Lighting Design - Weekly Blog

Week 8

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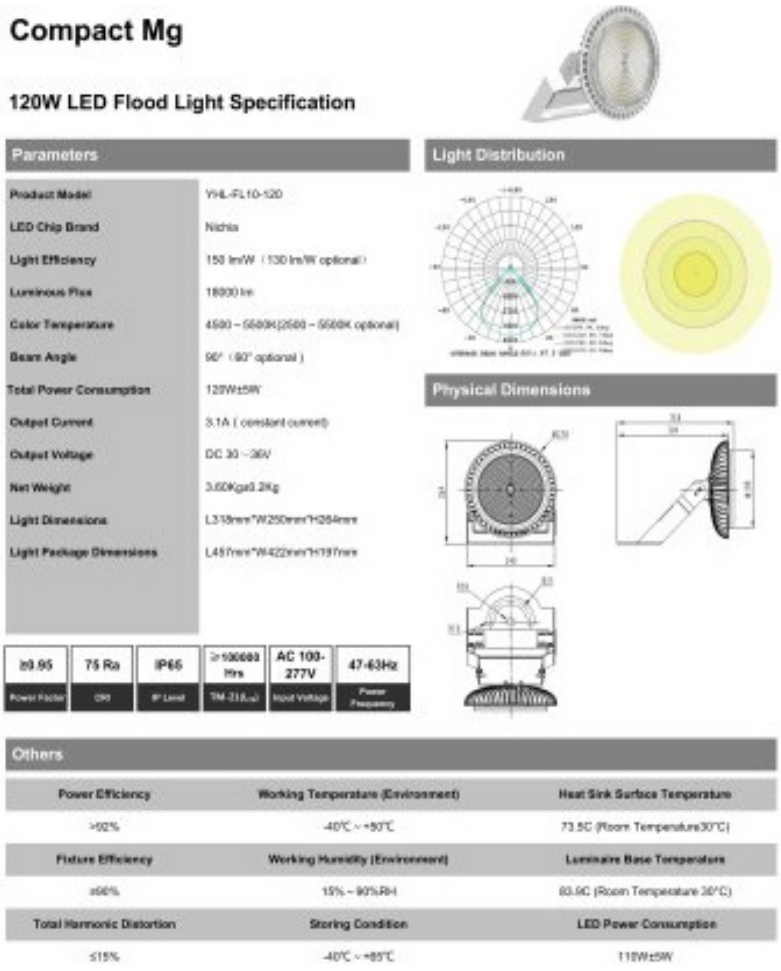
Calculating and Specifying Light

Turning Design Ideas into Reality

The themes during the lecture and workshop this week were about lighting specification sheets and lighting level calculations.

The image on the right is an example of a typical specification. Included are images of the luminaire, technical drawings, diagrams, efficiency, lux levels, beam angles, electrical information, dimensions, and other technical details. A brief description is also often included.



Compact Mg

120W LED Flood Light Specification

Parameters	
Product Model	YHL-FL10-120
LED Chip Brand	Nichia
Light Efficiency	150 lm/W （130 lm/W optional）
Luminous Flux	18000 lm
Color Temperature	4500 – 5500K(2500 – 5500K optional)
Beam Angle	90° （60° optional ）
Total Power Consumption	120W±5W
Output Current	3.1A (constant current)
Output Voltage	DC 30 ~36V
Net Weight	3.60Kg±0.2Kg
Light Dimensions	L315mm*W250mm*H264mm
Light Package Dimensions	L457mm*W422mm*H197mm

Light Distribution

Physical Dimensions

≥0.95	75 Ra	IP65	≥100000 Hrs	AC 100-277V	47-63Hz
Power Factor	CRI	IP Level	TM-21(L70)	Input Voltage	Power Frequency

Others

Power Efficiency	Working Temperature (Environment)	Heat Sink Surface Temperature
>92%	-40℃ ~ +50℃	73.5C (Room Temperature30°C)
Fixture Efficiency	**Working Humidity (Environment)**	**Luminaire Base Temperature**
≥96%	15% – 90%RH	83.9C (Room Temperature 30°C)
Total Harmonic Distortion	**Storing Condition**	**LED Power Consumption**
≤15%	-40℃ ~ +85℃	118W±5W

The lecture went over steps to use as a guideline for making our own specifications in the project

This week also focused on lighting level calculations. Specifically, we used lux level tables, chose a value for the space being studied, determined the average iumens needed, and looked at how different fixtures can achieve the desired results.

Calculations are a vital part of lighting design because they quantify our ideas and intents. They are able to take something like an aura and turn it into numbers, that can then be transformed into an artistic vision. Moreover, achieving the desired results (whether it be artistic or functional use) is vital for a successful outcome.

Many of the lessons this week pertained to the engineering side of lighting design. Coming from an engineering background, I was inspired by the intersection of artistic and technical components of the discipline. While I was familiar with the process of calculating lighting requirements, I learned more about how this applied to luminaire and lamp selection and placement, and how these decisions have a profound impact on the space.

10 Steps for Lighting Specifications

Communicating Design Ideas and Intent

When it comes to turning our design intent into reality, it is vital that the specifications are done comprehensively to ensure the result matches the vision. The lecture presented 10 steps and reminders to make sure our ideas are properly communicated to other disciplines.

1. Visualising Your Lighting Strategy

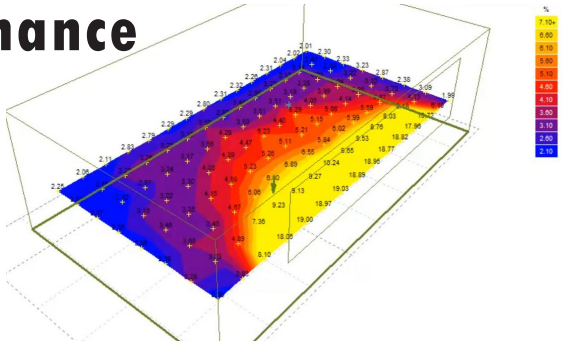
Sketches, Shading, Angles, Height

The first step designers should take is defining their intended outcomes, both with specific lighting strategies and overall aura. This can be done through rough, iterative sketches to get the message across.

2. Average Maintained Illuminance

Measuring Lighting Levels

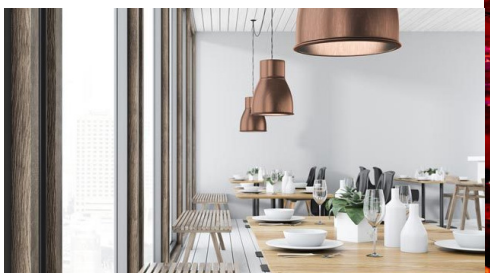
After making qualitative aims and objectives, quantifying how much light the space needs is equally important in a successful deliverable. These values come from both regulations and what is required, but can vary slighting based on the designer's intent.



3. Consider Design Narrative

Aesthetic, Materials, Colours

The design narrative is the story the space wants to tell. It also plays an important role in selling the design to the client and using ethos to encourage them to use a sufficient budget.



4. Colour Temperature

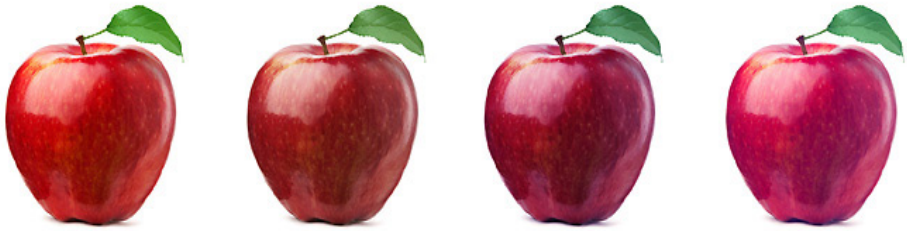
Warm, Natural, Cool

The colour temperature plays a huge part in defining the aura and vibe of a space. A lamp that is upwards of 10000 K will feel cold and sterile, while one closer to 1000 K will feel warm and comforting.

5. Colour Rendering

CRI and TM-30

The quality of the lamp also pertains to colour rendering. This could be chosen strategically if the designer wants to emphasise a particular colour.



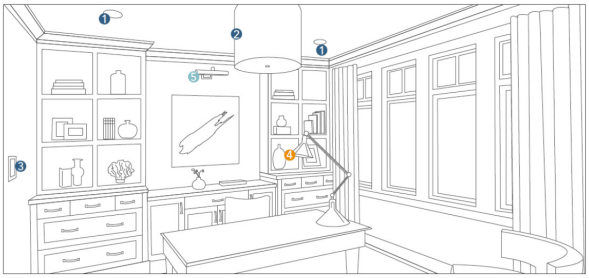
10 Steps for Lighting Specifications (cont.)

Methods for Quantifying

6. Start to Select Lamps and Luminaires

Based on Lighting Specification Sheet

Once the lighting scheme is designed qualitative and quantitatively, fixtures can be selected based on the criteria. It is helpful to create lists of each specification with a reference letter and/or number. For example:
D1 = downlight type 1
D2 = downlight type 2



7. Describe the Luminaire

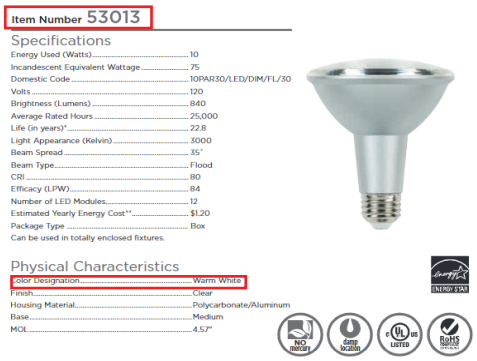
Technical and Qualitative Characteristics

While the specification is composed mostly of numeric, technical values, adding a brief description can be helpful. This can include: type of illumination (direct or indirect), the lamp it is designed for, if it is suspended or recessed, and the type of light it emits (warm/cold/neutral).

8. Select Lamp

Reference Letter and Number

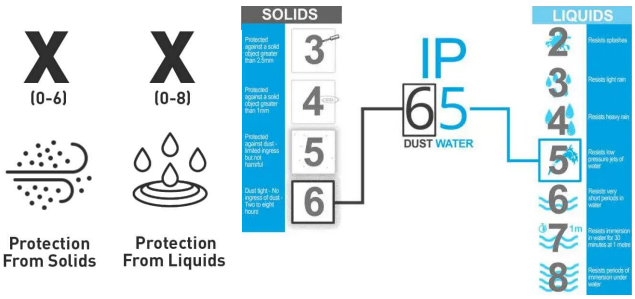
Now that the luminaire is specified, the lamp must be chosen, which is equally important. Calculations done previously can inform this decision. Luminaires and lamps should be chosen to harmonise with each other. It is important to specify the item/reference letter or number. In addition retrofit lamps may need a lamp base specification



9. Note Ingress Protection (IP) Rating

Make sure it suits Luminaire

An IP rating shows the effectiveness of a luminaire in terms of blocking out particles like dust and moisture. For solids, the levels range from 1-6, and 1-9 for moisture. The higher the number, the more protected the fixture is. For track lighting, length, control, suspension, loading, and finish should be specified.



10. Lighting Control

Accessories and Management

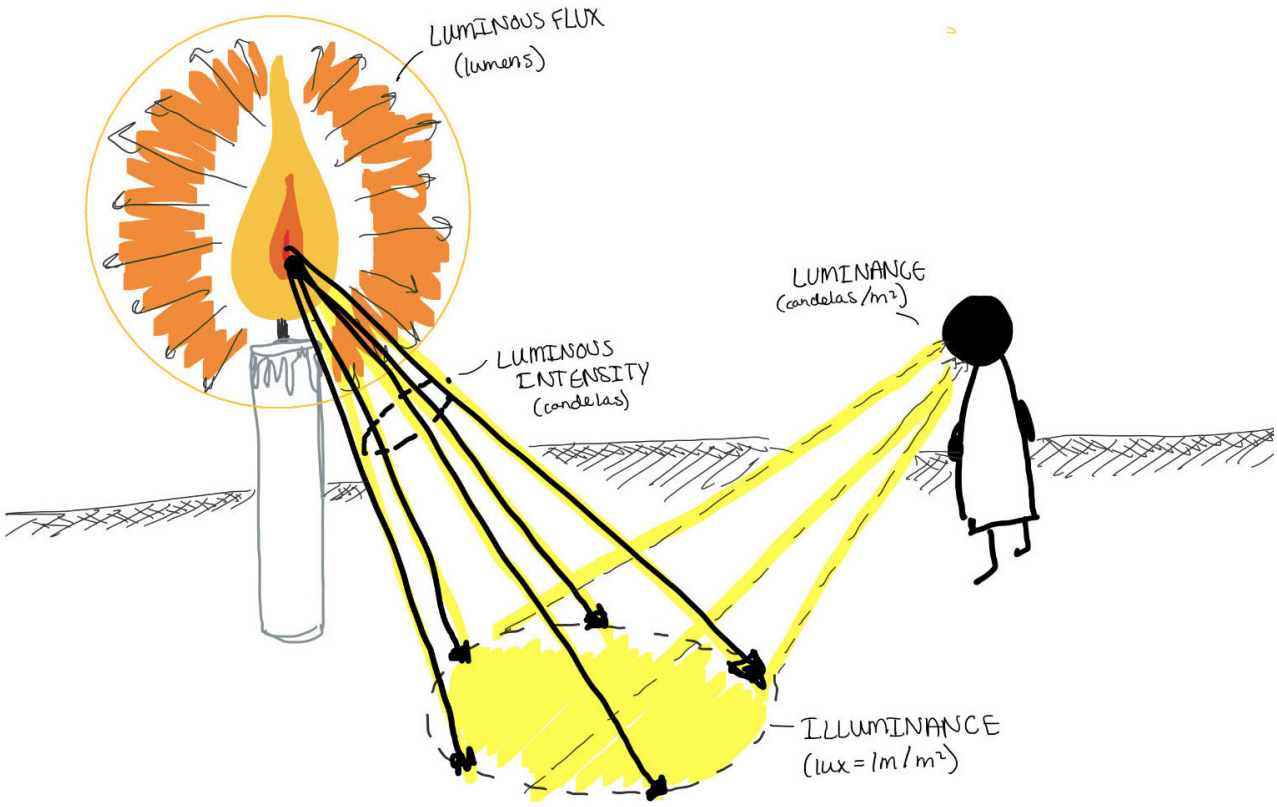
Finally, additional controls should be specified. These can include sensors triggered by daylighting, timers, occupancy, sound, touch, or a combination. In addition, overriding capabilities and other accessories should be noted.

Measuring Light

Luminous Flux, Luminous Intensity, Illuminance, Flux

An important part of turning design intents into reality is being able to quantify lighting levels. Metrics are also important in differentiating good and bad schemes. Every space, programme, and project have unique needs that require certain lighting levels and outputs. If a lighting scheme is too bright or dark, it can have profound impacts on the success of an architectural vision. Therefore, it is vital that calculations are done to ensure designer and occupant satisfaction.

The most common metrics used for lighting levels are luminous flux, luminous intensity, illuminance, and luminance. Luminous flux is a measurement of the total amount of light that shines from a source emits over its entire angular span. It is specified by manufacturers and measured in lumens (lm). Luminous intensity is similar to flux, except it measures light in a given direction. Luminance refers to the amount of light that is the amount of light reflected off of an object that meets our eyes.



Illuminance

Sample from CIBSE Guide Illuminance Levels

Building zone or space	Recommended illuminance (lux)
Entrances	200
Corridors	100 for daytime, 20 for night time
Stairs, stairwells, and lift lobbies	100 on the treads
Bathrooms and toilets	100 for toilets, 150 for bathrooms
Bedroom	100
Living room and kitchens	200
External lighting	10 for pathways and car parks, 20-30 for care homes with transition between interior and exterior areas

Illuminance is the amount of light that shines onto a surface, measured in lux, lm/m2. Building standards use it to regulate required lighting levels. The table on the left is a sample from CIBSE Guide A on illuminance levels based on space use. Designers can use this guide in their schemes to create a vision off of a baseline. A room's total lumen requirements can be found using the equation below:

Lux Levels Required from Table
x
Floor Area (m2)
=
Total Lumens needed in the space

Table Source:
Research Gate, https://www.researchgate.net/figure/The-CIBSE-recommended-lighting-levels-developed-from-7_tbl1_311519690

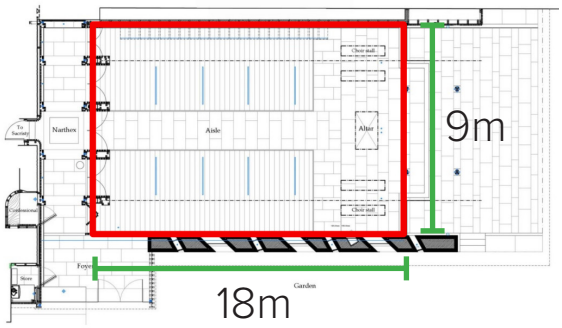
Calculation Examples

Chapel of Saint Albert the Great

In the workshop exercises, we used the Chapel of Saint Albert The Great to calculate the lux levels needed (see Week 2 blog post for a detailed description and lighting analysis of the church and space). Using various luminaires, calculations based on manufacturing data and desired lux levels were completed.

The space is 9m by 18m, and we assumed the space requires an illuminance of 300 lux based on the tables and measurements taken during the week 2 exercises. Therefore, a total of 48,600 lumens total are needed in the space.

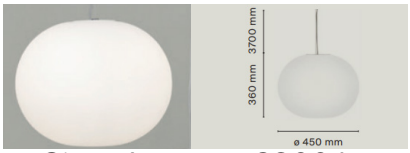
Noted in the plan below, 8 locations of ceiling lights are given, so the lux levels of 8 of the luminaires were calculated.



Sample Calculation

Lux Levels Required from Table	From table and week 2 exercises, lux levels = 300 lux
x	
Floor Area (m2)	Floor Area = 18m x 9m = 162m2
=	
Total Lumens needed in the space	**300 lux x 162 m2 = 48,600 lumens needed in space**

Flos - Glo Ball Suspension



Given Lumens: 3200 lm

48,6000 / 3200

=

15-16 lamps needed in space

If 8 lamps are used:

(3200 lm x 8 lamps) / 162 m2

=

158 lux

Erco 'Skim' Downlight

Given Lumens: 1640 lm

48,6000 / 1640

=

29-30 lamps needed in space

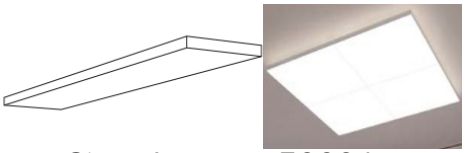
If 8 lamps are used:

(1640 lm x 8 lamps) / 162 m2

=

80 lux

Zumtobel Light Fields III



Given Lumens: 5000 lm

48,6000 / 5000

=

9-10 lamps needed in space

If 8 lamps are used:

(5000 lm x 8 lamps) / 162 m2

=

247 lux

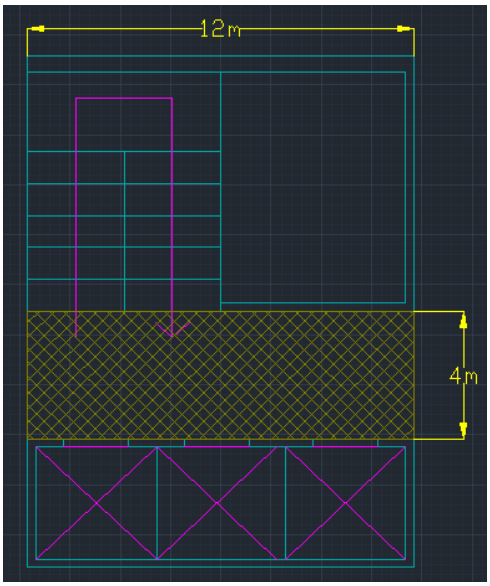
Calculation Examples

Space in Project

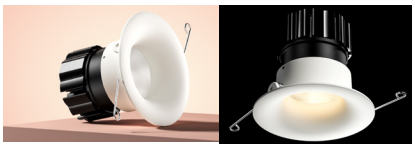
The second part of the workshop carried out the same calculations using a space from our project. My project is an office building designed for my Sustainable Design Methodology class. The space I used for the workshop is an elevator lobby, shown in the plan below. The reason I chose this space is because it is one of the few areas that receive no natural light, so it relies solely on artificial lighting. We were able to choose the lamps, so I tested recessed, suspended, and wall mounted luminaires.

Elevator lobbies are required to have a minimum illuminance level of 100 lux. They serve as the meeting place and waiting point, and they see a plethora of foot traffic from multiple directions. They should also be prominent from the main lobby. In my building, there are atriums on either side of the corridor that will bring in natural light. For these reasons, I kept the lux levels at 100, knowing that daytime conditions will be brighter.

100 lux
x
12m x 4m
=
4800 lux



Orluna, curved fit, origin natural



Given Lumens: 1200 lm
4800 / 1200
=
4 lamps needed in space

If 8 lamps are used:
(1200 lm x 8 lamps) / 48 m2
=
200 lux

XAL, VELA, Suspended

Given Lumens: 5,000 lm
4800 / 5,000
=
1 lamp needed in space

If 8 lamps are used:
(5000 lm x 8 lamps) / 48 m2
=
833 lux

tala, Kilter I Wall Light

Given Lumens: 375 lm
4800 / 375
=
12-13 lamps needed in space

If 8 lamps are used:
(375 lm x 8 lamps) / 48 m2
=
62.5 lux

Photo Source:
Bridge Water Studio, https://www.bridgewaterstudio.net/blog/elevator-lobby-design-4-corporate-interiors-raising-the-bar