“What do scientists do?” in museums: representations of scientific practice in museum exhibitions and activities

Ana Delicado
Instituto de Ciências Sociais
Universidade de Lisboa,
Portugal
ana.delicado@ics.ul.pt

Abstract:
This paper aims to discuss whether “science in the making” is given any kind of representation in museums. Science museums have been being promoted as adequate environments to teach science, to promote scientific culture or literacy, to develop scientific vocations. But do they really show how science is made, what scientists do, how research institutions work?
Science museums and science centres mostly favour presenting either the history (materialized in scientific instruments, most of them obsolete) or the results of science (scientific principles illustrated by interactive devices). Very little reference is made to contemporary science, to the organization of scientific work, to everyday life in the laboratory. Yet, other kinds of scientific museums already include in their exhibitions some reference to scientific practices. Such is the case of museums of palaeontology or archaeology, which show pictures or 3D models of diggings, or museums of anthropology, which acknowledge fieldwork and how objects were collected in their exhibitions.
Nevertheless, exhibitions are just one dimension of museum life. Scientific museums often promote an array of activities alongside exhibitions (live experiments, workshops, conferences, visits to laboratories), which in some way deal with recent research and establish a connection between visitors and working scientists.
The content and purposes of representations of “science in progress” will also be questioned. What explains the differences between scientific domains and dissimilar types of scientific museums? Which images of science are favoured? What kind of work is shown? Can museums effectively promote public debate and participation on controversial and cutting-edge scientific issues?

> I would like to create a museum where the visitor could be a palaeontologist for a day. Instead of looking at a dinosaur with a label and read that it’s a Dinosaurus Rex and lived 65 million years ago, I want him to understand how we know it’s a Dinosaurus Rex, how we chose that name, how we dig for it, how palaeontology is done, how science is done. (…) We can’t deliver and sell science as a finished product, that is not discussed, that comes out already done, we have to present science as a dynamic process, built by scientists, constituted by hard work, by exertion, by difficulties, but which is true science. (Head of Paleontology, Museu da Lourinha)

Scientific museums play several different roles. However, in the last few decades, one of them has gained special pre-eminence: the promotion of public understanding of science. This term and others similar (scientific culture, scientific literacy, public dissemination of science, science communication) encompass a diversified range of aims (Fourez 1997, Durant 1998, Gregory and Miller 1998): to provide scientific information, to promote a positive attitude towards science, to foster scientific vocations or “callings”, to facilitate dialogue between scientists and lay people. Though not exclusively, scientific museums have been considered privileged institutions to develop these activities (Macdonald and Silverstone 1992, Durant 1996, Gregory and Miller 1998, Einsiedel and Einsiedel 2004): they are public, open places, with a multitude of facilities (exhibitions halls, auditoriums, workshop rooms, libraries, cafeterias), frequently in close connection with universities and research centres, harbouring collections that can be shown in multiple ways and put to several different uses, an ideal meeting ground for scientists and the lay audiences.
Accordingly, do these museums show what scientists do and how science is done? This is not a new discussion, but it has emerged mainly in the field of public understanding of science studies, it is debated among museum and PUS professionals and above all with the aim of improving science

communication with the public (see Arnold 1996, and the collective works edited by Farmelo and Carding 1997 and by Chitetenden et al 2004). Facing accusations that museums (and most PUS efforts) promote an idealized vision of science, centred on technological progress, successful achievements and uncontested basic laws and principles, efforts have recently been made to deal with new subjects in exhibitions and activities: current research, controversies, social implications of scientific development, the process of research (see, for instance, Felhammer 2000, Kraeftner and Kroell 2003, Durant 2004).

This paper attempts, from the viewpoint of the social studies of science, to analyse representations of scientific activities and science professionals in museum exhibitions and activities. Unlike most studies, focused on science museums[1] and science centres, it is based on a broad definition of scientific museums, which covers natural history museums, archaeological museums and anthropological museums. It draws on a PhD thesis[2], whose empirical endeavours included document analysis, interviews and observation of exhibitions and activities. It deals exclusively with Portuguese museums; though some considerations may be applicable to other countries, others do not, in light of specific national conditions[3].

In general terms, the representation of **scientific results** is at the core of most scientific museums. Though there is a debate on whether scientific museums can teach science or merely create an appetite for it (Butler 1992, Miles and Tout 1998, Gregory and Miller 1998), these museums aim fundamentally to show what science "knows" about a certain subject. They work as "showcases" for scientific disciplines, tapping on the body of knowledge made available by decades or centuries of research to present to the public artefacts, images and texts.

> Their collections and their exhibitions are considered as potential resources for instructing the public on the beauty, the importance and the value of sciences and scientific research (Lewenstein and Allison-Bunnel 1998: 159)

Science museums frequently display the technological outputs of scientific research: machines, products, and inventions[4]. These traditional displays aim to demonstrate technological progress and national scientific prowess (Morton 1990, Butler 1992, Gregory and Miller 1998). However, since Portuguese science museums are university museums (whose collections derive more from teaching than research) and Portuguese science can be credited with few innovative discoveries (though there are exceptions, such as the angiography technique, given a due emphasis at the Museum of Egas Moniz), research results are not a common feature in this type of museum[5].

On the other hand, science centres, strongly influenced by international trends[6], use interactive devices to illustrate and "prove" some well-established "scientific law" (generally in mechanics, electricity or optics) or consolidated knowledge on a given natural phenomenon (such as volcanoes, sun radiation, the cycle of water, the formation of dunes) (Butler 1992, Bradburne 1998, Durant 1998, Bennett 2000).

Thematic exhibitions[7] usually draw on the latest "finished" knowledge on a subject, though seldom referring to the origins of that knowledge (which scientists, which institutions, which research projects, which publications or patents). Claims of scientific truth are stated both through written panels and interactive devices: little margin is left for uncertainty, controversy or the unknown (Butler 1992, Macdonald and Silverstone 1992, Arnold 1996).

> What science centres do not generally make clear is that the demonstrations they present to the public are part of an existing knowledge system. There is a danger that science is presented as simplistic truth, a mirror image of a 'real' physical world. The nature of scientific knowledge is, however, more complex and, in some cases, more problematic. (Butler 1992: 113)

Natural history museums, archaeological museums and anthropological museums usually present objects collected and organised according to current scientific classifications, interpretations and theories. Typological, evolutionary or ecological displays reflect the dominant theoretical paradigm in a discipline (see Stocking 1985, Triegger 1985, Durrans 1990, Knell 1996, Van Praet et al 2000, Girault and Guichard 2000). The information provided in labels and panels about each specimen derives from previous research. However, here also there is little mention to the processes and authors of that research.
Thus, though in minority, which representations can be found in scientific museums concerning by whom, how and why these research results where achieved? Considering the contributions made by several decades of social studies of science, how have museums responded to changing perspectives on the nature of scientific work?

Regarding the representation of **scientists**, science museums often mention the "founding fathers" of scientific research, through portraits and biographical notes, alongside the principles, laws and machines they have invented. "Individual genius" is highlighted (Durant 1998) and the vindication of history is used as source of legitimacy (personages are chosen by their unquestioned contribution to the "advancement of knowledge"). Such is the case of the Science Museum of the University of Lisbon[8], whose exhibition starts with a presentation of posters depicting Aristotle, Galileo, Newton, Faraday, Maxwell, Einstein, Max Planck and Heisenberg. Living working scientists are seldom mentioned in exhibitions and scant regard is paid to the centrality of teamwork in modern day research (Knorr-Cetina 1981). However, some active scientists do participate in museum activities, such as lectures, workshops and demonstrations[9].
In some cases, scientists are depicted as an abstract category and displays resort to archetypal images of men or women in white lab coats holding test tubes. For instance, at the Gaia Biological Park, in an exhibition about environmental threats, there is diorama of a laboratory, containing a mannequin in a white lab coat, surrounded by microscopes and test tubes, accompanied by the inscription "Scientific research opens the door to solving problems!" This conventional representation of a scientist is a very limited one: it applies only to chemistry or the life sciences, leaving out mathematics, physics, engineering, and social science.
Mainly as strategies to attract young visitors, science museums and science centres also make use of images derived from popular culture. The wonders and mysteries of scientific research are thus represented as similar to magical practices, wizardry and illusionism.

Representations of **scientific practices**, namely instruments, methods and techniques can also be found in museums.

Scientific instruments are by far the most common metonymy to symbolise scientific work in museums. However, most of the instruments displayed, mainly in science museums (but sometimes also in natural history museums and museums of medical history), are quite distant from the actual devices used in current research[10]. Museum instruments are usually obsolete and static, viewed in essence as works of art rather than as functional artefacts: "the traditional method of many science museums that depict the scientific revolution of the 17th century (…), that is, the practice of placing scientific instruments of brass and hardwood in glass cases and illuminating them against a background of green velvet" (Lindquist 2000: x). An exception to this rule can be seen at the Museum of Medical History of the University of Porto: series of surgical instruments on display comprehend both 19th century tortoiseshell, brass and steel bistouries and 21st century disposable plastic utensils. According to the museum director, this serves two purposes: to safeguard short-lived artefacts, so that future generations will not think operations were performed bare-handed; and to show lay people, who probably have no idea what goes on inside a operating theatre, what sort of instruments are currently used.
Additionally, some interactive devices in science centres use scientific instruments, such as microscopes, computers and measuring appliances (voltmeters, electroscopes, galvanometers). Though probably not used now in cutting-edge research, the manipulation of these instruments by the public does allow for a closer representation of scientific work.

One other quite common exhibit in science museums and centres is **scientific imaging**: photos obtained through electronic microscopes, X-rays and ultrasonograhy pictures, scientific drawing (used mainly in the life sciences), graphs and diagrams. These pictorial representations are quite close to the ones used in scientific publications, to convey research results and to transfer information between scientists (Latour 1989 and 1993).
Interactive apparatus on science centres vary from the basic "hands-on/push button" gadget to the so-called "minds-on" replication of the "**scientific method**": hypothesis-experimentation-observation-conclusions. In the Science Museum of the University of Lisbon, the permanent exhibition is preceded by a placard that exhorts visitors to:

> "Observe. Perform the experiments but read the texts beforehand. Try to apprehend the meaning of the results you have achieved. Try to obtain conclusions"

Though in line with much scientific rhetoric, this is a crude, idealized and mechanical representation of scientific research. It does not show the indeterminacy, the serendipity and the choices that pervade scientific work (Knorr-Cetina 1981, Latour and Woolgar 1986, Bradburne 1998, Gregory and Miller 1998).
In Palaeontology and Archaeology museums can sometimes be found mention, in labels and texts, of some of the techniques (e.g. radiocarbon dating) and deductive reasoning (e.g. the analysis of the shape of dinosaur's bones to infer their behaviour) used to reach interpretations and conclusions. On the one hand, current knowledge is presented not as "scientific fact" or "truth" but as a result of evidence-based procedures, that can be reversed by technological innovations (better analytical techniques) or new findings. On the other hand, this presentation approach adds legitimacy to scientific areas that rely on very scarce evidence.

Laboratory work, much at the root of the first studies in anthropology of science[11], is also a subject for representation in scientific museums. The Science Museum of the University of Lisbon has just finished restoring its 19th century Chemistry Laboratory, with the intention of presenting to the public both a historical display, based on authentic artefacts, and facilities for conducting experiments (rather like the Whipple Museum – Bennet 2001). It is quite frequent to find small laboratories in various kinds of museums (science museums and centres, natural history museums, even archaeological museums) where scientists demonstrate or where visitors perform basic bio-chemical tests. These are tried and tested experiments, to illustrate well-known principles and laws, using rudimentary and inexpensive equipment, quite distant from innovative research. However, some museums do organize visits to research laboratories as part of their external activities.
Fieldwork is by far the most common form of scientific practice represented in museum exhibitions. Both in palaeontology and archaeology museums, it is quite frequent to find photographs, maps or even dioramas representing field excavations[12]. These displays may serve the purpose of showing the more glamorous side of scientific research, omitting more gruelling and routine tasks. Some of these museums offer their visitors the opportunity to participate in field visits and even fieldwork.
The vast majority of ethnographic museums show only collections of artefacts, with little mention of by whom, how and why they were gathered. Yet, some museums, closer to academic anthropology (with professional trained anthropologists, that actually carry out research) have started to include in their exhibitions photos and information regarding the fieldwork underlying the collection. Such is the case of "Time for baskets", an exhibition presented at the National Ethnology Museum, based on research for a PhD degree, where the curator has chosen to show, alongside African baskets, photos of how they were collected, both by herself in the late nineties and by museum anthropologists in the sixties, during colonial rule.

If visitors search for in museums information regarding scientific careers, the workings of scientific institutions or the structure of the scientific system, they will not find it. The representations of the **social context of science**[13] are completely absent from museums. Issues as crucial as the academic rites of passage, the centrality of publication in peer reviewed journals or controversies among scientists are perhaps considered of no interest to the general public or impossible to display through the museum medium. At the same time, universities and research centres are possibly becoming more transparent, more open to public scrutiny and more willing to show what they do[14].

On the whole, it is quite difficult to see "what scientists do" in scientific museums. Nevertheless, the research process is more frequently displayed in Palaeontology, Archaeology and Anthropology museums than in science museums and centres. This may be due to several reasons:

- Contemporary "hard" science is considered difficult to exhibit. Instruments currently in use are mainly "black boxes", sometimes too large or too expensive to exhibit, with no aesthetic value, heavily relying on electronics and computer technology (often not very different outwardly from personal computers)[15] (Butler 1992, Durant 1996, Lindquist 2000, Bennett 2000, Schaffer 2000). Research processes and research subjects are frequently quite complex, the available knowledge changes rapidly and contradictory points of view abound. In view of the costs of setting up science exhibitions, it is difficult to modify displays in order to keep up with fast developments in science (Macdonald and Silverstone 1992, Farmelo and Carding 1997, Schaffer 1997 and 2000, Gregory and Miller 1998, Durant 2004, Lewenstein and Bonney 2004) [16].
- Most science centres are aimed preferably at children, so they have to be attractive and entertaining. The main policy concern is still with "public understanding of science" and scientific education (deficit model) (Wynne 1995, Bradburne 1998). Low citizen mobilization in controversial issues (such as GMO, BSE, non-renewable energies) and little public interest on the question of science funding means that science museums are not under pressure to deal with these matters and the "public understanding of research", unlike what has happened in other European countries (Durant 2004, Lewenstein and Bonney 2004).
- Active scientists (and social scientists of science[17]) seldom participate in designing exhibitions, although they do take part in other less "time-consuming" activities (lectures, seminars, field visits). Science students receive very little training in science communication, both at graduate and post-graduate levels, and there are no specific courses in exhibition design.

Whereas,

- Palaeontology, Archaeology and Ethnography museums frequently operate as research centres, they have their own research projects and their personnel perform both research and exhibition design (Durrans 1990, Knell 1996, Lewenstein and Allison-Bunnel 1998, Girault and Guichard 2000, Allison-Bunnel 2001).
- "Soft" sciences like Archaeology and Ethnography need to work harder to be recognised as sciences, thus resorting to stronger legitimising techniques when dealing with the public.
- Museum exhibitions are one of the traditional and accepted forms of output in Archaeology and Ethnography (Stocking 1985, Crowther 1989, Durrans 1990, Dias 2001). To curate an exhibition is almost as career enhancing as publishing a book or an article in a prestigious journal.

Scientific museums are products of the history of scientific disciplines, science policies and international trends and influences. Many different narratives can be on display in museums: the glories and successes of scientific research, the accumulated knowledge on the world around us, the process of research, the unexpected impacts of science and technology in social life. These narratives tell us much not only about museums, but also about science itself and how it wants to be seen by the public eye.

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[1] According to the UNESCO classification, science museums relate to one or several exact sciences or technologies: astronomy, mathematics, physics, chemistry, medical science, and engineering.

[2] PhD awarded by the University of Lisbon in 2006, with the support of a grant from the *Fundação para a Ciência e Tecnologia*.

[3] The Portuguese scientific system has only recently started to develop and to draw nearer to its European counterparts (in terms of research funding, number of researchers, research institutions, research output). Scientific museums are still scarce and hindered by several deficiencies (lack of funding, insufficient trained personnel, bureaucratic hurdles). Policies for promoting PUS are recent and still very much oriented towards scientific literacy and promoting a positive image of science.

[4] Two of the best examples being the Musée des Arts et Métiers (Ferriot and Jacomy 2000) and the Science Museum in London (Butler 1992).

[5] However, in other technical museums, such as transport museums, "traditional" displays of machines, ordered chronologically and by technical complexity, can be seen.

[6] The first science centre only opened in Portugal in 1996. Though some exhibitions were devised by Portuguese teams, they were strongly influenced by displays in science centres in other countries. Temporary exhibitions acquired abroad (from the Science Museum, the Cité des Sciences, Heureka!, the Deutsche Museum) are also quite common.

[7] Recent examples of thematic exhibitions in Portuguese science centres are "The brain", "Elementary, my dear friend" and "In the deep ocean"(Science Alive Centre Algarve), "Flight", "Music in the air", "To communicate", "The human factor – Living Ergonomics" and "The hair decoded" (Knowledge Pavilion, Lisbon).

[8] This museum combines aspects of a traditional science museum (display of scientific instruments, emphasis on the history of science) with typical exhibits from a science centre (interactive devices), which, in the words of its former director, makes it a "third generation" science museum, combining the best of the past two generations.

[9] "It is the scientist rather than the science that really inspires audiences. Therefore, an easy access to lecturers from universities and research institutions ('scientists to touch') is vital to introduce cutting-edge science in museums" (Fehlhammer 2000: 18).

[10] In Latour's terminology (1989), they are no longer instruments, since they have ceased to be applied to create visualisations used in scientific texts.

[11] In the classic work by Latour and Woolgar (1986), observation of laboratory life is the means to examine "the way in which the daily activities of working scientists lead to the construction of facts." (p. 40).

[12] The Science Museum of Minnesota has organised an exhibition about archaeological diggings in Turkey that focused on science as a social process (Pohlman 2004). Allison-Bunnel (2001) analyses a didactic film produced in the sixties by the Smithsonian Institute about the work of scientists in the museum.

[13] Which has been at the core of several seminal works in the social studies of science, such as Bourdieu 1975, Knorr-Cetina 1981, or Latour 1987.

[14] This may be due to the need to attract public funding, students and research contracts in an increasingly competitive environment.

[15] "Contemporary Physics is more difficult to exhibit. Is has accelerators and such things; instruments do have historical relevance but little museological value. (…) computers, electronics, would be interesting, but instruments nowadays are so complex" (interview Physics Museum, University of Coimbra)

[16] However, some museums and science centres in Europe have already set in motion successful programmes and exhibitions on contemporary science. That is the case both of the "Big Four" (in terms of visitors, budget and personnel – see Miller et al 2002)- the Science Museum (Ward 1997, Farmelo 2004, Durant 2004, Mazda 2004), the Darwin Centre at the Natural History Museum of London (Chalmers 2004), the Cité des Sciences in Paris (Farmelo 2004) and the Deutsche Museum (Felhammer 2000) – and of smaller scale initiatives, such as XPERIMENT! Working group for the experimentation with scientific ideas (Kraftner and Kroell 2003).

[17] Social studies of science are a comparatively new field in Portugal, which has still to earn the trust and recognition of "hard" scientists and science policy officials, who govern most science museums and centres.