Abstract

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 museums exhibition room.

Keywords

Artificial light, indirect luminaries, cove luminaires, sensitivity classifications, UV radiation, short-wave light, spot lamps, LED technologies

Introduction

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.

The lighting design, configuration of exhibition room depends on many planning parameters. Foremost among these is the architecture of the building with which the lighting is required to harmonise. 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.

There are many kinds of radiation, also in the visible region, that are potentially harmful to materials used in art. Therefore the limits of light exposure must be considered in lighting design. These values have recently been revised by the CIE (International Commission on Illumination) and they depend on materials, which are divided into three sensitivity classes. The most important are the maximum illuminances and the allowed annual exposures to light (see table 1). In many cases, 200 lx is a convenient illuminance for low-sensitivity materials. UV radiation should be totally suppressed.

The important thing to know is that the damage is done not by the radiation that strikes the object but by the rays it absorbs. UV (Ultraviolet) radiation and short-wave light are generally more harmful than long-wave light and IR (Infrared) radiation. Which means, radiation in the visible spectrum – i.e. light – can do damage.

<table>
<thead>
<tr>
<th>Material classification</th>
<th>Examples of materials</th>
<th>Limiting illuminance</th>
<th>Limiting annual exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Intensive</td>
<td>Metal, stone, glass, ceramic</td>
<td>No limit</td>
<td>No limit</td>
</tr>
<tr>
<td>b) Low sensitivity</td>
<td>Canvases, frescoes, wood, leather</td>
<td>200 lx</td>
<td>600 000 lxh/a</td>
</tr>
<tr>
<td>c) Medium sensitivity</td>
<td>Watercolour, pastel, variscose paper</td>
<td>50 lx</td>
<td>150 000 lxh/a</td>
</tr>
<tr>
<td>d) High sensitivity</td>
<td>Silk, newspaper, sensitive pigments</td>
<td>50 lx</td>
<td>15 000 lxh/a</td>
</tr>
</tbody>
</table>

Table 1. Limiting illuminances and annual exposures for material sensitivity classifications (CIE Div. 3 TC3-22, Museum lighting and protection against radiation damage)

The important of light

The most important lighting systems used in exhibition rooms are:

- luminous ceilings with opal glass enclosure (diffuse light) or satiniised and textured glass (diffuse/ directional),
- indirect luminaires (diffuse),
- cove luminaires (diffuse),
- wallwashers (directional or diffuse/directional),
- spot lamps.
1.1 Luminous ceilings

The idea of luminous ceilings is 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 satinsed/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...1,000 cd/m², ranging up to 2,000 cd/m² for very high-ceilinged rooms. Luminous ceilings are especially suitable for interiors with 6 metre 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 day lighting installations – need to be designed by a specialist.

1.2 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.

1.3 Cove luminaries

The diffuse light of luminaries 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 a luminous ceiling and corresponds roughly to that of perimeter luminaries 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 upper part 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 simple non-overlapping battens are installed, disturbing light-dark transitions are also visible around the lamp holders.

2 Interior lighting with daylight

Both daylight and artificial light contain rays, which may cause exhibits to fade, dry out or become discoloured or deformed if exposed to the light for long periods.

But daylight is certainly the more dangerous. Direct sunlight must always be “locked out”. But light...
protection is not alone in presenting high requirements: what all modern skylight solutions have in common is that they are expensive to design and construct for daylight direction, control and filtering. The use of skylights to harness daylight is confined to the upper storeys of a building or calls for single storey design. Skylights are no substitute for the visual contact with the outside world provided by windows. Today our knowledge of lighting engineering coupled with modern control and regulation technology makes it possible for daylight to be precisely directed and dosed. So once again daylight plays a major role in museum construction and design.

The Kumu Art Museum project is based on the winning proposal ‘Circulos’ of an international architectural competition in 1993-94. In the design by architect Pekka Vapaavuori, the building volume rests within a great circle embedded in a hillside in Kadriorg park in Tallinn. The main galleries are behind the northeastern double envelope façade. The architectural design goals are simplicity and spatial anonymity allowing room for the art.

The starting points of the lighting design of the galleries are the allowed annual exposures, visual appearance, methods of illumination, and lighting control strategy.

The double façade is a critical element for the daylighting design. Its behavior was simulated under three different sky models. These were maximum illuminance in summer (the sun at the highest position), morning light (clear sky with sun), and an overcast sky (moderate external illuminance). The results form the basis for further technical design of the wall.

When there is enough daylight the light coves are switched off. They switch on gradually when the vertical illumination levels decrease below a set limit (usually 150 lx). Illumination levels exceeding an upper limit (200 lx) are suppressed by shades between the window glazings. (Julle Oksanen, Markku Norvasuo).

If daylight and artificial light are mixed, their rays should be fully blended before they fall on an exhibit.

3 Foyers, corridors, staircases

The entrance area is the calling card of the establishment. It shapes visitors’ first impressions its design can overcome fear of crossing the threshold. A harmonious lighting atmosphere sets the scene for a friendly reception. Foyers also serve a functional purpose: they lead into the interior of the building.

3.1 Harmonious lighting

To meet these requirements, the lighting needs to incorporate a mixture of direct and indirect light – delivered by a combination of lighting systems designed to cater for every lighting task: the uniform general lighting provides security and facilitates orientation, accentuating light on ceiling and walls makes the visual impact less severe. Direct or
direct/indirect luminaires with efficient fluorescent or compact fluorescent lamps are the most widely used light sources for the general lighting; wall luminaires for indirect lighting form part of the accent lighting.

In the entrance zone, people step out of bright daylight into a darker building or out of night-time darkness into a brightly lit interior.

To enable their eyes to adjust to the change in brightness level, adaptation zones are recommended. During the day, the immediate entrance area needs to be particularly brightly lit; at night, the illuminance inside the building should decrease towards the exit.

**Fig. 8.** Distributor role – foyer and corridors provide both a physical and optical link with the deeper recesses of the building.

The calling card role of a foyer makes it an interesting place for special architectural features – features which lighting and lighting characteristics should underline. For high ceilings, for example, high-intensity spots with high-pressure discharge lamps are recommended. As pendant luminaires with direct/indirect light distribution, they emphasize the height of the room. Moulded plaster ceilings, columns or galleries can be very effectively stressed by accentuating light.

### 3.2 Guiding light

Corridors, staircases and lifts connect the entrance area with the deeper recesses of the building. If they are significantly darker than the foyer, they can be off-putting. To avoid this tunnel effect, the illuminance realized should either be the same or reduced very gradually in stages. DIN EN 12464-1 stipulates a minimum of 100 lux illuminance for circulating areas such as corridors.

A route guidance system provides an effective additional orientation aid for visitors. To ensure reliable guidance, it should include bright information panels or back-lit signs with a clear message.

### 3.3 Safe light

The risk of tripping on steps and stairs is reduced by good lighting. The illuminance should be at least 150 lux (DIN EN 12464-1).

As it is generally more dangerous to fall down stairs than to trip on the way up, it is particularly important that the lighting should ensure that treads are clearly discernible from above. In addition, light falling from the upper landing makes for short soft edged shadows. The treads can thus be clearly distinguished; each one is readily identifiable.

Floor-level orientation lighting provides added security. Wall lights at the side of the stairs casting direct light onto treads are a solution here. LED technology offers a new alternative, e.g. with luminous diodes set into risers. LEDs are also used for illuminating banisters.

**Fig. 9.** Corridor lighting provides guidance for visitors and makes their route safe. Minimum illuminance: 100 lux

### Conclusions

The missions of a museum are:
- Collect and exhibit art and historic artifacts for public education and enjoyment,
- Protect the collection from damage, and
- Do this all as efficiently as possible.

Museums can minimize light damage by minimizing the energy absorbed by artifacts. First, do this by using good lighting design to lower the overall light levels. Full visible spectrum lighting with all colours represented and none over or under represented can double visibility without increasing intensity. Eliminating shadows, glare and reflections, lighting artifacts and not areas, and keeping backgrounds subdued also increase visibility while letting us lower overall light intensity.

On top of that, it is easy to greatly reduce total absorbed energy without reducing any of the reflected energy. Do this by choosing the proper light sources, eliminating nonvisible radiation (UV and IR), and filtering lighting to match colors.

### References

5. Good lighting for museums, galleries and exhibitions. Fördergemeinschaft Gutes Licht publications.