# Partially Connected to Science:

## the Luxembourg Museum of Natural History and its Scientific Collaborators

PhD thesis by

Morgan B. Meyer

University of Sheffield – Department of Sociological Studies

2006

## Chapter 1: Exploring the boundaries of science in a museum of natural history

A literature review does not simply *review* a body of literature. It has to do more than this: it has to identify and propose how to fill a gap. The absence I help to create and attempt to fill is the following one. I suggest that academic work has insufficiently looked into museums as sites of knowledge production and that the relation between amateurs and professionals is under-researched. In science studies in particular the relations between scientists and non-scientists, expert and lay, have received little attention until recently (Callon and Rabeharisoa 2003). I argue that museums of natural history deserve more scrutiny and that actor-network theory is a useful - if limited - approach for this endeavour.

To put together the theoretical framework for this thesis, this chapter is divided into five sections. In the first section I am concerned with some of the spaces in which science takes place, namely the laboratory and the field. Next, I examine the museum. In the third part, I focus on actor-network theory in more detail. After this I consider the boundaries of science and discuss the notions of 'boundary-work', 'co-production' and 'boundary objects'. In the final section of this chapter, I examine one boundary in particular, that between amateurs and professionals.

### 1.1. Spaces of science

'[S]cience must take place somewhere', Livingstone (2005:100) writes, 'location, like embodiment and temporality, is essential to knowing'. There are many spaces in which scientific practice takes place. These include laboratories, museums, the field, the home, and universities. In this section I

discuss the laboratory and the field as places of scientific inquiry. Let's start with the laboratory.

*The emergence of the laboratory*

Today, a large amount of scientific research is carried out in laboratories. The history of most sciences is that of an extreme confinement that sets laboratories and instruments out of reach of the amateur and the layperson (Callon et al. 2001:65). The strength of the laboratory – its precision of measurement and the elimination of interferences – has made it necessary for experiments to be done in a private and confined space (Callon et al. 2001:72). Today's laboratory is a spatially and socially organised form that can be traced back to the 'house of the experiment' (Shapin 1988). To understand today's taken-for-granted form of the laboratory, we have, therefore, to revisit the emergence of this particular space and the controversies around different modes of organising science. The rise of laboratories in 17th century England, examined by Steven Shapin and Simon Schaffer, provides a good starting point.

For Robert Boyle, the main figure in the community of experimental philosophy in 17th century England, it was important to construct and maintain a crucial boundary around his programme for experimental philosophy (Shapin and Schaffer 1985:80). His main adversary Thomas Hobbes was to be excluded from the Royal Society and his anti-experimentalism gave grounds for this exclusion.

In Boyle's view science had to be demarcated from various other fields. He and the experimentalists were on guard against dogmatists and tyrants in philosophy, and secretists who produced their knowledge-claims in a private and undisciplined space (Shapin and Schaffer 1985:78). Instead, assent was to be secured through the production of experimental findings, mobilized into matters of fact through collective witnessing (Shapin 1994, 1988). Knowledge

was to be founded upon a 'collectivised individual sensory experience' (Shapin and Schaffer 1985:152). The experimentalists created a 'calm space' in which philosophers could collectively agree upon the foundations of knowledge (Shapin and Schaffer 1985:76). Giving witness traversed the social and moral accounting systems of Restoration England (Shapin and Schaffer 1985:59). Moreover, witnesses could be multiplied by 'virtual witnessing': the experimental report, besides being a narration of some prior visual experience, was also a visual source, a source of virtual witness that was agreed to be reliable (Shapin and Schaffer 1985:61). Nonetheless, as Hobbes critiqued in *Leviathan*, the Royal Society was not a public space. Witnessing of experiments was private and the space occupied by the experimentalists had a master (Shapin and Schaffer 1985:113-4). The emergent laboratory was a public space but with restricted access (Shapin and Schaffer 1985:336).

To have access to this space, philosophers had to be humble, noble, honest and trustworthy (Shapin and Schaffer 1985:130-1). Trust was an important aspect in experimental philosophy in 17$^{th}$ century England (Shapin 1994). Trust was crucial for demarcating the community of philosophers:

> The distribution of trust is therefore coextensive with the community, and its boundaries are the community's boundaries (Shapin 1994:36).

What counted as truth and science depended on who spoke on behalf of nature and whether he was respected as a gentleman. For Boyle and his colleagues, the success of the experimental programme rested upon the acceptance of certain social and discursive conventions and depended upon the production and protection of a special form of social organisation (Shapin and Schaffer 1985:22).

The emergent laboratory was a demarcated and protected space. Experimentalists mobilised various norms to define this space and the rules

by which science was to be conducted and which members had to respect. Stated differently, the laboratory was – and still is – a very disciplined space.

Foucault's notion of discipline and enclosure is useful here. For Foucault, there are several disciplinary techniques to distribute individuals in space.

> Discipline sometimes requires *enclosure*, the specification of a place heterogeneous to all others and closed upon itself. It is the protected space of disciplinary monotony (Foucault 1979:141).

At a first level, constructions and architectures will try to resolve this problem. However,

> the principle of 'enclosure' is neither constant, nor indispensable, nor sufficient in disciplinary machinery. This machinery works space in a much more flexible and detailed way. It does this first of all on the principle of elementary location or *partitioning* (Foucault 1979:143).

Transposed to science this means that by enclosure a delimited and disciplined space for science is created and maintained; that persons (as well as things) are located by 'partitioning' in a 'fragmented space' (Lefebvre 1991:282). Not only does a boundary exist that separates science from non-science. In addition, the 'calm space' that is demarcated is ordered by various disciplinary techniques. The experimental programme of the 17$^{th}$ century, as well as today's laboratory, utilizes mainly three technologies: a material technology (the construction of machines), a literary technology (the dissemination of results to non-witnesses) and a social technology (the conventions to use) (Shapin and Schaffer 1985:25-79). These technologies share a disciplinary aspect since they set out the organisational form of science.

*Spaces of natural history*

Natural history also takes place in locations other than the laboratory. Apart from the laboratory, there are three vital spaces for natural history: the museum, the lecture hall and the field (Naylor 2002). The museum is a crucial space since it houses collections, maps, models, books, etc. The lecture hall is necessary to communicate natural history. And the field is where specimens are observed and collected. In addition, the laboratory – as in other scientific domains – is the place where analysis and experiments are performed.

For professional scientists, the laboratory is a disciplined space where experimental, discursive, and social practices are collectively controlled by competent members (Shapin and Schaffer 1985:39). Yet, if amateurs are involved in the production of science, the laboratory, as well as the other spaces of natural history, must also permit a less professional, less rigid and less disciplined use. This is possible via a partially enacted laboratory and a less disciplined field. A first strategy, then, enabling and facilitating the co-production of science can be related to the laboratory itself. The amateur, when s/he uses a laboratory, seems less likely to master the same level of competence in each technological, intellectual and structural resource as the professional does. S/he uses only *some* of the material and intellectual resources available.

Second, the field, or the lab-in-the-field, is a less disciplined space than the laboratory. Control over natural phenomena is less than the 'socionature' produced within the laboratory by controlling or excluding the natural environment. Historically the field was not considered to be a very scientific space. The act of analysing data collected by others in the field was not problematic and was admissible for subsequent scientific investigation. More so, natural history fieldwork was not a gentlemanly activity: it was considered unpleasant and inglorious, physical and dirty work, and sometimes dangerous

(Kuklick 1997:53). However, accounts were not accepted as authentic until gentlemen-scientists attested to their veracity (Kuklick 1997:57). At the end of the 19th century, this changed and the best place for scientific inquiry was no longer to be the lecture hall but the site of direct inquiry: the laboratory or the field (Forgan 1994:152, Kuklick 1997). Fieldwork became the defining property of scientific research (Kuklick 1997:58-9). Put differently, the field became a more delimited and disciplined space in natural history.

Fieldwork as a scientific practice and social space is organised by specific methods and tools. The validity and reliability of data collected in the field are analysed or measured by practices 'inside' the laboratory or the museum. The field in natural history, although external to the museum and the lecture hall, is nonetheless defined by these latter (Naylor 2002:497). Being outside in the field means being partially inside the museum. Stated another way, to be able to turn the field into a space of scientific inquiry, methods and objects have to pass via a laboratory (see Latour 1984). Because of these movements, the distinction between the inside and outside of a laboratory becomes blurred (Latour 1984, see also Szerszynski, 2004). A laboratory does not stop at its walls. Nonetheless, even though transfers and translations exist between the laboratory and the field, even though the field is somehow disciplined, it is not overly disciplined. Translations, from the micro-world of the laboratory to the macro-world outside, and vice versa, transport some things, but not all. The field remains a space where amateurs can pursue scientific activity since standardised methods turn the field into a scientific space but also relieve some of the constraints and rigidity of professional science.

### 1.2. Museums

Having discussed the laboratory and the field, we now have to explore another crucial space of natural history: the museum. I first discuss the emergence of museums and then look at how to theorise them.

Acknowledging that there are contested accounts concerning the time and the place of the materialization of the first museums (see Abt 2006), I now briefly discuss how museums came into being and the key processes involved. According to Findlen (1994) the world's first museums emerged in Italy in the 16th century. Analysing the context and processes of this emergence, she writes:

> Humanists, natural philosophers, and collectors were not just found *anywhere* in society. They inspected nature in a precisely demarcated setting, the museum, that took its place alongside the courts and academies of late Renaissance and Baroque Italy as a space in which learned and elite culture converged (Findlen 1994:97, emphasis hers).

The museum, a demarcated setting, was a new kind of space. It was ordered by emerging scientific principles, it took on a name of its own, and, more uniquely, it was filled with objects. The museum emerged through a shift in knowledge from a predominately textual and discursive form to an increasingly visual form (Findlen 1994:199). A new way to connect things both to vision and to discourse developed, especially in natural history museums and botanical gardens (Foucault 1966:143). The museum was a space where objects were exhibited and bodies could move within.

For Bennett, the birth of the museum as we know it today took place in the 18th and 19th centuries through the development of the 'exhibitionary complex' through which institutions

> were involved in the transfer of objects and bodies from the enclosed and private domains in which they had previously been displayed […] into progressively more open and public arenas […] (Bennett 1995:60-1).

‘Objects’ and ‘bodies’, ‘things’ and persons’, are still today the two most common elements in any definition of museums. Let’s consider the following two definitions – one by a former director of the London Science Museum (Neil Cossons) and another one by the International Council of Museums (ICOM).

> Museums hold collections and reveal them to audiences. They are about objects and for people as they have always been (Cossons 2000:7).

> A museum is a non-profit making, permanent institution in the service of society and of its development, and open to the public, which acquires, conserves, researches, communicates and exhibits, for purposes of study, education and enjoyment, material evidence of people and their environment (ICOM 2006).

These definitions tell us that museums are still concerned with objects and with subjects: museums reveal and make objects intelligible in order to educate and entertain people. I now look at both these components of a museum: subjects and, after that, objects.

The subjects that make up museums can be further differentiated. For instance, four communities are said to be critical to science museums: scientists, public visitors, funders, and the museum staff (Friedman 2000). Accordingly it has been argued that a modern science museum should be a common natural stage for the actors from four sectors: the scientific community, the production sector, the government, and all of society (Wagensberg 2000:138). A more fine-grained definition might also differentiate between the scientific community and non-professionals who might also be actively involved in producing exhibits or scientific texts. If viewed as a place where different communities interact, we have, then, to follow these communities or actors through the museum.

According to Clifford (after Pratt (1992)), museums are '[c]ontact zones: the space in which peoples geographically, and historically separated come into contact' (Clifford 1999:438). But not only do people with different histories and geographies meet, different social and cultural backgrounds come together as well. For Clifford, contact zones are 'places of hybrid possibility and political negotiation, sites of exclusion and struggle', they are 'places of transit, intercultural borders, contexts of struggle and communication between discrepant communities' (Clifford 1999:451). For instance, museums can be contact zones for different kinds of knowledge as museums negotiate a nexus between expert and lay knowledge (Macdonald 1996:4). As Star and Griesemer (1989) have shown, a museum might be a place of encounter between professional scientists and amateurs.

Apart from bringing together different people, museums are also contact zones in the sense that objects geographically and historically separated are drawn together. In a natural history museum, for example, species from different parts of the world and from different periods in time are brought together. But not only does the museum classify, preserve and manage such diverse objects, some of these objects inhabit multiple worlds at the same time:

> The intersectional nature of the museum's shared work creates objects which inhabit multiple worlds simultaneously, and which must meet the demands of each one […] In natural history work, boundary objects are produced when sponsors, theorists and amateurs collaborate to produce representations of nature. Among these objects are specimens, field notes, museums and maps of particular territories (Star and Griesemer 1989:408).

For the present work, two elements of the above quote are central: the museum's intersectional nature and its involvement in the production of

boundary objects (these will be discussed in section four). In this view, the museum does two things: it is a contact zone, a place where some walls are made and unmade, and it is an institution that produces things (objects but also knowledge).

Since I will be concerned with *doing*, with the making of objects and knowledge, I now briefly discuss practice. Just as science has been increasingly theorised as a practice (see Pickering 1992a, 1995), a science museum might also be analysed in terms of practice. Stated differently, museums might not only be pictured in terms of what they *are*, or what they represent, but also in terms of what they *do*. What does a museum do? Museums do things through exhibitions: 'display not only shows and speaks, it also *does*' (Kirshenblatt-Gimblett 1998:6). Museums might be, for example, a means to spread and reinforce national consciousness (Hudson 1999:372-3). Museums also produce objects, knowledge, and science. A museum of natural history, for instance, does different things: it is a place where knowledge about nature is drawn together, analysed, interpreted and then published or exhibited, as much as it is a means to reinforce a certain value and respect towards nature and as it is a place where the making of displays and scientific texts is inherently political and reproduces a certain version of 'nature out there'.

Apart from the museum's intersectional nature and its involvement in the production of things and knowledge, I will take on board a third element. I will be interested at the Museum as a 'museum without walls'. It has been argued that the 'museum without walls' was the third step in the spatial evolution of museums (see Hetherington 1996:153). First, there was a 'pre-museum' space: collections were localised in palaces, private homes, churches, gardens, etc. Then, the classical museum developed during the 17$^{th}$ and 18$^{th}$ century to become a 'museum with walls'. Finally, the 'museum without walls' developed. Whereas for Malraux (1965) the museum without walls is located in books, brought about through the reproduction of art, 'unwalling' happens

through other means, in other places too. Hetherington lists three factors involved in the breakdown of the walls of the museum: forces of commercialisation, the emergence of the heritage industry, and popular interests in sites of historical interest outside the confines of the museum (see Hetherington 1996:154). We can add five more elements. First, democratic values and, especially for natural history museums, environmental and social movements have drawn places and people formerly outside of the museum project into the heart of its preoccupation. Second, while museums still predominantly display 'things' (Macdonald 2004:upd) some museums have shifted their allegiance from real objects to real experiences (Hein 2000:87) and can break down their walls more easily. Also, third, in the 'information age' with its digital information networks and databases, the museum's collection and expert information becomes linked to other organizations, and identities become blurred (Keene 1998:17).[1] Fourth, in theoretical terms too, the 'museum refuses to stand still' (Hudson 1998) as the concept of what a museum is has enlarged over the years (Hooper-Greenhill 2000b:180) and as the museum's walls opened up to the increasing interest of anthropologists, philosophers, economists, etc. alongside more classical academic work in history or in the arts. Finally, it has been argued that the walls between science and art are crumbling in the museum (Van Praet 1995, see also Macdonald 2003).

Foucault's insights about the carceral system are useful to think about the museum. For Foucault, the complex ensemble that constitutes the carceral system is

> not only the institution of the prison, with its walls, its staff, its regulations and its violence. The carceral system combines in a single figure discourses and architectures, coercive regulations and scientific

[1] Keene (1998:17) writes: 'The actual museum is sharply defined by its geographical presence, its organizational identity, and its physical collections. How will museum people feel if the identity of their organization becomes blurred? This is what will happen if the basis for the museum's existence,

> propositions, real social effects and invincible utopias, programs for correcting delinquents and mechanisms that reinforce delinquency (Foucault 1979:271).

The museum too is a similarly complex ensemble: it is not only an institution with walls, staff and regulations but also both discourse and architecture, combining regulations and scientific propositions, with real social effects and underpinning utopias. But the 'hard' approach of the carceral system differs from the 'soft' approach of the museum in that the former works by discipline whereas the latter by example and entertainment and depends on voluntary participation (Bennett 1995:87). In science museums and science centres, often based on an interactive model, 'subjects are not disciplined, they are *allowed*' (Barry 2001:129).

### 1.3. Actor-network theory – the museum test

Science (and technology) studies see science as an inherently political, cultural and social endeavour. There is no 'pure' technology or science: technologies reproduce and embody the complex interplay of professional, technical, economic, and political factors (Bijker and Law 1992a:3). Technical artefacts have politics (Winner 1986) and science is politics by other means (Latour 1987). Consequently, most science studies scholars hold that science cannot be objective. Haraway (1989:13) writes: 'The detached eye of objective science is an ideological fiction, and a powerful one'. Instead, knowledge is situated and 'only partial perspective promises objective vision' (Haraway 1991:190). A common threat that runs throughout science studies is the argument that science is both produced *in a place* and that it should be examined *as a space* - rather than placeless and spaceless knowledge. It is argued that science has a geography (see Livingstone 2005, Naylor 2002,

---

its collection and expert information, become linked apparently seamlessly to other organization's pools of expert knowledge'.

Naylor 2005, Shapin 1998, Turnbull 1993) and that science is a pliable and supple cultural space (Gieryn 1999:xi). But what, exactly, do we mean by 'space'?

For Lefebvre, to picture space as a frame or container into which nothing can be put unless it is smaller than the recipient is a common error (Lefebvre 1991:94). Space is neither a person nor a thing, it is neither subject nor object but a set of relations between these (Lefebvre 1991:82-3, 92, 116). Space is not only something material but also comprises social space.

> Social space contains a great diversity of objects, both natural and social, including the networks and pathways which facilitate the exchange of material things and information. Such 'objects' are thus not only things but also relations (Lefebvre 1991:77).

Moreover, space is both abstract and concrete in character:

> abstract inasmuch it has no existence save by virtue of the exchangeability of all its component parts, and concrete inasmuch as it is socially real and as such localised (Lefebvre 1991:341-2).

Foucault takes a similar stance when he asserts that space is real and ideal: real in the sense that it governs the disposition of buildings, rooms, and furniture, but also ideal as it projects over this arrangement characterisations, assessments, and hierarchies (Foucault 1979:148).

Lefebvre underlines the need to construct a 'spatial code', which would bring together the 'micro' level and the 'macro' level, inside and outside, work and non-work, the durable and ephemeral (Lefebvre 1991:64). He further argues:

> The form of social space is encounter, assembly, simultaneity. But what assembles, or what is assembled? The answer is: everything that

> there is *in space*, everything that is produced either by nature or by society […] Everything: living beings, things, objects, works, signs and symbols (Lefebvre 1991:101).

Lefebvre's social space in which subjects, objects, and symbols are assembled resemble actor-networks which 'draw together' humans and non-humans, the material and the social, etc. Space in actor-network theory is similarly relational (Murdoch 1998). Let us turn to actor-network theory now.

'[O]ne might represent actor network theory by **performing** it rather than **summarising** it' (Law 1997:2, bold in original). Damn! This should make it difficult to review actor-network theory (ANT), to *write about* ANT. Rather than summarising and giving an overview of ANT I will thus review some of its elements. I will selectively consider the themes I operationalise throughout this thesis. I will proceed as follows: first I discuss some of its particularities, then review some of its drawbacks and, finally, look at how to use, perform, and test it in a museum.

First of all, the notion of symmetry is central to ANT. ANT's principle of generalised symmetry is a radicalisation of the 'principle of symmetry' (first expressed in Bloor 1976) which calls for the use of the same types of causes to explain true and false beliefs. According to this principle 'true' scientific beliefs should not be seen as given by nature but they come within the scope of sociological analysis and explanation. The 'sociology of translation', the precursor of actor-network theory, extends this principle of symmetry. Three methodological principles are obeyed (Callon 1986): agnosticism (the impartiality between actors engaged in controversy), generalised symmetry (the commitment to explain conflicting view-points in the same terms and to use the same repertoire for Nature and Society), and free association (the abandonment of all *a priori* distinction between the natural and the social).

Building upon these principles, Callon (1986) defines 'translation' as a process involving four moments. The first moment, 'problematization', defines the nature and the problems of actors. The next moment, 'interessement', consists in 'a series of processes by which' actors are locked 'into the roles that had been proposed for them' (Callon 1986:196). Successful interessement leads to 'enrolment', a set of strategies in which it is 'sought to define and interrelate the various roles allocated to others' (ibid.). The fourth moment of translation is 'mobilisation' which renders mobile actors that were not so before - these are the methods 'to ensure that supposed spokesmen [people talking on behalf of others] for various relevant collectivities were properly able to represent those collectivities' (ibid.).

To summarise, translating an actor means: defining an actor; testing, stabilising and specifying the roles of this actor; and, finally, rendering it mobile. In Law's (2002:99) words,

> To translate is to connect, to displace, to move, to shift from one place, one modality, one form, to another while retaining something. Only something. Not everything. While therefore losing something. Betraying whatever is not carried over.

The fragility of the process becomes evident. '[*T*]*raductore-tradittore*, *traduction-trahison*, to translate is to betray' (Law 2002:99). Dissidence, or betrayal, might arise through controversy when the representativity of spokespersons is questioned, discussed, negotiated, rejected. If actors feel betrayed by those who represent them they might become dissident, they might betray an emerging network.

Out of this sociology of translation actor-network theory emerged. Actor-networks are defined as follows:

> The actor network is reducible neither to an actor alone nor to a network. Like networks it is composed of a series of heterogeneous elements, animate and inanimate, that have been linked to one another for a certain period of time […] The actor network can thus be distinguished from the traditional actors of sociology, a category generally excluding any nonhuman component and whose internal structure is rarely assimilated to that of a network […] An actor network is simultaneously an actor whose activity is networking heterogeneous elements and a network that is able to redefine and transform what it is made of (Callon 1987:93).

Actor-networks are both networks and points: 'they are individuals and collectives' (Callon and Law 1997:174). Even though actors should not be examined in isolation, definitions have been given: 'actors are those entities that exert detectable influence on others' (Law 1986:132); an actor is allegedly

> [a]ny element which bends space around itself, makes other elements dependent upon itself and translates their will into a language of its own (Callon and Latour 1981:286).

The list of actors in ANT case-studies is huge: scallops, doors, microbes, Louis Pasteur, Portuguese ships, scientists, fishermen, and so on.

Apart from a special definition of actors, within ANT the term network has a distinct meaning too. While the term is commonly used in social science to describe technological relations, economic forms, political structures and social processes, ANT uses the term in a way which is quite distinct from these applications:

> ANT bundles *all* these applications together for it concerns itself with the *heterogeneity* of networks, […] how social and material processes

> become seamlessly entwined within complex sets of associations (Murdoch 1998:359).

One of the defining characteristics of ANT is, then, the inclusion of non-human actors in the actor-networks it proposes to analyse. In other words, actor-network theory conceives the world which we build as a collective hybrid made out of humans and non-humans and asserts that it is not possible to study both constituents separately (Callon 1999a:67). Haraway makes a similar point: 'I insist that social relationships include nonhumans as well as humans as *socially* […] active partners' (Haraway 1997:8).[2]

ANT is, then, decentering the subject (Lee and Brown 2002:259), which consists in breaching the boundaries that separate the human subject from the media in which it subsists: language, discourse, materiality, technology, desire.[3] Yet, the symmetrical approach of ANT does not stop at the human/non-human distinction only. ANT opposes binarist thinking of all kinds and provides a means of navigating dualisms, such as nature/society, action/structure, local/global, social/technical.[4] According to Latour, these

---

[2] Haraway (1989:55) argues: 'The concept of social relations must include the entire complex of interactions among people; objects, including books, buildings, and rocks; and animals'. The main claim of ANT scholars is that it has opened the social sciences to non-humans (Callon 1999b:182). Yet, ANT does not stand alone with this claim. A perspective that bares some resemblance to ANT is that of the 'cultural bibliography of things' (Appadurai 1986, Kopytoff 1986). The argument is that commodities, like persons, have social lives and 'we have to follow the things themselves, for their meanings are inscribed in their forms, their uses, their trajectories' (Appadurai 1986:5). It is argued: 'that societies constrain both these worlds [the world of things and the world of people] simultaneously and in the same way, constructing objects as they construct people' (Kopytoff 1986:90). Ingold's dwelling perspective is comparable: people '"feel their way" *through* a world that is itself in motion, continually coming into being through the combined action of human and non-human agencies' (Ingold 2000:155, emphasis his). Pickering's notion of the 'mangle' (1995) also entails the recognition of material agency. These and other currents are discussed in Pels, Hetherington and Vandenberghe (2002).

[3] This is, in a sense, a kind of movement in a whole series of decenterings: as it was discovered that humans are not at the centre of creation, nor situated in the middle of space, and maybe neither on the summit and on the final step in life (see Foucault 1966:359).

[4] Other dualisms include: truth and falsehood, large and small, before and after, context and content, activity and passivity (see Law 1999a:3), prescientific and scientific culture (Latour 1990:20), primary and secondary (Latour 2000:119), common and private, objective and subjective (Latour 2004:93). The trend to be critical about dualisms can be traced back to Snow (1964:9): 'The number 2 is a very dangerous number […] Attempts to divide anything into two ought to be regarded with much suspicion' even though his main argument in *The Two Cultures* does just this - he writes: 'the intellectual life of the whole of western society is increasingly being split into two polar groups. […] Literary intellectuals at one pole – at the other scientists' (Snow 1964:3,4).

great divides do not provide any explanations but are the things to be explained (Latour 1990:20). Rather than thinking in terms of separations, ANT conceives the world relationally. According to Law (1999a:4), ANT may be understood as a 'semiotics of materiality':

> It takes the semiotic insight, that of the relationality of entities, the notion that they are produced in [and that their form is a consequence of] relations, and applies this […] to all materials.

Agency becomes a relational effect – hence the couplet actor-network.

Given its relational ontology, ANT differs from social constructivist thought. Neither prioritising the ('external') social context nor the ('internal') inherent structure, the relation between entity and context is problematized. It bypasses the question of 'social construction' and the 'realist/relativist debate', debates that might not be solved at all, as Hacking (1999:91-92) has argued. Nonetheless, although ANT tries to demarcate itself from the social construction tradition, it is clear that the way it describes science is usually closer to a constructivist and relativistic thought than to a realist thought.

The benefits of using ANT are various. As an actor-oriented approach it is valuable to uncover 'the micro-foundations of the macro framework' (Booth 1994:13). And it enables description of a world far richer than the society-nature dichotomy can allow (Castree and MacMillan 2001:212).

*Critiques*

ANT has been criticised for a number of (partially related) reasons.

*'In ANT the T is too much'* (Callon 1999:194). First of all, for the three major contributors of ANT - Callon, Latour and Law - the term 'theory' in actor-

network theory is problematic: ‘actor-network theory is not something in particular’ (Law 1999a:10), it is ‘more a method […] than an alternative social theory’ (Latour 1999:15), ‘ANTs main shortcoming is that it is everything but a theory’ (Callon 1999b:183), it is an ‘infralanguage’ rather than a theory (Latour and Crawford 1993:250). ANT represents more a sort of approach, a set of sensibilities, than a clear, framed and strong theory.

*Flattening*. ANT ‘flattens’ all distinctions between the entities which comprise networks (Murdoch 1998:367). Ontologically there is

> the problem of installing a great *indifference* between the countless things of world […] which arises when they end up being portrayed as potentially *all the same* (Laurier and Philo quoted in Castree and MacMillan 2001:221).

This flattening practice leads to an obscuring of differences between entities. The assumption of a radical indeterminacy of the actor risks to yield a too great ‘toleran[ce] that […] ends up presenting an actor which is an anonymous, ill-defined and indiscernible entity’ (Callon 1999b:182).

*Dehumanising*. ANT has also been criticised for dehumanising the human (Law 1997:7). As Hacking (1997) argued there are nonetheless differences between humans and non-humans as non-humans are ‘indifferent kinds’ and humans are ‘interactive kinds’ (or ‘intentional’ (Pickering 1995:17)). According to some, actor-network theory commits one important error in that it ignores the social, cultural and cognitive dimension proper to scientific action and contributes to create ‘desocialised’ representations (see Dubois 1999:64); and in that it pays too little attention to language and classification (Macdonald 2002:7).

*Missing marginality and temporality*. A critique raised by Star (1991) is that ANT fails to account for that which is not networked or marginalised. ANT is blind in the sense that it does not see what is excluded (Bowker and Star

1998:240). For Hetherington (1999:52), time and history also seem to be something of a blind spot for ANT since the metaphor of the network, with its emphasis on spatial relationships and distributions, seems to be in conflict with it.

*Ambivalence*. Ambivalence and fluidity have been downplayed within ANT (Murdoch 1998:364). For instance, ANT overlooks and conceals the ambivalence that actors might tacitly hold toward a network with which they apparently completely identify (Wynne 1992:300, 1995:383) - whereas in Callon's accounts betrayal looks like a sudden reversal, this might be only a minor shift in the balance of components of social identity. Responses to enrolment are varied along a rich continuum, including partial signings-on and partial commitments (Star 1991:49-50).

*Causality*. Related to these shortcomings, it becomes difficult to infer causes and explanations since ANT focuses on descriptions and 'how' questions rather than 'why' questions.

*Politics and power*. Another shortcoming concerns politics and power. ANT risks ignoring the possibility of some actors 'marshalling' the power of many others and not accounting for injustice (Castree and MacMillan 2001:222). ANT is often described as being too agnostic about social formations such as power and gender.

*Internal paradox*. For Gingras (1995), ANT is not coherent and clear. He holds that it is odd to argue that the social, technical, animate and inanimate cannot be distinguished *a priori* but at the same time use the term 'heterogeneous engineering' which suggests the contrary, namely the distinctiveness of these factors. ANT studies constantly make neat distinctions between different factors in their empirical descriptions while arguing for the contrary in introductory and concluding sections of papers.

The general shortcomings of ANT are its difficulty to discriminate, the deletion of Otherness and its flattening ontology. Concepts like fractionality, circulation, multiplicity, and overflows have appeared as a certain reaction to some of these critiques and the relatively flat and static image the notion of network encompasses. In recent years, ANT has evolved – as the book *Actor Network Theory and After* (1999) suggests – to try to grasp things that don't quite fit, that resist; to understand the contradictions that draw things apart and the complexities that can't be simplified (see also Mol and Law 2002). When studying the relation between amateurs and professionals in a museum, these concerns must be taken seriously. As we will see, amateurs are rather marginal to science, thus defying some principles of ANT. For this thesis I therefore use ANT as a temptation (Haraway 1989:6) rather than *the* theory.

*The museum as an actor-network*

Taking into account the benefits and drawbacks of ANT, how can we use ANT to examine a museum? Museums have not been much theorised using an ANT perspective. Yet museums are places where scientific knowledge is made, where subjects and objects are drawn together, where heterogeneous actors meet – all themes dear to ANT. More so, Hetherington (1999:53) argues that ANT can help us to understand the museum 'as a space whose topology will alter within specific temporal, epistemological, cultural and material contexts'.

Within science studies more generally, museums as scientific sites haven't been much researched and scholarly work has mainly focused on laboratories. Discussing about the new modes of knowledge production, Elzinga (2004:16) argues:

> We hear nothing about changes in astronomy, natural history museums, language laboratories or departments of archaeology and

> musicology […] the new images of scientific knowledge production have a social epistemology that is rather limited in scope.

Within STS there has not been much attention paid to study museums and academic work relating ANT to museums is rare.

ANT's relational ontology has been discussed in relation to a science museum. In her analysis of exhibition-making at the Science Museum in London, Macdonald (2002:256) has argued that agency is distributed among human and non-human actors, although not equally so. In a similar vein, it has been put forward that an exhibit does not bring together already existing objects, subjects and social groupings – 'rather, this is a conjunctural event in which the relevant objects, subjects and social groupings are co-produced' (Gomart and Hennion 1999:228). Seen through an ANT lens, the museum becomes an effect, an outcome of taxonomies, practices, negotiations, and agendas of the different actors involved, rather than a pre-existing entity. In museums things are co-produced: knowledge, objects and subjects are produced together with politics and society.

Haraway (1989:27) writes:

> Behind every mounted animal, bronze sculpture, or photograph lies a profusion of objects and social interactions among people and other animals, which can be recomposed to tell a biography.

For her, nature is constructed as a technology through social praxis, producing race, gender and class (Haraway 1989:54). She describes the American Museum of Natural History as a place where nature and culture, private and public, profane and sacred meet (Haraway 1989:29). In natural history museums, some of the dichotomies problematised by ANT tend to blur.

Translation and mobilisation both occur in museums. Discussing an illustration of the *Museum d'histoire naturelle* in Paris, Latour writes that through natural history expeditions a particular relationship permits the centre (the museum) to accumulate knowledge (Latour 1996b). An important gain is achieved through the transport and naturalisation of animals (such as birds) into the ordered space of the museum:

> The ornithologist can then quietly, sheltered, compare the relevant features of thousands of birds made comparable by immobility, by installation, by naturalization. What lived dispersed in singular states of the world, unifies, universalizes, under the precise glance of the naturalist (Latour 1996b:upd).

In this sense, the museum resembles the laboratory in that the natural and the social order are reconfigured (Knorr-Cetina 1995, 1999). Concerning laboratories, Knorr-Cetina (1999:26) writes:

> laboratories provide an 'enhanced' environment that 'improves upon' natural orders in relation to social orders.

Just as the laboratory takes its power from the 'enculturation' of natural objects, so does the museum. The museum does not need to accommodate objects as they are, nor where they are, nor cope with events when they happen but, instead, things can be 'brought home', into the museum (see Knorr-Cetina 1995:145-6, 1999:27). Museums are relational units that gain power by instituting differences with the environment: differences between the reconfigured order in the museum and the arrangements found in everyday life (Knorr-Cetina 1999:44).

But there are differences. Comparing experimental spaces in Restoration England to museums, Findlen (1994:200) notes:

> The precisely articulated experimental etiquette circumscribing the laboratories of the Royal Society appears in marked contrast to the more fluid parameters of the museum, whose creators openly delighted in its ambiguities.

Less categorically, Kraft and Alberti (2003) hold that museums and laboratories are 'equal though different'. They state that there are continuities between museum and laboratory traditions and the laboratory supplemented rather than eclipsed the museum (Kraft and Alberti 2003:207, see also Desmond 2001, Pickstone 2000).

The difference also lies *within* museums themselves. Between the classical museum and the museum without walls there are significant differences:

> the museum without walls involves not one utopic practice like the classical museum but many […] It is the very ambivalence and uncertainty of this space, however, in contrast to the classical museum that allows many voices to be expressed. It is also a contested space, a space with many actors who all wish to project their ideas about society, their utopics, through its space (Hetherington 1996:162).

Since a museum without walls is characterised by a multitude of voices, actors, ideas, practices, ANT is useful to account for such heterogeneities. However, the ambivalent and contested nature of such a space calls for an understanding beyond ANT.

On the one hand, the concept of 'hybrid forums' (Callon and Rip 1992:147-153) looks suitable. Hybrid forums are characterised by the multiplicity and diversity of actors that interact; actors whose interests or projects are different and who are less sensitive than others to institutional boundaries. It is hybrid since the actors, the problems they formulate and the resources they mobilise are heterogeneous. The hybrid forum is the space in which knowledge, actors,

and the identity of these actors are negotiated simultaneously. Museums, as places where both amateurs and professionals meet, where heterogeneous actors are enrolled into the production of science, can be such hybrid forums. Yet, on the other hand, there are limits to hybridisation. Or, in other words, while extending the principle of symmetry to include amateurs and professionals we have to be careful not to downplay differences, asymmetries, resistances, marginalities and ambiguities. We might well use ANT to *question* dualities, but we should remain able to *see, authorize, and explain* them.

### 1.4. The boundaries of science

Collins and Evans (2002:239) argue that most science studies (especially within the 'Second Wave of Science Studies'[5]) have become unable to distinguish between experts and non-experts. In science studies

> [m]uch excellent work has been done […] by 'deconstructing dichotomies', dissolving boundaries, and the like, but like it or not, the world is made of distinctions and boundaries (Collins and Evans 2002:251).

While the tendency to dissolve boundaries is widespread in science studies, this tendency is also visible in the more general trends of post-structuralism and post-modernism. Post-structuralism, for instance,

> deconstructs the boundaries between categories, be they ontological, epistemological, ethical or material; and it demonstrates the

[5] Collins and Evans describe three 'waves' of science studies. The first wave clearly demarcated science from society. The second wave, emerging at the end of the 1960s, was triggered by Kuhn's work (1996). Within this wave are the traditions of sociology of scientific knowledge and actor-network theory. The third wave, they claim, is the study of expertise and experience. For a critical review see Rip (2003).

> inescapability of the leaks and flows across all such bodies of knowledge and bodies of matter (Shildrick 1997:4).

Postmodernism prefers the shifting and unstable to the unified and integrated, and can see nothing but instability while celebrating fragmentation (Epstein 1997).

In science studies it is commonplace to argue that what demarcates science from non-
science is not some set of essential or transcendent characteristics or methods but rather an array of contingent circumstances (Guston 2001:399, Evans 2005:3). It is a matter of power and authority, rather than a matter of truth (Evans 2005:7).

Barnes and Edge (1982a:18), for instance, hold that communication and rewards constitute the boundaries of science:

> [The] communication/reward system […] erect[s] *boundaries* – between 'science' and 'non-science'; between scientists in different disciplines and specialities; and between accredited professionals and lay 'outsiders'.

They further write:

> Any scientist who can earn recognition or credibility within the system can be seen to be 'playing the game', and has established a claim to be treated as an *expert* in the particular field in question. This status is consolidated, and the boundaries reinforced, by command of esoteric *language* and skills […] The matter is of practical consequence, since many disputes, both within and outside science, raise such questions as whether or not claims are 'scientific', […] or who is to 'count' as a 'relevant expert'; or whether or not an expert witness has 'exceeded the

> limits of his area of competence' (Barnes and Edge 1982a:18, emphasis theirs)

In science, boundaries play an important role as they construct and maintain the status of experts and the territory of science. In addition, they demarcate scientific disciplines since:

> The scientific community is not a monolithic, homogeneous institution: it is subdivided into a complex of smaller units. […] Scientific disciplines […] have in common only a loose allegiance to widely-defined subject matters, characteristic concepts or techniques: members tend to share few, if any, specific research interests (Barnes and Edge 1982a:18).

In other words, not only are there boundaries around science, there are also boundaries within science.

*Boundary-work*

Boundaries are often crossed. While some work goes into 'boundary maintenance' (Barnes and Edge 1982b:241, Kuklick 1980), other forces tend to dissolve boundaries. Laboratories, for example, are sites where boundaries can be permeable.

> The traffic of objects, researchers, and information produces a *lifeworld* within which laboratories are locales, but which extends much further than the boundaries of single laboratories (Knorr-Cetina 1999:39).

In line with this, it has been argued that, in general, there are three types of bridges across boundaries: people, artefacts, and interactions (Wenger 2000:235). The material, embodied, and informational flows across boundaries can bring the 'outside world' into laboratories (see Latour 1984).

For Gieryn (1983, 1995, 1999) science is a space on maps of culture, bounded off from other territories. He writes:

> These cultural maps locate (that is, give a meaning to) white lab coats, laboratories, technical journals, norms of scientific practice, linear accelerators, statistical data, and expertise (Gieryn 1999:x).

The spaces in and around the edges are a perpetually contested terrain and what is at stake is the credibility and authority of science within 'credibility contests'. These contests divide into three genres, into different sorts of 'boundary-work': expulsion, expansion, and protection of autonomy. Throughout expulsion 'Real science is demarcated from several categories of posers: pseudo science, *amateur science*, …' (Gieryn 1999:16, emphasis mine). Expansion is 'when two or more rival epistemic authorities square off for […] control over a contested ontological domain' (Gieryn 1999:16). And during protection of autonomy: 'scientists put up interpretative walls to protect their professional authority' especially if outside powers try 'to exploit that authority in ways that compromise the material and symbolic resources of science inside' (Gieryn 1999:17).

While Gieryn (1995:419) stresses the usefulness of a cartographic vocabulary to think about science, the image of maps is limited – practically and metaphorically. On a practical level, Kraeftner and Kröll (2003) have shown some difficulties to represent 'science in action' on two dimensions. They followed an evolving scientific project about genetically modified food and, as a preliminary report, elaborated a 280 square meters large 'socio-technological-graph'.[6] The map they initially wanted to draw, representing the relationships between the different actors involved, turned out to be a messy storyboard rather than a map. On a theoretical level, Martin (1997:140) has argued that

> the ‘space’ in which science and culture contend is too discontinuous, fractured, convoluted, and constantly changing for a map of any landscape to be useful.

What we ‘need [is] an image of process that allows strange bedfellows, odd combinations, discontinuous junctures’ (idib.).

There are three more aspects of boundaries worth to be stressed – process, materiality and permeability. First, boundaries are made.

> Division […] is a process. Boundaries do not exist in and of themselves. Rather, they are made and re-made, conceptually, socially, and materially (Unnamed 2003, underlined in original).

Gieryn’s notion of ‘boundary-work’ (1983) points to the fact that boundaries are constructed. More than this, boundaries are ambiguous (Evans 2005). Gieryn writes:

> The boundaries of science are ambiguous, flexible, historically changing, contextually variable, internally inconsistent, and sometimes disputed (Gieryn 1983:792).

Yet, the notion of boundary-work is restrictive. Boundary-work

> is a rather limited [exercise], for it does not deal with the ways in which such processes of demarcation are *heterogeneous*. That is, it does not deal with the materialities of such processes of boundary work (Michael 2002:370).

---

[6] The scientific project they followed was about a genetically modified strain of rice called ‘Golden Rice’. The messy ‘storyboard’ they elaborated was a preliminary report for the Ministry of Science in

This is the second aspect of boundaries worth examining: boundaries take many forms. They can be situated at structural level and at agential level, they take social, material, and embodied forms:

> [boundaries are] the lines which divide bodies of all kinds, at whatever level: institutions, people, activities or subjects. The lines may be formal or informal; they may have a legal, social or pragmatic status; they may be watertight or in varying degrees porous (Schuller 1995:3).

More so, 'boundary-work' does not take into account 'temporal boundaries' (Zerubavel 1990:172), such as the boundaries between being on duty and off duty.

Third, the boundaries of science can become permeable. Bridges are built, differences are temporarily and/or locally annihilated, exchanges across dividing lines can become easier and more intense. The 'co-production of knowledge' and 'boundary objects' are two useful concepts to understand how science, while still demarcated, can be at the same time more closely connected to society, to the layperson, to the amateur.

*Co-production*

Scientific work is often very heterogeneous and conducted by diverse groups of actors: researchers from different disciplines, amateurs, professionals, patients, etc. Therefore science requires cooperation. Common understandings have to be created to

> ensure reliability across domains and to gather information which retains its integrity across time, space and local contingencies (Star and Griesemer 1989:387).

---

Austria and was presented at the Swiss National Museum in Zürich in 2002.

I now discuss three examples where both experts and laypersons are involved in the making of scientific knowledge. A first example is that of 'popular epidemiology',

> a process by which laypersons gather scientific data and other information and direct and marshal the knowledge and resources of experts to understand the epidemiology of disease (Brown and Mikkelsen quoted in Kleinman 1998:137).

This kind of knowledge production falls near the end of the democratic science continuum opposite scientist self-governance as laypeople are engaged in practices typically reserved for certified scientists (Kleinman 1998:138). Second, AIDS treatment activists are also involved in the production and evaluation of biomedical knowledge (Epstein 1995). In this case too, laypeople are engaged in practices typically restricted for certified scientists thus challenging the idea that only certified experts can engage in research practices. A third example where science is conducted by heterogeneous actors is the French Association of Muscular Dystrophy (Callon 1998a, Callon et al. 2001). Although this association is mainly composed of patients and their families, these non-professionals are sometimes actively involved in scientific research and collaborate with professionals.

In these three cases, the production of knowledge is a collective work where users are particularly active, rather than an activity confined only to researchers. Interactions between lay-people and professionals are permanent, forming a 'hybrid collective' (Callon 1998a:71). In this new 'model of co-production of knowledge' (Callon 1998a, Callon and Rabeharisoa 2002), a form of organization permits a close cooperation between specialised people and laypersons (i.e. the patients and their families).

The 'model of co-production' can be distinguished from two other models. These are the model of public instruction and the model of public debate, both of which share the same obsession: demarcation (Callon 1998a). In these two models laypersons are denied any competence to participate in the production of scientific knowledge. However, rather than demarcating science from non-science, the 'model of co-production of scientific knowledge' associates

professionals and lay-people actively – and legitimately - into the elaboration of scientific knowledge and very often results are published in academic journals.

Let's turn to the term co-production now. The term co-production has not only been used to describe the production of knowledge through different actors, but in many other ways too. In Jasanoff's (1996) work, for example, the term co-production stands for the simultaneous production of knowledge and social order. She writes:

> the realities of human experience emerge as the joint achievements of scientific, technical and social enterprise: science and society, in a word, are *co-produced*, each underwriting the other's existence (Jasanoff 2004b:17).

In early ANT writing we can find a similar stance: 'actor networks […] simultaneously give rise to society and to technology (Callon 1987:99). According to this 'co-production framework', scientific knowledge both embeds and is embedded in social identities, institutions, representations and discourses (Jasanoff 2004a:3).

For Callon and Latour (1992:349, see also Jasanoff 2004a:2), the term co-production initially related to the simultaneous making of society and nature. Turnbull (2002), on his side, is interested in how the cognitive and the material are co-produced with the social as well as in the spatial co-production of knowledge and material objects. In his view people, objects, knowledge and space co-produce one another (Turnbull 2002:138).[7] Recently, the co-production of scientific knowledge and social identities has been examined (Callon and Rabeharisoa 2003). In this thesis, I use the term co-production

[7] Giddens has argued that to study the production of texts is to study the production of the author (Fyfe 1988). In other words, texts and authors are co-produced.

mainly to describe the production of knowledge through amateurs and professionals.

Having discussed the co-production of knowledge, a few words need to be said about the production of knowledge. In their book *The new production of knowledge*, Gibbons et al. (1994) discriminate between two modes of knowledge production. Within the 'older' mode (mode 1), a very disciplinary knowledge production took place. This mode was characterised by homogeneity and hierarchy. The new mode (mode 2), in contrast, is defined by a transdisciplinary knowledge production,

> Knowledge which emerges from a particular *context of application* with its own distinct theoretical structures, research methods and modes of practice but which may not be locatable on the prevailing disciplinary map (Gibbons et al. 1994:168).

The organisational form of this kind of knowledge production is based on heterogeneity and heterarchy. This new mode, they claim, is more flexible and socially distributed and it has temporary forms, fluid contours, and temporary institutional spaces. As it is less firmly institutionalised and regroups a wide and heterogeneous set of practitioners (Gibbons et al. 1994:3-6), these practitioners form 'hybrid communities' – people who have been socialised differently (Gibbons et al. 1994:37).

This model is useful to examine the association between researchers and patients and the related new forms of knowledge production. However, concerning the collaboration between amateurs and professionals within natural history museums, this model has only a limited validity. Hybrid communities, which would unite amateurs and professionals, are no recent phenomena. Instead, they have characterised museums from their early beginnings, as we will see below. Since their emergence, natural history

museums and the production of natural history knowledge were constituted by a heterogeneous group of actors.

More generally, Pestre (2003) critiques the work of Gibbons et al. arguing that the 'new' mode of knowledge production is a recent invention and that it is a too a-political model. For Pestre, mode 1 never existed in a pure form. Thus, the most interesting contrast is not in historical terms, but the fact that heterogeneous regimes of knowledge production can co-exist.

*Boundary Objects*

In museums of natural history, science connects participants from several distinct social worlds: amateurs, professionals, patrons, etc. If they wish to cooperate - when the world of these actors intersect - a difficulty appears: the task of reconciling the meanings of (the same) things in these different worlds (Star and Griesemer 1989:388). To examine how museums manage both diversity and cooperation, Star and Griesemer have coined the term 'boundary objects'. In their own words, boundary objects are

> those scientific objects which both inhabit several intersecting social worlds […] *and* satisfy the informational requirements of each of them. Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individualist use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds (Star and Griesemer 1989:393).

Star and Griesemer (1989:410-1) define four types of boundary objects:

- *Repositories*. Ordered 'piles' of objects which are indexed in a standardized fashion such as museums or libraries.
- *Ideal types*. Vague but adaptable objects such as the species, diagrams, and atlases.
- *Coincident boundaries*. Objects with the same boundaries but different internal contents such as maps of California.
- *Standardized forms*. Methods of common communication across dispersed work groups such as standardized forms.

In natural history, boundary objects are produced when theorists and amateurs collaborate to produce representations of nature. Among these objects are specimens, field notes, museums and maps of particular territories (Star and Griesemer 1989:408). Their boundary nature is reflected by the fact that they are simultaneously concrete and abstract, specific and general, conventional and customized, and often internally heterogeneous (Star and Griesemer 1989:408). Museums, for example, lie at the intersection of different epistemological infrastructures and serve as boundary objects between the past and the present and between the known and the unknown (Hedstrom and King 2003:35).

To the different kinds of boundary objects listed by Star and Griesemer we have to add digital libraries, as they too have been described as boundary objects.

> A digital library is a heterogeneous network of users, researchers, funders, operators, and other people; of documents, images, databases, thesauri, and other information artifacts; of practices and understandings; and of technology. It is a boundary object, both created and used by different communities for different purposes. It is the locus of multiple translations as various participants try to enroll others to ensure that the DL [digital library] meets their needs (Van House 2003:upd).

Apart from specimens, notes, museums, maps, and digital libraries, boundary objects have also become to signify non-material things: for some, boundary objects include discourses and processes (Wenger 2000:236), while others have focused on temporal boundary objects (Davies and MacKenzie 2004). In this thesis too, I will expand the concept of boundary objects beyond mere 'thinginess'.

Apart from boundary objects, another way to ensure collaboration is the use of standardised methods for labelling and collecting. These methods can be learned more or less easily by amateurs since they don't require an education in professional biology to understand or to execute them. But, at the same time they render the information collected by amateurs amendable to analysis by professionals (Star and Griesemer 1989:406). On the one hand, data coming from amateurs must be accurate and reliable. On the other, directions for amateurs cannot be made too complicated. More abstractly, the 'allies enrolled by the scientist must be disciplined, but cannot be overly-disciplined' (Star and Griesemer 1989:407).

Museums can thus be described as 'boundary organisations' since: they provide the opportunity and incentives for the creation and use of boundary objects, they involve the participation of actors from both sides of a boundary, and they exist at the frontier of relatively different social worlds (Guston 2001:400-1). As boundary organisations, museums are involved in co-production in two ways: they facilitate collaboration between scientists and non-scientists, and they create the combined scientific and social order through the generation of boundary objects and standardised packages (Guston 2001:401).

## 1.5. Professionals and amateurs: history, symmetries, asymmetries and marginality

The concept of boundaries is useful to understand how professions came to be distinguished from one another – experts from laymen, science from nonscience, etc. (Lamont and Molnar 2002:177). The boundary I will be most interested in throughout this thesis is that between amateurs and professionals. In the final section of this chapter I examine this boundary from three points of anchorage: its emergence, the symmetries and asymmetries involved, and the marginality of amateurs. First, then, let's turn to the historical context of the (co)emergence of amateurs and professionals.

*Co-emergence*

For Findlen (1994:10) a common problem in the history of science is the neat division between 'scientists' and 'amateurs'. She argues that professional and amateur systems of knowledge could and did co-exist in the 16th and 17th centuries. It is commonly held that the emergence of amateurs paralleled that of professionals:

> As professionalization occurs, those who retain their serious, albeit part-time, commitment to the activity are gradually transformed into amateurs (Stebbins 1992:14-5).

Concomitant with professionalisation, amateurs were constructing a new identity through 'amateurisation' in the 19th century (Alberti 2001:117, 132-6, see also Taylor 1995:504). Through this evolution a semantic switch of the term 'amateur' has occurred (see Stebbins 1992:10, Drouin and Bensaude-Vincent 1996:417-8). 'Amateur' etymologically comes from *amatore*, the one who loves, and denotes a devotee who takes an interest in a particular activity out of 'love' (see Stebbins 1977). But whereas up to the 19th century amateur meant the one who loves, there was a shift of the term to signify the one who does it in spare time (Alberti 2001:116).

Towards the end of the 19th century, the contrast between 'amateur' and 'professional' was reinforced (Drouin and Bensaude-Vincent 1996:418-9). Mathematization and the growing complexity of practical laboratory work were two key factors of the disappearance of the amateur from certain sciences (O'Connor and Meadows 1976:78).

> [P]rofessionalization, involving as it did increasing stress on credentials, research apprenticeship, and sophisticated instrumentation, pushed even the wealthy amateur toward the sidelines (Lankford 1981:289).

In natural history there have been important shifts in the nature of knowledge practices which affected amateurs. There was a transition from observational and comparative approaches (for classification and morphology) to include experimental, manipulative and quantitative techniques (Star and Griesemer 1989:394). In Pickstone's (2000) words, natural history has been supplemented by other 'ways of knowing'. *Natural history*, the description and classification of things, was superseded (although not completely replaced) by the *analysis* of things into various kinds of elements, and *experimenting* to control phenomena and to systematically create novelties.

Throughout these shifts, professional scientists have sought to demarcate themselves from amateurs. Historically, the development of the research natural history museum was an important stage in the professionalization of natural history work, and an example of the changing relationship between amateurs and professionals (Star and Griesemer 1989:391). In America during the first decades of the 20th century, professional biologists sought international credibility by distinguishing themselves from amateurs, establishing advanced degrees as credentials, and establishing specialised journals for publication (Star and Griesemer 1989:393). There were attempts to 'expulse' amateur science from professional science – to put it in Gieryn's terms. The creation of the museum was in effect a means for professional

zoologists to claim greater scientific authority for their work by distancing it from activities of amateurs and conservationists (Gieryn 1995:415). It has been argued that, in general, professions seek to establish their authority and autonomy through the construction of various boundaries around themselves (Fournier 1999:282).

By the end of the Victorian era, then,

> the sciences were rapidly dividing into a multitude of specialized domains, each requiring rigorous academic training and access to expensive and complex research facilities. The process separated amateurs and professionals […] Yet the amateur was not driven from the field (Lankford 1981:277).

Despite the increase of laboratory science, amateurs continued to collaborate with laboratory-based biologists (Alberti 2001). In natural history especially, amateur and professional developed a fruitful and continuing relationship (Lankford 1981:276) – and their collecting practices were united (Asma 2001:113). In today's museums too, the increasing professionalisation has not entirely excluded non-professionals:

> At the same time that […] staff hiring [is] more routinely based on certification, museums are turning to nonprofessional, noncertified, indigenous sources (Hein 2000:40).

In natural history museums amateurs were and still are a vital element. They ensure the museum's scientific success, as providers of specimens and information that scientists were and are too few to gather by themselves (Gieryn 1995:415). Thus, developments in natural history museums are to some extent dissimilar from the laboratory space discussed in the earlier sections of this chapter. The museum is a space where science doesn't seem to have closed itself off so hermetically as in the university or the laboratory.

*Symmetries and asymmetries*

Amateur invokes reference to the term 'professional'. Stebbins (1992:41-2) writes:

> the term 'amateur' should be used only with those activities that constitute, for somebody, a *professional* work role […] there must be a professional counterpart to the status of amateur.

In other words, amateurs are to be relationally defined, against the background of professionals and professionalism – and vice versa. However, while doing so:

> we must avoid the unidimensional thinking that pits amateur against professional in terms of, say, little versus great skill, intrinsic versus extrinsic reward, avocational versus vocational orientation, or leisure versus work activity (Stebbins 1992:58).

The term amateur does not mean that the work amateurs carry out is necessarily less pertinent:

> In natural history especially, 'amateur' science in Victorian Britain was anything but amateur in its conduct and contribution to learning (Withers and Finnegan 2003:335).

We should therefore analyse both amateurs and professionals symmetrically:

> More symmetrical accounts will not prejudge 'amateurs' and 'professionals' so much as look at the social processes involved in their formation and the context of their existence (Desmond 2001:15).

Yet, a priori, there seem to be some differences between amateurs and professionals, as

> professionals are seen […] as people who spend the majority of their working hours enacting their professional roles, roles from which they receive the bulk of their livelihood (Stebbins 1992:21).

Money is frequently seen as the major difference, as amateurs usually don't get paid. Yet, amateurs do sometimes receive money, even if they depend very little on it (Stebbins 1992:5). A monetary and organisational relationship is frequently established when amateurs are related to professionals (Stebbins 1992:39), even if the receipt of a fee for amateur efforts is rather symbolic (Stebbins 1992:54).

Apart from money, there are various other stated differences between amateurs and professionals. Professions are frequently distinguished from non-professions by identifying core defining characteristics:

> formal education and entry requirements; a monopoly over an esoteric body of knowledge and associated skills; autonomy over the terms and conditions of practice; collegial authority; a code of ethics; and, a commitment to a service ideal (Anleu quoted in Taylor 1995:499).

To roughly sum up the above features and translate them to science, amateurs differ in the degree and form of their socialisation into science (Lankford 1981:297). Amateurs thus occupy a marginal status, a status that is incompletely institutionalised (Stebbins 1992:120).

*Marginality*

Compared to professional scientists, amateurs enjoy more freedom (Lankford 1981:298). Their marginality thus surfaces, amongst other things, as a

tendency toward uncontrollability (Stebbins 1992:55-7, 2004:100-3). This uncontrollability is a feature that runs throughout the history of amateurs in natural history. Drouin and Bensuade-Vincent (1996:419) suggest that in the early 19th century,

> the difficulty was not to get the cultivators of natural history to work, since they volunteered and worked eagerly. Nor was it to gather reports, information and collections from them, since many local natural history societies included both volunteers of various degrees of training and a few paid naturalists, and were able to provide such materials. The main problem was that the cultivators of natural history formed an undisciplined crowd which the professionals would like to keep under their control.

For museum professionals to collaborate with amateurs thus means to manage an ambiguous and sometimes contradictory situation. As volunteers, amateurs are able to move more or less freely within the museum's institutionalised science; as scientists they tend to be controlled and fixed into a rigid system. However, this does not mean that this situation is temporary, that in the long run amateurs will either move towards professional science or be excluded from it. They are not necessarily on a trajectory to become either full members or non-members. Instead, amateurs can be on the 'periphery of practice',

> a region that is neither fully inside, nor fully outside and surrounds the practice with a degree of permeability (Wenger 1998:117).

The term peripherality suggests that

> there are multiple, varied, more- or less-engaged and – inclusive ways of being located in the fields of participation defined by a community (Lave and Wenger 1991:35-6).

‘Peripheries […] refer to continuities, to areas of overlap and connections, to windows and meeting places’ (Wenger 1998:120). Thus, being a member or ‘belonging’ to a scientific community is not an all or nothing relationship.

> Belonging, then, is not just an either/or categorical matter: it is also potentially a journey [...] One can belong more or less; and one can come, over time, to belong more – and, sometimes, less (Macdonald 2001:14).

Amateurs can belong to the world of professionals since the boundary between amateurs and professionals is not clear-cut. Drouin and Bensaude-Vincent (1996:417) write:

> Between the full-time naturalists – a few paid professionals […] – and the more or less literate lay public, there were also occasional practitioners who did not content themselves with reading but *practised* natural history by collecting specimens […] And presumably […] historians would find a number of other intermediate categories.

To distinguish a category between (‘unserious’ or ‘casual’) amateurs and professionals, Stebbins introduced the concept of ‘serious leisure’ (Stebbins 1992, 2004). He writes:

> serious leisure enthusiasts are usually more obliged to engage in their pursuits than are their less serious counterparts (Stebbins 1992:5).

For others, the amateur and the professional worlds are ‘two separate yet interconnected, antagonistic, yet mutually respectful worlds’ (Ellis and Waterton 2004a:upd). The boundary between professionals and amateurs is complex and porous as there are three sorts of flows between both (Waterton 2003). First, the concepts of science, the notion of scientific work as a

particular expertise can be challenged. Does publishing, for example, remove amateurs from the amateur category? A second flow is that of technologies. Published maps and card-punching technology are devices used by both amateurs and professionals. Third, money and capital is sometimes exchanged.

To describe ‘amateurs as experts’ (Waterton 2003) recaptures well the ambiguous situation of amateurs. Some amateurs are ‘experience-based experts’, that is

> members of the public who have special technical expertise in virtue of experience that is not recognised by degrees or other certificates (Collins and Evans 2002:238).

The term ‘experience-based experts’ refers to those whose expertise has not been recognised in the granting of certificates, while shifting the focus to experience as an important factor in the exercise in demarcation (Collins and Evans 2002:251). When we move towards experience as a criterion of expertise the boundary around science softens (Collins and Evans 2002:253). The boundary is no longer between the class of professional accredited experts and the rest; it is between groups of specialists and the rest. In this sense, amateurs can be ‘lay experts’ (Epstein 1995).

### 1.6. Summary

The main absences I have identified in academic work throughout this literature review can be summarised in five points. I would argue that these absences need more attention and it is – no surprise - these I am going to address in this thesis. Scholarly work has not paid much attention to (and in this thesis I will be):

- exploring a museum as a place where different social spaces intersect, where boundary objects are produced, and where walls are unmade;

- expanding the common focus of science studies on laboratories by concentrating on museums as sites of knowledge production;

- analysing the interrelationships between amateurs and professionals in the co-production of scientific knowledge;

- doing the ‘museum test’ for ANT;

- paying attention to the processes, materialities, permeabilities and ambiguities of boundary-work.