On how lighting shaped museums

Viviana Gobbato

Abstract

Nowadays, museum lighting functions to protect, contemplate, and visually restore works of art and exhibits. This seems to have been established quite recently in the history of museums – as late as the 1960s and 1970s. But natural and artificial lighting within museums stems from an older tradition that remains largely unexplored in museum studies. When did this tradition begin? And what are the main theories and practices it has established? This paper examines the main turning points in the history of museum lighting, architecture, and exhibition arrangements, based on a literature review of articles, case studies, manuals, and notebooks. To describe this evolution, we study four major periods: (i) the prelude of the museum from ancient times to the Renaissance; (ii) classical public museums in the eighteenth and nineteenth centuries; (iii) modern museums in the twentieth century; and (iv) the beginnings of contemporary museums in the 1950s and 1960s. The paper aims to encourage an understanding of the impacts that lighting had in museums and so, its contemporary practice.

Keywords: lighting, museum, architecture, history.

Introduction

The importance of museum light design in exhibitions is undeniable. Museum practice handbooks systematically have included chapters on museum lighting since the 1990s (Bergeron, 1992; Edson, Dean, 1994; Ezrati, 1995; Hernández Hernández, 1994; Maroevi, 1998). Besides, preventive conservation standards are respected worldwide (CIE, 2004; Druzik, Michalski, 2011; Richardson et al., 2020; Saunders, 2020). Museum lighting design enhances artifacts, guides visitors, creates a visual interest in the context, and illuminates key words (Turner, 1994). It participates in storytelling (Schielke, 2019) and sets up scenography to communicate a message (Rispal, 2009). It is a co-language in the exhibition (Ezrati, 2010, 2014). It also nourishes studies on visual perception and audience preference on color rendering (Liu et al., 2013), on color temperatures (Nascimento, Masuda, 2014; Feltrin et al., 2019, 2020) and on the impact of dynamic lighting in visitor experience and the construction of knowledge (Gobbato et al., 2020; Gobbato, Schmitt 2021).

Although this field has increased over the past four decades, the concern for exhibition lighting is ancient. Architects, managers, and artists have been searching for the arrangement of lighting since the collection of objects, artifacts, and works of art. But even though some literature on this history exists (Ezrati, 2012; Georgel, 1994; Mamoli, Manthorne, 2019), the origins and evolution of museum lighting mostly remain to be explored and written in museum studies.

When did this tradition begin? And what are the main theories and practices it has established? This paper examines museum architecture and exhibition arrangements to describe this evolution. It studies four major periods: (i) the prelude of the museum from ancient times; (ii) classical public museums in the eighteenth and nineteenth centuries; (iii) modern museums in the twentieth century; and (iv) the beginnings of contemporary museums from the 1950s and 1960s. Each period questions key matters that have contributed to the emergence of museum lighting. The study stops at the turning point of the contemporary museum lighting revolution, which would deserve further study. This paper encourages an understanding of how lighting influenced museums, architecture, exhibition arrangements, and then contemporary standards.

Protomuseums prelude

The rhetoric of sacred light

According to museologists such as Georges-Henri Rivière and François Mairesse, the origin of museums lies with sacred spaces, which are considered forms of protomuseums (Weis, 1989; Mairesse, 2014). Ancient peoples deposited offerings, spoils of war, artifacts, and relics in temples and churches. These places testified to an almost innate need to gather, to organize, and to display objects, a behavior considered as the origins of musealization (Mairesse, 2011). The Parthenon and Pinacoteca of Athens (fifth century BC), Hellenistic temples (fourth-first century BC), Mouseion of Alexandria (third century BC), and the Pantheon (first century BC and second century) all attest to two vocations for future Western museums. According to Georges-Henri Rivière, they were to collect and to research (Rivière, 1989). Light was assumed there to be symbolic, metaphysical, and a mystical language of forms and spaces (Plummer, 2009). Daylight was therefore divine matter.

In Greek temples, light came from ceilings, clerestory windows, and doors (Illuminating Engineering Society, 1947). It entered at an oblique angle, and temple orientation highlighted statues at sunrise. Thus, light created a dark and subdued atmosphere, where Greeks believed the gods resided (Ziabakhsh, Amrei, 2011). Later, the Romans built a new prototype, the Pantheon, which remained iconic through the centuries. This temple dedicated to all divinities had a dome with an oculus for zenithal lighting. Sparkles of light on the surfaces caught the gaze and directed it towards the sky (Plummer, 2009).

The Christian era elaborated more sophisticated arrangements. Gilded mosaics and stained-glass windows affirmed a new architectural grammar and language (Sokol Gojnik, Gojnik, 2018). Sacred architecture became a reflector. The Hagia Sophia stood as a symbol since Emperor Justinian renovated it in the sixth century (Kilde, 2008; Ziabakhsh, Amrei, 2011). Light penetrated through forty windows at the base of the dome, reflecting on the mosaics and illuminating the space. As other lighting programs developed over regions and centuries, sacred spaces became more and more intimate and dramatic (Nesbitt, 2012). Later, Gothic architecture brought new standards thanks to ogival structural design. Elongated windows allowed as much light as possible, even on the cloudiest days (Kilde, 2008). The Basilica of Saint-Denis, renovated by Abbot Suger (1081-1151), introduced the concept of "*lux nova*", in which light can translate the material into the immaterial (Baek, 2009, p. 112). Architecture created a continuous indoor-outdoor space with colored stained-glass windows (Capanni, 2009). Thus, dynamic-colored rays enhanced different perceptions of architecture and artifacts.

During the Renaissance, higher and larger openings brought plenty of light (Illuminating Engineering Society, 1947). Lighting became neutral, clearer, and devoid of mystery, as in Brunelleschi's Church of San Lorenzo in Florence (1429); in contrast, the Counter-Reformation made it more theatrical and tumultuous, as in Saint Charles at the Four Fountains Church (1634-1680) and the Basilica of San Pietro in Rome (Plummer, 2009). Baroque light came from hidden niches, lanterns, domes, and hit polychromic marble and gold-leaf volumes with dramatic shadows (Ziabakhsh, Amrei, 2011). The Rococo style intensified this trend (Plummer, 2009).

These daylight layouts established an architectural tradition of the early collection arrangements. Lighting played a central role in the structuring of both sacred and exhibition spaces. So, the design of windows, skylights, and other top lighting systems shaped protomuseums. Awareness of these practices is undeniable to understand the challenges of the first museum buildings that succeeded. The aim was certainly "to see" but also, to create atmospheres, to evoke the divine presence through light, to incite meditation, to stimulate the contemplation of objects.

Cabinets, Studioli, and Utopian musaea

Private collectors accelerated the establishment of museums during the Renaissance. Princes and humanists set up collections of objects, treasures, and fragments of ancient remains (Murray 1904). They first created collections on the Italian peninsula, then influenced the rest of Europe (Desvallées, Mairesse, 2005). Cardinal Pietro Barbo, Federigo Borromeo, Isabella d'Este, Thomas Howard, and Ferdinand II, the Archduke of Austria, were some of the most famous names from 1400 to 1600. Curiosity cabinets were placed in the center of the room, in front of walls equipped with windows to benefit from the daylight (Hurley, 2010). Sculptures and painting galleries were mainly in palace wings to benefit from side lighting (Bazin, 1967). The first museum installations, although they were still unsophisticated, incorporated the place of an ideal lighting design.

For instance, we might refer to Samuel von Quiccheberg's first known museum treatise, published in 1565 (Meadow, Robertson, 2013). Quiccheberg had spent time traveling throughout Europe to visit cabinets of curiosity. According to Mark A. Meadow and Bruce Robertson (2013), he was particularly inspired by the *Kunstkammer* in Munich, built by Wilhelm Egkl in 1563. The *Kunstkammer* had a quadrilateral plan, an open courtyard in the center, and four long, narrow galleries lit by windows on both sides. Quiccheberg's ideal museum described in his treatise had provided basilicas or ambulatory cloisters around. It also had a garden or an inner courtyard in the middle. Halls opened extensively to four directions of the sky. According to Koji Kuwakino, Quiccheberg might also have been inspired by *cavedia*, from Latin *cavum aedium*, an internal courtyard in Roman houses considered during the Renaissance as a space for exhibitions (Kuwakino, 2013). Natural lighting thus came from lateral cross openings, or from interior courtyards. This first ideal museum model was open to the outside, suggesting a *continuum* with nature. The integration of a communication between the interior and exterior space was necessary for simple visual accessibility. At the same time, it established a tradition of visitor experience that would necessarily include an experience with the surroundings.

During the Renaissance, architecture also inherited from the Pantheon features and standards, like domes and *oculus*. One example is the octagonal room called the Tribuna degli Uffizi in Florence, Italy, completed by Bernardo Buontalenti in 1584 (Bazin, 1967). This model influenced utopian *musaea* in artwork representations too. Marcin Fabianski

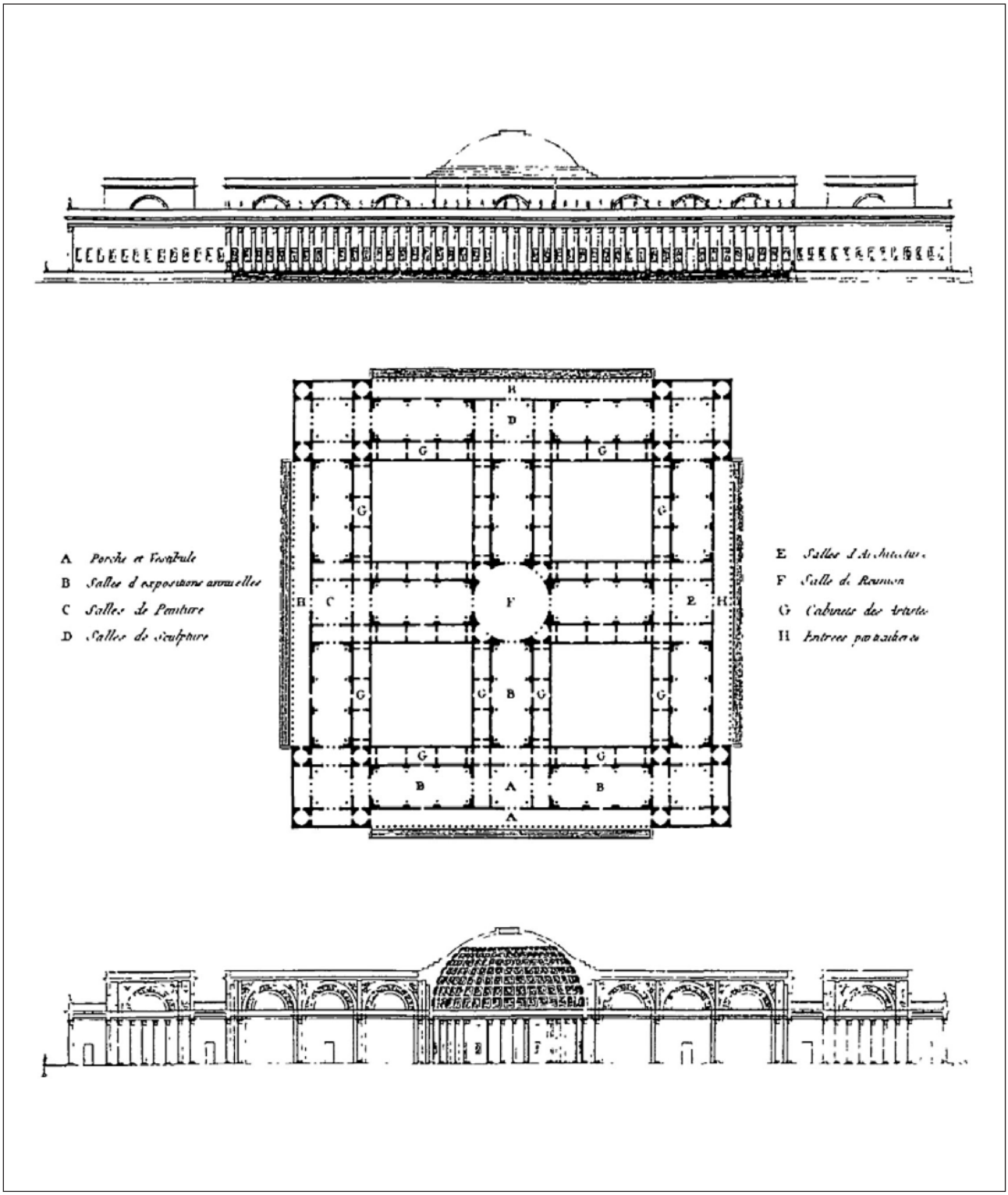

Figure 1 - *Jean-Louis Durand,* **Muséum. Précis**, *graved by C. Normand, 1825, planche 11. (A) Porch and Vestibule; (B) Annual Exhibition Hall; (C) Painting Rooms; (D) Sculpture Rooms; (E) Architecture Rooms; (F) Meeting Room; (G) Artists Cabinet Rooms; (H) Back Entrance. (© BnF)*

has studied artistic and architectural iconography from the fifteenth to eighteenth centuries (Fabianski, 1990). He pointed out that *Musaea*, the temples of muses, were small *rotonda* provided with lanterns or an *oculus* to create a connection with the sky and light. Abundant light merged with the background and atmosphere, suggesting a connection to universal knowledge. Fabianski examined how in the first projects of utopian museums, the lighting was zenithal under the dome for masterpieces and lateral in galleries. Examples were Giacomo Colli's design for the Concorso Clementino of Accademia di San Luca in Rome (1709), for Jean-René Billaudel's design for the Grand Prix of the Académie Royale d'Architecture of Paris (1754) or for Charles-Joachim Bérnard's design for the competition of the Académie Royale d'Architecture of Paris (1774).

These examples should draw attention to how lighting shaped the first European museums. Architects designed ideal models, drawing inspiration from the architectural lay-out of the protomuseums. This happened even before artificial technologies. Thus, protomuseums were first daylight institutions.

The public museum

The neoclassical model

In the seventeenth and in the eighteenth century, the earliest public museums were mostly established in palaces and historic or religious buildings converted into painting and sculpture galleries, repositories, and permanent exhibitions (Georgel, 1994). At this very moment in the founding history of museums, lighting still played an essential role in the design of conservation spaces and the display of early public collections.

Daylight came from large and glazed windows. Zenithal lighting was preferred for paintings, and side lighting for reliefs and sculptures (Bazin, 1967). The clerestory system was also implemented in some art galleries. Clerestory lighting avoided reflection, improved visibility, and expanded the available surface to hang and show artworks. The Gallery of Aeneas and its corner salon at Palais Royal in Paris demonstrated such a model (Heraeus, 2014). It inspired architect Charles du Ry to design Landgrave Wilhelm VIII's Picture Gallery in Kassel, which existed between 1753 and 1807. There, upper windows were placed under the roof. Jean-Louis Durand settled such a standard, writing that the best museum lighting came from upper windows (Durand, 1827/1825) (Figure 1).

The search for good daylight began to spark debates, between top and lateral arrangements. The Louvre and its Grande Galerie stood as one of the most famous examples. This case marked a turning point in designing lighting solutions for architectural structures converted into exhibition galleries and museums (Hooper-Greenhill, 1992). The Grande Galerie was built by Louis Métezeau and Jacques II Androuet Du Cerceau in 1595 to connect the Palais Royal du Louvre with the Palais des Tuileries (Aulanier, 1950). The Comte d'Angiviller designed the Grande Galerie in 1778 as the place for the royal collection, installed at the Palais du Luxembourg, and commissioned a new design. The Grande Galerie was a vaulted corridor of 432 meters long with 46 windows on both the northern and southern sides (Georgel, 1994). Good lighting was thus a problem for appreciating the works of art. Architect Jacques-Germain Soufflot proposed the creation of upper windows, such as clerestory windows; however, the project was refused because of its cost (Bazin, 1967). Other artists studied and proposed revolutionary solutions, such as Hubert Robert and his zenithal lighting (Sahut, 1979). Finally, between 1805 and 1810, the gallery was divided into nine crossings, still lit alternately by vertical and lateral windows, both to allow good light and view. Top lighting was ultimately adopted later in 1849 (Aulanier, 1950). Félix Duban designed two lanterns to add then thirty-two others. The aim was to illuminate uniformly the corridor. He proposed a longitudinal opening covered with frosted glass, receiving light from the two upper attics. His successor Hector Lefuel completed the project. This example illustrated the issues and dynamics that still characterize lighting design in museums to this day: the need for a substantial budget; the change in policies that can interrupt committed projects; the debates on architectural redevelopment; the issues of conservation and visibility.

Such as protomuseums, the neoclassical model was also inspired by the Pantheon. Rotundas provided with *oculi* particularly encouraged glyptotheks (Ranellucci, 2016). When Michelangelo Simonetti and Giuseppe Camporese built the Pio-Clementino Museum in 1770, they designed Sala Rotonda as such a statement. This rotunda was covered with a dome and a skylight (Forcolini, 2012), and a dozen small high-arched windows around the base (Visconti et al., 1822). Von Klenze's Glyptothek in Munich (1816-1830), Antonio Canova's Gipsoteca in Possagno (1819-1833), and Karl Friedrich Schinkel's Altes Museum in Berlin (1823-1830) were also inspired by the upper lighting of the Pantheon (Ballé, Poulot, 2004; Rosa, 2008; Wezel, 2001). This standard also encouraged some hazardous experiments. For instance, Louis-Etienne Boullée designed an unrealized project based on a total dazzling lighting, a providential light coming from sacred architecture (Forcolini, 2012).

These cases shown how lighting became, in modern times, a political element for the neoclassical museum, but also one of innovation and aesthetic. The search for "good

lighting" manifested an architectural structure. It was therefore more than just a pretext for viewing the collections. The daylight system went so far as to modify the entire architecture of the museum. This aspect is essential to consider in the foundation of the first museums and core challenges.

From natural light to artificial light

Until the beginning of the nineteenth century, museums were mostly daytime institutions. Since natural light was often changing – according to the weather and the seasons –, Grand Tour travelers' notebooks regularly described the lack of light. For instance, in Italy, Johann Wolfang Von Goethe explained the rare use of torch lamps in guided tours in museums in Rome, such as the Museo Pio-Clementino. Goethe quoted that according to Heinrich Meyer, torch lamp tours had several advantages for the appreciation of sculptures (Goethe, 1929/2011, p. 493). They helped (i) to isolate the artworks and focus the attention; (ii) to render the details of the materials more effectively; (iii) to avoid disturbing reflections; (iv) to maximize contrasts to see better the modelling; (v) and above all to highlight sculptures placed in an unfavorable light. This example is exceptional, however, as daylighting was perceived as insufficient. In France, Léonce de Pesquidoux criticized Marseille Museum for being too dark, to the point where he could not even distinguish the paintings (Pesquidoux, 1857). M. George decried Toulouse's museum because of its poor light compared to the huge gallery size (George, 1873). In Spain, R. Roberts considered Sevilla Museum lighting in 1859 insufficient to appreciate works of art (Géal, 2005), and so wrote Willis Baxley about Barcelona Museum (Baxley, 1875).

Some pioneer museums experimented with gas lighting invented at the end of the eighteenth century. This expanded opening hours in the afternoon in the winter and fall (Desvallées, Mairesse, 2011). For example, Charles Willson Peale adopted gas lighting in his museum in Philadelphia in the late 1800s (Kummerow, 2019). In a letter dated 30 August 1802 and addressed to Eleanor Short Peale, Peale described some Argand lamps invented in 1784 by Aimé Argand in Geneva. They were used during one exhibition dedicated to moving pictures in 1785 (Miller, 1998). His son Rembrandt Peale inherited this fascination for gas lighting when he founded a museum in Baltimore (1814-1830) (Coleman, 1939). In 1816, he installed gas lighting to attract further the local population. The galleries had lamps defined as "One Hundred Gems of Light", according to a local advertisement in the American Commercial and Daily Advertiser (Kummerow, 2019).

However, gas lighting remained poorly diffused in museums because of fire risks and costs, and a certain injunction to open at night. For instance, the trustees of the British Museum initially opposed gas lighting before adopting it in the 1860s (Swinney, 1999). Some other British museums had become exceptions, including the Edinburgh Museum of Science (1854), South Kensington Museum (1857), Oxford University Museum (1860), and Birmingham City Art Gallery (1885) (Nye, 2019).

But as early as the 1880s, electric lighting opened new possibilities. Compared to coal gas lighting, incandescent electric light was less reddish and cooler, and its color rendering was different. Some doctors preferred it for vision health (Hartridge, 1892). This technology needed time to be accepted and deployed on a larger scale (Coleman, 1950; Nye, 2019). Curators were barely familiar with gas lighting, so they needed to get used to electric lighting on artworks in their homes before they could consider it in their museums (Stevenson, 1907). Yet in 1918, philosopher Pavel Aleksandrovich Florensky was against electric light for appreciating artworks in sacred spaces (Florensky, 2003). He stated that electric light was charged with dark blue and violet rays. They destroyed and burnt both the color of the artworks and psychic receptivity. Nevertheless, some early electric lighting was adopted by pioneer museums, such as British institutions, which had already successfully experimented with gas technologies, such as the Ashmolean Museum, the South Kensington Museum and the British Museum.

The modern museum turning point

Architecture and Modernity

At the turn of the twentieth century, museum architecture changed profoundly, and so did lighting. This change embraced uncluttered space and minimal displays and canceled visual obstacles to become an open and transparent box (Cabral, 2011). Exhibitions were liberated from ornaments and aimed for rationalism. Modernity was synonymous with a quality and plenty of light, which had to be plentiful, bright, and refined (Plummer, 2009).

New principles emerged. The Museums Association wrote that museum organization and the arrangement of new buildings had to combine "*the maximum amount of light*" with "*the greatest amount of available space for exhibition*" (Museums Association, 1890, p. 39). George Brown Goode recommended that museums place showcases in the center of the rooms to benefit from zenithal and lateral light, simplifying lighting problems in the evening (Goode, 1895). In contrast, Henry Heathcote Statham suggested establishing abundant zenithal general lighting (Heathcote Statham, 1898). John Cotton Dana advised lateral lighting on one side only, allowing both light to penetrate and visitors to look outwards (Dana, 1917, 1920). Louis

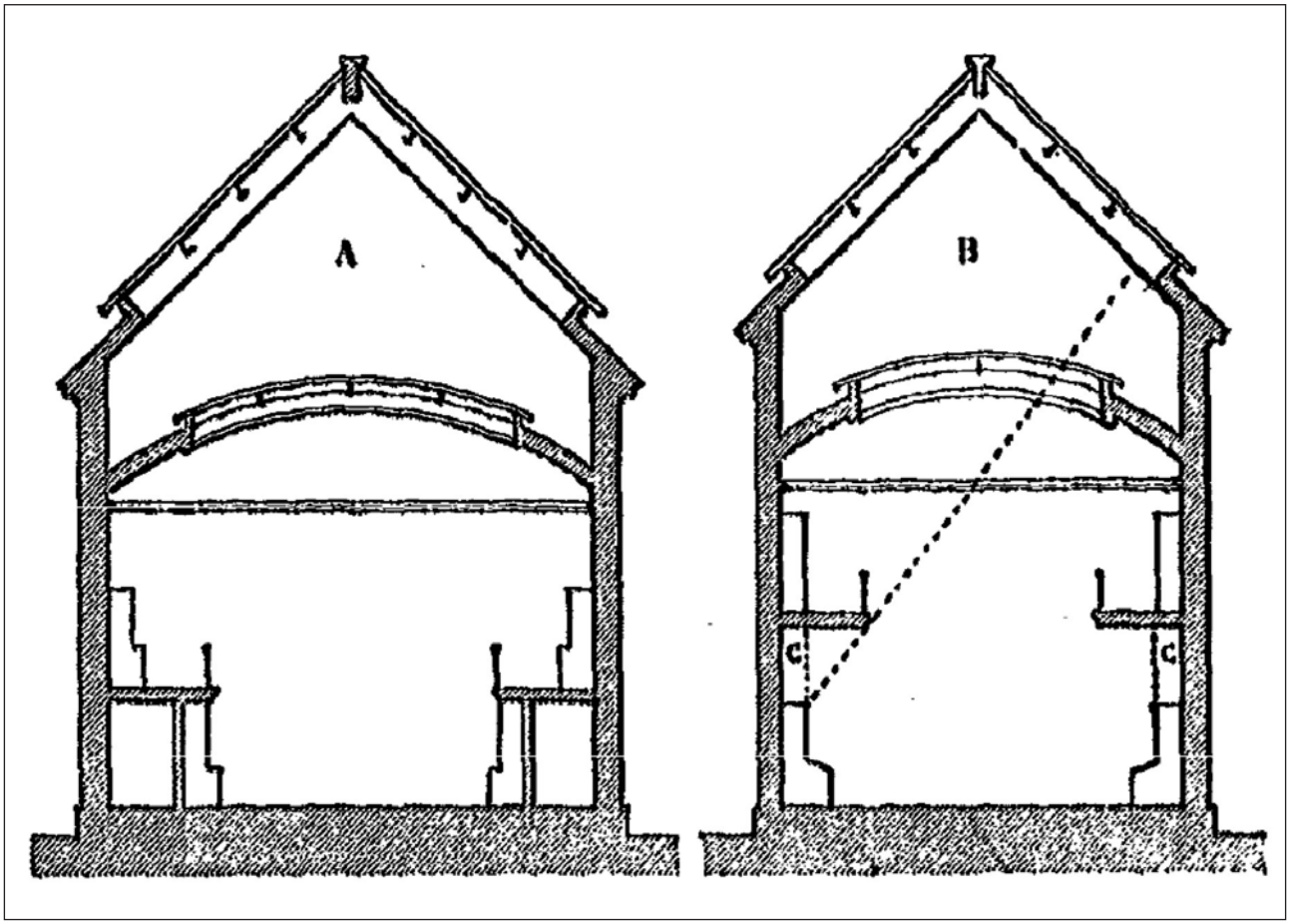

Figure 2 - ***Julien Guadet,*** **Éléments et théorie de l'architecture*****, Tome II, Aulanier et Cie, Paris, 1901-1904, p. 344. Museum halls. On the left, a museum room with two stories of showcases (the second one set back). On the right, a museum room with two floors of superposed showcases. (© BnF)***

Réau considered the ideal museum lighting based on the German model, because of the harmony created between quality of light and distribution of space (Réau, 1909). In contrast, he criticized modern French and Dutch museums, such as the Salon Carré in the Louvre whose zenithal new lighting was installed too high, or the Rijksmuseum where the lighting was too dark. Finally, Lewis Foreman Day stated that sacrificing museum lighting was a crime, writing that "light we must have" (Day, 1908, p. 146). Thus, the debates were mainly driven by the innovations experimented within some European museums. They asserted as influential and ideal architectures, and which animated the debates between the curators attached to the neoclassical museum and the progressives of the modern museum.

Meanwhile, museum lighting began to be taught in universities. In 1894, for instance, Julien Guadet published four volumes dedicated to the theory of general architecture. It was reedited in 1901-1904, based on his course at the National and Special School of Fine Arts in Paris. In the second volume particularly, Guadet referred to museums and theorized some recommendations (Guadet, 1901). Lighting needed to be applied according to museum types: artistic, archaeological, industrial, or scientific. Guadet suggested designing rooms of various sizes, layouts, and lighting, adapting to different objects and artworks according to their nature and medium (Figure 2).

Modern museum lighting principles also brought into question the study of visitor experience. Benjamin Ives Gilman considered that the wrong light caused psychological discomfort (Gilman, 1918). He studied traditional solutions such as top and lateral lighting. The former helped to save exhibition space, and the latter was suitable for low or small rooms. But he observed that they both caused museum fatigue because of their low light levels, reflection, and

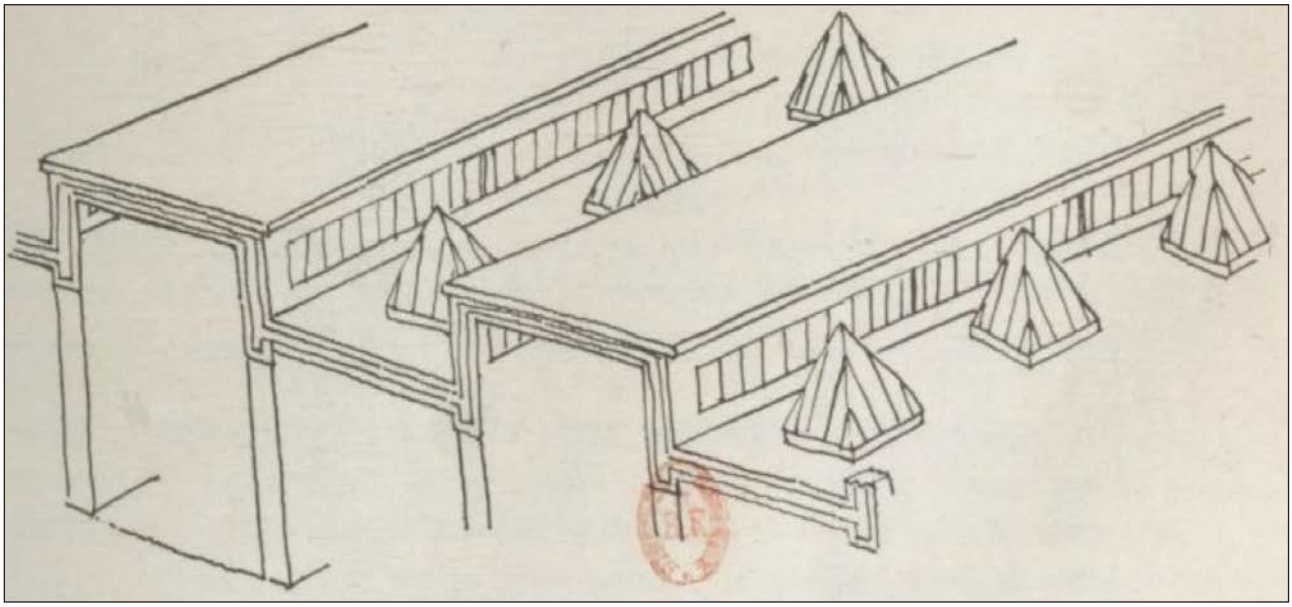

Figure 3 - ***Auguste Perret,*** **Le musée moderne*****, in*** **Mouseion*****, vol. 9, 1929, p. 230. Lighting plan of the Modern Museum by Auguste Perret. Lighting by clerestory and zenithal lighting due to pyramidal skylights. (© BnF)***

glare. Gilman referred to Dr. Karl Koetschau, Director of the Kaiser-Friedrich Museum in Berlin, who defined top lighting as a "*necessary evil*" (Koetschau, 1911, p. 85). Gilman hence indicated a third solution as best fitted for museums: clerestory windows, which he considered the light of cathedrals. Gilman explained that Leonardo Da Vinci also recommended it for the artist's workshop (Da Vinci, 1651). Examples cited by Gilman included Galleria del Belvedere (1770), Sala a Croce Greca at the Museo Pio-Clementino (1780) and Museum Chiaramonti in Vatican (1810), Kelvingrove Museum in Glasgow (1893-1901) and the Decorative Arts Wing of the Metropolitan Museum of Art in New York (1910). However, clerestory windows required high ceiling height. Gilman therefore suggested adapting lower rooms to achieve this ideal gallery. He also advised installing curtains on the windows to exclude direct light and to reduce reflections on paintings and display cases. Gilman opposed artificial lighting, as he still considered museums as daylight institutions. As a result, two major issues emerged at the time: the modernization of museums, and thus the overcoming of the neoclassical model.

Museum lighting, an international debate

The 1920s and the 1930s marked a radical turning point in the evolution of museum lighting. Architecture layout and artificial lighting principles accelerated this process. At the end of the 1920s, the International Museums Office (IMO) founded the museum review Mouseion, which contributed to an international debate on modern museum lighting. Despite the past discussions on natural lighting, architects still debated over the best solutions. Pierre Auguste Perret considered the quality of lighting as a major factor of good modern museums (Perret, 1929). Paintings needed a top natural lighting, but low to avoid losing intensity, while sculptures required a high lateral system (Figure 3). According to Louis Hautecoeur, lighting had a direct influence on museum room layout (Hautecœur, 1933). Therefore, the plan had to be rectangular for zenithal lighting, and polygonal and deep with cut-off sides for side lighting. Clarence Stein criticized roof lighting, considering it too flat, excessively uniform, and costly to maintain (Stein, 1933). He suggested building partition walls to create smaller rooms, and to light them with daylight by reflection. Jacques De Soucy recommended the installation of large vertical windows, glass canopies to filter light and spread it subdued, or skylights with vertical glazing (Soucy, 1934). He also indicated painting walls with lighter colors to emphasize and homogenize this bright effect. Dirk Hannema and Ad Van Der Steur suggested combining zenithal and lateral natural lighting as much as possible, equipped with a slat system with lateral diffusion to avoid glare (Hannema, Van Der Steur, 1936).

Some articles examined case studies and influent renovations, such as the National Gallery (Holmes, 1928), The Hague Museum (Van Gelder, Berlage, 1931), and the Tokyo Museums (Akiyama, 1935; Nakamura, 1935). These papers

also dealt with specific regional issues, such as visual perception preferences and natural light characteristics. For instance, the Committee for the Reorganization of the Imperial Museum of Tokyo published an article based on a survey of visitor lighting satisfaction (Nakamura et al., 1936). The research asked forty-seven visitors to evaluate natural lighting on forty-three Japanese paintings and twenty-five oil paintings under different atmospheric conditions. Results indicated that oil paintings were considered satisfactory when exposed to 50 per cent of the light dose used on Japanese artworks. They concluded that lighting in the museum gallery was unsatisfactory for oil paintings, but satisfactory for Japanese artworks. So, they needed to design a new solution.

Another case concerned the natural lighting in painting galleries exhibited in a Mediterranean climate (Moya, 1935). According to the architect Moya, southern lighting was more dazzling, abundant, intense, abrupt, and irregular. Thus, this light required special treatment. He evoked some possible solutions, such as mechanical systems, prisms, mirrors, timers, or photoelectric devices following the movement of the sun. He recommended the use of awnings in rooms receiving too much light to absorb and reduce its quantity, and to distribute it evenly in the space. Moya recognized that artificial lighting was a good ally in lowlight regions. But in others, such as in Spain, it was not needed. It was expensive and could then be avoided.

The major event in Madrid at the International Museum Conference of 1934, organized by IMO, overviewed all these criteria, then published them as a synthesis with an entire chapter dedicated to lighting systems (Stein, 1935). However, these principles were only applied after the war which suddenly interrupted the projects.

The expansion of electric lighting

Another major point of innovation at that time was artificial electric lighting based on incandescent lamps. Architects, engineers, and museum directors mostly argued for general artificial lighting reproducing a natural effect, such as Auguste Perret (1929). Artificial lighting therefore had to be installed around canopies and skylights, and below clerestory windows. Perret also suggested ideally reflecting and diffusing light on ceilings by using special mirrors or glasses placed in front of the lamps. Richard Bach agreed to reproduce a general lighting effect (Bach, 1930). He stated that architects and electrical engineers must work together to achieve such a solution. Most of all, according to A. G. Ramsay and G. Smith, artificial lighting installations had to ensure light balance, intensity, and visual comfort while avoiding glare and reflections (Ramsay, Smith, 1936).

Discussions also dealt with color temperature rendering and its influence on perception. Architects, engineers, and museum directors mostly concurred that the best color temperature had to simulate natural white light, such as Jacques De Soucy (Soucy, 1934). Auguste Perret therefore recommended alternating blueish bulbs - called daylight bulbs - with classical bulbs (Perret, 1929). This solution was adopted at the National Museum in Stockholm with a ratio of one daylight bulb for every three classical bulbs (Folckar, 1932) (Figure 4). Blue tinted bulbs, however, involved a reduction in intensity, and consequently the need for more power usage (Stein, 1935).

Some specific aesthetic techniques emerged. Jean-Fernand Cellerier suggested focusing on the painting to emphasize its artistic effect by matching the tone of the artificial lighting with the general tone of the painting (Cellerier 1931). In the 1930s, for example, artificial lighting was installed at the Louvre Museum (Feret, 1938). Lights highlighted artworks according to their features (Verne, 1937). Egyptian sculptures were lighted by diffuse sources to evoke oriental brightness and daylight. Low reliefs or sculptures on the walls, such as the Scribe, were lighted by direct spotlights to accentuate shapes. Masterpieces such as the Venus De Milo, Parthenon Frieze, and Victory of Samothrace were highlighted by special spotlights that stressed *modélé* and curves.

In contrast, Ned Burns claimed that artificial lighting must be inspired by cinema techniques and referred to an exhibition of natural specimens within the Museum of the City of New York (Burns, 1933). Artificial lighting was studied there to harmonize the volume, recreate a group environment, accentuate lighting from above or from the side, and imitate the sunlight by using “baby-spots”, reflectors, and colored gelatin filters. Meanwhile, general lighting had to be diffused to give an impression of immersion. However, experimentations inspired by theater were criticized. Stein pointed out the limited mechanical and scientific possibilities and the social and functional results of the undesirable dramatic effect on three-dimension objects (Stein, 1935).

Therefore, technical innovations and modern bodies changed the dynamics, principles, issues, and consequences of museographic lighting. At the same time, the “traditional” principles were being asserted and the traditional trajectory was being followed. In contrast to what existed previously, however, the 1920s and 1930s decades set standards that are still available today (Ezrati, 2012). These standards concern: the color temperature of white light, the color rendering of the works, the hierarchization of the scenography with lighting, the gradual control or exclusion of natural light with dynamic devices.

Figure 4 - ***Nationalmuseum, Stockholm. Lighting installation under the ceiling, second floor, painting room, 1931. Archive number 20/24. Ingenjörsbryån, SFV archive (The National Property Board). (© Nationalmuseum, Stockholm)***

A new medium of communication

To the black box

The end of World War II marked the application of modern lighting design principles (De Felice, 1966). Museums damaged during the war and contemporary architecture museums favored new experimentations. At this time, when preventive conservation standards were being refined, the proponents of natural lighting (architects, curators) clear opposed the proponents of artificial lighting (conservators, engineers).

In Italy, Carlo Scarpa's projects were symbolic of the modern treatment of natural light (Hurley, 2010). He introduced a design characterized by an "*urgency*" and a "*necessity*" in the treatment of ancient architecture and light (Albertini, Bagnoli, 1992, p. 12). He preferred a light that connected to the outside environment, or that came from above and obliquely, such as clerestory windows. Artificial light was secondary. In contrast, museum curators considered artificial lighting as more stable and constant. It emerged as a solution to control the exposure of artworks and objects to light. This was the beginning of the black box. Artificial lighting affirmed a new aesthetic and criteria to control intensity, accentuate or balance contrasts, choose a color temperature, and to light exhibits and materials. At the Ethnographic Museum of Neuchâtel, Jean Gabus preferred to keep artificial lighting in a dark space and suggested excluding less stable daylight (Gabus, 1965). On the other hand, Georges-Henri Rivière favored a blurred light to avoid exaggerated contrasts, which he claimed unified the exhibits with the background (Rivière, 1989). Laurence Vail Coleman placed great importance in the difference in brightness between the room and the exhibit and formulated that the object should be about twice as bright as the background (Coleman, 1948). Color temperature was also considered as a new parameter in designing atmospheres. For instance, Laurence Vail Coleman suggested adopting

cold indirect general lighting, with fluorescent lamps at 4500 K, combined with lighting exhibits with incandescent lamps at 2900 K.

Standards also dealt with enhancing exhibits according to their material. For example, Robert T. Hatt formulated seven lighting solutions for the display of translucent minerals in science museums, due to the material of the exhibits and the shape of the display cases (Hatt, 1960). For the more fragile pieces, he suggested the installation of a lighting system manually operated by the visitor. It consisted in a switch equipped with a timer system that operated every three minutes.

Besides, artificial lighting techniques developed innovative strategies with the emergence of new instances, such as the International Association of Lighting Designers (IALD) founded in Chicago in 1969.

Lighting and visitor experience

In the 1960s, the "architects of light" specifically focused on the relation between space, light, and perception. For instance, Richard Kelly identified three pillars of the visual environment: (i) "*focal glow*" as the point of attention; (ii) "*ambient luminescence*" as the main visual atmosphere; (iii) and the "*play of brilliants*" as lighting decors, contributing to distraction or entertainment (Kelly, 1962; Neumann, 2010). William Lam also considered space as an environment of light (Lam, 1977). He recognized three steps in perception: association, expectation, and affective value. Association concerned the search for information, relating to the context and similar experiences. The "*stimulus*" assumed the value of a "*signal value*" or "*visual background noise*", depending on what was relevant to the individual according to their expectations. Consequently, the emotional component – such as sadness, boredom, security, insecurity, or intimacy – was influenced depending on the emotional or evaluative response to the *stimulus*. Lam reflected as well on the visions – central or peripheral – and on attention-disturbing elements, such as forms and luminance.

Lighting then started to be used for educational devices. For example, Stephan F. De Borhegyi detailed an experiment carried out at the Milwaukee Public Museum in Wisconsin. It consisted in lighting masks of the Northwest Coast (Borhegyi, 1963). To increase the dramatic impact of the presentation, these masks were displayed on a black background and illuminated with red, green, and blue lights. A dynamic 60-second light cycle installed in the exhibition would both illuminate and hide the exhibit. This cycle simulated sunrise and sunset, and the passage of time, eternity, and the "*immensity of geological time*" (Borhegyi, 1963, p. 48). Lighting was a fundamental part of the setting.

Furthermore, lighting started to be considered as a medium of communication. At the seminar organized by the New York City Museum in 1967, Marshall McLuhan, Harley Parker, and Jacques Barzun discussed the possibility of lighting devices for museum education. McLuhan proposed placing a console in the exhibition room, which would allow anyone to manipulate the intensity and warmth of the light, and to choose sounds corresponding to the objects (McLuhan et al., 2008). Parker recommended installing a sound and light system about fifteen minutes before the exhibition, called an "*orientation center*", to produce the same effect as a walk in the open air in the visitor's home (*Ibid*., p. 106). Barzun considered that light had to intervene among other elements as a stimulus to go beyond the linear in order "*to plunge into the effective thickness of the four dimensions*" (*Ibid*., p. 181).

These discussions and applications opened a new range of possibilities within exhibitions (now increased with the latest LED, dynamic and Li-Fi technologies).

Conclusions

Exhibition lighting has constantly contributed to the perception of artifacts and artworks by creating a stage set. For instance, when in 1754 the Sistine Madonna by Raphael arrived at the Palace of Augustus III of Saxony in Dresden, "the King of Poland, distraught, ceded his throne, [because] lighting at that place particularly emphasized the painting: 'Make way for the great Raphael', he would have cried out" (Bazin, 1967, p. 112)[1].

For the same reasons, lighting played a central role in the history of museums. Ancient architecture of sacred temples, then churches, established then a tradition of lighting their exhibits. Daylighting was composed of clerestory windows, *oculi*, reflectors, colored light, ascetic or dramatic atmospheres, and some artificial lighting programs. During the Renaissance, the daylighting of cabinets and *studioli* mostly came by lateral openings. But ancient layouts, such as the rotunda, inspired some utopian buildings in treatises and artistic representations. The *musaea* inherited, adopted, and adapted ancient principles. In the eighteenth century, the neoclassical museum borrowed from them. Debates between zenithal or lateral light were sparked. Several experimentations took place in Europe, and manuals were published to define preferred models. In the nineteenth century, industrial materials brought lighter and freer architecture, using the models from the architectural styles of the Great Exhibition. Artificial gas lighting then electric lighting opened a new range of possibilities. Few museums adopted it, due to costs and maintenance. In the twentieth century, modern architecture avoided clutter and decorations in museums. Daylight was abundant and studied to improve

visibility. For the first time, they sought to prevent the museum fatigue mentioned in the impact of lighting on psychological causes. In the 1920s and 1930s lighting became the subject of international debates. The magazine *Mouseion* (1927) and the advent of the Madrid Conference (1934) affirmed new standards and defined a major turning point for artificial lighting techniques. A second revolution has taken place since the 1960s and the 1970s when lighting was considered as a medium of communication.

Evidently, contemporary museum lighting stems from this long and rich history. Its evolution shaped museum standards and the exhibitions of artifacts. It brought fundamental criteria in architecture, scenography, preventive conservation, visual perception, reception, and visitor experience. The culture and practices of museum lighting therefore deserve to be recognized in museum studies to understand better such a tradition, and to establish contemporary fundamentals and future developments. Lighting the museum has always been, and still is, a radical gesture.

Viviana Gobbato *è dottoranda in Studi museali, Università Sorbonne Nouvelle, Parigi (Cerlis Lab). La sua ricerca riguarda l'architettura museale, l'illuminazione e la visitor experience.*

Notes

1. "Le roi de Pologne, éperdu, lui céda son trône, l'éclairage à cet endroit mettant le tableau particulièrement bien en valeur: 'Qu'on fasse place au grand Raphaël', se serait-il écrié" (Bazin, 1967, p. 112).

References

Akiyama T., 1935 - *Architecture, aménagement et activité des Musées au Japon*. Mouseion, voll. 31-32(3-4), pp. 83-102.

Albertini B., Bagnoli S., 1992 - *Scarpa. Musei ed esposizioni*. Jaca Book, Milano.

Aulanier C., 1950 - *Histoire du Palais et du Musée du Louvre. La Grande Galerie du bord de l'eau*. Editions des Musées nationaux, Paris.

Bach R., 1930 - *Le musée moderne. Son plan, ses fonctions*. Mouseion, n. 10, pp. 14-19.

Baek J., 2009 - *Nothingness: Tadao Ando's Christian Sacred Space*. Routledge, New York.

Baxley H.W., 1875 - *Spain. Art-remains and Art-realities, Painters, Priests, and Princes*. D. Appleton, New York.

Bazin G., 1967 - *Le temps des musées*. Desoer and Hachette, Liège-Paris.

Bergeron A., 1992 - *L'éclairage dans les institutions muséales*. Société des musées Québécois and Musée de la civilisation, Montréal/Montréal.

Bergeron A., 2011 - *Préservation*. In: Desvallées A., Mairesse F. (eds.), *Dictionnaire encyclopédique de muséologie*. Armand Colin, Paris, pp. 453-473.

Borhegyi S.F. de, 1963 - *Visual Communication in the Science Museum*. Curator: The Museum Journal, vol. 6(1), pp. 45-57.

Burns N., 1933 - *L'éclairage d'œuvres exposées par groupes dans les musées*. Mouseion, vol. 20(4), pp. 123-125.

Cabral M.C., 2011 - *La maison moderne des muses*. Cahiers philosophiques, vol. 1(124), pp. 43-65.

Capanni F., 2009 - *Spazio, luce, architettura = Space light architecture*. Noèdizioni, Prato.

Cellerier J.-F., 1931 - *Le chauffage, la ventilation et l'éclairage dans les salles d'exposition*. Mouseion, vol. 16(6), pp. 66-74.

CIE, 2004 - *Control of damage to museum objects by optical radiation. Technical report*. Commission internationale de l'éclairage, Vienna.

Coleman L.V., 1939 - *Museum in America*. American Association of Museums, Washington.

Coleman L.V., 1948 - *L'éclairage artificiel des objets d'exposition. Conférence générale Biennale de l'ICOM-Première session ICOM/BI. CONF.1/5, 7*. Maison de l'UNESCO, Paris.

Coleman L.V., 1950 - *Museum buildings*. American Association of Museums, Washington.

Dana J.C., 1917 - *The new museum*. The Elm tree press, Woodstock.

Dana J.C., 1920 - *A plan for a New Museum*. The Elm Tree Press, Woodstock.

Day L.F., 1908 - *How to make the most of a museum?* Journal of the Society of Arts, vol. 56(2877), pp. 146-180.

Da Vinci L., 1651 - *Traitté de la peinture, de Léonard de Vinci, donné au public et traduit d'italien en françois par R. F. S. D.* C. J. Langlois, Paris.

De Felice E.B., 1966 - *Luce-Musei*. De Luca Editore, Roma.

Desvallées A., 2009 - *L'expologie de Georges Henri Rivière: Des collectes systématiques aux unités écologiques: La question du contexte*. In: Boëll D.-M., Christophe J., Meyran R. (eds.), *Du folklore à l'ethnologie*. Éditions de la Maison des sciences de l'homme, Paris, pp. 277-293.

Desvallées A., Mairesse F., 2005 - *Sur la muséologie. Culture et Musées*, vol. 6(1), pp. 131-155.

Desvallées A., Mairesse F., 2011 - *Architecture*. In: Desvallées A., Mairesse F. (eds.), *Dictionnaire encyclopédique de muséologie*. Armand Colin, Paris, pp. 27-51.

Druzik J., Michalski S., 2011 - *Guidelines for selecting solid-state lighting for museums*. Canadian Conservation Institute and Getty Conservation Institute.

Durand J.-N.-L., 1817/1825 - *Précis des leçons d'architecture données à l'École polytechnique, par J.-N.-L. Durand*. Firmin Didot-Imprimeur du roi, Paris.

Edson G., Dean D., 1994 - *The Handbook for Museums*. Routledge, London.

Ezrati J.-J., 1995 - *Manuel d'éclairage muséographique*. OCIM, Dijon.

Ezrati J.-J., 2010 - *L'éclairage comme élément de la scénographie*. Culture et Musées, vol. 16, pp. 252-256.

Ezrati J.-J., 2012 - *Coup d'œil sur l'éclairage muséographique de 1907 à 1977*. In: Monin E., Simonnot N., Beltran A. (eds.), *L'architecture lumineuse au XXe siècle*. Snoeck, Gent, pp. 104-111.

Ezrati J.-J., 2014 - *Éclairage d'exposition. Musées et autres espaces*. Eyrolles, Paris.

Fabianski M., 1990 - *Iconography of the architecture of ideal musaea in the Fifteenth to Eighteenth Centuries*. Journal of the History of Collections, vol. 2(2), pp. 95-134.

Feltrin F., Leccese F., Salvadori G., Maccheroni D., Morozzi R., Nieri P., 2019 - *The visual perception of artworks at the National Museum of San Matteo*. Zumtobel Research.

Feltrin F., Leccese F., Hanselaer P., Smet K.A.G., 2020 - *Impact of Illumination Correlated Color Temperature, Background Lightness, and Painting Color Content on Color Appearance and Appreciation of Paintings*. LEUKOS, vol. 16(1), pp. 25-44.

Feret M., 1938 - *L'éclairage électrique au musée du Louvre*. LUX, pp. 2-8.

Florensky P., 2003 - *Beyond Vision: Essay on the perception of art*. Reaktion Books, London.

Folckar I., 1932 - *L'éclairage du musée national de Stockholm*. Mouseion, voll. 17-18, pp. 116-118.

Forcolini G., 2012 - *La luce del museo*. Maggioli Editore.

Gabus J., 1965 - *Aesthetic principles and general planning of educational exhibitions*. Museum, vol. XVIII(1), pp. 3-56.

Géal P., 2005 - *La naissance des musées d'art en Espagne (XVIIIe-XIXe siècles)*. Casa de Velázquez, Madrid.

George M., 1873 - *Rapport sur l'état actuel du musée de Toulouse*. Duplin, Toulouse.

Georgel C., 1994 - *Montrer, éclairer, presenter*. In Georgel C. (ed.), *La jeunesse des musées. Les musées de France au XIXe siècle*. Éditions de la réunion de musées nationaux, Paris, pp. 188-206.

Gilman B.I., 1918 - *Museum ideals of purpose and method*. Riverside Press, Cambridge.

Gobbato V., Schmitt D., 2021 - *Éclairer pour illuminer. L'éclairage, un dispositif muséal de médiation*. La lettre de l'Ocim, vol. 194, pp. 32-37.

Gobbato V., Blondeau V., Thébault M., Schmitt D., 2020 - *L'éclairage dynamique, un dispositif de médiation*. Activités [online], vol. 17(2).

Goethe J.W. von, 1829/2011 - *Voyage en Italie*. Bartillat, Paris.

Goode G.B., 1895 - *The principles of museum administration*. Coultas and Volans, York.

Guadet J., 1901 - *Éléments et théorie de l'architecture: Cours professé à l'École nationale et spéciale des beaux-arts*. Tome II. Libraire de la construction moderne, Aulanier et Cie, Paris.

Hannema D., Van Der Steur A., 1936 - *La technique de l'éclairage dans les musées et le système adopté au Musée Boymans*. Mouseion, voll. 33-34, pp. 161-183.

Hartridge G., 1892 - *The Electric Light and its Effects Upon the Eyes*. The British Medical Journal, vol. 1.1625, pp. 382-383.

Hatt R.T., 1960 - *Seven Lighting Problems; Seven Solutions*. Curator: The Museum Journal, vol. 3(4), pp. 361-370.

Hautecœur L., 1933 - *Architecture et aménagement*. Mouseion, voll. 23-24(3-4), pp. 5-29.

Heathcote Statham H., 1898 - *Modern Architecture: A book for architects and the public*. Charles Scribner's Sons, New York.

Heraeus S., 2014 - *Top Lighting from Paris in 1750. The Picture Gallery in Kassel and its Significance for the Evolution of the Modern Museum of Art*. In: Meyer A., Savoy B. (eds), *Transnational History of Museums 1750-1940*. De Gryter, Berlin, pp. 61-76.

Hernández Hernández F., 1994 - *Manual de Museología*. Editorial Síntesis, Madrid.

Holmes C.J., 1928 - L*es transformations de la "National Gallery" à Londres*. Mouseion, n. 4, pp. 1-6.

Hooper-Greenhill E., 1992 - *Museums and the Shaping of Knowledge*. Routledge, London.

Hurley C., 2010 - *Jalons pour une histoire du dispositif*. Culture et Musées, vol. 16(1), pp. 207-218.

Illuminating Engineering Society, 1947 - *Lighting Handbook*. IES, New York.

Kelly R., 1962 - *Focal Glow, Ambient Luminescence, and the Play of Brilliants. Statement to Mrs. Edward Emerson, editor of the Bulletin, after a talk at the Garden Club of America Forum in New York City on November 15*.

Kilde J.H., 2008 - *Sacred Power, Sacred Space: An Introduction to Christian Architecture and Worship*. Oxford University Press, New York.

Koetschau K., 1911 - *Museumskunde*. Vol. VII/3. Druck und Verlag Von Georg Reimer, Berlin.

Kummerow B.K., 2019 - *One hundred Gems of Light: The Peale Family Introduces Gaslight to America*. In: Mamoli Z., Manthorne K. (eds.), *From Darkness to Light: Writers in Museums 1798-1898*. Open Book Publishers, Cambridge, pp. 110-115.

Kuwakino K., 2013 - *The great theater of creative thought: The Inscriptiones vel tituli theatri amplissimi... (1565) by Samuel von Quiccheberg*. Journal of the History of Collections, vol. 25(3), pp. 303-324.

Lam W.M.C., 1977 - *Éclairage et architecture*. McGraw-Hill, New York.

Liu A., Tuzikas A. Zukauskas A., Vaicekauskas R., Vitta P., Shur M., 2013 - *Cultural Preferences to Color Quality of Illumination of Different Artwork Objects Revealed by a Color Rendition Engine*. IEEE Photonics Journal, vol. 5(4).

Mairesse F., 2011 - *Muséalisation*. In: Desvallées A., Mairesse F. (eds.), *Dictionnaire encyclopédique de muséologie*. Armand Colin, Paris, pp. 251-270.

Mairesse F., 2014 - *Le culte des musées*. Académie Royale de Belgique, Bruxelles.

Mamoli Z., Manthorne K. (eds.), 2019 - *From Darkness to Light. Writers in Museums 1798-1898*. Open Book Publishers, Cambridge.

Maroevi I., 1998 - *Introduction to Museology: The European Approach*. Verlag Dr. C. Müller-Straten, München.

McLuhan M., Parker H., Barzun J., 2008 - *Le musée non-linéaire: Exploration des méthodes, moyens et valeurs de la communication avec le public par le musée*. Aléas, Lyon.

Meadow M.A., Robertson B., 2013 - *The First Treatise on Museums: Samuel Quiccheberg's Inscriptiones, 1565*. Getty Publications, Los Angeles.

Miller L.B., 1998 - *The selected papers of Charles Willson Peale and his family*, II. Yale University Press-Smithsonian Institution, Westford.

Moya L., 1935 - *L'éclairage naturel dans les galeries de peinture et son application au climat de Madrid*. Mouseion, vol. 29(1-2), pp. 33-58.

Murray D., 1904 - *Museums, their history and their use*. J. MacLehose, Glasgow.

Museums Association, 1890 - *Report of Proceedings with the Papers Read at the First Annual General Meeting Held at Liverpool, June 17, 18, 19, 1890*. The Museums Association.

Nakamura S., Kamiya S., Inoné K., 1936 - *Détermination expérimentale de l'éclairage au Musée Impérial de Tokio*. Mouseion, voll. 33-34, pp. 191-193.

Nakamura S., 1935 - *Cloisons de verre pour la protection des peintures au Japon*. Mouseion, voll. 31-32(3-4), pp. 173-177.

Nascimento S., Masuda O., 2014 - *Best lighting for visual appreciation of artistic Paintings-Experiments with real paintings and real illumination*. Journal of the Optical Society of America. A, Optics, image science, and vision, vol. 31, pp. 214-219.

Nesbitt C., 2012 - *Shaping the sacred: Light and the experience of worship in middle Byzantine churches*. Byzantine and Modern Greek Studies, vol. 36(2), pp. 139-160.

Neumann D., 2010 - *The Structure of Light. Richard Kelly and the Illumination of Modern Architecture*. Yale School of Architecture, New Haven/London.

Nye D.E., 2019 - *The Artificial Lighting Available to European and American Museums, 1800-1915*. In: Mamoli Z., Manthorne K. (eds.), *From Darkness to Light: Writers in Museums 1798-1898*. Open Book Publishers, Cambridge, pp. 25-40.

Perret A., 1929 - *Le musée moderne*. Mouseion, n. 9, pp. 225-235.

Pesquidoux L. de, 1857 - *Voyage artistique en France*. Michel Levy, Paris.

Plummer H., 2009 - *Architectes de la lumière*. Hazan, Paris.

Ramsay A.G., Smith G., 1936 - *Notes sur l'éclairage artificiel et naturels des musées et des galeries de peinture*. Mouseion, voll. 33-34(1-2), pp. 184-189.

Ranellucci S., 2016 - *Museum. Trattato di museografia*. Gangemi Editore, Roma.

Réau L., 1909 - *L'organisation des musées*. Libraire Léopold Cerf, Paris.

Richardson E., Woolley E., Yurchenko A., Thickett D., 2020 - *Assessing the Impact of LED Lighting on the Stability of Selected Yellow Paint Formulations*. LEUKOS, vol. 16(1), pp. 67-85.

Rispal A., 2009 - *L'architecture et la muséographie comme médiation sensible*. Muséologies, vol. 3(2), pp. 90-101.

Rosa G., 2008 - *Lezioni di museografia*. Officina Edizioni, Roma.

Sahut M.-C., 1979 - *Le Louvre d'Hubert Robert, catalogue de l'exposition*. Éditions de la Réunion des musées nationaux, Paris.

Saunders D., 2020 - *Museum Lighting: A Guide for Conservators and Curators*. Getty Publications, Los Angeles.

Schielke T., 2019 - *The Language of Lighting: Applying semiotics in the Evaluation of Lighting Design*. LEUKOS, vol. 15(2-3), pp. 227-258.

Sokol Gojnik Z., Gojnik I., 2018 - *Constitutive Role of Light in Christian Sacred Architecture*. International Journal of Humanities and Social Sciences, vol. 12(3), pp. 365-368.

Soucy J. de, 1934 - *L'éclairage des musées de France*. Mouseion, voll. 27-28, pp. 192-214.

Stein C., 1933 - *Architecture et aménagement des musées*. Mouseion, voll. 21-22(1-2), pp. 7-26.

Stein C., 1935 - *Éclairage naturel et éclairage artificial*. In: Stein C. (ed.), *Muséographie: Architecture et aménagement des musées d'art/Conférence internationale d'études, Madrid, 1934, T.I. Société des nations*. Office international des musées, Paris, pp. 76-155.

Stevenson R.L., 1907 - *A Plea for Gas Lamps*. In: Stevenson R.L. (ed.), *Virginibus Puerisque' and Other Papers*. Small, Maynard and Co., Boston, pp. 249-256.

Swinney G., 1999 - *Gas Lighting in British Museums and Galleries*. Museum Management and Curatorship, vol. 18(2), pp. 113-143.

Turner J., 1994 - *Lighting: An Introduction to Light, Lighting and Light use*. Conway Lloyd Morgan, London.

Van Gelder H.E., Berlage H.P., 1931 - *Le nouveau musée de la Haye*. Mouseion, voll. 13-14(1-2), pp. 104-109.

Visconti E.Q., Visconti G.A., Labus G., 1822 - *Il Museo Pio Clementino*. N. Bettoni, Milano.

Weis H., 1989 - *La muséologie selon Georges Henri Rivière*. Dunod, Paris.

Wezel E., 2001 - *Die Konzeptionen Des Alten Und Neuen Museums Zu Berlin Und Das Sich Wandelnde Historische Bewusstsein*. Gebr. Mann Verlag, Berlin.

Ziabakhsh N., Amrei S.M.M., 2011 - *Spiritual Manifestation of Natural Light in Sacred Buildings: A Comparative Study*. International Journal Of Architecture and Urban Development, vol. 1(1), pp. 73-78.