Global Scientific JOURNALS

GSJ: Volume 9, Issue 7, July 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

Efficient Lighting for Museum Exhibition Halls.

BY

Dennis Alfred Ateli
Post graduate student, Rivers State University
Email: **atelialfred@gmail.com**
Lecturer; Prof. IMAAH Napoleon
Department of Architecture, Rivers State University
Nkpolu-Oroworukwo, Port Harcourt

ABSTRACT

A museum is a place to discover, explore and learn about the past, present and future of creativity, as well as history. Lighting plays a significant role in developing interaction between humans and museum artifacts in one defined space. "Museums are places where lighting design is critical to the overall experience" (Lowe,43, 2009). Lighting is essential for human interaction in a space. Technical illumination research lays a foundation to conduct analysis in a variety of museums. This research component is significant to understand the complexity and various facets of overall museum lighting design. This study evaluates both the quantitative and qualitative aspects of lighting design in museums. Psychological, physiological and experiential components are observed in these museums' environments to analyze lighting design within its exhibits.

Keywords: *museum, lighting, space organization, light protection, room lighting, exhibition lighting, diffuse lighting, directional lighting, luminous ceiling.*

1.0 Introduction

Lighting is vital for spatial impression and enjoyment of art. Different light colours and beam spreads, different designs and arrangements of luminaires and lamps create different lighting situations – light spaces – designed to meet the relevant needs of the exhibition. Special attention needs to be paid to conservation requirements.

Light protection plays an important role in any exhibition room.

There is more to a museum than just what it displays; it is also a place of research, where collections are stored, preserved and managed. Only in the right lighting can museum staff work effectively. Lighting also draws attention to tripping hazards and reduces the risk of accidents. So although the lighting designer has a great deal of freedom in exhibition rooms, functional lighting must always be provided.

Lighting is a critical component in a museum environment because the space enables visitors to see objects, experience new sights and react to the surrounding environment. Typically, environments have two types of light–natural and artificial.

For a museum, the role of light is an essential part of creating an atmosphere prime for discovery, while also preserving artefacts. This can be a very difficult balancing act between meeting preservation needs and forming interactive experiences that achieve the goal of the museum–a place to discover, explore and learn.

Qualitative as well as quantitative aspects of lighting in a museum.

2.0 Methods

For the purpose of this paper, the case study method of research has been adopted.

Secondary sources of information shall be from studies by other researchers through books, journals, published and unpublished literature, as well as online sources '. It can be used to get a new perspective on the current study, to supplement or compare the work or to use parts of it as long as the data remain relevant. The data collected will be reviewed and used as bases for concept generation and analysis.

For this paper I have chosen to do two things: summarize empirically validated findings from other studies that are relevant to the questions of this research and add my own line of thought.

3.0 Definition of terms

3.1 Museum

Museums stems from the age-old human desires to preserve cultural identity; gain social, political, and economic status, to pursue knowledge.

The word museum was first used in English in the 17th century derive from the Greek "Mouseion", meaning "seat of muses". (http;//www.wikipedia.com)

3.2 Lighting

Lighting is a critical component in a museum environment because the space enables visitors to see objects, experience new sights and react to the surrounding environment. Typically, environments have two types of light–natural and artificial. For a museum, the role of light is an essential part of creating an atmosphere prime for discovery, while also preserving artifacts. This can be a very difficult balancing act between meeting preservation needs and forming interactive experiences that achieve the goal of the museum–a place to discover, explore and learn. Illumination Engineering Society of North America (IESNA) provides parameters and standards for lighting design in a museum to ensure safety, preserve artifacts, and create an interactive

experience for guests of all ages. A brief review of literature will help understand this thesis. The literature encompasses qualitative as well as quantitative aspects of lighting in a museum.

4.0 The Action of Light

The design and configuration of exhibition room lighting depends on many planning parameters. Foremost among these is the architecture of the building with which the lighting is required to harmonize. Other factors are room proportions, interior design, colour scheme, available daylight and, last but not least, the nature of the exhibition. The way the ambience is shaped by light and shadow is a matter of fundamental importance.

5.0 Light Protection

Daylight and artificial light contain rays which may fade, dry out, discolor or deform exhibits. Conservation measures can protect against this but only if they are properly applied and observed. For more about light protection.

6.0 Room Lighting

Lighting for exhibition rooms in museums is made up of diffuse and directional light. The relative amounts and resulting mix of the two types of light determines the harshness of the shadows cast by picture frames and the three-dimensional impact of sculptures and spatial objects.

The diffuse and directional light mix also defines the overall impression made by the room.

A closely related matter here is the distinction between room and exhibit lighting. The diffuse lighting is almost all generated by the room lighting, which determines the distribution of brightness and sets lighting accents in the horizontal plane.

Room lighting alone is rarely enough to meet all an exhibition's needs. Conversely, the directional lighting used to illuminate exhibits does not provide bright enough room lighting except in a few – mostly small and bright –interiors.

7.0 Exhibit Lighting

Exhibit lighting uses hardedge directional light to accentuate individual items on display. As a general rule, it needs to be supplemented by softer room lighting. Exhibit lighting based on spots alone is advisable only where a particularly dramatic effect is required.

Otherwise, a stimulating spatial experience is obtained with a mix of diffuse (room) and directional (exhibit) lighting.

8.0 Diffuse Lighting

Diffuse lighting illuminates room zones or objects from a surface that radiates light in all directions. At the site of illumination, i.e. in the room zone or at the object illuminated, the direction from which the light comes cannot be clearly determined: the light flowing into the room and over the objects is not directional. Where it comes from very many directions, i.e. where the radiant surface is large, the lighting produces little or no shadowing.

9.0 Directional Lighting

Directional lighting is generated mostly by punctual light sources – i.e. lamps that are small in relation to the lighting distance – or spots of similar design. The light falls directly onto the object illuminated, striking it, or parts of it, at an angle defined by the geometry of the lighting arrangement.

Where the surface of the object is uneven, clearly defined shadows occur.

These enhance the visual impact of three-dimensional surfaces but can also be a source of visual interference if they are too dominant or too large.

Fig 1.0: Illuminating objects – exhibits are set off to dramatic effect by directional lighting
Source: Fördergemeinschaft Gutes Licht 2000

Fig 2.0: Ambience and the way we experience a room are shaped by light and shadows and the way they are mixed.

Source: Fördergemeinschaft Gutes Licht 2000

Diffuse/directional lighting in many applications, light cannot be clearly defined as wholly diffuse or wholly directional. This is the case where the surface radiating the light is neither large nor punctual – e.g. a spot with a diffuser disc. Depending on the diameter of the disc and on the lighting distance, shadows are narrower or wider, harsher or softer.

Diffuse/directional lighting also occurs where a surface is illuminated or backlit to produce diffuse lighting and part of the light is made to radiate in a particular direction and is thus partially directional. The direction from which the light comes can be seen on the objects illuminated. However, the shadowing that occurs on exhibits is less clearly defined than if the light were entirely directional.

The modelling is rendered subtler by the brightening effect of the diffuse lighting component.

Diffuse/directional lighting can also be produced, for example, by linear lamps in appropriately designed luminaires. Here, shadowing depends on the position of the luminaire in relation to the picture: wall washers with tubular fluorescent lamps mounted horizontally or parallel to the upper edge of the wall produce hard-edged shadows beneath horizontal picture frames, whereas the shadows cast by the vertical part of the frame are barely discernible.

Avoiding cast shadows

Directional light produces form shadows. Where it also results in cast shadows on neighboring objects, the hard contours and obscure origin of such shadows are disturbing.

Cast shadows are avoided by ensuring an appropriate mix of diffuse and directional light, correct positioning of the light source producing the directional light or appropriate positioning of the illuminated objects in relation to one another. Combinations of layers, with different light levels, create a complete lighting system. All of these layers should be in place to achieve a successful museum lighting system.

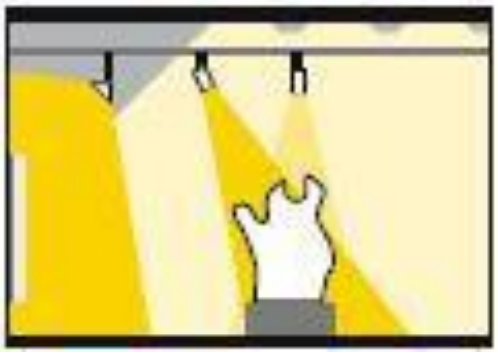

Fig. 3.0: Supplementary directional lighting for objects in the room

Source: Fördergemeinschaft Gutes Licht 2000

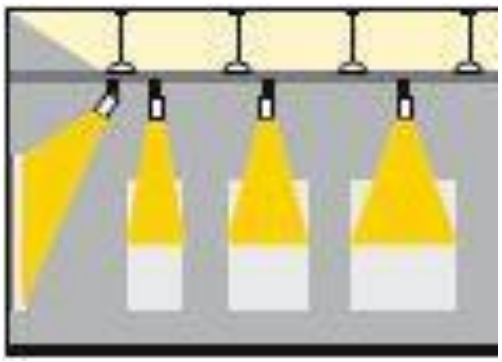

Fig. 4.0: Indirect and direct components produce diffuse and directional lighting respectively

Source: Fördergemeinschaft Gutes Licht 2000

The most important lighting systems used in exhibition rooms are:
_ Luminous ceilings with opal glass enclosure (diffuse light) or sanitized and textured glass (diffuse/ directional),
_ Indirect luminaires (diffuse),
_ Cove luminaires (diffuse),
_ Wall washers (directional or diffuse/directional),
_ Spot lamps.

10.0 Luminous Ceiling

The idea of luminous ceilings stems from a desire to imitate daylight. Luminous ceilings deliver light which is particularly suitable for painting galleries – predominantly diffuse with an opal enclosure, partly directional with enclosures of sanitized/textured glass. The heat that is generated in any luminous ceiling needs To be dissipated or extracted. The light sources of choice are tubular fluorescent

Lamps arranged according to the structural grid of the luminous ceiling. For good uniformity, they should be spaced no further apart than the distance to the ceiling enclosure. The size of the luminous ceiling, its subdivision and the transitions between ceiling and walls need to suit the proportions of the room and the nature of the objects displayed.

Luminous ceilings imitating natural daylight need to deliver a high level of luminance:
500 to 1,000 cd/m2, ranging up to 2,000 cd/m2for very high-ceilinged rooms. Luminous ceilings are especially suitable for interiors with 6 meter ceilings or higher. Where room heights are lower, their light can dazzle because they occupy a large part of the field of vision. Where the lighting is dimmed for conservation reasons or to reduce glare, the luminous ceiling loses its daylight quality and looks grey and oppressive. All luminous ceilings – including daylighting installations – need to be designed by a specialist

Fig. 5.0: Luminous ceilings are particularly suitable for painting galleries. The cove lighting provides additional brightness.

Source: Fördergemeinschaft Gutes Licht 2000

Fig. 6.0: Indirect lighting has an impact similar to that of a luminous ceiling.
Source: Fördergemeinschaft Gutes Licht 2000

11.0 Indirect Luminaires

An impact similar to that of a luminous ceiling is achieved with indirect light bounced off the ceiling and upper wall surfaces into the room. This diffuse, uniform light is predominantly used in rooms where no daylight enters. It is produced by suspended luminaires radiating light upwards.

In exhibition rooms, for example, luminaires for suspended power track systems are an option: they are inserted in the track from above while spots for directional lighting are accommodated in the lower channel.

12.0 Cove Luminaires

The diffuse light of luminaires installed in the curving transition between wall and ceiling – the cove or coving – is another indirect lighting solution. The cove luminaires most frequently used in modern museum buildings are models with housings which themselves form the coving.

The main direction of light with cove lighting is closer to the horizontal than with aluminous ceiling and corresponds roughly to that of perimeter luminaires mounted in continuous rows. The light is largely shadow-free. Linear lamps– generally tubular fluorescent lamps – are the most widely used light source.

Excessive luminance at the ceiling and on the upperpart of walls causes glare and interferes with spatial experience. This can occur in coves where no steps are taken to provide optical control – for example because the existing cove offers no space for prisms or reflectors. Where simpleton-overlapping battens are installed, disturbing light-dark transitions are also visible around the lamp holders.

13.0 WALLWASHERS

Wall washers are used as individual luminaires or in continuous rows. Installed flush with the ceiling (or with kick reflector protruding from the ceiling) or mounted close to the ceiling, they should illuminate the walls as uniformly as possible.

This task is performed by reflectors with asymmetrical optics. It is important to ensure good shielding in the direction of the observer. Element son the luminaire for mounting accessories – such as filters or anti-glare flaps – are useful. Favored light sources for wall washers include linear lamps: fluorescent lamps, compact fluorescent lamps in elongated designs, linear high-voltage halogen lamps. The diffuse/directional lighting delivered by the continuous row arrangements that are possible with these light sources produces relatively deep shadows, especially along the horizontal edges of picture frames.

The directional light delivered by individual luminaires with non-linear lamps, on the other hand, gives rise to additional shadows along the horizontal edges of a picture frame.

Spot lamps

Reflectors in reflector lamps (used in luminaires with no reflector) or spots direct Most of the light emitted by punctual light sources in a defined beam direction.

Spots and downlights without characteristics can be fully or partially integrated into a ceiling (or wall) as recessed ceiling spots. Surface-mounted ceiling spots and downlights as well as spots for power track have visible housings. Elements on the luminaire for mounting accessories – such as filters or anti-glare flaps –are useful. Punctual light sources include high-voltage halogen lamps

and low-voltage halogen lamps with and without reflector, incandescent lamps with or without chrome cap as well as metal halide lamps.

Fig. 7.0: Wallwashers distribute their light asymmetrically.

Source: Fördergemeinschaft Gutes Licht 2000

Fig. 8.0: The directional light of spot lamps raises the brightness for exhibits – here with an appropriate beam angle for paintings.

Source: Fördergemeinschaft Gutes Licht 2000

14.0 SHOWCASE LIGHTING

Showcases are miniature exhibition rooms and the exhibits they contain need to be illuminated accordingly

– With diffuse or directional light. In some cases, illuminating and accentuating light may also be mixed in glass display cabinets.

The right light for the task The type of lighting required Depends essentially on the characteristics of the exhibits – on three-dimensional form, structure, surface gloss and transparency or colour. Most metal objects – gold or silver receptacles, for example – acquire a fascinating beauty when they gleam. And that gleam occurs when they are illuminated by punctual light sources. Under diffuse lighting, the receptacles appear matt and lifeless.

For transparent or translucent objects such as glass exhibits, the key to heightening

Visual impact lies more in modelling than in gleam. The structure of

Surfaces – cut, etched or painted – also plays an important role here. Depending on the exhibit, the correct solution may be diffuser directional lighting (through-lighting) or combination of the two. With directional lighting, visual impact is determined by the angle of light incidence.

Diffuse lighting is appropriate for colored or transparent materials such as glass windows.

Integrated lighting Small, shallow display cabinets (glass-topped desks) and high or box-shaped showcases mostly have an integrated lighting system.

This has advantages:

_ Fewer or no reflections occur on the cabinet glass.

_ It is easier to avoid direct glare for the observer due to bright unshielded light sources.

_ It is easier to engineer special lighting effects for a dramatic presentation.

In small display cabinets, exhibits are normally illuminated from the side. In high

Showcases, lighting from the cabinet roof is an option.

Alternatively, objects can be bathed in light from below from the base of the cabinet.

In addition to the lighting Integrated in the showcase, separate ambient lighting is generally essential. Depending on the atmosphere required and the illuminance permitted for conservation, the room lighting should be just below the level of the showcase lighting or even lower. Orientation lighting which relies entirely on stray light from showcases and not on dedicated orientation lighting system should not be too low.

15.0 LIGHT PROTECTION

Light protection is also an important consideration for showcase lighting – not least because lamps in showcases are often closer to exhibits than in exhibition rooms. It must also be borne in mind that the enclosed space of a showcase has its own microclimate.

For the lighting, there are alternatives to the lamps used in the past: LEDs, for example, which deliver abeam that contains no IV or

IR radiation, and fibre-optic lighting systems.


Fig 9.0: LEDs for light protection – luminous diodes emit neither ultraviolet light nor heat.
Fig 10.0: Under the top-down showcase lighting, the suits of armor gleam in fascinating detail

Source: Fördergemeinschaft Gutes Licht 2000

16.0 FAÇADE LIGHTING

Buildings bathed in light impact at night because of their architecture. Where facade lighting makes this visible, decorative night images are created. Illuminated advertising signs and frontal floodlighting also help shape a museum building's night-time appearance.

Light can make any building an eye-catcher.

Combined with fascinating architecture, well-planned facade lighting imbues abuilding with a unique quality – and enhances the area around it at the sometime.

Illuminating the entire building has a long-range impact; harnessing light to emphasize only architectural details heightens its presence for passers-by.

Where the principal viewing direction and the direction of illumination are not identical, light-dark contrasts create a three-dimensional effect: an angle of around 60 degrees to the viewing direction is right for plain or fairly plain facades; for more detailed or ornate facades, the angle can be smaller.

Ensuring floodlights are not installed too close to the building avoids excessively deep shadows. Beams should not cross or shadows will be too light.

Floods with a long-range impact should be positioned high and mounted as inconspicuously as possible. High-pressure sodium vapor lamps underline the character of warm colours and materials; for cooler-looking surfaces, metal halide lamps are a suitable solution.

Illumination is also possible with wall luminaires integrated in the facade and recessed ground floods positioned directly in front of it.

The illuminance required is determined by the colour and thus reflectance of the illuminated building (building luminance) and by the ambient brightness: the darker the building and brighter the surroundings, the more light is needed.
Precise planning avoids light emission into the surrounding area.
Alternatives to classical illumination are presented by fibre-optic lighting systems and LEDs, with which facades or parts of facades can be bathed in dynamic changing colored light.
Another possibility is facade design based on activated (and controlled) interior lighting.

17.0 OTHER FORMS OF ILLUMINATION

Facade lighting is normally discrete design element.
However, illuminated signage
– e.g. the name of the museum in luminous letters
– needs to be planned to suit it. To achieve the desired effect, any additional signal lighting, such as floodlighting for flags or banners, needs to be coordinated with the facade lighting.
In other outdoor areas, attractive scenes are also created by illuminating trees or other vegetation. The rules to be followed here are the same as for outdoor feature lighting If the facade is also illuminated, lights should only be trained on plants well away from the building.
SEEING, IDENTIFYING, PERCEIVING

18.0 DIRECT GLARE, REFLECTED GLARE

Direct glare is caused by luminaires, general-diffuse lamps or other excessively luminous surfaces – including windows. Reflected glare is caused by reflections on shiny surfaces.
Glare can interfere with visual performance to such an extent that reliable perception and identification become impossible. Physiological glare is a measurable loss of visual functions such as visual acuity.
Psychological glare causes discomfort and loss of concentration.
Glare cannot be eliminated altogether but it can be significantly reduced. There are recognized methods for assessing both types of glare.
In exhibition rooms, reflected glare can be used to A limited extent as a design tool – for example where shiny exhibits with brilliantly reflective surfaces are bathed in dramatic directional light to maximize their impact.

19.0 Conclusion

Valuable data has been collected from different museums to date. Lighting parameters (illuminance and luminance values) and lighting sources choice should be carefully designed and strictly controlled while in use to protect sensitive exhibition goods and to provide comfortable exhibition conditions for visitors. LED technology seems to accomplish most of the requirements for this task. Adequate temperature and humidity rates cooperate in both preservation and comfort within museums, however still when recommendations have been met in some of the museum spaces, attention should be paid also to exhibition time. As shown, highly sensitive material should

be very carefully displayed to avoid short term deterioration. A reasonable balance between appropriate environmental conditions and exhibition times may lead to a better preservation and quality of the visual environment. The generation of an appropriate ambience for both objects and visitors in order to provide with the "museum experience" needs the expertise of various professionals and therefore it remains as an interdisciplinary challenge.

20.0 References

Allen, O.A (1974). *The Organization of Museums: Practical Advice, the Museum and its Functions* (3rd edition). Paris: UNESCO Publications.
Autorie D. D. (1980). *Architectural Drawing and Design*: Architectural Press. New York.
Ching, D. K. F. *Architectural form and Space*: Van Hostrand, Reinhold Company U.S.A.
Ching. D. K. Francis. (1980). *Architecture for Space and Order*: Van Nostrad Reinhold Company New York.
De Chiara, J & Crosbie, M.J (2001). *Time-Saver Standards for Building Types* (4th edition): New York: McGraw-Hill Companies.
David A. (Ed) (1999) *Metric Handbook Planning and Design Data* (2nd Edition) Architectural Press, Oxford Auckland Boston, Johannesburg, Melbourne New Delhi.
Flower, W.H (1972). *Essays on Museum*, Journal of Museum Organization, New York.
Fördergemeinschaft Gutes Licht, lichtwissen18_light_museums_galleries.
Haney, J (1973). *Air-conditioning for Museums*. Journal of Britain Museum Association, 73 (1).
Henry J. C. & Peter R. S. (2004) *Dictionary of Architectural and Building Technology (4th edition)* Spon Press, 11 New Fetter Lane, London EC4P 4EE
Lewis, J.A (1968). *Principles of Natural Lighting:* London: Applied Science Publishers.
Lighting in Art Gallery (1959): Architect's Journal, No. 3.
Lord, G.D & Lord, B (1991). *The Manual of Museum Planning. United Kingdom:* HMSO Publications.
Lynes J. A. (1978*): Development in lighting I:* Applied Science Publications Ltd. London.
Maguiness, R. S. (1980): *Mechanical and Electical Equipment for building:* John Wiley. New York.
Michael B. (2003), *Architectural Thought: the design process and the expectant eye:* Architectural
Neufert, E & Neufert, P (2001). *Neufert Architect's Data* (2nd & 3rd edition.): UK: Blackwell Publishing Company.
Roger H. C. & Michael P. (2006), *Precedents In Architecture Analytic Diagrams, Formative Ideas and Partis (3rd Edition):* John Wiley & Sons Inc. Hoboken, New Jersey.
Technical Report. (1970) *Lighting of Art Galleries and Museums:* The illuminating Engineering Society, New York, West Minister Bridge road, London.
Time Saver Standards for Building Types, Edited by Joseph De Chiara and John Callender, copyright 1983. "Cultural centre"
Thompson, C (1963). *Day lighting in Art Galleries*: journal on the Planning of Museums and Art Galleries.
White T. E. (1975) *Concept Source book. A Vocabulary of Architectural forms:* Architectural Media Ltd,
Zevi, B (1949). *Towards an Organic Architecture:* London: Faber & Faber Ltd.