On the Evolution of Scientific Display and New Exhibition Design – Learning and Communication in the Museum Environment through Times

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Overview

A vast array of transformations have inundated the scientific exhibition world in the past fifty years, bringing considerable challenges to museum professionals who had to ride with difficulty the wave of change from object-based professional practice to reconsiderations of social purpose and communicative efficiency. Spatial and sensory factors that make up the holistic embodied experience of the visitor may emerge as increasingly relevant in the future – especially with regards to recent ‘experientially-based’ approaches to practice – affirming a role at the very core of communicative and learning processes. This paper illustrates the revolution with the learning, communication in museum environment through times, argues that the understanding of the scientific exhibition as a medium ‘unique to itself’, but also play a significant part in the learning process, as a constant and complex series of experiences. Strengthening reflection on the place of the embodied experience in communication and learning may thus encourage practitioners in the future to imagine new roles for science museums, with a more complex understanding of ‘what it does the best through times’ and ‘how to move it forward’.

Introduction

This study is to provide a brief schematic account of the evolution for science museums development, with intention is to select key examples in order to highlight some of the major continuities and shifts within the history of exhibition design, especially in the science museum context. In doing so, the author divides the account into four unequal periods. The first part deals with conceptions of scientific systems in early cultures, then moves to the early modern museums of science. Later, the growth of collecting during the Renaissance fostered the beginnings of ‘scientific’ ways of knowing. And the development of world fairs and the rapid expansion of public museums of science, represented the beginning of the modern museum, as a new approach to exhibition design emphasised a new dedication to combining functionality and aesthetics. In the aftermath of the first introduction of digital technologies in the twenty-first century, in addition to the past-focused industrial heritage and the forward-looking interactive and multimedia display technologies, there was an increased number of exhibitions inside museums of science attempt to interact with their audience in a bigger environmental setting. The issues of augmented reality, digitally augmented materials and embodied interactions around the space also fostered the changes on the digital layer brings for curating scientific exhibitions in science museums. Those augmentations changed the original spatial formed and acted as a new genre of communication for science museums.

Conceptions of scientific systems in early cultures

There has been a long history of creating a place to look backward and preserve the early history of human activity. As mentioned by Antonello Marotta in his article, some of the earliest remnants of the human impulse to remember can be found in caves. The earliest forms of proto-museums can be found around the third and second millennia BC, as those palaces, temples, and libraries of Mesopotamia, where the preservation and communication of knowledge began (Marotta, 2012).
However, as Forster claimed, the word ‘Museum’ was first revived in 15th-century Europe, and it did not come into general usage until the late sixteenth century (Forster, 1961). The word ‘Museum’ derived from the Greek ‘Mouseion,’ which means ‘a temple of the Muses.’ More specifically, as it is mentioned by Paula Yong Lee, the French term ‘musée’ directly referred to the Hellenistic Mouseion of Alexandria (Lee, 2014). The date of its foundation was 295 BC when a former pupil of Aristotle was chosen to be in charge of the twin institutions, the Library and the Mouseion (as fig. 1), both of which have a significant impact on the building up of scientific systems in early cultures.

The institution of libraries has a long history, as many ancient and medieval civilizations have their great libraries, such as in Egypt, Mesopotamia, India, Syria, Greece, Rome and the Islamic world (Findlen, 2000). Unfortunately, all of them have perished beyond redemption due to the passage of time and its vicissitudes. But from what we know, there is no doubt that the most famous among them all was the ancient library of Alexandria for, not only was it the largest in all antiquity, but it was also associated with a remarkable movement of scientific research so that scholars flocked to it from all over the Mediterranean (Fraser, 1972), it soon became a major centre for learning and scholarly research, particularly in the fields of astronomy, geography, mathematics, and medicine (Durrell, 1986). Even after its disappearance with the decline of the ancient world, it continued to survive in the memory of medieval authors, just as its fate continues to be a debated question among scholars to this day.

![Figure 1: (Left) Spatial planning of the Mouseion in Alexandria. (Right) The cross-section of the Mouseion](source)


As regards the Mouseion, it followed the well-known basic patterns of the two famous Athenian philosophic schools, the Academy of Plato and the Lyceum of Aristotle (Empereur, 1998). It was common belief to attribute philosophic and artistic inspiration to the Muse and some sometimes even scientific, as Vitruvius claimed, quoting the story of Pythagoras who believed that he would not have made a certain mathematical discovery, had it not been for the inspiration of the Muses and to whom he sacrificed and gave thanks (Vitruvius & Morgan, 2001). The combination of science and literature was indeed best represented at the Mouseion of Alexandria. The spatial layout of the Mouseion is described by Strabo in the following words: “It was part of the royal palaces, it had a walk peripatos1, an arcade exedera2 and a large house in which was a refectory for the members, as shown in fig. 1 right (Empereur, 1998). Public teaching in the form of lectures and symposia, occasionally attended by the King, may also have taken place and it is generally

1 Peripatos was the name of the beltway-like road that surrounded the Palace along the foothills of the sacred rock at a level slightly higher than the historic Tripodon Street.
2 Exedra was a semicircular recess or pilaster, often crowned by a semi-dome, which is sometimes set into a building's façade or is free-standing.
believed that teaching gradually increased with time. In spite of the fact that by the end of the Ptolemaic rule in Egypt and the arrival of the Romans, scholarship tended to be on the decline, yet the Mouseion in Alexandria still continued to offer the best academic training in the ancient world (Errera, 1997).

In addition to the library, the space of the Mouseion included rooms for the study of astronomy, anatomy and even a zoo of exotic animals (Finashin, 2015). With the founding of these twin institutions, the right approach to scientific studies on a sound basis was established from that moment, and it is perhaps no exaggeration to say that for the first time, the principles of a scientific method of research were developed in various disciplines with highly impressive results in physics, geography, mathematics, medicine and biology... (Forster, 1961). The Mouseion of Alexandria can be regarded as a hybrid born of science and philosophy, with its research centres, laboratories, and technical communities.

As the Mouseion of Alexandria first formed the conceptions of a space embodying scientific system and proto-museum from the ancient and medieval civilisations. After that, a mnemonic technique based on spatial and visual logics, the memory palace took root in Ancient Rome (Uricchio, 2012), where the visitors essentially mapped memories into an imaginary architectural space by rehearsing the passage through space (or remembering an already familiar space), and mentally adorning the room with distinctive visual associations, so, not only can the ‘palace’ serve as an organised repository of changeable memory cues, but the user can easily change their routes and access different ‘rooms’ and their memory cues more or less on demand.

With newly awakened interest in a golden past, especially in the beginning of the Renaissance, the desire to remember the past and make a new legacy intensified. An architecture as a repository of miscellaneous knowledge and relics was demanded by scholars. With this background, the perception of the museum as a theatre began to emerge from the 16th century as it is mentioned by Antonello Marotta, it was with two parallel strands, the theatre of memory and the theatre of nature (fig.2) (Marotta, 2012). But Camillo’s theatre was different from the memory palace, as it was not a unique creation of each individual’s imagination, but rather Camillo’s invention, drawn and as far as we know and prototyped, there for other users to share. It was a public place.

![Figure 2: (Left) The plan of the memory theatre by Giulio Camillo; (Right) The theatre of memory in 3D. Source: Akademie Verlag, 2000](image_url)

This place reveals a coherent system of cultural knowledge, a taxonomy of early scientific references and beliefs, complete with scrolls and visual signs. What is so striking about Camillo’s construction is that it should take a seemingly abstract idea (memory based on place theory) and turn it into a real structure. His theatre embodied the idea inherent in the tradition of the ‘art of memory’ that knowledge rested on memory and that the act of remembering rested on the minds ability to ‘see’. That this happened in physically real structures with real pictures and objects provided an embodiment of a metaphorical ideal in which museums
could effectively take up residence—a place crowded with things that triggered acts of memory leading to knowledge.

In other word, Camillo’s theatre functions as a systematic repository of information, which plays an important role in forming the first conception of the science museum in early cultures. And soon in the mid sixteenth Century, Ulisse Aldrovandi began to assemble the collection of zoological and botanical specimens, as the theatre of natural (Marotta, 2012). Almost at the same time, Wunderkammern, also known as the cabinet of curiosity, which started a brand new chapter of the evolution of science museums.

The cabinet of curiosity – from collection to exhibition

In terms of museums of science, their origins can generally be traced to the curiosity cabinets (fig. 3) of Renaissance princes and scholars in the sixteenth Century (Findlen, 1994; Impey & MacGregor, 1985).

![Figure 3: Three illustrations of those original natural history cabinets. Source: Ferrante Imperato’s Dell’Historia Naturale (Naples, 1599)](image)

Though often an absolute given, thinking about how objects relate to their physical and architectural contexts can also be liberating and inspirational. From the spatial features of the scientific exhibiting in the seventeenth century, in making those natural history cabinets more attractive, architecture and interior design played an irreplaceable role to strengthen the exhibition effect. The physical setting designed by seventeenth century architects or artisans often had a strong architectural metaphor, but often became more important than exhibits in terms of its educational values. Even exotic items including ivory, enamels and soapstone were among the exhibits, but according to descriptions, most of them were just for abundant decoration. In most instances, those natural history cabinets are viewed as pieces of highly-decorated furniture, made from all imaginable exotic and expensive materials and filled with contents and ornamental details intended to reflect the entire cosmos on a miniature scale (Alexander, 1995), which makes the final assemblage exhibited in space reveals a strong connection between the natural and the manmade, creativity and instruments. It acted as a strange bridge between atavistic myth and Dawning scientific reality (Hoare, 2014).

It also anticipated the idea of the museum as entertainment and opened the way to presentation techniques more akin to those found in many new facilities (Marotta, 2012). Those collections which started by the father, was further expanded by the son, collection itself gradually grew to be an enormous one and was eventually opened to the curious public. As in 1659, when the collection passed into the hands of Elias Ashmole, and he presented the collection to the University of Oxford, with the belief that the study of nature was “very necessary to humane life, health, and the conveniences there of” (MacGregor, 1985). The original collection was sorted, catalogued and winnowed out in the university, and this randomly acquired cabinet of curiosities was taken over by the modern museum. This renaissance approach to collection and
display survives in various forms even today. Inside the Pitt Rivers Museum, Oxford, it keeps the original form and exists as an excellent example of a modern curiosity cabinet with modern collection methods, meanings and purposes. The museum is a typical example of Victorian Gothic architecture, although the large glass roof over the central part of the museum with cast iron shafts gives visitors a much lighter impression and provides them an open-plan space in the central hall, which has a number of black-framed cases containing natural artefacts by its sequence, as it shown in fig. 4.

Figure 4: The central hall of Pitt Rivers Museum still adopted the concept of cabinet of curiosities. 
Source: Oxford University Museum’s Achieve, edited by author

According to Imogen Burrell, the central hall space today still does not incorporate 3D technology, and there are no electronic display, digital learning materials, interactivity devices nor hand-held guides within its physical facility (Burrell, 2013). However, the absence of technology within the museum does not make it less significant than other museums. The simple, airy, open-plan layout space contains modern curiosity cabinets which act as physical ‘augmentation’, visitors are able to move freely from one cabinet to another to observe a cornucopia of entomology, taxidermy and animal skeletons which trigger the “wow effect”. The exhibition space attempts to make the exhibit more interesting and worth exploring, by appearing to offer choice to the visitor. Alternative and self-discovering routes are provided to them, so that they may have short and fragmented axial paths to be aware of several things simultaneously. In conclusion, collections assembled by those cabinets not only helped in shaping the collective knowledge, but helped to instantiate new concepts in developing scientific method.

Display changes and exhibition modernisation

While universal exhibitions, which were largely concerned with industry and technology, and most museums established in this period, with the exception of art galleries, could be seen as broadly scientific (Forgan, 1996), the nineteenth century is also characterised by the development of more specialised public museums of science. Many of the earliest of these, some of which were established in the late eighteenth century, were devoted to natural history, as was the Musée d’Histoire Naturelle, which opened in Paris in 1793 or Charles Willson Peale’s Museum in Philadelphia (1784), though this also included some scientific and technological artefacts. So too were many of the first ‘scientific’ museums to open in the New World (Sheets-Pyenson, 1989). Anthropology collections were sometimes incorporated in the natural history museums, as in the case of the Smithsonian’s Museum of Natural History, the Chicago Field Museum or
the Dutch Museum of Natural History, or as part of national self-representations as in the case of the National Museum of Denmark (1916). Museums specialising in machines and technical and scientific instruments also became a distinct type in the nineteenth century, beginning with France's Conservatoire National des Arts et Métiers, which was established in 1794. More specialist science museums often developed out of more general collections, as at the Museum of the History of Science, Oxford, which originated from the Ashmolean collection and the Natural History Museum, London, which originates from the British Museum collections (Hackman, 1992).

The architectural space was designed by Francis Fowke and Alfred Waterhouse and it soon became Britain's most striking example of Romanesque architecture, which is considered a work of art in its own right and has become one of London's most iconic landmarks (History and architecture / NHM, N.D.). The architecture of the Natural History Museum can be seen as a 'cathedral' of the creations, and the museum identity is expressed by the idea of imperial wealth manifested through the encyclopaedic collection (Psarra, 2009). The creator and first director of the Natural History Museum was Professor Richard Owen. The building was opened to the public in 1881, and the story of its design is reported by Mark Girouard (Girouard, 1981). According to its first proposal, the ground floor was basically organized as a comb-like plan with a hall at the centre of its major axis (fig. 5) (Pepois & Hedin, 1982). The central hall acted as a fulcrum from which all parts branched off. This helped to differentiate the departments of skeletons and specimens of animals while the central hall acted as an index to the museum as a whole.

![Diagram of the Natural History Museum](image)

**Figure 5:** The Layout of the central hall inside Natural History Museum, London, a ‘cathedral’ of the creations.
Source: History and architecture, NHM, N.D.

The museum space adopted natural history as a science of classification, and the space inside each gallery was also carefully designed to provide an instructive framework for most exhibits, as the museum literature offered to visitors affirms. According to the director of the Natural History Museum, London, Sir William Henry Flower, the curator carefully considered the capacities of the audiences, the variety of objects, and the available gallery space. In this case, different subjects were carefully divided and illustrated into groups, considering their relative proportions and according to the planned gallery space.

In each gallery, there were certain propositions to be illustrated, either in the classification, genetic structure, geological position or geographical distribution, the primitive instinct for survival, or evolution of the subjects dealt with. Since both museum structure and gallery space were ‘strongly correspond to a scheme where knowledge is inherently spatially’ (Psarra, 2009). When seeing and knowing were closely related as in ‘classification’, the process of transmission of knowledge was not very different from that of acquisition. What expert knew was the same classification that was made visible to visitors. However, this also meant visitors were instructed to visit following the fixed journey to avoid the ‘discontinuities’ in
knowledge. As it has been affirmed ‘the layout of the exhibition space affects the narrative, because things placed together will look logically connected, and things separated will be seen as logically distinct.’ (Miles, 1979)

The Palais de la Decouverte ("Discovery Palace") can be regarded as the first science centre that took education as its main purpose (Hudson, 1987). Unlike traditional science museums, it did not concern itself primarily with the preservation of artefacts. Instead, this discovery palace describes itself as ‘a scientific cultural centre’ in which a large number of scientific experiments were (and still are) demonstrated to visitors (Hudson, 1987). According to its founder, Jean Perrin, one of the objectives of the Palais was to realise the potential for scientific research which he hoped might be found in the population at large, and the whole concept of the institute was formed around the idea of education. As it is described in the book - Exhibiting Cultures, the Poetics and Politics of Museum Display, it targeted from the youngest child to the oldest adult (Karp & Levine, 1991). Both the exhibitions and the demonstrations given by guides were planned from an educational point of view.

Figure 6: The Palais de la Decouverte, Paris, in 1985.
Source: History and architecture, NHM, N.D.

Fully-interactive exhibitions for museum learning

Two thousand years ago, ‘science’ was studied by technologists as a branch of politics and religion, but today scientific knowledge has been enormously expanded to embrace many disciplines such as Physics, Chemistry, Mathematics, Biology, Astronomy and Natural History. In other words, a scientific study covers the entire natural and human world, including industry, built environment and computing technology. As Macdonald states: “Science in the late twentieth century was widely conceived of as difficult and abstruse, a matter for every specialised expertise” (Macdonald, 2006). As the body of science is expanding at an accelerating rate, the idea of modern science museums keeps evolving as well.

Science museums were largely adopting the rhetoric and exhibition techniques that the Exploratorium pioneered because the designed exhibitions ‘let the visitor be the laboratory subjects of their own perceptual experiments’ (Heln, 1990). The intended effect of this pedagogic strategy was not just to teach perceptual theory, but to encourage the visitor to experience the process of discovery and thus to become an experimenter. This extraordinary enthusiasm for interactivity, which had been initiated by the Exploratorium, has subsequently spread across the world. In the meanwhile, many researchers noticed that the interactivity in many modern science museums was simply a copy of the American original. As sociologists of technology have been at pains to argue, the process whereby a technology is “transferred” from one place to another should be thought of as a form of translation or reinterpretation rather than merely a form of diffusion (Latour, 1986). In the UK, the radical concerns of the American centre with the issue of empowerment were marginalised and, with exceptions, Oppenheimer’s interests in the links between
science and art were ignored at the time. Instead, interactivity came to operate in relation to the failure of the traditional science museum to address a rather more mundane set of concerns with the public understanding of science and the attractiveness of the museum to visitors.

However, the recognition that visitors came to interactive science centres and exhibitions to enjoy themselves created a problem for proponents of interactivity (Gregory, 1989). In the view of their designers, interactive exhibits were always expected to be as many instruments of informal education as a means of entertainment. The museum visitor was conceived of as an active learner, and not just as a consumer. Critics pointed to the lack of historical or industrial contextualisation of many interactive exhibits and the frequent absence of any explanation of what scientific principles were supposed to be revealed through the process of interaction. Some exhibits, it was said, can be interpreted in ways which lead museum visitors to false conclusions.

Indeed, it is unclear “whether any of the scientific principles that many interactivity is meant to demonstrate would be grasped by any except those already possessing a good scientific education” (Barry, 1995). As Sharon Macdonald suggests, the failure of interactivity to communicate scientific principles may, in part, reflect the limitations of the museum as a medium: “museums might not be particularly good...at getting across scientific facts and details, then furthering understanding through more general images and messages about the nature of science, its possibilities, its relevance and its limitations” (Macdonald, 1992).

Moreover, some question whether many interactive devices are really interactive. Many so-called interactive touchscreen computers “simply allow the visitor to select from a predetermined set of options”. Interactivity like that is “far from providing the possibilities for experimentation”, “such interactive devices may merely serve to create the illusion of choice” (Strathern, 1992). With the aim to build up new and innovative interactive exhibition concepts, science museums and science centres nowadays widely adopted augmented technology to carry out social and cultural agendas (Quistgaard & Kahr-Højlandh, 2010). Evolved from historical/aesthetic representations into immersive learning objects using cognitive load and constructivist theories, modern science centres and museums saw Augmented Reality as a possibility for new ways of communication and engagement styles with the visitors (Hsi & Fait, 2005; Dindler et al., 2009).

Those augmentations provide museums a lot of new opportunities, but one of the most essential is the fact that these augmented technologies allows for completely different interactions and activities that otherwise would not be feasible (Hawkey, 2004). Hawkey also emphasises the power of the technology when it comes to learning in the museum, and that a different range of media can disseminate knowledge (Hawkey, 2004). On the other hand, knowledge becoming limitless for the museum visitors, because with augmented technologies, visitors are continuously connected to the internet wirelessly, and are therefore are provided with real time data in any location in which they are situated. Taxén also discusses the wide variety of the technology that is used in the museums, and points out that application of these has as a goal to “augment, enhance or replace traditional exhibition techniques” (Taxén, 2005), and “will totally change the existing visitor experience” (Sharp et al., 2009) in more and more museums.

**Conclusion**

This study provides a schematic historical timeline as an overview of the historical context and cultural perspectives on science museums. It starts from the emergence of the word “Museum”, which can be derived from the Mousheon of Alexandria in early cultures. Then it moves to the Early Renaissance, when encyclopaedic collections of objects (normally known as cabinets of curiosities) emerged, which saw the beginning of change in the criteria for authenticating and validating scientific findings, with the growth of taxonomic knowledge based upon new ideas of order, visibility and objective observation in the first half of the century. The second half of the century sees the process of producing scientific knowledge become increasingly associated with, and dependent upon, the methods employed in its dissemination - with
processes for transforming private insights into public knowledge. The following years saw the display changes and scientific exhibition modernisation, museums came to be conceived as ‘symbols of national identity and progress’, and as ‘sites of civic education for the masses’ (Hooper-Greenhill, 1992; Kaplan 1994; Bennett, 1995; Duncan, 1995). In the meanwhile, much of the 19th century science museum moves from ‘museological science’ to ‘experimental science’, which entails ‘control over phenomena in laboratories’ (Pickstone, 1994). It heralds a renewed significance in its role in ‘the public understanding of science’, and builds a solid foundation for the widespread popularity of hands-on exhibits. With existing museums of science coming adopt new technologies of display, new interpretive experiments and new concerns with their visitors and communities, a massive expansion of two particular forms including industrial heritage and science centres are also revealed in the 20th century.

From the 21st century, science museums started to step into the digital era with more and more new media and advanced technologies being widely adopted in museums for interactive and immersive experience-making. This extraordinary enthusiasm for interactivity has been gradually spread across the world. However, many of those failed completely, because interactivity in many science museums was imitated, and many so-called interactive exhibits ‘just allow the visitor to select from a predetermined set of options’ with zero ‘social and cultural agendas’ (Strathern, 1992; Macdonald, 1992; Quistgaard & Kuhl, 2010). In light of the above concerns, Augmented Reality (AR) is promising technologies which have a wide impact on creating new interaction approaches, and at the same time, are not commonly associated with traditional Human-Computer Interaction (HCI) methods. AR provides direct displaying information related to real objects and projects into real physical space that visitors are currently perceiving. This new spatial format has a great potential to attract the audiences and increase their engagements, interests, and usability with new museum visiting and learning experience.

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