as a museum of 'science, art and human perception' - Hein 1990: 148; see also Barry 1998, 2001). This is something to which I shall return later. The key features of the wave of science centres which opened from the 1970s on were their attempts to demonstrate basic scientific principles by allowing visitors to themselves conduct 'kind-of' experiments in order to 'discover' these principles for themselves: 'orchestrated discovery', we might call it. 'Hands-on' became an alternative name for such centres and more generally for exhibits organised along these lines.

For Oppenheimer, and surely for many of those who pioneered other such interactive science centres, allowing visitors to interact and discover in this way was about more than just transmitting information about the particular scientific principles being demonstrated. As Oppenheimer said:

> The whole point of the Exploratorium is to make it possible for people to believe 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. If we give up trying to understand things, I think we'll all be sunk. (Quoted in Hein 1990: xv)

So, the idea was that by helping people to understand some scientific explanations of natural phenomena, a window would be opened to help them understand much more about the world.

This was a worthy ambition and it may have worked for some visitors. However, it is probably fair to say that many of those involved in science centres and science museums have become more sceptical since the early days (see, for example, Lindqvist 2000). It has been questioned, first, whether most visitors do indeed learn much about the scientific principles being demonstrated; secondly, whether this does help them to infer much beyond the particular examples which they experience (i.e. whether using science centre exhibits provides any more general basis or framework of understanding); and thirdly whether the hands-on experience does lead to a more general quest to understand the physical world - or the social and political world - in the way that was hoped. These are, of course, difficult things to evaluate and some of the evidence is conflicting. My own view is that while science centres could not have really expected to provide a grounding in basic science for their visitors, they nevertheless probably are rather effective in more nebulous ways rarely evaluated, in particular, in helping to stimulate a more general interest in science. My suspicion is that, ironically, science centres are probably especially good at conveying a sense of the 'magic' of science (see also Conn 1998: 262 on science museums generally). I have certainly witnessed as much talk of magic, and expressions of wonder, as of scientific explanation in them. Yet rather than this serving to undermine science - as the usual science/anti-science or rationality/irrationality dualisms would have it - my untested hypothesis is that this increases levels of interest. (I shall return to this observation below.)

Nevertheless, in terms of the problem of evaluating the multiple and competing sources of alternative information and deciding which to trust, science centres and hands-on exhibitions of this type are unlikely to give much help. This is because most of the difficult decisions that we have to make about STM matters are not directly related to the first principles and scientific laws that are the main stuff of such exhibitions. It is probably also worth noting here that despite Oppenheimer's hope that the Exploratorium would indirectly help people to understand the social and physical world, he was himself absolutely emphatic that the Exploratorium would contain no exhibits that made reference to social or political matters or that were in any way controversial. The environment, for example, was a subject which he vetoed on these grounds (Hein 1990). The reason for his strong stance on this matter was not, of course, a lack of awareness of the controversial nature of science and technology. He had himself worked for a time, alongside his brother Robert, on a project to design the atomic bomb. The atomic bomb is clearly one of the products of modern science and technology which has generated more controversy, more social and political side-effects, and more public mistrust than any other that our age has known. Frank Oppenheimer's attempt to present 'pure' science, disassociated from resulting technologies or their effects, and to present science as a humanistic achievement like art, was undoubtedly also an attempt to rescue science from its tarnished public image (see also Macdonald 1998a).

Most hands-on science centre type exhibitions have followed Oppenheimer's lead in presenting science as decontextualised - the exhibits being demonstrations of eternal truths - though some have also provided information about its technological applications. Science centres, and science centre type exhibits, by their very form, tend to present science as a set of natural laws and principles about which there is a single truth which we can all discover. This is an approach which some scientific commentators have seen as unhelpful, not only in relation to the messy controversial areas about which we might have to make decisions in our everyday lives, but also in relation to actual scientific practice, which historians and sociologists of science have shown to be rarely as neat as the science centre approach depicts it as being (though anybody who has struggled with some hands-on exhibits in science centres will know that the lesson that experiments often do not work is one which such exhibits sometimes demonstrate very effectively). Exhibits, tightly orchestrated to yield single correct answers and removed from everyday experience, may be effective in some ways, but this basic principles approach is unlikely to provide the public with much direct, or even much indirect, help in making decisions about science-related matters themselves.

Public stories about science and everyday life

A basic principles approach is not the only one available to museums of science, technology and medicine - and, indeed, it is neither the most traditional nor the most common one employed. Another approach is to address the role of STM in everyday life directly. This is something which museums and exhibitions have long done, though the contexts and ways in which they have done so have changed significantly, and I want to briefly

outline this because it highlights some of the exhibitionary dilemmas faced by museums and exhibitions today.

The exhibition of the relevance of scientific, technological and medical achievements to everyday life has been performed, for example, through the display of subjects such as transport or electricity production and their roles in transforming daily life. In the early years at the Deutsches Museum there was even an X-Ray machine which was used for the diagnosis of fractures (Mayr 1990: 9) - in the days before the dangers of X-rays became known. This must have made for a rather spectacular - even 'magical' - exhibit; and it is worth remembering that STM exhibits, including those highlighting the relevance to everyday life, might well also play on the apparently 'nature-defying' and 'amazing'. This, surely, was a key reason for the ubiquity of van der Graaf generators in science museums, and for the presence of extraordinary architectural structures - such as the Eiffel Tower (1889, Paris) or the Atomium (1958, Brussels) - in great exhibitions.

What the X-ray example also shows, as do those of the atomic bomb, transport and electricity already mentioned, is a significant change in the exhibitionary challenge. Achievements in STM are today less readily accepted as unequivocal 'goods': we are more aware than were those in the first half of the twentieth century of their hazards and side-effects. As historians of both science museums and great exhibitions have shown, one of the important social roles of these institutions was conveying a sense of progress - of performing the idea that STM could bring about positive transformation (e.g. Bennett 1995, Conn 1998). Museums and exhibitions were predominantly, and often overtly, celebratory. Today, however, museums and exhibitions can neither so easily tell unequivocally positive public stories about the achievements of science, technology and medicine; and nor can they rely upon their audiences to accept them as readily as nineteenth- and early twentieth- century exhibitors seemed to do. This means that they are challenged to tell more complicated stories. At the same time, however, there are other features of the changing contexts in which museums, and STM themselves, operate, which add to the challenge.

Challenges of changing science

One feature of the changing context is the changing nature of science, technology and medicine themselves. Evolutionary stories of progress were, after all, fairly straightforward to grasp, and easily translated into three-dimensional exhibitionary form and demonstrated through objects. Steve Conn, in his excellent book *Museums and American Intellectual Life, 1876-1926* (1998), has argued that in the late nineteenth century, the dominant forms of science - or indeed of knowledge more generally - were premised on what he calls 'an object-based epistemology'. In other words, physical objects were regarded as sources of knowledge, which, if properly classified and arranged, could be read in order to reveal underlying scientific principles. The visual and the 'objective' were dominant forms of scientific proof. This was also a reason why museums were very important sites of *research* in the late nineteenth century (ibid.; see also Dias 1998; Forgan 1996; Pickstone 2000). By the 1920s, however, the 'object-based epistemology ceased to be

persuasive in a world now governed by electromagnetism, relativity, and quantum mechanics' (Conn 1998: 245). The visual - that manifested by objects - was no longer regarded as a reliable form of proof. On the contrary, '[b]y the time of the Second World War the sense that the world was *not* what it seemed to be had become.. pervasive' (ibid.: 246). This meant that the museum function of providing 'visual truth' was seriously undermined; and in a sense the very premise on which museums and exhibitions of STM were based - that exhibited objects were evidences of STM and that looking at objects was a robust route to knowing STM - became precarious. This was manifest in the fact that museums ceased to be so important as sites of scientific research and in their reorientation to what Conn calls 'less knowing visitors', namely children rather than adults. It was also manifest in concerns over whether museums and exhibitions could possibly show these new forms of science.

Another science-related change which makes the task of representing science today more difficult is the decreasingly *national* dimension of STM. A central motive for setting up the great exhibitions and science museums of the late nineteenth and early twentieth centuries, was national exhibitionism: showing off national achievement (Greenhalgh 1989). The great exhibitions were acknowledged competitive arenas, medals being awarded to winning nations in an Olympics-like ceremony. Today, national competition undoubtedly lives on and continues to drive great exhibitions, such as EXPO 2000; and striving to have the most stunning museums also continues, as part of a global competition in place-marketing. However, coming up with 'home-grown' STM achievements to represent in these has become more difficult.

A quick reflection on EXPO 2000 suggests that flagging national STM achievements was not a predominant concern. For example, the remarkable paper achievement of the Japanese pavilion was displayed more as a statement of Japan's 'very special attitude towards nature' (*EXPO 2000* 2000: 42) than as national STM prowess as such; the Beetle in the German pavilion seemed to be more part of a semi-ironic presentation of stereotypes than a confident assertion of national achievement; and the UK display of pencils made from recycled plastic cups was, perhaps, a mix of eco-credentials and self-irony in the face of a lack of imposing home-grown products. Indeed, one characteristic of EXPO 2000 was surely that the nations which got it relatively right were the ones which managed to take a, perhaps ironic and amusing, reflective look at themselves, or which drew on ecological themes or simply conjured up an aesthetic or dramatic spectacle, rather than those which tried to earnestly show off their products and achievements (see also Harvey 1996 and 1998 on EXPO 1992). The latter tended to look more like tourist offices and trade exhibitions; whereas the more successful pavilions were those like Germany, with its intriguing half-finished 'workshop of fame', the Dutch with their amazing eco-house, the Norwegians with their extraordinary replication of a stunning natural phenomenon (a waterfall) and interior emptiness, or Switzerland, consisting of a large maze filled with peculiar sounds.

For the most part, the display of cutting-edge technologies was not in the national pavilions at all. Instead, it was either in the 'theme parks' - non-national areas concerned with subjects such as 'Mobility', 'The Future of Work', or 'Health Futures', all of which dealt with the potential of technology to transform our lives; or it was in pavilions belonging to multi-national corporations. The latter is a phenomenon which was also noted by Penny Harvey in her study of EXPO '92 (Harvey 1996, 1998). In EXPO 2000, some of the most remarkable technological achievements were demonstrated by companies such as Bertelsmann, whose 'Planet M' told a history of media development leading into an already partly-realised future in which Bertelsmann technology was playing a part, and Siemens, with their 'Mediaversum of the Knowledge Society'. Although both companies are German in origin and identity, they are also global to the extent that they operate well beyond national boundaries, not only in terms of their sales, but also their operations, finances and workers. This globalism, and the role of media within it, was a message contained in their exhibits themselves.

One reason for the fact that the national pavilions have become less likely to show cutting-edge STM developments is that, as historian John Pickstone has charted, 'Since the 1970s, governmental influence has decreased... and commercial interests have become more concentrated and more global' (2000: 189). There is today considerably more international traffic in research and researchers, in which careers and even research teams may span several nations and research findings be disseminated in international journals. Perhaps more challengingly for the idea of 'national' science, technology and medicine, however, is that more and more research is funded by, and conducted under the auspices of, private commercial companies which, as in the case of Bertelsmann and Siemens, are themselves increasingly transnational (and increasingly able to shift operations to wherever labour costs, tax demands and regulation prove most favourable). Governments, according to Pickstone's account, and there is widespread agreement on this, are no longer nearly such significant players in the science, technology and medicine game.

Implications for Exhibitions

Why should this complicate the business of science exhibition and public understanding of science? After all, there has long been a strong commercial element to great exhibitions (Greenhalgh 1989) and corporations themselves frequently use the exhibition format to sell themselves. Indeed, my own most striking image from my first post-Wende visit, in 1993, to the former German Democratic Republic is of corporate exhibitions of modern technologies - especially information technologies - set out on the pedestrianised streets of Leipzig. Siemens had even built a climbing wall as part of their exhibit - a dramatically unequivocal symbol of the idea of progress and clear message to the Ossies that they should climb their way to a better future with corporate technology.

Yet, herein lies the problem. Corporate commercial interests are likely to involve presenting public stories which will encourage the purchase of their products. And they typically have the financial wherewithal - and motive - to

do so in style. Since the 1970s the costs of mounting exhibitions have rocketed, partly because of the use of ever-more sophisticated exhibitionary technologies, including audio-visuals and interactives. State funding in many countries has not been able to keep pace; and science museums and national pavilions at Expos have come to rely on ever greater amounts of commercial sponsorship in order to be able to create state-of-the-art exhibitions. This does not mean that science museums have simply become trade exhibitions: on the contrary, they often seem to negotiate what can easily be a rather difficult area very well. But we should note the particular problem for museums of STM here. Companies sponsoring the arts or sporting events are relatively unlikely to have a close product-interest in the subject displayed: in STM exhibitions they almost certainly will do so. This creates difficulties. For example, in an exhibition about food, whose making in the Science Museum, London, I observed as an anthropologist, there was a clear statement made that the Museum would retain what was called 'editorial control' - that is, museum staff would make the decisions about content. Nevertheless, it was clear that the commercial interests of many of those involved caused problems for the curators. For example, the museum staff found it almost impossible to gain useful information from scientists employed by companies because those scientists were reluctant to reveal anything that might help rival companies or to say anything negative about any aspects of the food industry, even products which were not their own, for fear of creating a negative image of the industry in any way (see Macdonald 2002).

At the same time, lay people have become more aware of commercial interests and this may lead to them evaluating what they are being told in these terms, and exhibiting scepticism over the validity of what they are being told if they perceive commercial parties to be involved. Public understanding of science research has shown that lay responses to scientific information are highly dependent on evaluations of the trustworthiness and possible bias of those who are promoting particular sources of information (e.g. various contributions to Irwin and Wynne 1996). In other words, lay-evaluations of science are as, or more, likely to be based on *social* judgements as on any kind of 'first principles' or 'scientific content' bases.

This has implications for public understanding of science initiatives. In particular, it clearly means moving beyond what is sometimes called the 'hypodermic model' - the idea that what is needed is just to inject the public with more science and technology. To make good judgments, perhaps what are especially needed are more forms of training in evaluating and reasoning, and better knowledge about where to go to find out information not just on the content of science but on such matters as the activities of scientists and commercial entanglements (see also Shapin 1992).

My own research on visitors to the Science Museum in London showed some pertinent results in relation to understandings of science and commercial interests. I looked at an exhibition about food which had been sponsored by a range of food companies, particularly a major supermarket chain.[4] Some of

[4] Further discussion of this research can be found in Macdonald 1995 and 2002.

these companies, for example, a confectionary manufacturer and sugar companies, could be seen to be organisations which would want to promote ideas about food that might not be in the public interest. The research showed that members of the public were very aware of the presence of the commercial sponsors and indeed the great majority assumed that the supermarket chain would have been substantially responsible for the content of the exhibition (which was not, in fact, the case: museum staff had written the text and defined the content). They also assumed that these sponsors would have their own commercial interests in mind: selling their products. However, visitors assumed themselves able to identify and resist this. Furthermore, most thought that the exhibition content itself would not be 'unduly' (as several expressed it) misleading or biased. (Though a minority of visitors did make such complaints and pointed out specific areas of omission.) The reason for this was their sense of trust in the main sponsor - the supermarket company (which they frequently judged with words such as 'respectable' and 'quality') - and in the museum itself. So, although they clearly recognised a commercial presence and knew that there might be commercial interests involved, they judged themselves capable of not being 'caught' by these and they believed that there could not be anything 'too untoward' (words of one respondent) because the national institution in which the exhibition was housed would not allow this.

One implication of this for museums, especially national museums, is that, in a world of complexity and uncertainty over whom to trust, such institutions are viewed as relatively authoritative. Contributing to this is their architecture - generally solid and reliable; the fact that exhibitions are typically 'unsigned' - the products of the institution or even 'super-human' authority; their modes of display and address - still predominantly through 'things', which are themselves 'real' and 'solid', and in terms of 'facts'; and their history - they have inherited a cultural role of being authoritative and acting as custodians for the future. They also have definitional power. My research in the Science Museum also showed that while many visitors said that they were not sure whether the subject of 'food' was really 'scientific', several declared that it must nevertheless surely be so 'because it's in the Science Museum'.

Clearly, in a world in which science, commerce and public image-making are all more highly developed and entangled, museums need to be mindful of their roles as especially reliable and authoritative. They need to address the base-line of public trust which is invested in them and decide how to respond to this.

Everyday life, familiarity and trust

One strategy of public understanding of science initiatives in relation to museums and exhibitions has, then, been the 'basic principles' science centre approach, and another has been characterised by an emphasis on science in everyday life and society. While neither of these was new in the late twentieth century, both took on new dimensions and tended to be approached in a more full-scale way, rather than being just parts of other broader approaches (e.g. exhibiting objects). The everyday life approach came to entail not simply giving some examples of 'the appliance of science' (a phrase which has, in

contemporary fashion, itself been commercially colonised), but a more extensive turning of the earlier approach on its head, making the everyday and the social the starting point and the lens through which science and technology are introduced.

This was part of the explicit exhibition philosophy of the food exhibition which I looked at in the Science Museum. Science was to be introduced 'through the back door', visitors having first been presented with experiences (e.g. shopping), settings (e.g. a McDonald's burger outlet) and objects (e.g. items of food) with which they were expected to be familiar. The thinking here was that many visitors would find science and technology 'threatening' and 'difficult', and that this would hinder their potential to be interested in the subjects or to learn about them. The 'back door' would be more accessible.

As with some of the other approaches, this one too was undoubtedly worthy and reasonable. My own research, which also involved detailed attention as an ethnographer to the making of the exhibition, highlighted some potential problems, however. Perhaps most significantly, beginning with the familiar did not always 'lead to science' in the way that was hoped. In a context of proliferating content, something which is probably characteristic of many exhibitions, the 'scientific depth' behind the surface stories tended to shrink. This was also a consequence of the fact that once the everyday became the orienting frame, this tended to supply the three-dimensional artefacts (particularly reconstructions) and 'the science' then became predominantly text. While this was a good way of dealing with the non-material or microscopic nature of some of science involved, it also had the effect of rendering it relatively invisible within the overall, physical, framework of the exhibition. There was also another consequence, related to visitors' senses of trust discussed above. Presenting science and technology in terms of the familiar, everyday and non-threatening also fed into visitors' relative trust in what was presented. Rather than stimulate them to ask questions about whether they should trust the products that they ate and bought (as beginning with some of the mass-production processes might have done), the familiarising approach seemed to foster a sense of security.

The kinds of exhibitions that this approach tended to produce often contained fairly high proportions of reconstructions - for example, reproductions of building interiors - and of text panels (providing the explanations). Such exhibitions are typically softly (and sometimes overtly) didactic, with their own clear educational ambitions but couched in terms of familiarity, fun and play. In some cases they incorporate hands-on exhibits too. What they are less likely to include are historical artefacts from the museum's collections, and where such objects are included, they are fitted into the overall educative framework. While this can result in more objects than typical of the science centres, it yields many fewer than traditional museums. The resulting overall dwindling of numbers of objects in museums has been the cause of consternation among some museum staff, as well as of historians of science and some interested members of the public. One consequence has been an increase in calls for, and growing evidence of, a return of the object (e.g. Brüning this volume; Bennett 2000).

Objects, control and wonder

The exhibition of the collections of the Humboldt University of Berlin, between December 2000 and March 2001, generated considerably more public interest than had been anticipated, and this, together with the hope to create a home where this splendid collection can be on permanent public view, was part of the motive for holding the workshop which is documented here. The title of the exhibition, *Theatrum Naturae et Artis: Wunderkammern des Wissens,* itself indicates a kind of exhibitionary return - to an earlier model in which there were no boundaries between science/nature and art, and wonder and knowledge/science were performed together.[5] In being called a 'Wunderkammer des Wissens', a curiosity cabinet of knowledge, the exhibition evokes those collections of objects which are usually said to prefigure the development of museums. 'Wondercabinets' of the fifteenth, sixteenth and seventeenth centuries contained what today seem rather heterogeneous and even 'irrational' aggregations of artefacts, though they were governed by their own rules (see Hooper-Greenhill 1992). The objects that filled the cabinets were regarded as constituting a kind of language which could be read by those who had skills in the arts of memory (ibid.). Objects were, in a sense, regarded as able to speak for themselves - though not everybody was credited with the ability to be able to hear what they were saying. Rather than only being objects of knowledge or science, however, they were simultaneously objects of curiosity, capable of exciting wonder - a response which Steven Greenblatt describes as 'the power of the displayed object to stop the viewer in his or her tracks, to convey an arresting sense of uniqueness, to evoke an exalted attention' (1991: 42) - and this was a part of their 'voluble' capacity.

Theatrum Naturae et Artis followed this Wunderkammer idea in that objects were thoroughly prioritised in the exhibition: it was, primarily, an exhibition of objects. General textual orientation was available, fairly inconspicuously placed, in each room and computer terminals were available for further information, but the most of the exhibition consisted of the display of the objects with little immediately accompanying commentary or text. Objects were doing the 'speaking' in this exhibition.

As Jim Bennett has observed, objects have tended to be viewed with some suspicion by those concerned with promoting public understanding of science: 'For a single-minded mission to explain "the science", objects are problematic because of their ambiguity and the richness of their associations for the viewer: their meaning and significance are not fixed, and visitors' reactions to them are difficult to control' (2000: 56). What has been especially characteristic of the public understanding of science approach in museums, he argues, has been an attempt to 'carefully control' visitors' understandings. Yet, this relies on a rather restricted notion of 'understanding' in which '[i]n a sense, and to a limited extent, we expect visitors to *become scientists.* We measure their success as visitors, and our success as exhibition builders, by how far they have been able to enter into the belief system characteristic of

[5] For information about the exhibition see Bredekamp, Brüning and Weber (eds) 2001.

the science in question, to follow in the footsteps of those who actually make use of this system professionally' (2000: 57). This is rather different from what is expected in, say, an art or ethnography exhibition (ibid.).

If objects are in a sense 'dangerous' because they escape the visitor-controlling urge, what *Theatrum Naturae et Artis* seemed to show was that this was highly attractive to visitors.[6] Not only was this an exhibition which made objects its main feature, those objects themselves frequently defied easy identification and classification. For example, exhibited materials used in the teaching of biology were a mix of the 'natural' and the constructed (e.g. pickled creatures or wax models of organs); and in some cases original exhibit labels themselves were presented as exhibits. Furthermore, these 'scientific' objects were all exhibited in a predominantly 'artistic' style: white painted, wooden-floored galleries, elegant, black-plinthed perspex cases. Given the arresting visual nature of so many of these artefacts, 'wonder' - as defined by Steven Greenblatt above - was undoubtedly being evoked.

So, was this exhibition in any way successful as a 'science exhibition'? Conventional evaluation focusing narrowly upon facts that visitors had understood and learned, might conclude that it was not. Visitors would probably be more likely to describe it in terms of wonder and even magic, and might well talk about specific artefacts that had fascinated them for all manner of reasons. Yet, in some more recent perspectives on public understanding of science and critical museology, the muliplicity and *richness* of response that an exhibition such as this might well have evoked, is coming to be recognised as a positive feature rather than a failure of clarity. Anthropologist Emily Martin, in her work with colleagues on public understandings of science, has emphasised the rich array of meanings that may coalesce around scientific 'facts' or 'images' (e.g. Claeson 1996, Martin 1994). Her work shows that it is not just 'strange' historical artefacts that may evoke multiple and perhaps predominantly aesthetic responses, so too may modern scientific images, such as the photographs of various kinds of cells that she and her team asked lay people to discuss (1994). She argues that the kinds of metaphors that people use in their talk is itself often revealing of their understandings and that when they talk about scientific facts or images they often do so in ways which 'create knowledge about a whole range of topics' (1996: 114). What is needed, her research suggests, is less narrowly constrained ways of investigating and talking about the relationships between science and the public.

Jim Bennett makes a similar suggestion specifically in relation to museums of science. 'Insisting on "understanding", narrowly construed', he argues,

[6] An interesting, if unfortunate, example of public interest in relatively unordered aggregations of objects is the number of visitors who came to see art works rescued from flooding in Dresden in the Summer of 2002, exhibited in the city's Albertinum. As the director of the national art collections, Martin Roth, observed: 'Diese zufälligen Arrangements sind unglaublich beeindruckend' ('These accidental arrangements are unbelievably captivating'), leading to a suggestion that this could become a new type of exhibition concept (Friedrich 2002: 167).

> involves condescension on one side and apology on the other. Creative exhibition curatorship, however, *enhances* access through alternative appreciations, and exhibitions of modern science can pursue these curatorial virtues just as much as treatments of the more distant past. The very ambiguity of objects, the unpredictability of visitors' engagements with them, becomes in this account of the science museum's future a virtue and a benefit, where formerly it provoked anxiety and banishment. (2000: 60)

The value of objects in this regard is a point developed too by Simon Schaffer, who suggests that precisely because of the different meanings and histories which objects may evoke, they can provide an ideal means for telling focused but 'entangled stories' that are needed to escape the impoverishing effects of narrow classification (2000: 73). It is perhaps worth noting here too that the perspective suggested - one of 'following the object' in order to tell more complex stories - is one which also has been argued for in a number of disciplines as a methodological technique to avoid the limitations of existing dualisms (e.g. between the social and the technical) (e.g. Latour 1996; Marcus 1998).

Mixing science and art

In its mixing of science and art, *Theatrum Naturis et Artis,* was part of a growing trend.[7] Again, this is not altogether new: recall not only that such boundaries did not exist in the curiosity cabinets but that Oppenheimer's *Exploratorium* was intended to be concerned with art as well as science. But what has been seen more recently in science museums is more extensive use of art to reflect upon and provoke further responses to, the STM exhibited. In *Theatrum Naturis et Artis*, not only were many of the 'scientific' artefacts displayed in an artistic style, the exhibition also included selected art works, such as Stephan von Heunes' 'Tischtänzer' (table-dancers) - a kinetic sculpture of dancing legs and lower torsos, set among the busts on pedestals in the main entrance hall.

Other recent examples of the exhibitionary mixing of science and art include *Iconoclash*, partly designed by the sociologist of science and technology, Bruno Latour, at the Zentrum Kunst Medien in Karlsruhe, Germany; and the art programmes in the Deutches Museum and in the Wellcome medical wing in the Science Museum, London, both of which have also employed artists in residence to create their own pieces on the basis of the exhibits. We might also include the spectacularly popular *Körperwelten* or *Body Worlds* - the now travelling exhibition of 'plastinated' bodies created by Gunther von Hagen.[8]

Where the mixing of science and art is conducted primarily to turn science *into* art, this is potentially problematic in that such an aestheticising approach could have the effect of screening out the social and political, as well as of

[7] See Arnold 2000 for discussion.

[8] Information about these exhibitions is available as follows: *Iconoclash* – www.iconoclash.de ; the art programme at the Deutsches Museum - Fehlhammer 2000; the art programme in the Science Museum Wellcome wing - www.sciencemuseum.org.uk/on-line/art/index.asp ; *Körperwelten* – www.bodyworlds.com, von Hagens and Whalley 2002.

some of the values of science itself.[9] The kind of mixing of science and art desired by Oppenheimer - in which both were to be considered as pure creative activities - was a similar limiting approach. Yet, the current mixing of science and art is frequently much more provocative, as in *Iconoclash*, where the aim is to challenge our classifications themselves; or, as in some of the Science Museum art-works, where the effect can be unnerving, partly because the art pieces are placed throughout the exhibition and it is not always immediately clear whether a piece is 'art' or 'science'. In some cases, art works have also been used to make political commentary on STM. In the Deutsches Museum, for example, the planes in the aviation galleries have been accompanied by pieces such as Christoph Bergmann's 'Enola Gay', a sculpture showing an elegant woman's torso with its base being the tail fins of a bomb, named after the plane that dropped the atomic bomb on Hiroshima; or his male torso, entitled simply 'Oppenheimer' (Fehlhammer 2000). Also featured in the aviation gallery were a set of carpets by Sabrina Hoffmann, which showed pictures of 'carpet bombed' German cities, such as Dresden (ibid.: 22). All of these works are clearly not just adding an aesthetic flourish, or making a general point about creativity, but are seeking to probe and provoke complex social, political, moral and aesthetic reflection and response simultaneously.

Concluding note

In this essay I have considered some of the ways in which exhibitions of STM have been variously used in the public understanding of science and at some of the particular challenges of the current information age, which creates a paradox in which the public is deemed increasingly scientifically illiterate while at the same time knowing more than ever before. Exhibitionary strategies range from the predominantly didactic to the predominantly aesthetic. In the former, exhibitions are considered within a cognitive framework as educative tools, and the intention is to control and direct the meanings which visitors will gain from the exhibits. Aesthetically-oriented exhibitions, by contrast, aim to work predominantly on an emotional, affective level. Didactic exhibitions seek to promote the understanding of specific content, such as scientific principles or the implications of technological or medical developments. Aesthetically-oriented exhibitions, by contrast, are less likely to be concerned with specific content or messages – though as in the 'Enola Gay' sculpture this may be fairly unequivocal, and their 'meta-messages' may also be fairly clear-cut, as in spectacular exhibitions intended to highlight national achievement. There is, however, a range of approaches here from the specific to the meta, and from the relatively closely directed to the more openly associative. In the latter, the exhibitions may be more generally seeking to highlight the fluidity of boundaries between science and art or the beauty of technological objects.

[9] *Körperwelten* is an interesting case here in its ambiguity between the scientific and aesthetic, sometimes being shown in technical museums (it having been first exhibited in the Museum for Technology and Labour in Mannheim, Germany) and sometimes (as in London) in art galleries. Its main presentational style is aesthetic though it is supported by educational materials (as in the catalogue), perhaps partly in order to legitimate it as science in the face of the moral outrage that would ensue if human body parts were to be exhibited purely as art works. For discussion, see contributions to von Hagens and Whalley 2002.

It is important to note that exhibitions towards the aesthetic end of the didactic-aesthetic spectrum can also contribute to public understanding of science. As I suggested above, the kinds of provocations provided by less tightly orchestrated exhibitions may often be more appropriate to the current age in which what is most needed is for the public to be able to engage in critical reflection. Perhaps it is partly because museums are so often seen by the public as authoritative spaces – sites of answers rather than questions – that some of the most intriguing and publicly attractive exhibitions in recent years have been those which have clearly not been driven by a tightly directive pedagogy. Such exhibitions simultaneously challenge existing museology while at the same time seeming to promise a more unmediated, and thus apparently more authentic, access to that which they exhibit. In a world in which lay people are often told that they are scientifically illiterate and in which so much STM is presented to them in the form of narratives of risk or self-improvement, exhibitions which provide more multiple and self-directed dimensions of engagement are, perhaps, especially compelling.

In his 'new history' of STM, John Pickstone discusses the rise, and changing nature, of public understanding of science initiatives. A major impetus towards the public understanding of science emphasis, he argues, are predominantly economically-oriented managerialist attempts to 'get more science across' to the public (2000). What is needed, he maintains, is to move beyond the 'output culture' in which 'knowledge is a commodity', to appreciate the different kinds of 'meanings' that the (diverse) public may bring to their understanding of science (2000: 196-7). Rather than look at public understanding of science in terms of '"levels", as if it were the water in a bath fed by a "trickling down" from scientists and by natural "upswellings" of public concern', he maintains that it is:

> [b]etter to see public concern as contested ground, where organised bodies do battle, and in which journalists of various kinds may grind axes as they look for good "angles". Surely such debate is to be encouraged... (2000: 196)

A move towards encouraging public debate rather than trying to tightly orchestrate and control responses is characteristic of one of the developments in museums.[10] Of course, the apparent encouraging of debate can sometimes be rather spurious. Some of the recent moves to incorporate visitor responses into exhibitions themselves seem to be at such risk, with their gathering up and playing back of perhaps mostly uninformed opinions (see Gammon and Mazda 2000). It can also easily be the case that controversy is supposedly presented, and visitors encouraged to believe that they are witnessing debate or an even-handed presentation of the arguments on various sides, when the cards are all carefully stacked from the beginning, perhaps by corporate interests (for an example, see Ross 1995).

[10] It might be argued that this has been recognised for longer in some sorts of museums - perhaps especially museums of art and ethnography - than others. See Karp and Lavine 1991, Macdonald and Fyfe 1996.

Nevertheless, there is undoubtedly much more awareness now of the limitations of some of the earlier approaches to public understanding of science and there is increased will to address the multiple facets and potentials of the museum. While there is still much call for the need for the public to understand science better, there is surely evidence in museums that 'understanding' is no longer being understood narrowly but that museums are coming to tap more of their particular abilities to excite interest and multiple understandings and meanings. In part this is a consequence of that STM paradox in which the public both knows more about, and is more sceptical of, STM and the networks in which these are embedded. It is also a consequence of an apparent desire of audiences to evade tight control. And, not least, it is a consequence of some brave and imaginative attempts by those who work in museums to create innovative and original exhibitions which do not just simply follow narrow formulae for getting STM 'out'.

Acknowledgments

I would like to thank participants at the *Ausstellungen als Instrument der Wissenvermittlung/Exhibitions as a Tool for Transmitting Knowledge* workshop in Berlin, April 2002, for discussion which helped me in writing this essay; and especially to Alex Färber and Jochen Brüning for inviting me and for their comments; and to Penny Harvey and Mike Beaney for further valuable discussion.

References

Arnold, Ken 2000 'Fact and fancy: art in the presentation of science', in S.Lindqvist (ed.) *Museums of Modern Science*, Canton, MA: History of Science Publications and the Nobel Foundation, pp.87-103

Barry, Andrew 1998 'On interactivity: consumers, citizens and culture', in S.Macdonald (ed.) *The Politics of Display*, London: Routledge, pp.98-117

Barry, Andrew 2001 *Political Machines. Governing a Technological Society*, London: Athlone

Bennett, Jim 2000 'Beyond undestanding. Curatorship and access in science museums', in S.Lindqvist (ed.) *Museums of Modern Science*, Canton, MA: History of Science Publications and the Nobel Foundation, pp.55-60

Bennett, Tony 1995 *The Birth of the Museum*, London: Routledge

Bredekamp, H., J.Brüning and C.Weber (eds) 2001 *Theater der Natur und Kunst. Theatrum Naturae et Artis. Dokumentation der Ausstellung. Wunderkammer des Wissens,* Berlin: Henschel and Humboldt University

Claeson, Bjorn *et al.* 1996 'Scientific literacy, what it is, why it's important, and why scientists think we don't have it. The case of immunology and the immune system', in L.Nader (ed.) *Naked Science. Anthropological Inquiry into Boundaries, Power and Knowledge*, London: Routledge

Conn, Steven 1998 *Museums and American Intellectual Life, 1876-1926*, Chicago: Chicago University Press

Dias, Nélia 1998 'The visibility of difference. Nineteenth century French anthropological collections', in S.Macdonald (ed.) *The Politics of Display. Museums, Science, Culture*, London: Routledge, pp. 36-52

Durant, John 1992 'Introduction', in J.Durant (ed.) *Museums and the Public Understanding of Science*, London: Science Museum and Copus, pp.7-11

Expo 2000 2000 *Hannover Journal Special*

Fehlhammer, Wolf Peter 2000 'Communication of science in the Deutches Museum: In search of the right formula', in S.Lindqvist (ed.) *Museums of Modern Science*, Canton, MA: History of Science Publications and the Nobel Foundation, pp. 17-28

Forgan, Sophie 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*, Manchester: Manchester University Press, pp. 46-68

Friedrich, Julia 2002 'Das Dresdner Bilderwunder', *Der Spiegel* no.35, 26.08.02, pp.166-7

Gammon, B. and X.Mazda 2000 'The power of the pencil. Renegotiating the museum-visitor relationship through discussion exhibits', in S.Lindqvist (ed.) *Museums of Modern Science*, Canton, MA: History of Science Publications and the Nobel Foundation, pp. 159-68

Giddens, Anthony 1990 *The Consequences of Modernity*, Cambridge: Polity

Greenblatt, Steven 1991 'Resonance and wonder', in I.Karp and S.D.Lavine (eds) *Exhibiting Cultures: The Poetics and Politics of Museum Display*, Washington: Smithsonian

Greenhalgh, Paul 1989 *Ephemeral Vistas.The Expositions Universelles, Great Exhibitions and World's Fairs, 1851-1939*, Manchester: Manchester University Press

Harvey, Penelope 1996 *Hybrids of Modernity. Anthropology, the Nation-State and the Universal Exhibition*, London: Routledge

Harvey, Penelope 1998 'Nations on display. Technology and culture in EXPO '92', in S.Macdonald (ed.) *The Politics of Display. Museums, Science, Culture*, London: Routledge, pp. 139-58

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

Martin, Emily 1994 *Flexible Bodies. Tracking Immunity in Ameican Culture from the Days of Polio to the Age of AIDS*, Boston: Beacon Press

Hein, Hilde S. 1990 *The Exploratorium. The Museum as Laboratory*, Washington: Smithsonian

Hooper-Greenhill, Eilean 1992 *Museums and the Shaping of Knowledge*, London: Routledge

Irwin, A. and B.Wynne (eds) 1996 *Misunderstanding Science? The Public Reconstruction of Science and Technology*, Cambridge: Cambridge University Press

Latour, Bruno 1996 *Aramis or The Love of Technology*, translated by Catherine Porter, Cambridge, MA: Harvard University Press

Lindqvist, Svante 2000 'Introduction: Einstein's pipe', in S.Lindqvist (ed.) *Museums of Modern Science*, Canton, MA: History of Science Publications and the Nobel Foundation, pp.vii-xii

Macdonald, Sharon 1995 'Consuming science: public knowledge and the dispersed politics of reception among museum visitors', *Media, Culture and Society*, 71.1, pp. 13-29

Macdonald, Sharon (ed.) 1998 *The Politics of Display. Museums, Science, Culture*, London: Routledge

Macdonald, Sharon 1998a 'Exhibitions of power and powers of exhibition. An introduction to the politics of display', in S.Macdonald (ed.) 1998, pp.1-24

Macdonald, Sharon 2002 *Behind the Scenes at the Science Museum*, Oxford: Berg

Macdonald, S. and G.Fyfe (eds) 1996 *Theorizing Museums,* Oxford: Blackwell

Marcus, George 1998 *Ethnography Through Thick and Thin*, Princeton: Princeton University Press

Mayr, Otto *et al.* 1990 *The Deutsches Museum. German Masterworks of Science and Technology, Munich*, London: Scala

Pickstone, John 2000 *Ways of Knowing. A New History of Science, Technology and Medicine*, Manchester: Manchester University Press

Ross, Max 1995 '"Passive smoking": controversy at the Science Museum', *Science as Culture*, 5.1, no.22, pp. 147-51

Schaffer, Simon 2000 'Object lessons', in S.Lindqvist (ed.) *Museums of Modern Science*, Canton, MA: History of Science Publications and the Nobel Foundation, pp. 61-76

Shapin, Steven 1992 'Why the public ought to understand science in the making', *Public Understanding of Science*, 1, 27-30

Shapin, Steven 1994 *A Social History of Truth. Civility and Science in Seventeenth-Century England*, Chicago: Chicago University Press

Von Hagens, Gunther and Angelina Whalley (eds) 2002 (3rd English printing, translation of the 11th German printing) *Body Worlds. The Anatomical Exhibition of Real Human Bodies*, Heidelberg: Institut für Plastination