ARCHITECTURAL LIGHTING SCHEMATICS

ARCHITECTURAL DESIGN CONCEPT

One of the architectural design agenda is holistic wellness. The wellness center will weave health and wellness together into everyday life, focusing on health, nutrition, education, counseling, wellness and treatment programs under one roof. Under education, the intellectual aspect of the user will be focused on. One of the architectural spaces included under intellectual aspect is the library.

As gateways to knowledge and culture, libraries play a fundamental part in society. Measuring 13.0 m. by 7.0m (LxW), the library will create opportunities for learning, support literacy, and education. This will serve as the brain of the building as it is the place of learning resources and information. This will also aid to shape the new ideas and perspectives that are center to an innovative society. The library is divided into three zones/rooms which offers different functions and caters the needs of the users.
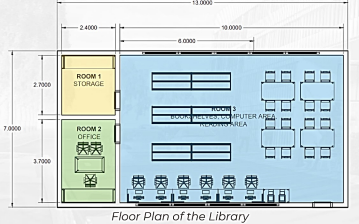
Floor Plan of the Library

3 ZONES/ROOMS OF LIBRARY

- Room 1: Storage Room
- Room 2: Office Room
- Room 3: Storage Room
  - 3A: Bookshelves and Computer Area
  - 3B: Reading Area

LIGHTING DESIGN CONCEPT

In libraries, reading is the most important task. The overall success of the library is dependent on its proper lighting. There are factors that determine good functional lighting design in libraries, such as the amount of light energy available for specific tasks, direction of the light relative to the eyes, brightness of objects surrounding the task object and within the field of view, surface reflectance, and light-diffusing characteristics of the task object.

(Malman, D. (2001). Lighting for Libraries Architectural Lighting Design 2001, Revised 2005)

The principal objective of lighting design of the library is low glare environment which specifies the ideal ratios of brightness levels within the field of view to create a good level of visual comfort. Also, in consideration of simplifying the maintenance and luminaire stocking, the minimal number of different luminaire types is utilized. Each zone has its own function. Thus, each room also has its own set of luminaire that can produce the good and quality lighting needed for each task.

LUMINAIRE USED IN EACH ZONE

Room 1: Storage Room
- It is where documents, film, and books are stored.
  - Arkoslight - LEX ECO 3 CRI 90 DIM PUSH 2700K N
  - It is a ceiling recessed downlight with COB LED and without diffuser, which makes it a very distinct luminaire.
  - As the location of its LED is set back, it achieves great visual comfort through its matte finish shade.
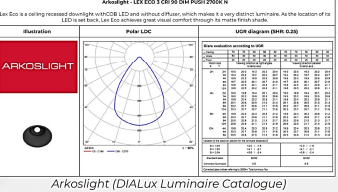
Arkoslight (DIALux Luminaire Catalogue)

Room 3A: Bookshelves and Computer Area
- It is where the books and computers are located.
  - Cooper Lighting - Define LED Suspended Luminaire
  - It is the ultimate in minimalist simplicity, providing clean, uniform lines of illumination in any architectural or academic environment.
  - This delivers industry-leading efficacy and is customizable with options.

Cooper (DIALux Luminaire Catalogue)

Room 2: Office Room
- This will serve as the office of the library manager.
  - Regent - ceiling mounted luminaire Solo Slim L2 75W 10400 lm CRI >80 3000K white DALI 980mm
  - The luminaire integrates itself harmoniously into any architecture because of its round design.
  - Whether as a ceiling, pendant or freestanding luminaire, this produces pleasant light everywhere.

Regent (DIALux Luminaire Catalogue)

Room 3B: Reading Area
- This will serve as reading space for the users.
  - It is typically used in environments involving visual tasks where a diffused and soft light for an optimum visual comfort and the source total shielding are required.

3F Filippi (DIALux Luminaire Catalogue)

BASIC DAYLIGHTING STRATEGIES

The natural light is one of the most important elements in architecture. It helps transform spaces and save energy. In each building, every space is different. The main objective is to maximize daylighting to minimize the amount of artificial light and reduce the electricity costs. The design elements to bring in as much as natural daylight as possible to the interior spaces of the building are the following:

1. Courtyard
   - One of the building features a central courtyard that connects the interior and interior spaces. Aside from it being an open-air area surrounded by walls, it serves as a way for the daylight to come inside the building. The rooms on each floor is protected with a single corridor to control the solar radiation and to let the air pass through the building.

2. External shading façade
   - On the west orientation where the library is located, there is a custom external shading façade to prevent glare and unwanted solar heat gain while still allowing more diffuse light into the space.

External Shading Facade

3. Light wall colors
   - Reflective paint helps light to bounce around the room and makes the space feel brighter.
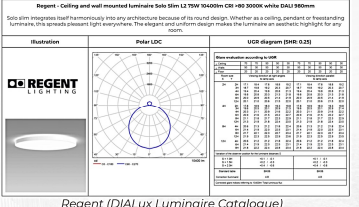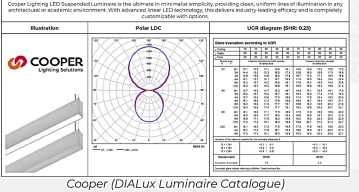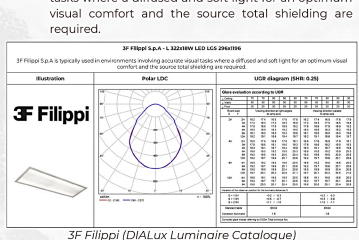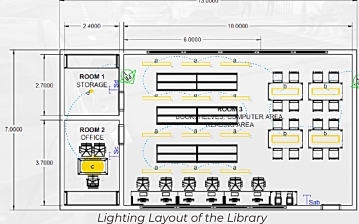

Interior Perspective of the Library

LIST OF SPACES

1. Wellness Center Building	GFA: 5,500 sq. m.
2. Main Outdoor Park	1,370 sq. m.
3. Secondary Outdoor Park	620 sq. m.
4. Parking	1,500 sq. m.
5. West Drive	
6. North Drive	
7. East Drive	
8. South Drive	
9. Library	

Perspective View of the Courtyard

Site Development Plan

Shown in the lighting layout of the library below, the number of fixtures to be put in a room is supported and computed by the Lumen Method. Also, to check whether it is sufficient, the DIALux software is used. For the storage room measuring 6.48 sq. m, only one fixture is needed. Next, for the office room with an area of 8.88 sq. m, one fixture is also placed to light up the entire room. As what can be seen for the bookshelves and computer area, there are 12 lighting fixtures placed equally and parallel to the bookshelves. It follows the parallel scheme where there is a row of suspended linear fixtures centered on each aisle. Lastly, for the reading area, the fixtures are ceiling mounted and are centered on each reading table.

Lighting Layout of the Library

ANALYSIS

For checking the sufficiency of the number of fixtures in each room, the Lumen Method method is used. The computation provided below shows the number of fixtures needed in each room that will satisfy the required illuminance level of the room.

Aside from that, the DIALux software is also used to further check the sufficiency of the number of luminaire in each room. DIALux is the leading software for lighting design. It is used to plan, calculate, and visualize light for indoor and outdoor areas. In this presentation, the images provided show the plan view of the library with its corresponding illuminance level, perspective view of the room, and the section.

Lumen Method Results

I. Zone/Room 1: Storage room

a) Givens:
- Dimension: 2.4 x 2.7 x 3.0 m (LWH)
- Initial Reflectances:
  - Ceiling – 70%
  - Wall – 50%
  - Floor – 20%
- Average Illuminance = 200 lux
- Lighting fixture
  - Arkoslight LEX ECO ceiling recessed downlight with COB LED and without diffuser
- Mounting height: 2.670 m
- Work plane height: 0.80 m
- Initial luminous flux: 4102 lm
- LLF: 0.80 (fixed)

b) Zonal Cavity
- h_{RC} = 0.80 m
- h_{CC} = 0.80 m
- h_{FC} = 1.87 m

- ρ_c = 70%
- ρ_w = 50%
- ρ_f = 20%
- E = 200 lux
- LL = 4102 lm

c) Cavity Ratios
- $RCR = \frac{5(1.87\,m)(2.4\,m+2.7\,m)}{(2.4\,m\times2.7\,m)} = 7.36$
- $CCR = 7.36\frac{(0.8\,m)}{(1.87\,m)} = 1.30$
- $FCR = 7.36\frac{(0.8\,m)}{(1.87\,m)} = 3.15$

d) Effective Reflectances
- ρ_{cc}, use ρ_c = 70%, ρ_w = 50%, CCR = 1.30
- ρ_{cc} = 56% or 0.56
- ρ_{fc}, use ρ_f = 20% ρ_w = 50%, FCR = 3.15
- ρ_{fc} = 17.5% or 0.175

e) Coefficient of utilization
- RCR = 7.36
- ρ_c = 50%
- ρ_w = 50%
- ρ_{cc} = 17.5% or 0.175
- CU = 50% or 0.50

f) LLF
- LLF = 0.8 (fixed)

g) Number of luminaires
- $N = \frac{200\,(4.6\,m\times7.0\,m)}{(1\times4102\,lm\times0.8\times0.50)} = 0.79$
- $N = 0.98 \approx 1$
- Number of luminaires for room 1 = 1

II. Zone/Room 2: Office room

a) Givens:
- Dimension: 2.4 x 3.7 x 3.0 m (LWH)
- Initial Reflectance:
  - Ceiling – 70%
  - Wall – 50%
  - Floor – 20%
- Average Illuminance = 500 lux
- Lighting fixture
  - Regent ceiling mounted luminaire solo slim L2 75W 10400lm CRI >80
- Mounting height: 2.670 m
- Work plane height: 0.80 m
- Initial luminous flux: 10400 lm
- LLF: 0.80 (fixed)

b) Zonal Cavity
- h_{RC} = 0.33 m
- h_{CC} = 0.80 m
- h_{FC} = 1.87 m

- ρ_c = 70%
- ρ_w = 50%
- ρ_f = 20%
- E = 500 lux
- LL = 10400 lm

c) Cavity Ratios
- $RCR = \frac{5(1.87\,m)(2.4\,m+3.7\,m)}{(2.4\,m\times3.7\,m)} = 6.42$
- $CCR = 6.42\frac{(0.33\,m)}{(1.87\,m)} = 1.13$
- $FCR = 6.42\frac{(0.8\,m)}{(1.87\,m)} = 2.75$

d) Effective Reflectance
- ρ_{cc}, use ρ_c = 70%, ρ_w = 50%, CCR = 1.13
- ρ_{cc} = 57.5% or 0.575
- ρ_{fc}, use ρ_f = 20%, ρ_w = 50%, FCR = 2.75
- ρ_{fc} = 18% or 0.18

e) Coefficient of utilization
- RCR = 1.86
- ρ_c = 50%
- ρ_w = 57.5% or 0.575
- ρ_{cc} = 19.25% or 0.1925
- CU = 95% or 0.95

f) LLF
- LLF = 0.8 (fixed)

g) Number of luminaires
- $N = \frac{590\,(4.0\,m\times7.0\,m)}{(1\times6644\,lm\times0.8\times0.95)} = 10.2$
- $N = 10.2 \approx 12$
- Number of luminaires for room 3A = 12

III. Zone/Room 3A: Bookshelves and Computer Area

a) Givens:
- Dimension: 6.0 x 7.0 x 3.0 m (LWH)
- Initial Reflectance:
  - Ceiling – 70%
  - Wall – 50%
  - Floor – 20%
- Average Illuminance = 500 lux
- Lighting fixture
  - Cooper Lighting LED Suspended Luminaire
- Mounting height: 0.80 m
- Work plane height: 0.80 m
- Initial luminous flux: 6644 lm
- LLF: 0.80 (fixed)

b) Zonal Cavity
- h_{RC} = 1.00 m
- h_{CC} = 0.80 m
- h_{FC} = 1.20 m

- ρ_c = 70%
- ρ_w = 50%
- ρ_f = 20%
- E = 500 lux
- LL = 6644 lm

c) Cavity Ratios
- $RCR = \frac{5(1.20\,m)(6.0\,m+7.0\,m)}{(6.0\,m\times7.0\,m)} = 1.86$
- $CCR = 1.86\frac{(1.0\,m)}{(1.2\,m)} = 1.55$
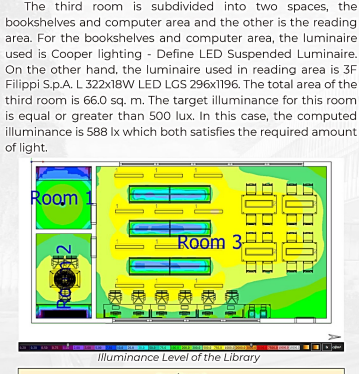- $FCR = 1.86\frac{(0.8\,m)}{(1.2\,m)} = 1.24$

III. Zone/Room 3B: Reading Area

a) Givens:
- Dimension: 4.0 x 5.0 x 3.0 m (LWH)
- Initial Reflectance:
  - Ceiling – 70%
  - Wall – 50%
  - Floor – 20%
- Average Illuminance = 500 lux
- Lighting fixture
  - 3F Filippi S.p.A L322x18WLED LGS 296x1196
- Mounting height: 2.765 m
- Work plane height: 0.80 m
- Initial luminous flux: 4102 lm
- LLF: 0.80 (fixed)

b) Zonal Cavity
- h_{RC} = 0.235 m
- h_{CC} = 0.80 m
- h_{FC} = 1.965 m

- ρ_c = 70%
- ρ_w = 50%
- ρ_f = 20%
- E = 500 lux
- LL = 4102 lm

c) Cavity Ratios
- $RCR = \frac{5(1.965\,m)(4.0\,m+5.0\,m)}{(4.0\,m\times5.0\,m)} = 4.42$
- $CCR = 4.42\frac{(0.235\,m)}{(1.965\,m)} = 0.53$
- $FCR = 4.42\frac{(0.80\,m)}{(1.965\,m)} = 1.80$

d) Effective Reflectance
- ρ_{cc}, use ρ_c = 70%, ρ_w = 50%, CCR = 0.53
- ρ_{cc} = 64% or 0.64
- ρ_{fc}, use ρ_f = 20%, ρ_w = 50%, FCR = 1.24
- ρ_{fc} = 19% or 0.19

e) Coefficient of utilization
- RCR = 4.42
- ρ_c = 50%
- ρ_w = 64% or 0.64
- ρ_{cc} = 19% or 0.19
- CU = 66.5% or 0.665

f) LLF
- LLF = 0.8 (fixed)

g) Number of luminaires
- $N = \frac{590\,(4.0\,m\times5.0\,m)}{(1\times4192\,lm\times0.8\times0.665)} = 10.2$
- $N = 3.58 \approx 4$
- Number of luminaires for room 3B = 4

(d) Effective Reflectances
- ρ_{cc}, use ρ_c = 70%, ρ_w = 50%, CCR = 1.30
- ρ_{cc} = 56% or 0.56
- ρ_{fc}, use ρ_f = 20%, ρ_w = 50%, FCR = 3.15
- ρ_{fc} = 17.5% or 0.175

DIALux Results

Shown in this portion are the results from the software. The luminaire used in the storage room is Arkoslight LEX ECO 3 CRI 90 DIM PUSH 2700K N. The area of the room is 6.48 sq. m. The target illuminance level for this room is at least 100 lx. Upon computation, the illuminance level is 156 lx which is sufficient enough to produce the required amount of light in the storage room.
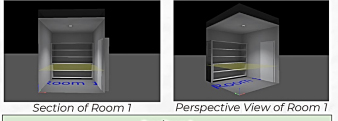
For the office room, the luminaire used is Regent Ceiling mounted luminaire Solo Slim L2 75W 10400lm CRI >80 3000K white DALI 980mm. The area of the room is 8.88 sq. m. The target illuminance level for this room is 300 to 500 lx. The computed illuminance level is 467 lx which is also sufficient to produced the required amount of light in the office room.

The third room is subdivided into two spaces, the bookshelves and computer area and the other is the reading area. For the bookshelves and computer area, the luminaire used is Cooper lighting - Define LED Suspended Luminaire. On the other hand, the luminaire used in reading area is 3F Filippi S.p.A. L 322x18W LED LGS 296x1196. The total area of the third room is 66.0 sq. m. The target illuminance for this room is equal or greater than 500 lux. In this case, the computed illuminance is 588 lx which both satisfies the required amount of light.
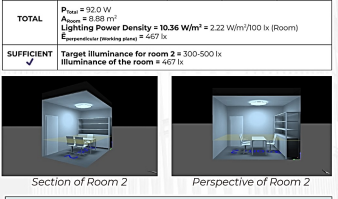

Section of Room 1   *Perspective View of Room 1*

Section of Room 2   *Perspective View of Room 2*

Illuminance Level of the Library

Zone/Room 1				
No. of Fixtures	Manufacturer	Article No.	Article Name	P	$\Phi_{luminaire}$
1	Arkoslight	A0700131N	LEX ECO 3 CRI 90 DIM PUSH 2700K N	24.0 W	1619 lm
TOTAL	P_{total} = 24.0 W A_{room} = 6.48 sq.m Lighting Power Density = 3.70 W/m2 = 2.37 W/m2/100 lx (Room) $E_{perpendicular\,(Working\,plane)}$ = 156 lx				
SUFFICIENT ✓	Target illuminance for room 1 = minimum 100 lx Illuminance of the room = 156 lx				

Zone/Room 2				
No. of Fixtures	Manufacturer	Article No.	Article Name	P	$\Phi_{luminaire}$
1	Regent	1021.7211 - SOLO S CW980 LED110400-B 30 DLII WH DALI	Ceiling and wall mounted luminaire Solo Slim L2 75W 10400lm CRI >80 3000K white DALI 980mm	92.0 W	10400 lm
TOTAL	P_{total} = 92.0 W A_{room} = 8.88 m2 Lighting Power Density = 10.36 W/m2 = 2.22 W/m2/100 lx (Room) $E_{perpendicular\,(Working\,plane)}$ = 467 lx				
SUFFICIENT ✓	Target illuminance for room 2 = 300-500 lx Illuminance of the room = 467 lx				

Zone/Room 3				
No. of Fixtures	Manufacturer	Article No.	Article Name	P	$\Phi_{luminaire}$
4	3F Filippi S.p.A.	21600	L 322x18W LED LGS 296x1196	40.0 W	4102 lm
12	Cooper Lighting	S125DIP-585 0D1205U940 -4FD- 1E-UDD-D1	Define LED Suspended Luminaire	56.9 W	6644 lm
TOTAL	P_{total} = 842.8 W A_{room} = 66.0 m2 Lighting Power Density = 12.77 W/m2 = 3.57 W/m2/100 lx (Room) $E_{perpendicular\,(Working\,plane)}$ = 588 lx				
SUFFICIENT ✓	Target illuminance for room 3 = ≥ 500 lx Illuminance of the room = 588 lx				
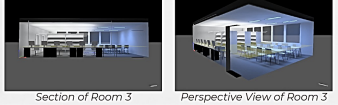
Section of Room 3   *Perspective View of Room 3*

Overall Luminaire List

OVERALL LUMINAIRE LIST									
No. of Fixtures	Location	Manufacturer	Article No.	Article Name	CCT	CRI	P	$\Phi_{luminaire}$	Luminous Efficacy
1	Room 1	Arkoslight	A0700131N	LEX ECO 3 CRI 90 DIM PUSH 2700K N	2700 K	90	24.0 W	1619 lm	67.5 lm/W
1	Room 2	Regent	1021.7211 - SOLO S CW980 LED110400 -B30 DLII WH DALI	Ceiling and wall mounted luminaire Solo Slim L2 75W 10400lm CRI >80 3000K white DALI 980mm	3000 K	80	92.0 W	10400 lm	113.0 lm/W
4	Room 3	3F Filippi	21600	L 322x18W LED LGS 296x1196	4000 K	82	40.0 W	4102 lm	102.6 lm/W
12	Room 3	Cooper Lighting	S125DIP-5 85001205 U940-4FD- 1E-UDD-D	Define LED Suspended Luminaire	4000 K	90	56.9 W	6644 lm	116.8 lm/W
TOTAL							P_{total} = 958.8 W	Φ_{total} = 109135 lm	Luminous Efficacy = 112.8 lm/W

Shown in the table above is the overall luminaire list of the library. The number of fixtures are supported and calculated using the Lumen Method and the DIALux calculation object function.

SUMMARY AND CONCLUSION

Aside from the architectural design of the building, lighting also plays a vital role in creating an environment for the users to experience and understand architecture. Balancing the amount of daylight and artificial lighting can draw the attention of the users to textures, colors, and forms of the space. Moreover, to make the building more efficient, it is important to assure that the majority of the light is reaching its target level to minimize energy consumption and reduce the amount of wasted light.

In this lighting schematics, it can be said that the library is efficient in achieving goals. The choice of the type of luminaires is dependent on the function of the room. Using the two mentioned methods in computing the number of luminaires, the sufficiency of the amount of lighting in each room can be proved enough and efficient.

RECOMMENDATION

In lighting design, it is best to plan first the orientation of the building and the location of the apertures where the windows and doors are to be placed. Furthermore, it is also important to consider the light distribution and brightness inside the building, conservation of energy, luminaire maintenance and stocking, glare, colors, cost of implementation, and etc. For future lighting design studies, it would be better if the cost computation is also considered as it would help save money on lighting and reduce waste. Lastly, the number of luminaires to be placed in a room should be calculated to prove the sufficiency of the amount of light and reduce wasted light.