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Research Article

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 intents 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. [u]nless 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.

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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 (golden yellowish 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
- Manufacturer of **lightsources, lamps & gear** (including LED components, filters, drivers etc)
- Manufacturer of **exterior lighting** luminaires (including projectors)
- Manufacturer of **emergency lighting** luminaires
- Manufacturer of **street/amenity lighting** luminaires (including bollards, poles etc)
- Manufacturer of **lighting control** (including lighting control software)
- Manufacturer of **lighting design software**
- Manufacturer of equipment and technology for **control or manipulation of daylight**

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 1: Colour of light and their respective CCT values.

Figure 2: Cove Lighting.

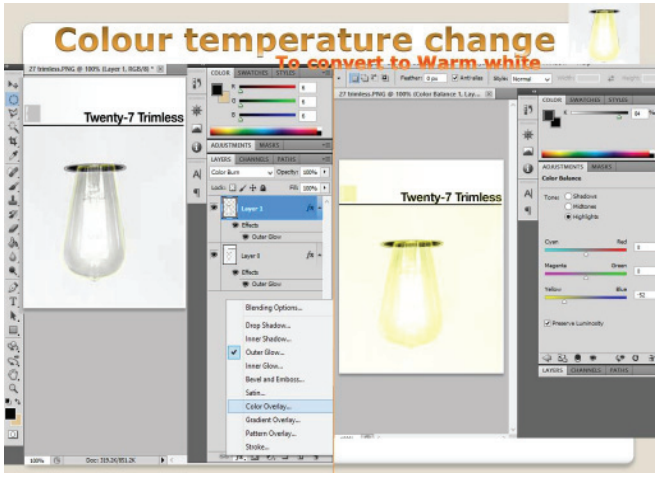

Figure 3: Layer-wise segregation, color overlay and color adjustments.

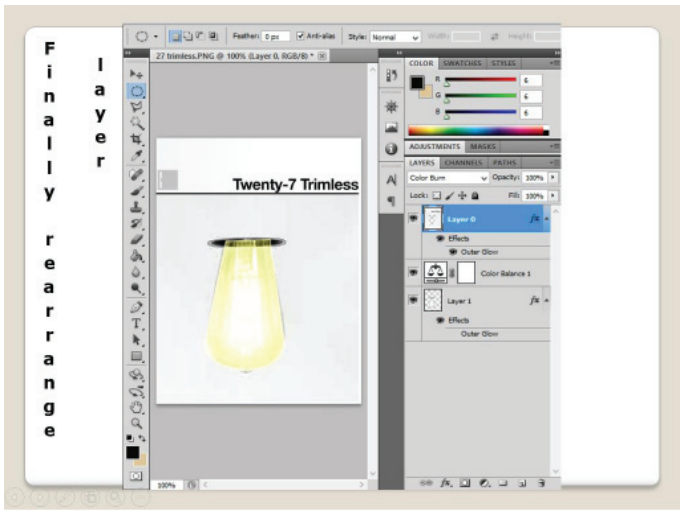

Figure 4: The screenshots showing the photoshop color correction steps.

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.

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Figure 5: Case study-1.

Figure 6: Case study-2.

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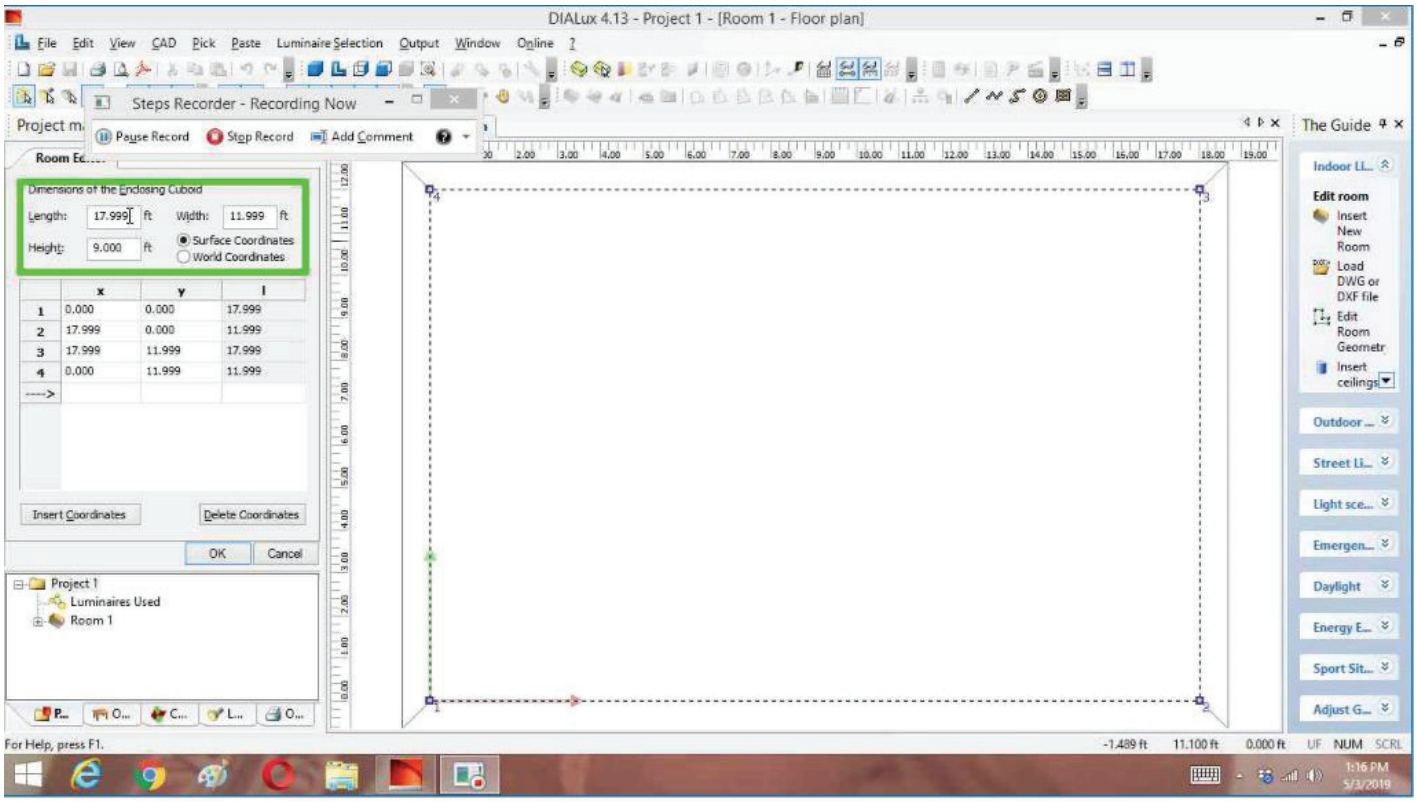

Figure 7: Screenshot of Dialux showing the area definition after entering the appropriate dimensions in the menu and also the location of coordinates.

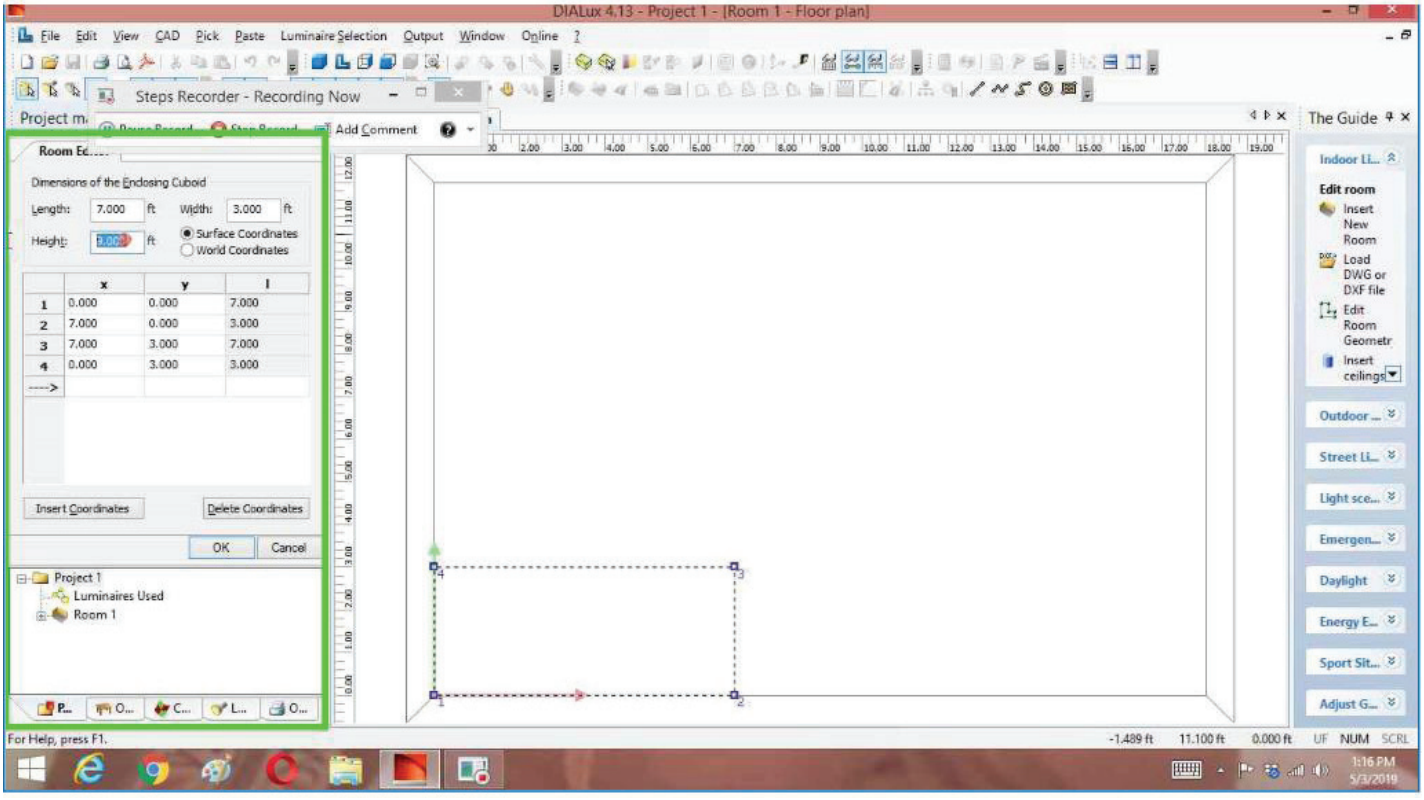

Figure 8: Screenshot of Dialux highlighting the area of focus.

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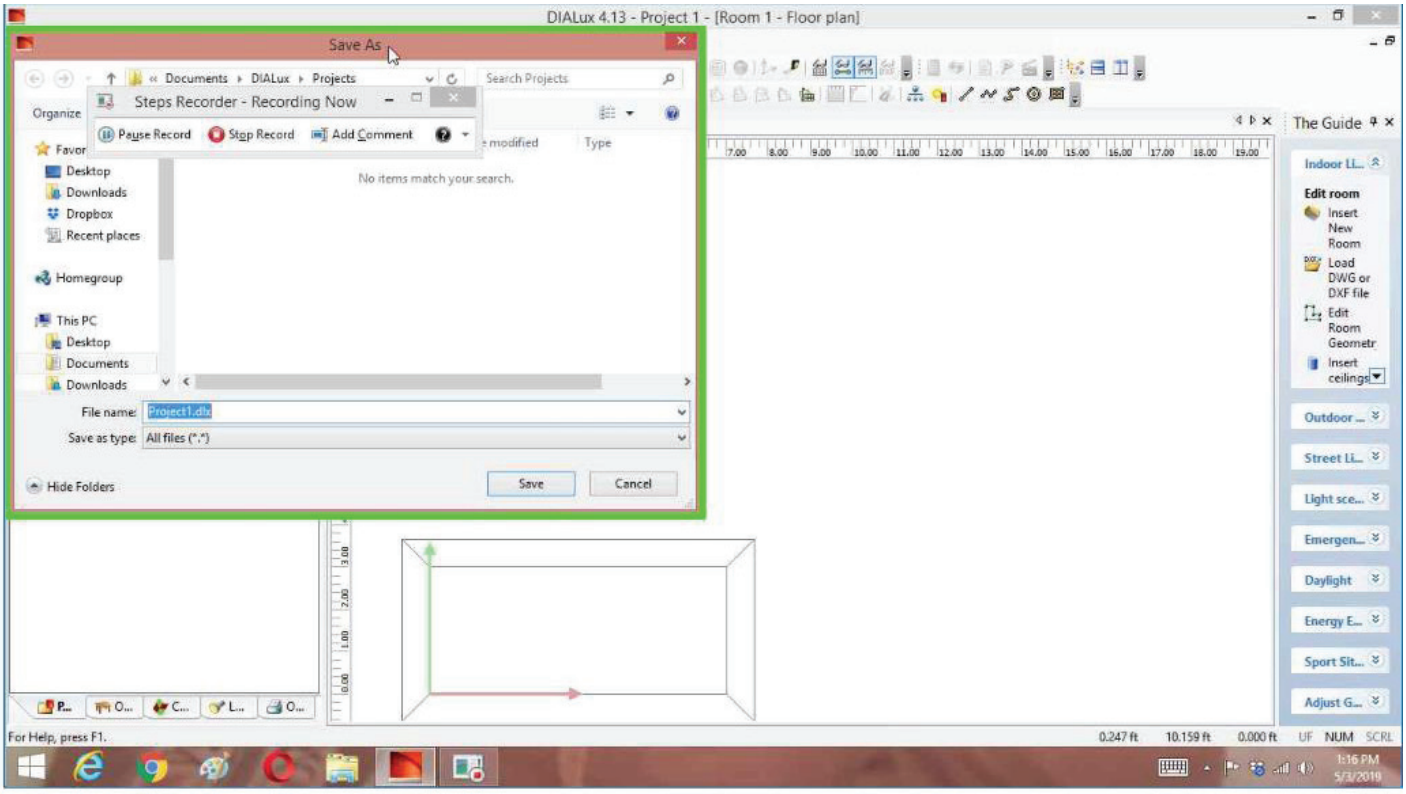

Figure 9: Final steps include saving of the work.

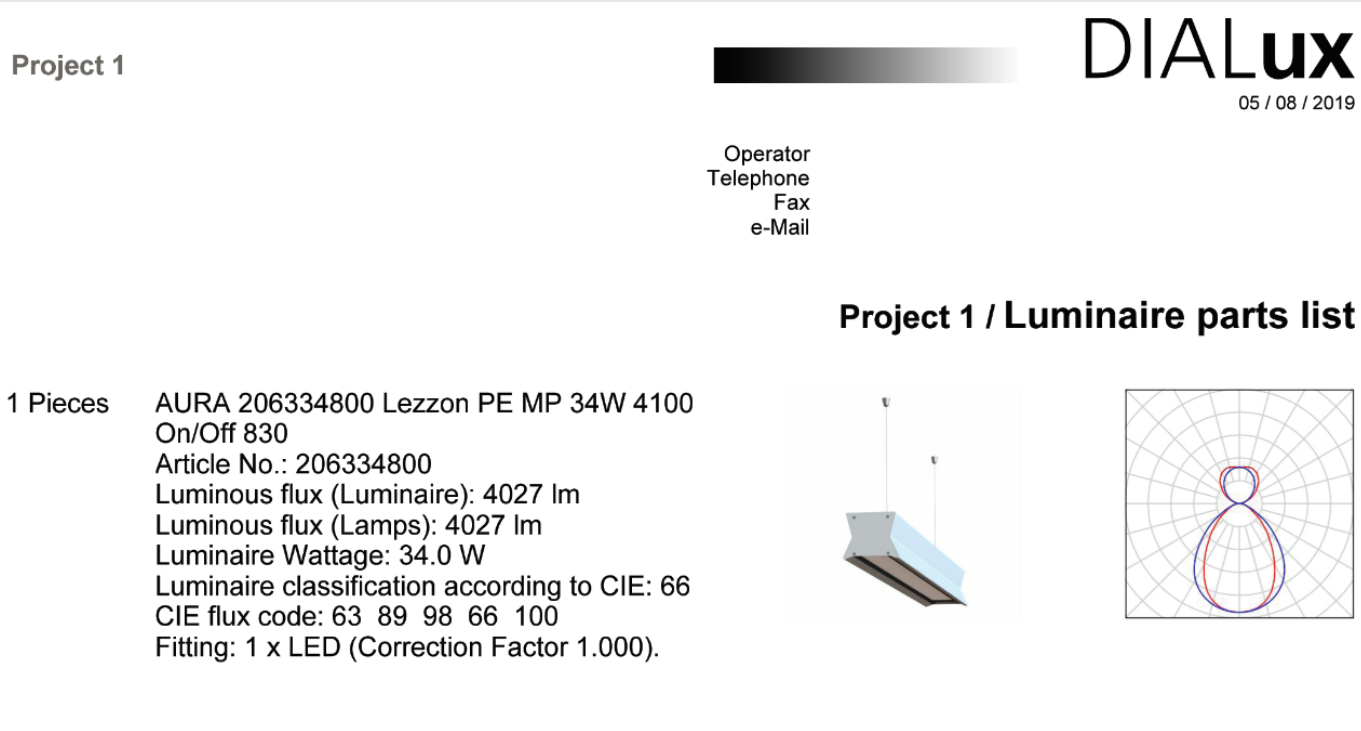

Figure 10: The first page of the output of the calculations listing the technical details of the lighting product.

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Project 1

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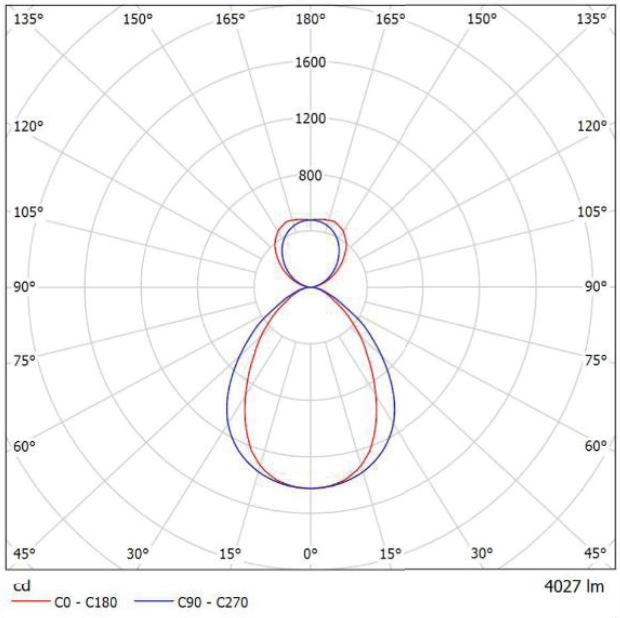
AURA 206334800 Lezzon PE MP 34W 4100 On/Off 830 / Luminaire Data Sheet

Luminous emittance 1:



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 diff user for the direct light and a line-prismatic diff user 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:
220-240V 50-60 Hz, IP20. SDCM 3. Ambient temperature: -25°C – + 25°C. CE.

Luminous emittance 1:

Glare Evaluation According to UGR

ρ Ceiling		70	70	50	50	30	70	70	50	50	30
ρ Walls		50	30	50	30	30	50	30	50	30	30
ρ Floor		20	20	20	20	20	20	20	20	20	20
Room Size X	Y	Viewing direction at right angles to lamp axis					Viewing direction parallel to lamp axis				
2H	2H	16.4	17.2	17.1	17.9	18.8	18.3	19.1	19.0	19.8	20.6
	3H	17.0	17.8	17.8	18.5	19.4	18.9	19.6	19.6	20.3	21.2
	4H	17.3	18.0	18.0	18.7	19.6	19.1	19.8	19.8	20.5	21.4
	6H	17.5	18.1	18.3	18.9	19.8	19.2	19.9	20.0	20.6	21.6
	8H	17.5	18.1	18.3	18.9	19.9	19.3	19.9	20.1	20.7	21.6
	12H	17.6	18.2	18.4	18.9	19.9	19.3	19.9	20.1	20.7	21.6
4H	2H	16.8	17.5	17.5	18.2	19.1	18.3	19.0	19.1	19.8	20.7
	3H	17.6	18.1	18.4	18.9	19.9	19.1	19.7	19.9	20.4	21.4
	4H	17.9	18.4	18.7	19.2	20.2	19.4	19.9	20.2	20.7	21.7
	6H	18.2	18.6	19.0	19.5	20.5	19.7	20.1	20.5	21.0	22.0
	8H	18.3	18.7	19.2	19.5	20.6	19.8	20.2	20.7	21.0	22.1
	12H	18.4	18.7	19.3	19.6	20.7	19.8	20.2	20.7	21.0	22.1
8H	4H	18.0	18.4	18.9	19.3	20.3	19.4	19.8	20.3	20.7	21.7
	6H	18.4	18.8	19.3	19.6	20.7	19.8	20.1	20.7	21.0	22.1
	8H	18.6	18.9	19.5	19.8	20.9	20.0	20.2	20.9	21.1	22.2
	12H	18.8	19.0	19.7	19.9	21.0	20.1	20.3	21.0	21.2	22.3
12H	4H	18.0	18.4	18.9	19.2	20.3	19.4	19.7	20.3	20.6	21.6
	6H	18.5	18.7	19.4	19.6	20.7	19.8	20.1	20.7	21.0	22.0
	8H	18.7	18.9	19.6	19.8	20.9	20.0	20.2	20.9	21.1	22.2
Variation of the observer position for the luminaire distances S											
S = 1.0H		+0.3 / -0.4					+0.2 / -0.3				
S = 1.5H		+0.6 / -1.1					+0.6 / -1.0				
S = 2.0H		+1.1 / -1.5					+1.4 / -1.6				
Standard table		BK04					BK03				
Correction Summand		2.2					3.2				
Corrected Glare Indices referring to 4027lm Total Luminous Flux											

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

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Project 1

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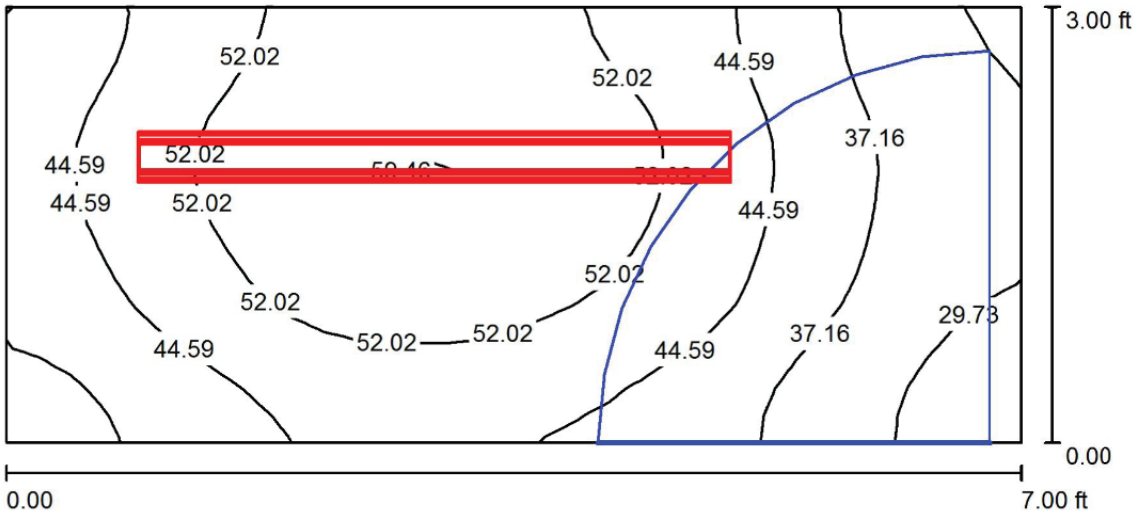
Room 1 / Summary



Height of Room: 7.500 ft, Mounting Height: 7.500 ft, Light loss factor: 0.80 Values in Footcandles, Scale 1:16

Surface	ρ [%]	E_{av} [fc]	E_{min} [fc]	E_{max} [fc]	u0
Workplane	/	46	26	60	0.567
Floor	20	27	21	31	0.759
Ceiling	80	62	7.91	1116	0.127
Walls (4)	50	25	9.27	81	/

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

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

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

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Project 1

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Room 1 / Photometric Results

Total Luminous Flux: 4027 lm
Total Load: 34.0 W
Light loss factor: 0.80
Boundary Zone: 0.000 ft

Surface	Average illuminances [fc] direct	indirect	total	Reflection factor [%]	Average luminance [cd/m²]
Workplane	31	15	46	/	/
Floor	17	10	27	20	19
Ceiling	50	12	62	80	171
Wall 1	11	14	24	50	41
Wall 2	8.59	11	20	50	34
Wall 3	14	13	27	50	47
Wall 4	14	13	27	50	46

Uniformity on the working plane
u0: 0.567 (1:2)
E_{min} / E_{max}: 0.434 (1:2)

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

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

Computations & Results

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

References

1. Correlated Color Temperature- Elemental LED. (n.d.). Link: http://bit.ly/2TwyrAc
2. What is CCT. (n.d.). Link: http://bit.ly/2VKZ4Eq

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