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Assessment of Day Light Design Considerations in Kogi State Museum

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Abstract: *As much as light is a basic requirement in museum design, to appreciate the articles on display, so also are they destructive if not properly controlled or used in display areas! Light have destructive effect on artifacts with various degrees of damage; it also causes discomfort to the eyes of observers who are meant to appreciate the displayed artifacts. Glare is a common phenomenon that brings such discomfort to observers in museums with discoloration of objects thereby making the displayed object not pleasing to the eye. Lighting in museums and art galleries plays a key role in a visitor's ability to perceive and enjoy the artifacts in total. In order to achieve a successful lighting scheme, the architect or designer must put into consideration the preservation and presentation of these artifacts thereby increasing their life span. The article seeks to highlight some architectural design considerations that will give optimal use of day light in respect to the museum in view. To achieve these, sampling of literature of previous works relating to the topic was referred. Physical observations were also made with respect to the museum in view.*

Keyword: *artifacts, conservation, daylight, display, museum designers*

I. Introduction

Design is defined by light and
Shade, and appropriate lighting is
enormously important.
-Albert Hadley-

Light is another agent of long-term deterioration to objects on exhibition. Light can damage what it reaches, and its major effect is on surface of materials, organic and inorganic, are at risk under light. Light and heat are forms of energy, and the energy, which is held in molecules, causes deterioration. In museum, activation energy may be brought to an object by heating it or illuminating it (Cronyn J. M., 1990, [1]). Lighting for Museums and Art Galleries has a unique set of priorities, those of conservation and effective display. In many ways these two requirements conflict as there is a necessity to restrain lighting levels to promote the former whilst the latter requires sufficient light of a high quality to provide optimum viewing conditions. Light damage on museum artifacts accumulates over a period of time; this forms the reason why some advice that over time such artifacts be removed and replaced to avoid unnecessary light damage. This is slowly being adopted as a common practice in museums around the world. Light spectrum contains can be seen to contain, ultraviolet light (UV), visible light, and infrared light (IR). Ultraviolet light is most damaging to objects, while infrared light produces heat which also causes damage. Museums generally use halogen or metal halide track lighting in galleries and fluorescent light in storage; however, these are not energy efficient options. Halogen lights waste energy by creating four times the amount of heat as a regular incandescent light and can become fire hazards. In a world where the use of more energy-efficient products is on the rise, museums have more opportunities than ever to cut down on the amount of electricity they use. Some scholars believe that a focus on sustainability is a way for museums to be relevant in the 21st century (Brophy, Wylie, Sarah S., and Elizabeth, 2008, [2]). The challenge of the architect as a designer is to achieve a balance between creating interesting and desirable spaces, maintaining visual comfort and health of the visitor. A perceptual contact with the sky is also a strong and desirable contact between the display and artifacts and the real world without the museum building, these requirements of low level controlled lighting and the dynamic high level natural light are apparently in conflict and one of the principal challenges in designing the modern building is to resolve these issues. Ignoring good lighting design, glare and reflection can make even wonderful artifacts difficult to see. Bad lighting will make artifacts dull, lifeless or distorted. The amount of light into a space depend strongly on the depth to which it will travel through, this is characterized by the length, breadth and height of the space. Also the building orientation with respect to north lighting, sizes of the fenestrations (windows and openings on walls). Will be keenly considered.

II. Problem Statement

Museums in recent times have been designed with much focus on the use of artificial lighting as supporting in the areas of display. This is as a result of the difficulty in achieving absorbing maximum day light into the display areas as a result of their hazards on artifacts and viewing of displayed objects.

Architect and museum designer in the region placed little or no attention on achieving daylight particularly to the fact that the area of study is endowed with abundance of daylight per day. Research also has proven that daylight gives the best of view for displayed objects (Mardaljevic J., 2002, [3]) architects and museum designers have shy away from designing with much concern on daylight due to the variety of artificial lighting options available. The world is now talking about sustainable designs, with much being spent to light museums artificially in this part of the world needs awareness, a call to architects and museum designers to take up the challenge to design for maximum daylight utilization in our museums.

III. Aim and Objectives

The study aims at giving a summary of areas of focus/concentration for architects in the region in museum design in order to harness and utilize maximally daylight into museums without having deteriorating effect on artifacts and displeasing in viewing displayed objects.

The objectives are to include;

i. Identifying and categorizing technical areas where light is most required
ii. Suggesting architectural design forms as a measure to control glare
iii. Determining the hazards of day lighting on artifacts
iv. Suggest the best building orientation for museum design in the region.

IV. Scope of the study

The study focuses on identifying and showing how the museum design has harness optimally the available amount of day lighting architecturally in the display areas, base on building orientation, window orientation and sizes.

V. The Study Area

Kogi State was carved out of Benue and Kwara States on August 27, 1991 by the Federal Military Government. Kogi State is the most centrally located of all the states of the federation. It comprises the Igala, Ebira, Kabba, Yoruba and Kogi divisions of the former Kabba province. It shares common boundaries with Niger, Kwara, Nassarawa and The Federal Capital Territory to the north. To the east, the state is bounded by Benue and Enugu states, to the south by Enugu and Anambra States, and to the west by Ondo, Ekiti and Edo states. Lokoja, the state capital Lokoja town was originally established in 1945, as the provincial headquarters of Kabba. The area has contributed in no small measure to the political growth of the Nigeria before, during and after the colonial period in 1904. Located within coordinates $7^0$49N, $6^0$45E, the city has since grown till date, with an estimated land area of 3180km^2 and about 195,261 as at 2006 census. With an average temperature of 28^0 C, the study area all experience an average mean day light of 12 hours, which could be harnessed for the benefit of the museum for display.

VI. Sources of Light

Light has two sources: Natural and Artificial. Sunlight the major source of natural light has a high percentage of ultraviolet UV ray. Natural light has proved to be beneficial for the health, productivity, and safety of building occupants.

Day Light

The most obvious vehicle for energy saving in buildings is in exploiting the most abundant source of light available to us – daylight. Environmentally conscious assessments of building design are recognizing that daylight is an important commodity and should be exploited to the full. Generally, people when asked, always prefer to work in a daylit environment. There is a growing acknowledgement that daylight produces positive effects, both physiological and psychological (Mardaljevic J., 2002, [3]) Forms of control are necessary to limit the potentially excessive levels of daylight, if it is not to become a nuisance, particularly on bright sunny days. Daylight comes from not just direct sunlight but also from illumination from the sky on overcast days (Farley K M J, V. J. A. A, 2001 [4]). A wide range of devices are available, from relatively inexpensive and simple internal blinds (roller, venetian etc.) through to high tech, computer-controlled heliodens, which track the sun. Whilst a day lighting strategy will be needed in those buildings where a decision to provide air-conditioning has been adopted, it is in those buildings described as 'passive' where the greatest savings can be made.

A passive building is one in which the greatest use is made of natural resources natural light, solar power and ventilation derived from making use of the natural environment.

Artificial Light

The two primary artificial light sources currently in use in museums and archives are incandescent and fluorescent lamps. The term "lamp" is used by architects and engineers to refer to the various types of light bulbs, rather than to the fixtures containing the bulbs. Driven by the need for energy conservation and cost savings, manufacturers continue to refine lamp technologies to produce longer-lived lamps that consume less energy and provide better light. Compact fluorescent, tungsten-halogen, high intensity discharge (HID), and electrodeless lamps have all been developed in response to these concerns. Conventional incandescent lamps produce light when an electric current is passed through a tungsten filament, heating it to about 2700 degrees Celsius. Incandescent lamps convert only a small percentage of this electricity into light; the rest becomes heat. Conventional incandescent lamps emit very little ultraviolet light and do not require UV filtering. Examples of conventional incandescent lamps include the ordinary household light bulb and a variety of lamps used for exhibition lighting, such as the Reflectorized (R), Ellipsoidal Reflectorized (ER), and Parabolic Aluminized Reflector (PAR) lamps. Tungsten-halogen lamps (also called quartz lamps) are a variation on the traditional incandescent lamp; they contain halogen gas inside a quartz bulb, which allows the light to burn brighter and longer. These lamps emit significant UV light and do require filtering. Filters can be expensive and special housings designed to accept the UV filters may be necessary. Tungsten-halogen lamps are also used in exhibition lighting; examples include the Halogen PAR and the Mirrored-Reflector (MR) lamp. Fluorescent lamps contain mercury vapor inside a glass lamp whose inside surface is painted with white fluorescent powder. When electricity is passed through the lamp (via a filament), the mercury vapor emits UV radiation which is absorbed by the fluorescent powder and re-emitted as visible light. Some UV light passes through most fluorescent lamps, however, so they are more damaging than incandescent lamps. The newest type of fluorescent is the compact fluorescent lamp; these are smaller, last longer, and have a more pleasant color than traditional fluorescents, and they can usually be used in incandescent sockets. These lamps must still be filtered, however.

Fiber optic lighting is an energy-efficient means of providing display lighting, particularly in exhibition cases. In a fiber optic system, light is transmitted from a light source through glass or acrylic fibers. The fibers do not conduct infrared or ultraviolet light, and unlike fluorescent lamps, fiber optic lighting does not cause buildup of heat within the case (provided the light source is mounted outside the case).

VII. Day Light Phenomenon on Museum Artifact

Since the late 19th Century the destructive effect of light on colours and materials has been studied specifically in relation to works of art and museum exhibits. The full spectrum of daylight has been seen to be particularly damaging due to the Ultraviolet (UV) content and the high levels of light normally experienced. The colour quality of daylight is however not satisfactorily reproducible and this quality is highly desirable in the viewing of art and artifacts.

A perceptual contact with the sky is also a strong and desirable contact between the displays and artifacts and the real world without the museum building. these requirements of low level controlled lighting and the dynamic high level natural light are apparently in conflict and one of the principal challenges in designing the modern museum building is to develop a strategy to resolve these issues.

Categories

In respect of potential light damage museum objects can be considered in three broad categories:

i. Extremely susceptible to light damage: This category includes works on paper, textiles, naturally occurring dyes, Natural history exhibits including fur, feather, insect and plant material etc. This category of object requires strictly controlled lighting conditions.
ii. Susceptible to light damage: This includes Oil paintings on canvas, most wood bone and Ivory and other materials painted or coloured.
iii. Not susceptible to light damage: Metal most Stone , most ceramics and glass, wooden objects that have largely been used out doors or have otherwise lost their natural colouring through design or use etc.

Traditionally maximum light levels are applied to these categories however this is a rather oversimplified approach when considering the realities of light damage. The effects of light are cumulative and the true measure of the effect of light is that of total exposure over time. In reality the commonly accepted measures of maximum light level are based on the exposure before which a detectable change would be observed over a ten year period on display. Given the relative ease with which it is now possible to measure and record data, exposure based conservation strategies are now possible and highly desirable.

At a practical level objects that fall in the first category above cannot be displayed under natural lighting. The levels for these need to be set to the narrow band before the eye loses the ability to fully appreciate colours. In nature this is the early morning when the sun is just below the horizon or the evening as the sun has set, controlling natural light to these levels creates a perpetual gloom, conditions not conducive to feelings of comfort and well being that you wish to enjoy in a museum environment. The second category of exhibits can be lit to levels and with sufficient variation to accommodate changing natural light conditions in a much controlled way. The third categories of objects are easily displayed under natural lighting without substantial risk of damage.

Natural daylight potentially has a major role in museum and gallery lighting however consideration has to be given to display and conservation policy and exhibition design in relation to the architecture of the proposed gallery space.

Conservation Considerations

From the discussion above it is essential to develop a lighting conservation strategy based on overall exposure values rather than maximum light levels. This provides a flexibility that is essential to allow experience of the variable nature of daylight. As discussed above exhibits in the first category are generally unsuitable for lighting by natural light however as they are the most susceptible to damage they equally need the highest level of care. Despite the low light levels for exhibition of these materials the time of exposure must still be controlled.

The relationship between the different categories of objects is of key importance in determining exhibition layout. For comfort and accurate visual response it is essentials to keep lighting levels within the field of view reasonably similar to allow the eye to adjust to a comfortable visual range and to allow transition areas between areas of differing light level. The major question is the appropriate level of control in largely daylit spaces. It is clear that a level of daylight control is

VIII. Architectural Design Consideration

Building Orientation

Fig. 1 Google map showing existing museum building orientation

The path of the sun as it rises and sets have great significance on a building's interior particularly with respect to lighting, literatures have reveal the orientation of building for optimal gain of day light, this orientation if well selected for display areas in museum considered will ease of any threat of poor visual appreciation of artifacts. To maximize daylight advantage a building should have its longer end running east west and the shorter end southwards, it's also good to note that for maximal daylight use, display spaces should be in areas with the least daylight access, work areas in the west facing should be avoided due to late evening control of glare and overheating. Fig. 1 above show the orientation of the existing museum conforming to the argument earlier stated for optimal absorption of daylight In a situation where there is need to control the amount of day light into the building, various options avails in design to include,

i. Provision of double glazed window
ii. Light shelf
iii. Shading devices

Wall and Roof Openings

Openings or apertures significantly allows much of light into a space base on the intention of what the space is meant for a museum design where much emphasis is place in day light absorption. Direction of window is critical, systematic approach of apertures vertically (windows) and horizontally (skylight), south-facing window (north-facing in the southern hemisphere) is easiest to protect. Fig. 2 shows the approach of the museum, evidently, the window design which also intend to serve as shading device is poorly constructed and not suitable to bring in the desired light level thus causing dark areas on the displayed artifacts.

Fig. 2 Approach of museum showing poor window design

In as much painting suffers deterioration by directly light source (artificial or natural) glare has set in which cause poor appreciation of the artifacts on display. Artificial lighting elements as seen in fig. 3 are not necessary in a situation where the day light is properly controlled into the display area. Light shelve introduced in areas as this will bring in day light covering a wider range of space in the display area. The forms of glare present in the display area can also be handled if the architect considers introducing from the design stage clerestory windows, making provision for enough head room to contain them. Clerestories (high windows) can provide 20 feet of daylight while horizontal sunshades above eye level provide good shade and less obstruction for light penetration.

Fig. 3 Display Area (artificial lighting) showing Glare and Dark areas.

Fig. 4 Clerestory windows to avoid glare

Fig. 5 Light shelves for optimal daylight absorption

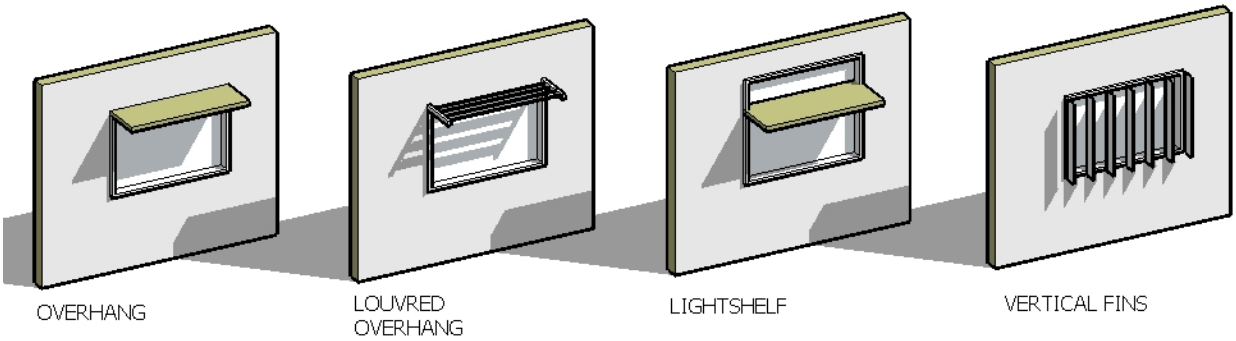

Fig. 6 Exterior shading devices

IX. Day Lighting a Museum

There are some basic principles to follow and aspects to consider when day lighting a museum. The following list provides helpful guide for optimal day lighting of museum.

i. Direct sunlight should be avoided completely in display spaces. The use of light shelves comes handy in such spaces
ii. Ultraviolet exposure should be limited using Ultraviolet filters. These filters can be built into the glazing and should be specified appropriately.
iii. A range of components should be considered:
- Side lighting (view windows),
- Top lighting (clerestories and skylights),
- Shading systems (interior and exterior),
- Sensors (light and occupancy), etc.

iv. There are 3 ways to bring daylight into a space:
- Side lighting: windows, etc.
- Top lighting: skylights, light wells, etc.
- Reflected light technique: clerestories, light shelves, etc.

X. Discussion and Recommendation

The analysis has shown that problems associated with light use and control technique, as regards artifacts conservation and display is common concern in almost all museums. The shortcomings is tailed towards the fact that most of the museum buildings were not purposed built.

After much observation and discussions, it was revealed that measures were not put in place in considering the effective use of day lighting in the museum, where the other museums are housed in inherited buildings, this shows that it's about time that the bodies in charge of museum establishment in the country stop adopting and rather start building museum, because it is usually difficult and expensive to achieve optimal lighting with inherited buildings by retrofitting, if such buildings have so much history and require preservation it can be preserved as a monument building rather than being used as a museum building so as to avoid the constant need for intervention and start thinking prevention. These are issues that the article tried to tackle by suggesting the following recommendations.

i. Efforts should be made by the design leader to ensure that day lighting design is achieved and integrated at all design stages and contribute to the design and construction process.
ii. To encourage architects to design museums with much considerations of daylight concept instead of shy away from it and looking for alternative measure.
iii. Relevant bodies or authorities should allow for museum designs as purpose made not as a make shift building or structure.

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