Modern essentials of architectural, Design and computation principles dictating the lighting of spaces

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Abstract

Happiness brings good health and wellbeing. A properly lit space helps to bring in a sense of happiness. Nowadays, urban people in general rely on artificial lighting mostly even during daytime especially within office buildings. This research paper intends to discuss about responsibilities of a lighting designer, the effect of lighting on emotional well-being of the occupants and attainment of comfort from a lighting designer’s point of view. Offices, factories and public gathering spaces such as markets etcetera are given more emphasis in this research. The latest trends include day-lighting methodology, passive lighting, anti-glare lighting and lastly, from good health perspective, anti-bacterial LED lights.

Some of the significant psychological aspects discussed include mood betterment caused by artificial lighting, increasing hygiene through lighting and therapeutic effects of lighting. This paper features a few case studies where the scenes and corresponding lux values (using the software Dialux Evo and Dialux 4.13) have been charted along with the commentaries on comfort which have been achieved. Other notable Lighting design software include Autolux, Agi32, Luxicon, Lite Pro and Lumen micro.

Also, we intend to discuss basic Lighting Analysis techniques and Photoshop color correction techniques in separate individual sections.

Introduction

“Lighting ultimately is not about light, but about people. Unless you understand people, love people, are concerned about them and empathize with them, you’re not much more of value than a calculator” (Raymond Gernald, 2012).

An architectural lighting designer is consulted to figure out the technical factors and effects of lighting such as how much light is needed for maximum visual comfort. He/ She chooses lighting fixtures and positions them on electrical drawings and reflected ceiling plans (plans showing layout of ceiling).

Prominent Professional Lighting designers association include the International Association of Lighting designers (IALD) and Illuminating Engineering Society of North America (IESNA). These are two main bodies regulating and supporting lighting designers. An electrical engineer, civil engineer or architect can professionally work as an architectural lighting designer.

A lighting designer must be well aware about the characteristics of a light such as source of illumination, watts consumed, price, lamp’s life, extent of reach of light, area lit by it, daylight utilization, colour rendering index (the aspect ratio between how the light illuminates the object by how that object is seen in sunlight, termed CRI), colour, efficiency and warmth provided by the light (colour temperature). The designer must have command over computer based software for calculating the lux levels in a space.
Background research

Our aim has been achieved through background research on the optimum lux (unit for Intensity of Light) levels of brightness with assistance from Dialux Evo software. The Dialux Evo is a freeware which calculates the brightness achieved by a single or a group of luminaire in an indoor or outdoor scene or environment.

All residential spaces have to be fitted with warm white (goldenish white light) in order to provide maximum comfort for the occupants. Colors in relation to lighting can be categorized into three varieties namely, warm, neutral and cool white. We are conveying shortcuts a lighting designer utilizes to create mood enhancing warm white light.

Here in the Figure 1, CCT means Correlated Colour Temperature. Correlated Color Temperature refers to the Kelvin-based scale used to measure the color temperature of a luminaire (Correlated Color Temperature- Elemental LED, n.d.) [1]. In other words, CCT measures appearance of light source’s colour as defined by the proximity of its chromaticity co-ordinates against the standard blackbody locus. Here, chromaticity stands for the quality of light irrespective of its brightness [2].

The significant symbols representing manufacturers and distributors engaged in the development & commerce of lighting fixtures, lighting control and software are shown below:

![Manufacturer of interior lighting luminaires](https://example.com/manufacturer.png)
![Manufacturer of light sources, lamps & gear (including LED components, filters, drivers etc)](https://example.com/manufacturer.png)
![Manufacturer of exterior lighting luminaires (including projectors)](https://example.com/manufacturer.png)
![Manufacturer of emergency lightning luminaires](https://example.com/manufacturer.png)
![Manufacturer of street/amenity lighting luminaires (including bollards, poles etc)](https://example.com/manufacturer.png)
![Manufacturer of lighting control (including lighting control software)](https://example.com/manufacturer.png)
![Manufacturer of lighting design software](https://example.com/manufacturer.png)
![Manufacturer of equipment and technology for control or manipulation of daylight](https://example.com/manufacturer.png)

Cove lighting, Figure 2, is an indirect form of lighting that is made to pass and journey through recesses high up in the ceiling or on the walls of a room. It provides a uniform, linear or staggered arrangement.

![Figure 2: Cove Lighting.](https://example.com/figure2.png)

Figure 1: Colour of light and their respective CCT values.

Colour temperature change

Shortcuts in Photoshop

![Colour temperature change](https://example.com/figure3.png)

![Figure 3: Layer-wise segregation, color overlay and color adjustments.](https://example.com/figure3.png)

Figure 4: The screenshots showing the photoshop color correction steps.

Color temperature correction

Color temperature correction can be carried out with the help of the software, Photoshop as shown below, Figures 3, 4.

Case studies

In the chart given above, the method of calculation and deduction of luminous emittance has been provided Figures 5–9.
Figure 5: Case study-1.

Figure 6: Case study-2.
Figure 7: Screenshot of Dialux showing the area definition after entering the appropriate dimensions in the menu and also the location of coordinates.

Figure 8: Screenshot of Dialux highlighting the area of focus.

Figure 9: Final steps include saving of the work.

Figure 10: The first page of the output of the calculations listing the technical details of the lighting product.
Luminaire classification according to CIE: 66
CIE flux code: 63 89 98 66 100

APPLICATIONS:
Offices, schools and public areas.

MATERIAL:
Housing made of extruded aluminium for excellent heat dissipation. Micro prismatic diffuser for the direct light and a line-prismatic diffuser for the indirect light. White RAL 9016.

INSTALLATION AND CONNECTION:
Pendant installation. Delivered with 1 m suspension wires that can be moved along the luminaire for easier installation. Delivered with 2 m white main cable with earthed plug. DALI version is supplied with 2 m 5 lead cable. The DALI version can also be dimmed by phase pulse control.

COMPONENTS:
LED 3000K and 4000K. LED driver. Lifetime 50 000 hours (L70B10), CRI>80.

TECHNICAL DATA:

Figure 11: Cut-sheet of the lighting product from the manufacturer as well as the luminous emittance observed in our experiment.
Room 1 / Summary

Height of Room: 7.500 ft, Mounting Height: 7.500 ft, Light loss factor: 0.80

<table>
<thead>
<tr>
<th>Surface</th>
<th>ρ [%]</th>
<th>$E_{av}$ [fc]</th>
<th>$E_{min}$ [fc]</th>
<th>$E_{max}$ [fc]</th>
<th>u0</th>
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</thead>
<tbody>
<tr>
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<td>46</td>
<td>26</td>
<td>60</td>
<td>0.567</td>
</tr>
<tr>
<td>Floor</td>
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<td>27</td>
<td>21</td>
<td>31</td>
<td>0.759</td>
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<tr>
<td>Ceiling</td>
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<td>62</td>
<td>7.91</td>
<td>1116</td>
<td>0.127</td>
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<tr>
<td>Walls (4)</td>
<td>50</td>
<td>25</td>
<td>9.27</td>
<td>31</td>
<td>/</td>
</tr>
</tbody>
</table>

Workplane:
- Height: 2.493 ft
- Grid: 32 x 16 Points
- Boundary Zone: 0.000 ft

Illuminance Quotient (according to LG7): Walls / Working Plane: 0.661, Ceiling / Working Plane: 1.361.

Luminaire Parts List

<table>
<thead>
<tr>
<th>No.</th>
<th>Pieces</th>
<th>Designation (Correction Factor)</th>
<th>Φ (Luminaire) [lm]</th>
<th>Φ (Lamps) [lm]</th>
<th>P [W]</th>
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<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>AURA 206334800 Lezzon PE MP 34W 4100 On/Off 830 (1.000)</td>
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<td>4027</td>
<td>34.0</td>
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<tr>
<td></td>
<td></td>
<td>Total: 4027</td>
<td>Total: 4027</td>
<td></td>
<td>34.0</td>
</tr>
</tbody>
</table>

Specific connected load: 1.62 W/sq ft = 0.35 W/sq ft/10 fc (Ground area: 21.00 sq ft)
### Computation & Results

In the chart given above, the method of calculation and deduction of luminous emittance has been provided Figures 10,11.

### References