# Science and Technology Museums Meet STS
## Going Beyond the Galleries and Into the Practices

**Roberta Spada**
*Politecnico di Milano*
*National Science and Technology Museum "Leonardo da Vinci"*

**Abstract:** Science and technology museums and centres are usually conceived as settings for science communication. In the STS tradition of Public Communication of Science and Technology (PCST), galleries and exhibitions represent the museum side most exposed to research. However, these museums are complex organisations where artefacts are not only exhibited but also collected, stored, studied, and preserved because they make the technoscientific heritage of a place. In this Scenario, I review the literature in PCST/STS and Museum Studies to show how the PCST approach is insufficient to study science and technology museums because issues about the private side and heritage are not addressed. I argue for the need for STS to enter the private sides of science museums and study them as places of technoscientific knowledge production. The Scenario suggests an STS approach situated in sociomaterial ecologies to study museum practices which, as discussed by Museum Studies, are the sites where narratives about science and technology arise.

**Keywords:** science and technology museums; museum artefacts; heritage; sociomaterial ecologies; museum practices; narratives.

**Corresponding author:** Roberta Spada, Department of Design, Politecnico di Milano, Via Durando, 10, 20158 Milano (MI), Italy.
E-mail: roberta.spada@polimi.it

## 1. Introduction

Science and technology museums and centres are usually conceived as places where to engage with hands-on science and technology or the history of great accomplishments in these fields. In Science and Technology

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Studies (STS), studies in Public Communication of Science and Technology (henceforth, PCST) have fully embraced this view and thoroughly studied their contributions to science communication. Nevertheless, galleries, exhibitions, and public events are only one of the many layers that make up the complex organisations that are science museums and centres.

In this Scenario, I review the literature in PCST and Museum Studies[1] to analyse key issues around object-based science and technology museums[2] and argue that the PCST approach is insufficient to study them as a whole. STS must mobilise other traditions to go beyond galleries and engage with the practices of S&T museum practitioners' daily work. The reflections in Museum Studies about science museums and how their practices and materiality affect narratives about science and technology are very similar to what STS ask about other organisations such as laboratories. Thus, an integrated approach can help answer critical questions about the practices, objects, and people that participate in the construction of the narratives about technoscience within and beyond exhibitions.

In the first section, I position science and technology museums in the debate of PCST to show that, despite the invaluable theoretical tools developed to understand how science and technology are publicly displayed in such museums, the field generally misses an understanding of the museum that goes beyond the gallery. Instead, Museum Studies attend to the private sides of museums. In the second and third sections, I address two recurrent topics in science museums literature – the role of museum practices and the role of objects in science museums – to show their value in understanding the construction of narratives about science and technology. Finally, by drawing from these insights, I propose an integrated approach based on conceiving the S&T museum as a sociomaterial ecology.

## 2. Science and Technology Museums and Science Communication

Studies in PCST tend to refer to science and technology museums and centres in relation to their publics, as they consider these places as one of the possible settings of science communication, where questions about the relationship between science, technology, and society unfold (Bucchi and Trench 2014, 1-14; Davies and Horst 2016, 4). According to Bernard Schiele (2014), S&T museums and centres have several public objectives that range from making the publics aware of the latest discoveries of science and displaying a history of inventors and discoveries to contributing to science education and helping the publics develop skills and competences. Thus, the role of science museums and centres in society is "to make science and technology present in the social imagination and in the public space" (Schiele 2014, 44).

These institutions, too, have been influenced by the changing paradigms of deficit, dialogue, and engagement in science communication. Since the second half of the 20th century, museums have shifted their attention towards visitors. This shift goes hand in hand with the loss of safe resources, forcing museums to opt for marketability and a logic of profit in their internal activities, such as choosing blockbuster exhibitions over the valorisation of collections (DesRoches 2015; Poulot 2008, 24-28). The birth of Visitor Studies – a discipline focussing on why visitors go to the museum and how they behave in the gallery (Gregory and Miller 2000, 210-214) – and the expansion of science centres are also part of this shift (Schiele 2014). However, according to curator Robert Bud (2017), science centres have challenged the legitimacy of object-based science museums in a time of defunding and shifting perspectives towards these institutions. In fact, at the beginning of the 1990s, the "New Museology" paradigm called museums to prove their social relevance and to redefine their very methods and objectives as institutions, shifting the theoretical reflection towards understanding that the meanings of objects and collections are not value-free but contextual (Macdonald 2011; Vergo 1989). Therefore, while science centres demonstrated their social and market value by presenting themselves as places where to showcase cutting-edge science and technology and educate the publics about it, science museums could not count on that asset, leading to a major sense of crisis among practitioners (Bennett 2005; Bud 2017).

Today, S&T museums and centres have strengthened their relationship with the publics by adapting to the new participatory and dialogic conceptions of science communication (Bandelli & Konijn 2015). Some approaches entail co-curation and conceiving these places as "sites of deliberative democracy" that embrace broader social goals than just science communication (Cameron and Deslandes 2011; Pedretti and Navas Iannini 2021). Simultaneously, PCST has investigated the many social issues surrounding science galleries – e.g., matters of access and inequality in science museums and centres, that generate different attitudes towards the institution depending on the visitors' gender, class, and race (Dawson 2014; 2019) and how such issues contribute to configuring science communication as a "white, Western paradigm" (Finlay et al. 2021). Ultimately, one of the key objectives of PCST is to understand how science communication in museums and centres works. Therefore, whether they are interpreted as "brokers of participation" (Bandelli and Konijn 2015), safe places where to engage with contentious topics (Cameron 2005), or exclusive white, middle-class venues (Dawson 2018), the centre of the reflection for science communication is the public space of the museum/centre and its relationship with visitors. This is understandable since these studies focus on unveiling the very issues of presenting science in public and have developed invaluable frameworks and concepts to do so.

Nevertheless, such focus misses at least two important points that would bring more depth and context to what emerges from the galleries.

The first point is a lack of attention to the museum beyond its public facade, both in its physical spaces and its people. A museum is a complex organisation, where galleries – its public side – are only one part of its components, communication and exhibition being only two of its many duties. Indeed, according to the current International Council of Museums definition, a museum "acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment" (ICOM 2007). Although this definition is currently under revision – due to the ongoing debate about the changing social role of museums (Brown and Mairesse 2018) – we can consider it an operative description of the actions that museums put in place. In the case of science and technology museums and centres, the situation is no different. As demonstrated by Sharon Macdonald (Macdonald 1998b; 2002) in her ethnography of the making of the *Food for Thought* gallery at the London Science Museum, the narratives encoded in an exhibition stem from complex negotiations that entail both the team involved in its making and the many constraints that the museum poses as an organisation and institution, such as sponsorship, managerial rearrangements, and practical decisions about what competences and professional figures ought to design an exhibition.

Macdonald's account is in line with what research in Museum Studies has been doing for at least thirty years, and that I will present in the next section: investigating from within the practice how museums construct knowledge and narratives about what they display. At the same time, STS have been studying the emergence and circulation of scientific knowledge and narratives in laboratories and industries, such as in the case of Laboratory Studies (Latour 1987), and in public arenas where technoscience is co-produced with society and politics and is part of an imaginary for the future (Jasanoff 2004; Jasanoff and Kim 2015), although they have not given enough attention to science museums and centres as institutions that construct imaginaries and knowledge about technoscience.

The second element that current science communication approaches miss applies primarily to object-based science and technology museums. Current studies discard aspects about heritage and artefacts, which are vital from a museological perspective because they represent the very reason why museums exist as institutions, as I will argue in the fourth section. Science communication contemplates objects, too, and many science educators and practitioners have asked how objects and their affordances – mostly interactive exhibits – invite experiences and learning (Davies and Horst 2016, 159-185). Yet, both its study and practice in the museum have not looked in depth at object-based galleries and at how presenting material objects as "texts" of a specific story generates certain narratives and understandings of the history of science and technology (Boon 2011).

## 3. From the Gallery to the Storeroom: The Practitioners' Point of View

Museum Studies have looked more reflexively at the role of museums as institutions and producers of knowledge, especially after movements like the "New Museology" at the end of the 1980s. The museum started to be conceptualised as a medium, with the same issues of authorship, framing, and encoding/decoding as television or newspapers (Gregory and Miller 2000, 196-219). However, as Eilean Hooper-Greenhill (2000, 12) remarks, "[i]n beginning to consider the museum as a communicator, we realise that we are just at the beginning of finding the answers", meaning that we should go beyond considering museums as institutions only devoted to communication and link the theoretical understanding of communication models to museum practice in general. For media scholar Roger Silverstone (2003), the museum-medium has three distinctive features: it holds objects and constructs precise biographies that are re-inscribed by the visitor into their personal experience; it constructs its texts according to different logics and ways of ordering and classifying both collections and exhibitions; it mediates content through time and space.

Answering the call by Ludmilla Jordanova (1989) for exploring how museums constructed the idea that objects tell a univocal story about abstract concepts (e.g. childhood), museum scholars have developed historical perspectives about museum practices related to knowledge. The seminal work by Hooper-Greenhill, *Museums and the Shaping of Knowledge* (1992), asks precisely what counts as knowledge and rationality in the museum. Following Michel Foucault's *The Order of Things*, the forms of reason and regimes of truth of the museum lie in the practices of collecting, ordering, and classifying objects. Thus, three different discourses about objects and knowledge unfold along with the three *épistèmes* – the Renaissance, the Classical Age, and Modernity – reflecting different circulations of power and different understandings of the truth (Hetherington 2013).

Drawing from Hooper-Greenhill, Macdonald (1998a) develops a historical perspective on science museums and their changing role. If, during the 16th and 17th centuries, collections were developed around ideas of observation, mathematisation, and natural order, in the 19th century, museums built their presence and collections upon the modern idea of displaying progress and the order and control of nature. Much of this demonstration of power came about with the World Fairs, which have influenced museums in many ways since the 19th century. Not only do many collections of modern science museums come from what was exhibited at these expositions; Fairs also granted public endorsement and funds to S&T museums, inserting them in their moral and political economy, due to the shared mission to disseminate science (Canadelli et al.

2019; Friedel 2019). Such mission is prioritised during the 20th century when science museums moved away from the institutional analogy with libraries and started looking for appealing narratives to make science attractive to the public (Macdonald 1998a, 11-12). These narratives of heroes, innovation, and progress create a mythology about both present and past science and technology. Representing myths and heroic figures is understood by curators both as problematic – because it serves precise interests by presenting a morally charged idea of science – and as a great source of science museums and centres survival, because the publics crave such stories (Jordanova 2014). Similarly, Gregory (2016) shows how presenting a rhetoric of progress associated with technology and innovation in science centres is problematic, especially if presented as a socially-oriented dialogue. Indeed, these tendencies reveal how science museums depend on a wide range of stakeholders, like scientists and science enthusiasts, whose opinion counts as much as that of curators.

These historical works highlight how certain discourses about knowledge, science, and technology have been intertwined with discourses about exhibitions and collections. Most of all, they bring forth the invaluable viewpoint of the curators and heritage experts working in museums. However, their effectiveness falls short when studying the present state of science museums and centres, and especially when it comes to processes and narratives within them that still have not been historicised.

This is not to say that scientific museology completely lacks sociological perspectives. Concerning science practitioners and enthusiasts, Soraya Boudia and Sébastien Soubiran (2013) explore the relationship between these interest groups and heritage in France and conclude that scientists have an ambiguous relationship to heritage and the history of science: on the one hand, heritage is a means for scientists to make themselves intelligible; on the other hand, they wish to talk more about present science and technology rather than the past. Even Macdonald's *The Politics of Display* (1998c) goes towards a more sociological approach. In line with the claims of *New Museology*, she asserts that both scientific facts and exhibitions are publicly presented as unequivocal and objective rather than as outcomes of specific processes:

> By analogy with the use of the term "black box" […] in the sociology of science […], we might suggest that exhibitions tend to be presented as "glass-cased" – that is, as objects there to be gazed upon, admired, and understood only in relation to themselves. (Macdonald 1998a, 2)

For example, in describing his experience with the controversial exhibitions *Science in American Life* and *The Crossroads: The End of World War II, The Atomic Bomb and the Origins of the Cold War*, Thomas Gieryn (1998) analyses the internal political negotiations and compromises that the directors and curators of the Smithsonian Institution, the pub-

lics, the press, and stakeholders went through, linking the debate to the broader context of the Science Wars and the question of which interest group between curators and veterans' organisations had authority over the history of the Hiroshima bombing.

STS traditions such as the Social Construction of Technology and Laboratory Studies have referred to black boxing as a common practice in science and technology. They understand the act of opening the black box as going into the private, inaccessible places where technoscience is constructed (e.g., laboratories, industries) to understand what happens from within the practices, and to grasp the tacit knowledge and assumptions that are discarded or deliberately concealed when presenting technoscience to the public (Latour 1987; MacKenzie and Wajcman 1999, 22). Instead, for Macdonald, opening the black box of exhibitions means asking questions of power, authorship, exclusion, political and economic interests in exhibitions, and the relationship between the values we attach to science and the representations we make by exhibiting it. In the black box metaphor, this is still looking at the surface of the box, i.e. the public presentation of science, technology, and their history and social value. The practices that happen inside the box besides exhibition-making – and that, even indirectly, allow galleries and public narratives to exist – remain understudied, despite their utmost importance to museum practitioners who have underlined how the private side of the museum is hardly ever an object of scholarly attention, both in museums of science (Alberti 2017) and of other disciplines (Brusius and Singh 2018, 2; Domínguez Rubio 2020, 15).

What is worth asking now is what are the practices and private places of science museums and centres that would benefit from an STS analysis beyond PCST, and what is their impact on public narratives about science and technology in the museum. Curator Sam Alberti (2017) identifies three practices besides exhibiting and engaging the public in the science museum: to collect, to store, and to study. Criteria of collecting vary and are not always logical or scientific; they do not always respond to the mission of illuminating a particular historical period or aspect of science and technology. For instance, scientific instruments have been collected with many different scopes in mind; some are kept for aesthetics and spectacle, others are performatively collected as expressions of power or pride (Alberti 2019). Collections are ultimately made by individuals who may have personal motivations to collect certain items, while institutional reasons may involve national identity and public good (DeVorkin 2006). These values and motivations impact how an object will be classified and catalogued in the museum or presented to the public. Strong emphasis is also put on contemporary collecting and how it makes collections dynamic, more relatable to contemporary science and technology, and open to participatory approaches, while also posing practical issues (Alberti et al. 2018; Boyle et al. 2017, vi-ix): How to collect enormous research equip-

ment such as colliders or immaterial objects such as software? How to make the uncertainty of science-in-the-making intelligible through artefacts? What stories will come out?

The acts of collecting and studying objects are united by the venue where they happen: storerooms. Although such places have become a metaphor for the confiscation of artefacts from the public domain (Poulot 2008, 24-28), they deserve an STS study for two reasons. First, museum practitioners view storerooms in quite the opposite way, as places for conservation and research. Secondly, they are the place where many objects spend their whole museum life, another aspect that practically impacts and reflects the narratives circulating in the museum. Storerooms hold objects that are not displayed for many reasons: they could be too fragile, too big, too small, morally sensitive, controversial, collected randomly, or unknown. People who have access to these spaces develop unique relationships with objects. Object-love, the affection and emotions that keepers attach to objects, shape storerooms as affective places and influences the work ethically and practically in conservation (Geoghegan and Hess 2015). Storerooms are also liminal spaces for scholars and museum practitioners who are granted access (Brusius and Singh 2018, 1-33), and the same scholars and curators who access storage are the ones who construct narratives about science and technology for displays and dissemination. Many questions arise: how is meaning maintained in storerooms? Who and what concurs to the production of meaning? How does object-love or other emotions affect the stories taken out of stores and into the gallery? Answers to these questions lie in the practices happening in storerooms, from everyday curation and conservation to allowing donors into the storage and establishing a relationship with them centred on the object they are donating and what the museum will make of it.

In conclusion, museology has been able to develop critical perspectives on science museums, by being careful to represent their many layers and by inserting them and their contentious role in the context of society. As the exhibition is only the tip of the iceberg-museum, I suggest that the relationship between science, technology, and society in the museum starts way before the exhibition, which is the cementing of a specific narrative through the display. However, although the many historical perspectives on science museums have illuminated the evolution of ideas about the S&T museum, its practices, and professions, we could look more attentively at the present through an STS lens based on Laboratory Studies or, as I argue below, sociomaterial ecologies. In fact, science museums are yet another organisation where narratives and knowledge about technoscience are constructed. Practices such as collection, donation, study, and conservation, happening in collection sites, storerooms, and research areas, are well known by practitioners in the intimacy of their institutions, and they ultimately impact the stories that are told through the collections and the very image of technoscience kept in science muse-

ums. Relevant questions for STS would be: how do narratives form in the study, conservation, and curation of a collection of objects? How do object classifications contribute to creating a specific narrative of science and technology? Engaging with such questions would show S&T museums in their process of producing results and stories about science and technology. As I will argue in the discussion, STS have their traditions of understanding ecologies of practices, people, and objects, especially in organisations, which would give unity to the understanding of the museum-institution, where all the practices are intertwined together, whether they refer to exhibition-making or curation and research.

## 4. The Role of Objects in Science Museums

As Sandra Dudley puts it, "Museums are about things" (2012a, 1), meaning that the very reason why museums are distinct institutions from libraries and archives is that they hold, preserve, and exhibit collections of objects. Thus, including objects and materiality in an STS study of science museums is necessary because they are the centre of museological practices. Indeed, one could argue that STS have developed invaluable theoretical lenses to integrate materiality and ask why we need to integrate Museums Studies approaches with already consolidated material theories in STS. Museum Studies attend to a particular kind of materiality: material culture. And as I argue in this section, being sensitive to this concept allows us to look at materiality from within the practice.

Material Culture Studies permeate museology, increasingly demystifying the misconception that objects in the museum are dead. For practitioners and scholars, objects have value beyond the stories they can bring due to their physical and sensible properties, which are fundamental to their nature and the possibility of engaging with them (Dudley 2010, 1-17). Reviewing the dense debate around materiality in this field goes out of the scope of this paper. Yet, it is worth noting that "material culture" does not refer to a univocal definition or approach. Prown (1996) describes two kinds of practitioners approaching it: one, the "farmer", is more interested in material and tangible aspects of the artefact – e.g., its shape, colour, size, material, chemical composition, structure – while the other one, the "cowman", is more interested in the social and cultural context that can be derived from the artefact and its material form. The two approaches, either emphasising more the *material* or the *culture* of an artefact, span across the whole literature (Dudley 2012a, 5; 2012b, 4), and they also pertain to science museums.

Out of the many approaches to material culture, science museum practitioners generally refer to the biographical approach to objects discussed by Sam Alberti in his seminal paper *Objects and the Museum* (2005). Drawing from *The Cultural Biography of Things* by Igor Kopytoff,

he argues that science artefacts should be studied as sources of their two lives: the one in their context of use and the one in the museum, which is no less important. Through the movements of artefacts from their context to the acquisition, from the storeroom to the display and across collections and classifications, we can follow both the object in its changing meaning and status and the museum in its transformations. Artefacts become the standpoint from which to study the museum, the people, and the relationships between them:

> In doing so, we study a series of relationships surrounding objects, first on the way to the museum and then as part of the collection. These are relationships between people and people, between objects and objects, and between objects and people. We encounter not only collectors, curators, and scientists but also visitors and audiences. (Alberti 2005, 561)

The biographical discourse is familiar to STS. In parallel to Alberti, objects' biographies have been used by Lorraine Daston (2000) to talk about scientific objects, not just as material entities but broadly speaking as what scientists invent and discover. Daston's and Alberti's claims resonate with material semiotics. Materiality is relational; it cannot be separated from the enactment of relations, which is done through the practices. In other words, through the practices, the performance of the material goes hand in hand with the performance of relations (Law 2009). Alberti refers to Actor-Network Theory when talking about the agency of museum objects and claiming that biographies do not animate things but allow to study the meanings and values attributed to them, in line with the theory (Volonté 2017).

So, if we want to study S&T museum practices and materiality, objects' biographies allow us to do so from a museological perspective akin to material semiotics. By looking into the biographies of museum objects, we can explore the reality enacted in the relations between objects and people. Thus, studying the biographies of objects in their museological life allows us to enter the materiality of everyday practices in science museums and, ultimately, the construction of narratives and knowledge through objects.

When we look at the museum practices, we see that they are highly affected by the materiality of an object, which offers peculiar affordances that shape museum work. Science museums collect objects that enormously vary in terms of shape, dimension, fragility and conservation, materials, and texture. If one must exhibit a space aircraft, collect a telecommunication infrastructure, or preserve a personal computer composed of different plastics and circuitry, every object will impose distinct possibilities, bans, and conditions. Studying these practices biographically is what best allows us to make sense of material culture in science museums because it puts the objects at the centre of the study as much as they

are central to the communities of practice of the museum. As I will argue in the next section, this allows us to define museum practices as particular sociomaterial practices.

## 5. Museums as Sociomaterial Ecologies?

In the previous paragraphs, I argued how current approaches in PCST and STS only look at museums' public side due to their necessity to study how science is performed in public. I claimed that S&T museums are a fascinating object of study for STS because they are complex organisations, like laboratories, where narratives about science and technology are enacted. Thus, an STS question that is worth asking is what kind of shape technoscience takes in the narratives and knowledge produced in the museum, not only in exhibitions but in all the hidden practices of the museum.

I showed how Museum Studies have produced historical reflections from the practitioners' perspective about the context and role of science museums in relation to knowledge and practices such as collecting, storing, and studying objects. These practices are interesting to investigate from an STS point of view because they allow us to see how narratives practically circulate in the museum environment. At the same time, STS cannot overlook the attention that Museum Studies pay to materiality as material culture, because materiality in the museum is not contingent on the work; it does not only lie in its infrastructures and tools. It is the object of the museum practices and what makes it an institution of its own.

What kind of STS perspective could better understand science museums in their entirety? Surely it cannot leave out either the role of S&T museums and their practices and relationship to knowledge or artefacts and materiality. My suggestion is to study S&T museums as sociomaterial ecologies. The ecological approach (Star 1995; Star and Ruhleder 1996) allows us to see the museum as a unitary organisation where the practices are intertwined and inseparable from the social and material infrastructure, which entails material and immaterial modules made of technologies, standards, know-hows, and visible and invisible labour to maintain the ecology and its equilibrium. Concretely, this means that the practices of collecting, storing, curating, and exhibiting a particular collection or artefact are entangled together and to other practices related to other objects that collectively construct narratives and knowledge about science and technology. The relationship between the private space and the gallery also offers reflections about the boundaries of the organisation and the work required to trace them, made of other practices not strictly related to collections such as exhibition design, public relations, fundraising, and science communication.

The unit of analysis of a similar study should be the objects because material culture is what makes constitutes museums as institutions. While organisation studies akin to STS see technological artefacts as what helps workers do their jobs, in museums, artefacts are not a tool but the object of practitioners' work. The practices are performed with the objects but also on the objects. For this reason, one should understand the ecology of the museum as sociomaterial (Barad 2007; Orlikowski and Scott 2008). Sociomateriality helps put artefacts at the centre of the analysis because it methodologically demands cutting the object out of the broader ecology, without discarding the latter's value (Bruni 2020), in line with the object's shadowing through its biography in the museum (Alberti 2005).

## 6. Conclusions: STS and Science and Technology Museums

In this Scenario, I claimed the value of considering science and technology museums as venues for STS ecological approaches and how integrating STS with Museum Studies helps to be sensitive to issues regarding material culture and knowledge in the museum and the practitioners' point of view, shifting artefacts and their biographies at the centre of the analysis to investigate how the hidden practices in the museum's "black box" participate in the construction of narratives about science and technology.

The current general shift in Museum Studies and practice towards reflexivity profoundly resonates with the STS call to understand science, technology, knowledge, and expertise as situated in a cultural, social, and political environment. They are organisations that produce narratives and imaginaries about science and technology. Moreover, the exchange between the fields would be bilateral. Science museums are not interesting organisations to study per se. An STS ecological perspective on S&T museums would benefit museum practitioners by offering an external contribution to museum work that could foster a reflexive understanding of the museum in relation to the broader environment of science communication and the relationship between science, technology, and society.

### Acknowledgements

## Notes

[1] The PCST literature that I review represents the mainstream anglophone tradition of studies in Science Communication in Europe and North America. As far as Museum Studies are concerned, I refer to the British and American mainstream traditions of the last forty years in Museology and Material Culture Studies.

[2] Unless otherwise stated, when writing "science and technology museum", "science museum", or "S&T museum", I will refer to object-based science and technology museums, which differ from science centres because they keep collections of historical artefacts (Friedel, 2019; Friedman, 2010). When writing only "museum", I will refer to all museums in general, regardless of their disciplinary orientation.

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