LIGHTING DEPTH BACKGROUND

The new Pennsylvania Academy of Music facility will require a lighting system that both accents the architectural aspects of the architecture and enhances the functionality of the Academy. This will be done by placing light where it would be the most flattering to the building and the most conducive to the task necessary in the space. Likewise, light will be reduced where it is not necessary or where it's lack will generate significance. Since the target demographic ranges from children to adult learners, the design should attempt to appeal to as wide a population as possible. Since this building is one of the last that the prolific Philip Johnson had significant input on, it will be very important to address the architecture without putting a separate branding upon it.

Though each space has a unique and varied set of design issues that need to be addressed, some issues show up in every space. Because of the expansive use of wood throughout the building, I decided upon a uniform color temperature of 3000K. This warmer color temperature will provide a good balance between neutral whites and incandescent, as well as being available in most types of lamps. As a general rule, I assumed that the fixtures would be cleaned once a year along with lamp replacement.

An added layer of consideration in lighting this building is keeping in mind that the primary tasks in most spaces throughout the building are auditory, not visual—indeed, visual stimulation might distract from an ideal auditory experience. Most importantly among these aspects are glare and facial modeling. Glare is best reduced by shielding or diffusing point sources and reducing unnecessarily large differences in contrast. Facial modeling is best ameliorated by a balance of horizontal illumination with vertical illumination originating in front of the face. Another design issue to take into consideration is the Recommended Illuminances published by the Illumination Engineering Society of North America. These levels provide a good starting point for establishing a base level that can be adjusted either up or down depending on the specific, primary design criteria that the space dictates. Though these recommended values are in no way strict or binding, illuminances that vary significantly from these values should be avoided.

BUILDING ENTRANCE LIGHTING DEPTH

Design Intent

The main entrance to the building is the part of the façade that will be seen by most people who travel past the building. It consists of a three-story, curved glass structure looking in at the two-story lobby and a performance space on the third floor. This is nestled between extensions of the third floor supported by square columns that go to the street level. At night, the glass atrium will be given the chance to glow from the lighting in the lobby. The exterior spaces should get equal treatment.

I am proposing to pair the glowing surfaces behind the glass by making the volumes enclosed by the canopies and columns glow as well. This should be guided by the need to provide accurate facial rendering and the need to have ample horizontal illumination so that the steps scattered throughout the path are visible. Another design guideline is minimizing light trespass coming from the exterior lighting. Additional light will be placed on the steps leading to this section of the building as well as underneath the low canopies to direct attention to the entrances. Outside of these areas, the lighting is taken care of by the city.

Design Criteria

The IESNA Recommended Illuminance for this space would call for 50 lux of horizontal illumination on the ground and 50 lux of vertical illumination at about head height. My target illuminances were well above this value. The primary reason for this is that the primary use of this area will be where the students would wait to be picked up from lessons. Since there are a substantial number of younger students at the Academy, their safety is very important. Higher and uniform vertical illumination levels will help to aid in this safety. The secondary reason for higher illumination levels is due to the pairing of this volume with the lit planes within the Grand Foyer. The higher levels are necessary to balance out and extend the lighting scheme of the Grand Foyer. An additional consideration is that since the students will likely be spending time waiting in this area, the light fixtures within reach of a person should take care to minimize heat through the exposed portions of the fixture. The reflectances I assumed for this space are given in Table 1: Building Entrance Reflectances.

Surface	Assumed Reflectance
Limestone	0.50
Glass	0.10
Concrete	0.40
Metal	0.40

Table 1: Building Entrance Reflectances

Equipment

The lighting equipment specifications can be cross referenced through Table 2: Building Entrance Specification Cross Reference in Table 3: Building Entrance Luminaire Specifications, Table 4: Building Entrance Ballast Specifications, and Table 5: Building Entrance Lamp Specifications. The catalog pages for these products are provided in Appendix A: Entrance Lighting Equipment.

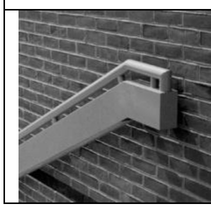
Image	Fixture Label	Type	Lamp	Lamp Quantity	Ballast	Fixture Quantity
	EF1	Downlight	EL1	1	EB1	10
	EF2	Uplight	EL2	1	EB1	12
	EF3	Downlight	EL3	1	EB2	5
	EF4	Rail Light	EL4	1	EB3	3

Table 2: Building Entrance Specification Cross Reference

Fixture Label	Manufacturer	Catalog Number
EF1	Erco	81022.023
EF2	B-K Lighting	S-HP2-T635-MS-TR-0-SAP-ICEE
EF3	Lightolier	8091CCLW-32
EF4	Cole Lighting	LR-5W-RE-120

Table 3: Building Entrance Luminaire Specifications

Ballast Label	Manufacturer	Catalog Number	Lamps	Input Watts	ANSI Code
EB1	Advance	71A5081	1	56	M130/E
EB2	Advance	ICF2S4290CM2LD	1	37	-
EB3	Advance	ICN-2S28	1	33	-

Table 4: Building Entrance Ballast Specifications

Lamp Type	Manufacturer	Catalog Number	Nominal Wattage	ANSI Code	Initial Lumen Output
EL1	Philips	CDM35/T6/830	39	M130/E	3300
EL2	Sylvania	CF32DT/E/IN/830/ECO	32	-	2400
EL3	Philips	F28T5/830/ALTO	28	-	2900

Table 5: Building Entrance Lamp Specifications

Light Loss Factors

Since this is an outdoor space, I have assumed that the space would garner a dirty cleanliness rating with a 12 month cleaning cycle. Based on this, I have assumed a generic Dirt Depreciation of 0.77 as a safety factor. The calculations for the light loss factors are given in Table 6: Building Entrance Light Loss Factors.

Fixture Label	Ballast Factor	LLD	Luminaire Maintenance Category	Assumed Dirt Depreciation	Total LLF
EF1	1	0.78	V	0.77	0.607
EF2	1	0.78	V	0.77	0.607
EF3	1.1	0.86	V	0.77	0.728
EF4	1.04	0.95	V	0.77	0.759

Table 6: Building Entrance Light Loss Factors

Power Density

The exterior lighting power density according to ASHRAE 90.1-2004 varies according to what objects are being lit. The total number of watts available to be used is calculated in Table 7: Building Entrance Allowable Power Density. The power used in my design is calculated in Table 8: Building Entrance Designed Power Density. In total, I will be using less than half the lighting watts allotted to this space.

Item Description	Measurement	Allowable Power Density	Allowed Wattage (w)
Stair	81 ft^2	1.0 W/ft^2	81
Main Entrances	42 ft	30 W/ft	1260
Secondary Entrance	3.5 ft	20 W/ft	70
Canopy (3rd Floor)	1520 ft^2	1.25 W/ft^2	1900
Canopy (Signage)	183 ft^2	1.25 W/ft^2	229
		Subtotal	**3540**
		Multiplier	x 1.05
		TOTAL	**3717**

Table 7: Building Entrance Allowable Power Density

Ballast Label	Lamps	Input Watts	Ballast Quantity	Watts per Ballast Type
EB1	1	56	22	1232
EB2	1	37	5	185
EB3	1	33	3	99
			TOTAL	**1516**

Table 8: Building Entrance Designed Power Density

Luminaire Locations and Controls

The luminaire locations are given in Figure 1: Building Entrance Luminaire Locations. Controls for these luminaires would be integral with a timeclock as part of the main theatrical lighting control system. Please see the Electrical Depth section for circuiting information.

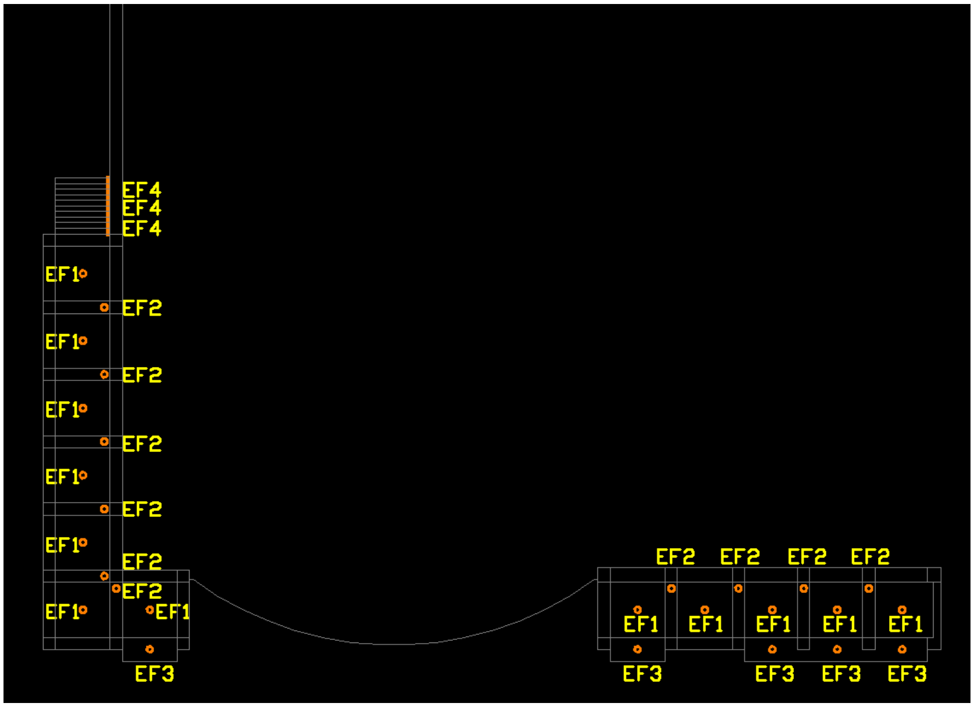


Figure 1: Building Entrance Luminaire Locations

System Performance

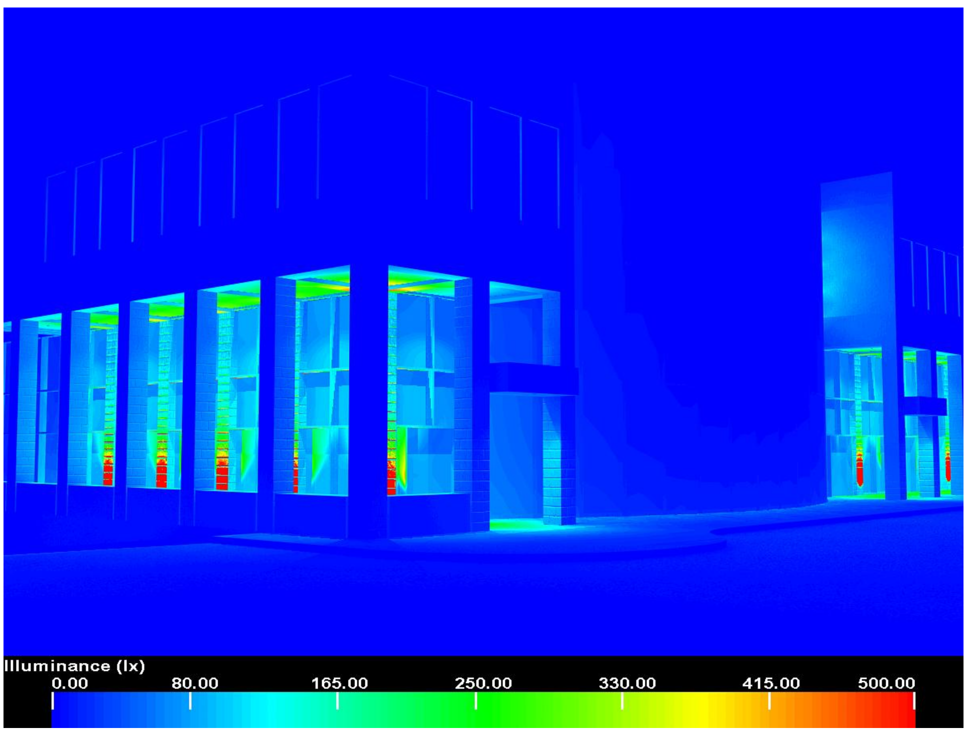


Figure 2: Building Entrance Pseudocolor, Corner Perspective View

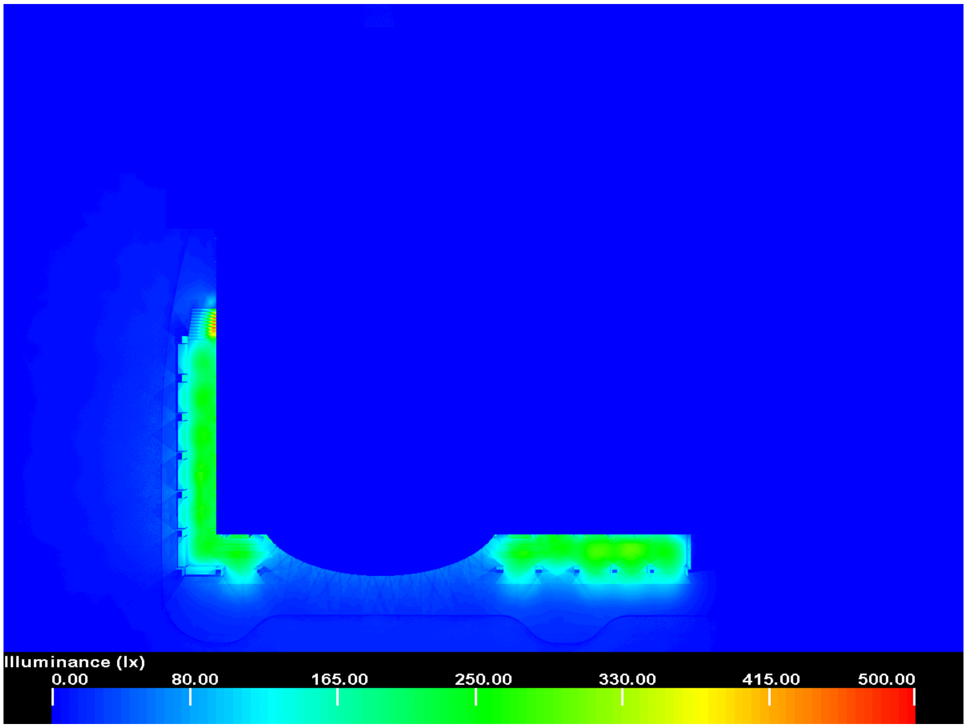


Figure 3: Building Entrance Pseudocolor, Horizontal Illuminance (with Camera Clipping)

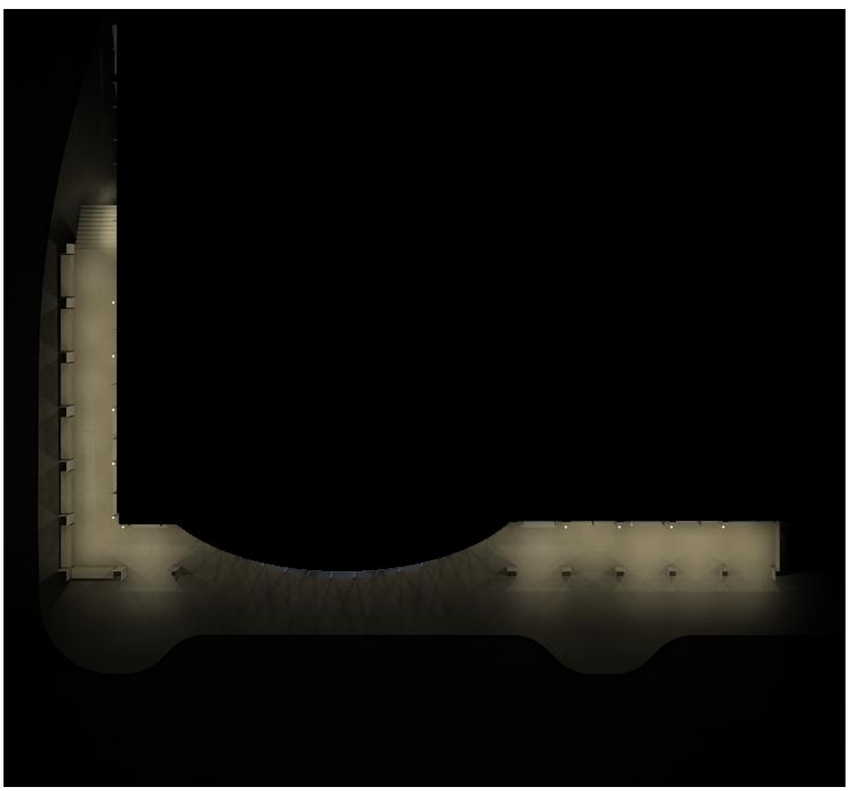


Figure 4: Building Entrance, Top Down View (with Camera Clipping)

Figure 5: Building Entrance, Front View

Figure 6: Building Entrance, Corner Perspective View

Conclusions

Lighting the volumes enclosed by the columns from both the top and the bottom help to create even illumination of this space through use of different layers of light. A tight beam spread was selected for the uplights, and they were placed as close to the building as possible to minimize upwards light pollution. The higher levels of illumination did not cause the lighting power density to be exceeded, and the luminance levels pair well with the interior.

GRAND FOYER LIGHTING DEPTH

Design Intent

The two-story Grand Foyer that occupies mush of the area of the first floor is prominently visible from the outside through a two-story glazing system. The biggest feature in this space is the large oak-veneer wall of the recital hall which is completely surrounded by the Grand Foyer. This space will be primarily used for circulation and events. This space also includes an information desk near the entrance with a computer kiosk and a lounge space in the rear of the facility. A balcony from the second floor overlooks this space and was included in this design.

Since this space is so visible from the outside, it was the architect's intent to have it be an integral part of the façade lighting scheme. The primary function is to make the facility appear to glow through the windows. This is accomplished not by lighting the windows but by lighting the surfaces behind the windows. Additionally, light should be used to aid in circulation.

The lobbies of most theatrical facilities use incandescent lamps as their primary light source both out of tradition and for its ease in dimming. The original design of this space called for a power density of 3.285 watts/ft^2 which is rather high, but less than the 3.3 watts/ft^2 allowed according to ASHRAE 90.1-2004. One of my goals will be to reduce the lighting power density without losing the control flexibility of the space through use of longer lasting, more energy efficient light sources.

I am proposing to use a continuous line of fluorescent wallwashers around the oak recital hall as the primary source of illumination in the space. Light will easily bounce off of this wall and illuminate the rest of the space near the wall. Additional downlighting will be used to aid in the general illumination farther away from the walls. In the circulation areas on the north side of the space, downlighting will be used to provide general illumination.

Design Criteria

The IESNA recommended illuminance of a lobby and circulation areas for a facility such as this is about 100 lux of horizontal illumination on the ground. Because this signature space will also be used for events such as performances, classes, and gatherings, I am making the target illumination level about 300 lux on the ground. The target illuminance in the circulation areas will be slightly higher due to their lower ceiling heights. Due to the logarithmic sensitivity of the eyes to light, the areas of increased light levels to aid in circulation will need to be illuminated to at least 500 lux in order for a difference to be perceptible. An additional technique of contrasting with the illumination of the main part of the lobby is to create a darker transition area in between the two. I recommend that the screen on the computer kiosk in this area have anti-glare coating applied to it due to its nearly horizontal orientation. This orientation makes it very prone to veiling reflections.

Vertical illumination on the Recital Hall wall will need to be as even as possible from top to bottom as well as around the wall, with a slightly higher illuminance on the portion of the wall closest to the two-story window. The difficulty of this goal is increased by the change in height of the space in the rear of the Grand Foyer. In this area, the lights will need to be located at a different distance from the wall to provide even illumination and will also need to be dimmed to balance the change in illuminance caused by the change in distance.

After analyzing the daylighting contribution to this space, it has become apparent that due to the architecture of the overhang as well as the proximity of the neighboring building to the south that daylight contributions to the space will enter the space very little during typical hours of operation. This is unfortunate because dimming fluorescent ballasts have already been incorporated into the design. A separate issue, however, is that the dimming system that is integrated into the rest of the theatrical systems does not at this time have the capability of responding to a daylight sensor due to its roots in the theatrical realm. For additional information, please see Appendix F: Daylighting Study.

A summary of the assumed reflectances for this space are given in Table 9: Grand Foyer Reflectances.

Surface	Assumed Reflectance
Doors	0.33
Glass	0.10
Wood	0.50
Ceiling	0.85
Walls	0.65
Floor	0.20
Metal	0.40

Table 9: Grand Foyer Reflectances

Equipment

The lighting equipment specifications can be cross referenced through Table 10: Grand Foyer Specification Cross Reference in Table 11: Grand Foyer Luminaire Specifications, Table 12: Grand Foyer Ballast Specifications, and Table 13: Grand Foyer Lamp

Specifications. The catalog pages for these products are provided in Appendix B: Grand Foyer Lighting Equipment.

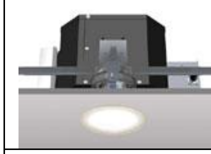
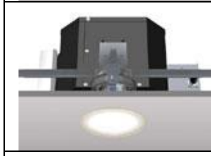
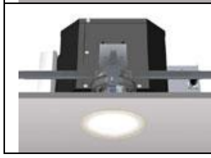
Image	Fixture Label	Type	Lamp	Lamp Quantity	Ballast	Fixture Quantity
	GF1	Wallwasher	GL1	1	GB1	53
	GF1A	Wallwasher	GL1	1	GB1	20
	GF1B	Wallwasher	GL2	1	GB2	2
	GF2	Downlight	GL3	1	GB3	29
	GF3	Downlight	GL4	1	GB4	18
	GF4	Downlight	GL5	1	GB5	19
	GF5	Downlight	GL6	1	GB6	11
	GF6	Downlight	GL7	1	GB7	4

Table 10: Grand Foyer Specification Cross Reference

Fixture Label	Manufacturer	Catalog Number
GF1	Lightolier	WM-R-L-1-4-3-120-PS-WL4DF/UNV
GF1A	Lightolier	WM-R-L-1-4-3-120-PS-WL4DF/UNV
GF1B	Lightolier	WM-R-L-1-3-3-120-PS-WL4DF/UNV
GF2	Lightolier	8091CCLW-26
GF3	Lightolier	8091CCLW-32
GF4	Lightolier	C4A20T4E1
GF5	Lightolier	C4A39T4E1
GF6	Lightolier	C4A70T4E1

Table 11: Grand Foyer Luminaire Specifications

Ballast Label	Manufacturer	Catalog Number	Lamps	Input Watts	ANSI Code
GB1	Advance	REZ-132	1	35	-
GB2	Advance	REZ-132	1	30	-
GB3	Advance	ICF-2S26-H1-LD	1	29	-
GB4	Advance	ICF2S4290CM2LD	1	36	-
GB5	GE	GEMH20-MLF-120	1	23	M156
GB6	Advance	71A5081	1	56	M130
GB7	Advance	71A5281	1	94	M139

Table 12: Grand Foyer Ballast Specifications

Lamp Type	Manufacturer	Catalog Number	Nominal Wattage	ANSI Code	Initial Lumen Output
GL1	Philips	F32T8/TL830/ALTO	32	-	2950
GL2	Philips	F25T8/TL830/ALTO	25	-	2225
GL3	Sylvania	CF26DT/E/IN/830/ECO	26	-	1800
GL4	Sylvania	CF32DT/E/IN/830/ECO	32	-	2400
GL5	Sylvania	MC20TC/U/G8.5/830 PB	20	M156	1700
GL6	Sylvania	MC39TC/U/G8.5/830 PB	39	M130	3400
GL7	Sylvania	MC70TC/U/G8.5/930 PB	70	M139	6300

Table 13: Grand Foyer Lamp Specifications

Light Loss Factors

As previously mentioned, some of the fixtures lighting the Recital Hall wall will need to be dimmed to balance their illumination with similar fixtures that are farther from the wall. These fixtures will have a permanent dimming factor of 0.50 applied in the programming of the system. Due to the complexity and varied heights in this space, a generic Room Surface Dirt Depreciation value of 0.95 was applied to all light loss factors in this space. The calculations for the light loss factors are given in Table 14: Grand Foyer Light Loss Factors.

Fixture Label	Ballast Factor	LLD	Luminaire Maintenance Category	LDD	RSDD	Total LLF
GF1	1.00	0.95	IV	0.89	0.95	0.803
GF1A	0.50	0.95	IV	0.89	0.95	0.401
GF1B	0.50	0.92	IV	0.89	0.95	0.390
GF2	1.10	0.86	V	0.88	0.95	0.791
GF3	0.98	0.86	V	0.88	0.95	0.705
GF4	1.00	0.75	V	0.88	0.95	0.627
GF5	1.00	0.80	V	0.88	0.95	0.669
GF6	1.00	0.80	V	0.88	0.95	0.669

Table 14: Grand Foyer Light Loss Factors

Power Density

The allowed power density for this space is 3.3 watts/ft² over 8320 ft². The original design called for a total of 27334 watts in this area, or a power density of 3.285 watts/ft². This design uses 5533 total watts for a power density of 0.665 watts/ft², or 20.2% of the originally designed watts. The lighting power is calculated in Table 15: Grand Foyer Designed Power Density.

Ballast Label	Lamps	Input Watts	Ballast Quantity	Watts per Ballast Type
GB1	1	35	73	2555
GB2	1	30	2	60
GB3	1	29	29	841
GB4	1	36	18	648
GB5	1	23	19	437
GB6	1	56	11	616
GB7	1	94	4	376
			TOTAL	**5533**

Table 15: Grand Foyer Designed Power Density

Luminaire Locations and Controls

The luminaire locations in the Grand Foyer are given on the following reflected ceiling plans. I have included some of the furniture to more easily understand the layout of the spaces. The continuous strip of GF1, GF1A, and GF1B fixtures will be recessed in such a manner that the corners closest to the Recital Hall wall of adjacent fixtures will be touching in order to create as smooth of a shape as possible using rectangular segments.

I have opted not to change the specifications of the controls for this system of the building. This is due to the tight integration and intercommunication of the lighting system and the rest of the theatrical components of the building. I have specified a Mark 10 Powerline ballast for the linear fluorescent wallwashers because of its ability to easily interface with the theatrical lighting control system in place of incandescent as well as its low cost of installation due to its lack of complexity. Please see the Electrical Depth section for additional control and circuiting information.

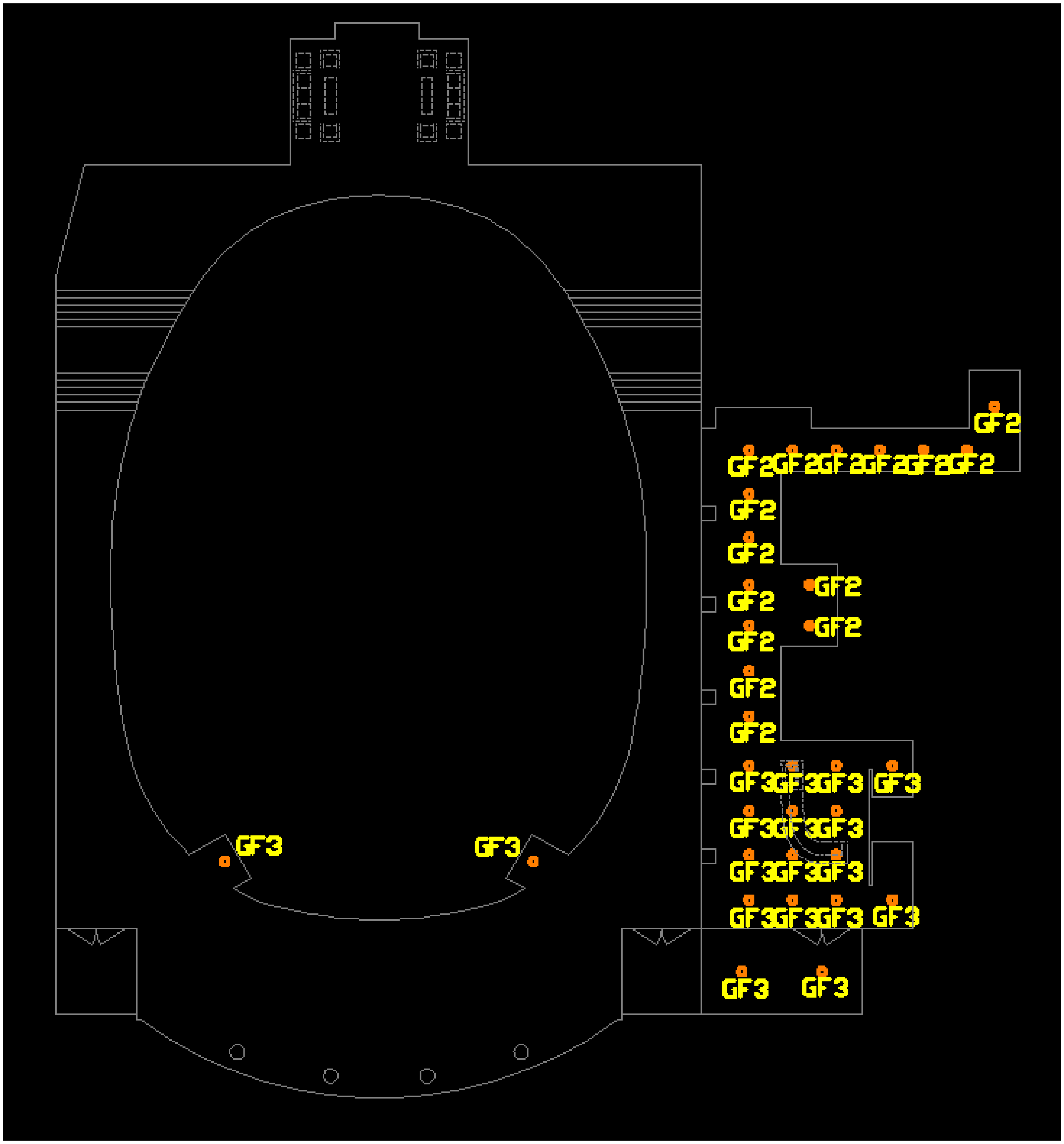


Figure 7: Grand Foyer Ground Floor Luminaire Locations

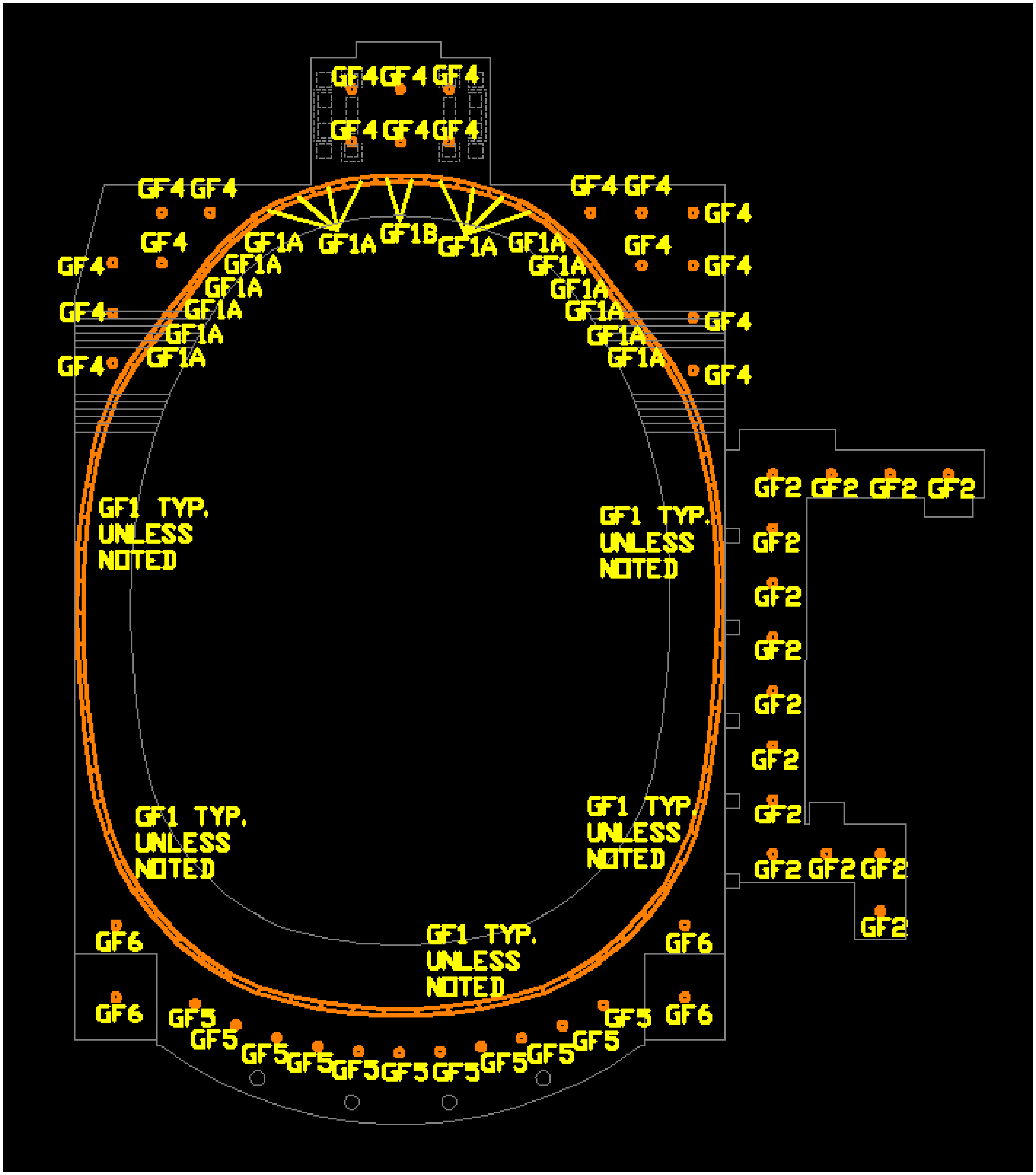


Figure 8: Grand Foyer Second Floor Luminaire Locations

System Performance

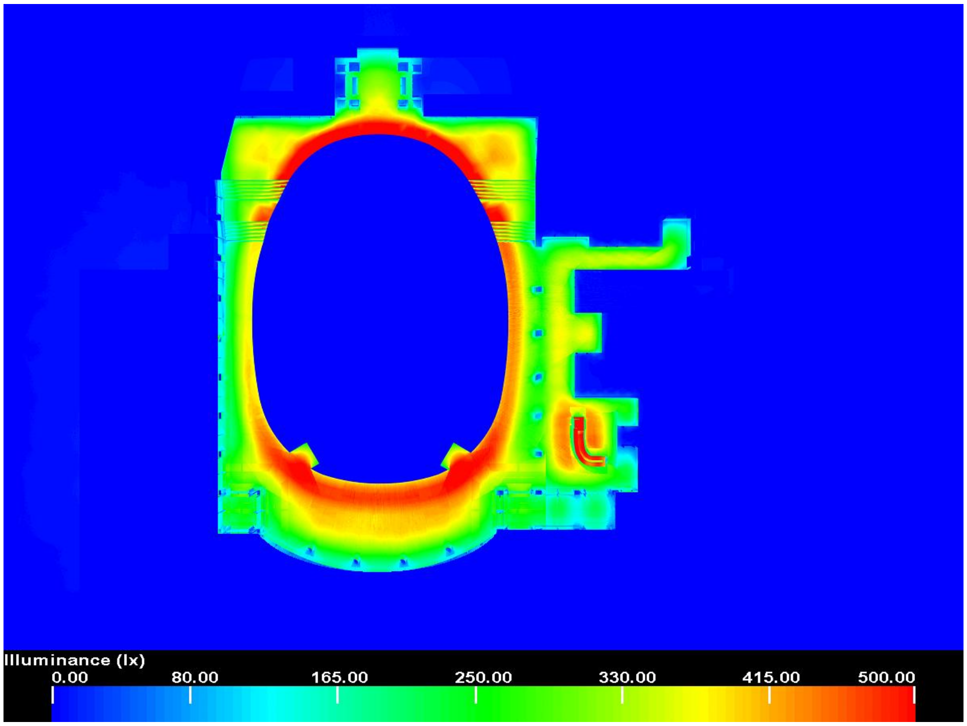


Figure 9: Grand Foyer Ground Floor Horizontal Illumination

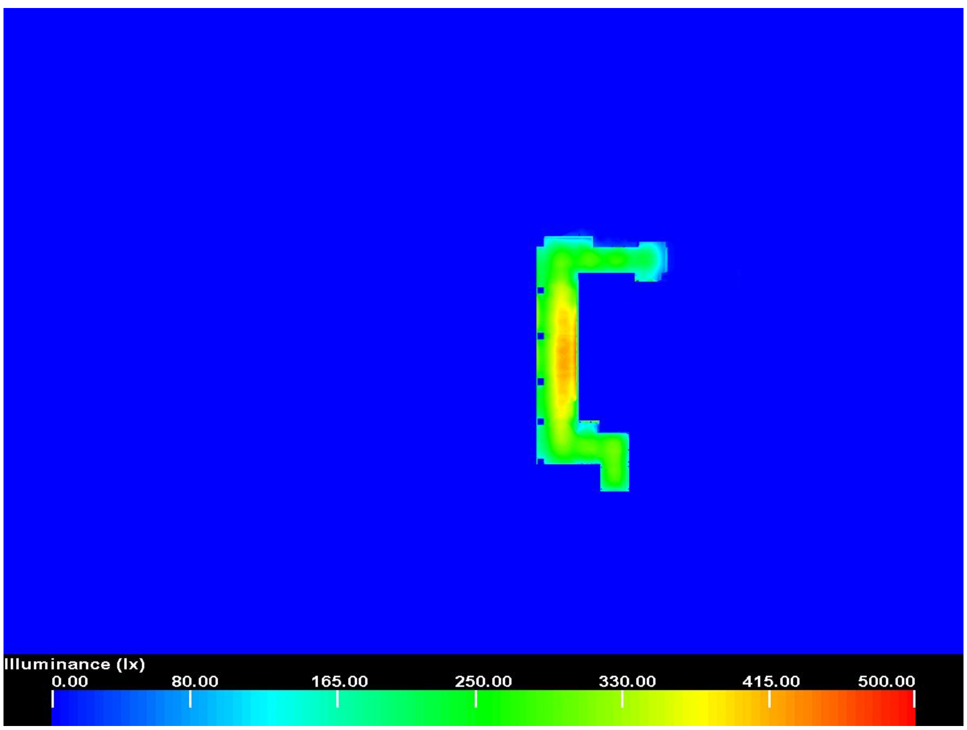


Figure 10: Grand Foyer Second Floor Horizontal Illumination

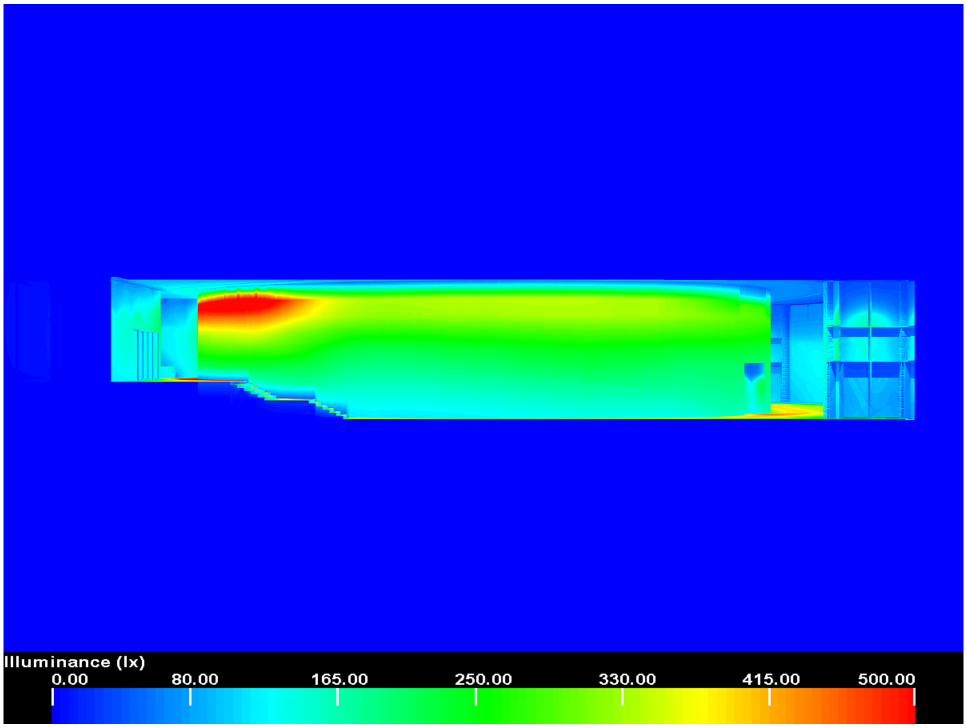


Figure 11: Vertical Illumination on Recital Hall Wall, Facing North

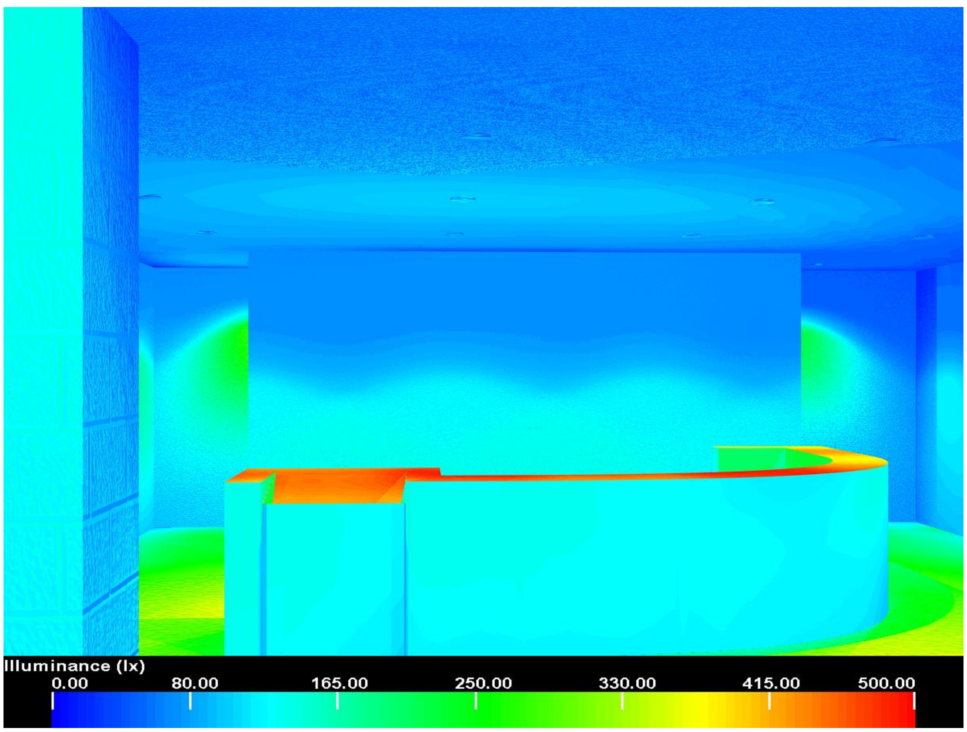


Figure 12: Illuminance Levels on Information Desk

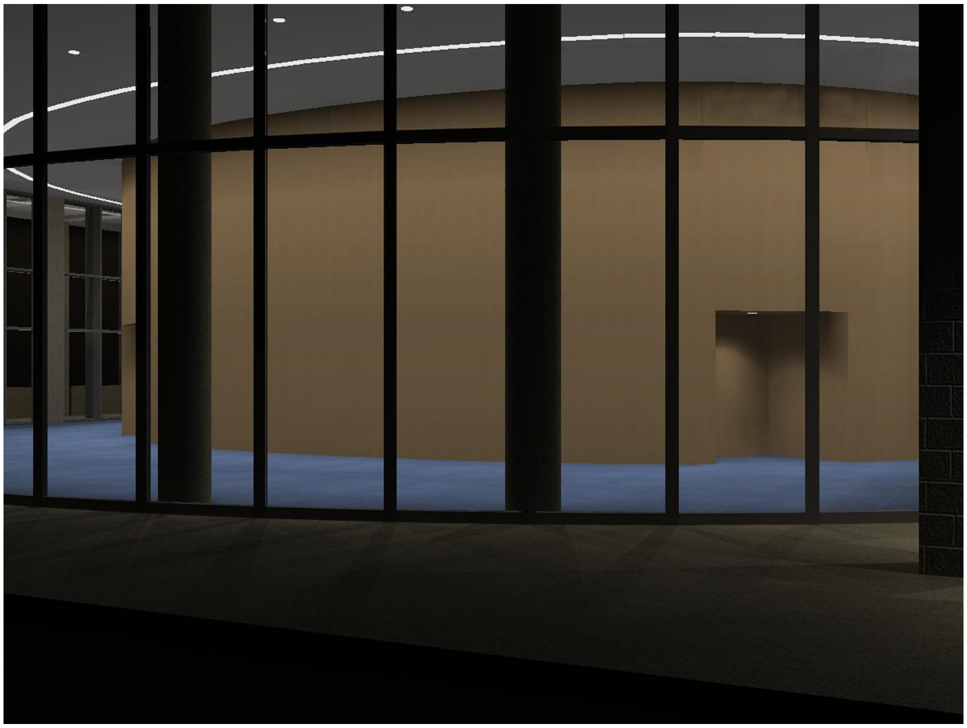


Figure 13: Rendering From Outside Looking Inside

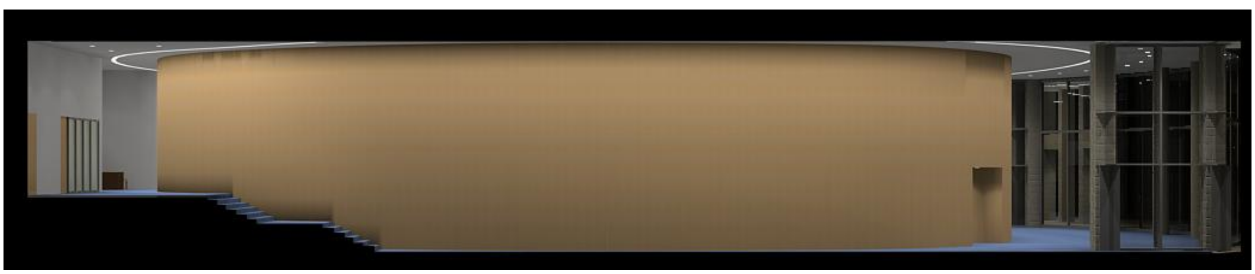


Figure 14: Rendering of Recital Hall Wall (With Camera Clipping)

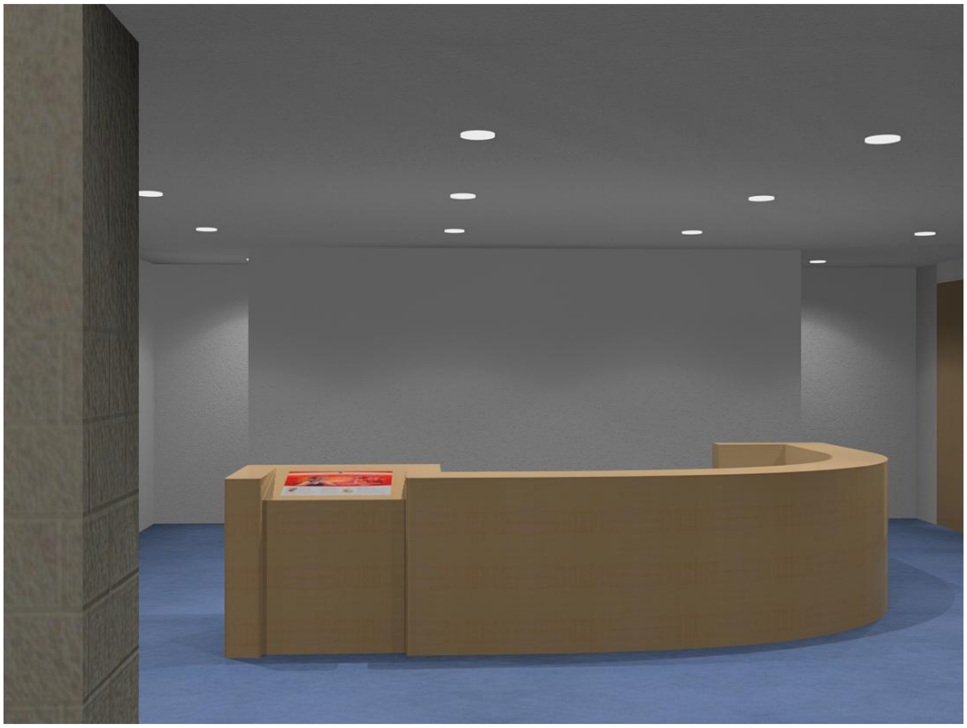


Figure 15: Rendering of Information Desk

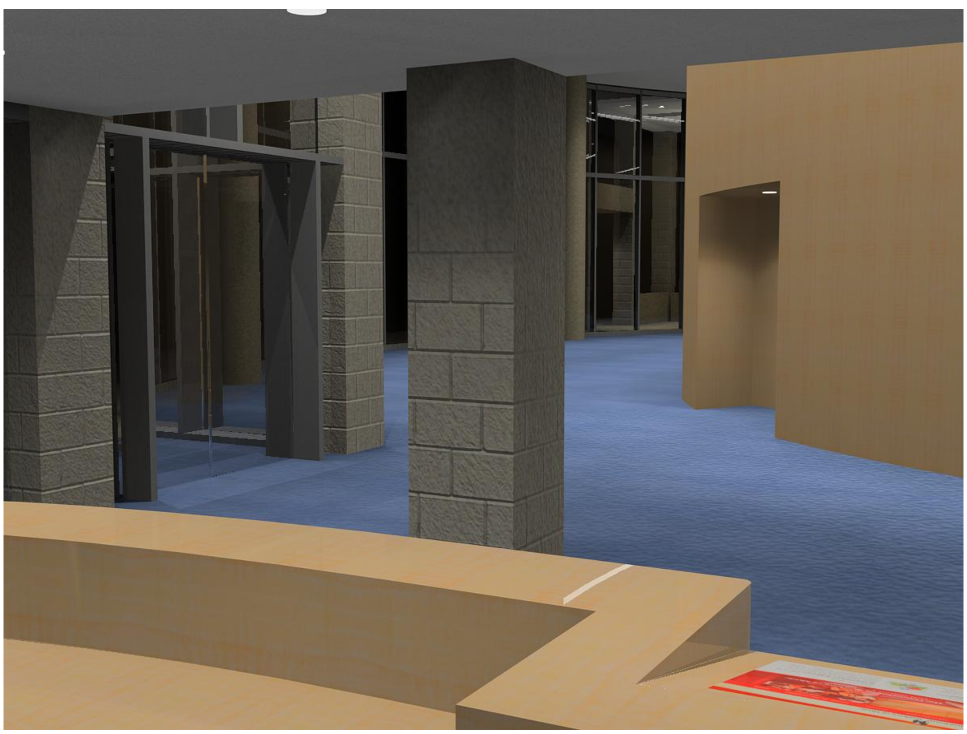


Figure 16: Rendering from Information Desk

Figure 17: Rendering of Hallway Along Grand Foyer

Figure 18: Rendering of Lounge Area

Conclusions

The redesigned system accomplishes the same major goals as the original design but using far less energy. There will also need to be fewer circuits, fewer fixtures, and fewer lamps, so the redesign will reduce cost up front as well as over the life of the system. In addition, the lamps used in the redesign last much longer which is important to consider when dealing with a double-height space such as this.

LIBRARY LIGHTING DEPTH

Design Intent

The Library is a space that will hold music and books for use by the students of the Academy. The bookshelves are all along the north wall and have inspection counters in them. Reading tables and an administration desk fill the rest of the space.

This space will be used for group and individual education as well as informal gatherings and meetings. It is unlikely that this space would ever be used as a performance space due to its acoustical characteristics. With this in mind, it is my intent to bring a reminder of the music though silently. I have included an alternate redesign for the lighting in this space so that comparisons between the two redesigns can be made.

Design Criteria

Since the task of reading music involves more active thought and visual complexity than reading words, higher than recommended illumination levels will not be viewed as detractive. The task in this space will be visual interpretation of fine details of music. Though there is no actual recommendation by the IESNA for the illumination levels of this task, similar tasks have target horizontal illuminations of 500 lux. Since the Academy is home to musical students of all ages, this will be the minimum target for the reading tables as well as the inspection tables, and higher values will be desirable to aid older sets of eyes. The IESNA recommends 300 vertical lux at 30 inches off of the floor on the shelves. Because of the high target illuminance values of this space, most of the allowed power consumption will be utilized in the design.

A summary of the assumed reflectances for this space are given in Table 16: Library Surface Reflectances.

Surface	Assumed Reflectance
Doors	0.33
Glass	0.10
Wood	0.50
Ceiling	0.85
Walls	0.65
Floor	0.20
Metal	0.40

Table 16: Library Surface Reflectances

Equipment

This design will use a series of five thin linear fluorescent strips to emulate the five lines of the musical staff. The lighting equipment specifications can be cross-referenced through Table 17: Library Lighting Specification Cross-Reference in Table 18: Library Luminaire Specifications, Table 19: Library Ballast Specifications, and Table 20: Library Lamp Specifications. The catalog pages for these products are provided in Appendix C: Library Lighting Equipment.

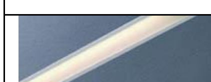
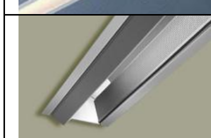
Image	Fixture Label	Type	Lamp	Lamp Quantity	Ballast	Fixture Quantity
	LF1	Downlight	LL1	1	LB1	40
	LF2	Wallwasher	LL2	1	LB2	8
	LF3	Downlight	LL1	1	LB3	5

Table 17: Library Lighting Specification Cross-Reference

Fixture Label	Manufacturer	Catalog Number
LF1	se'lux	M6R1S-1T5-OD-RC-008
LF2	Focal Point	FAVA-RL-1T5HO-1C
LF3	se'lux	M6R1-1T5-SD-RC-004-WH

Table 18: Library Luminaire Specifications

Ballast Label	Manufacturer	Catalog Number	Lamps	Input Watts	Ballast Factor
LB1	Advance	ICN-2M32-MC	2	68	1.05
LB2	Advance	ICN4S5490C2LS	3	182	1.00
LB3	Advance	ICN-132-MC	1	33	1.05

Table 19: Library Ballast Specifications

Lamp Type	Manufacturer	Catalog Number	Nominal Wattage	Initial Lumen Output
LL1	Philips	F28T5/830/ALTO	28	2900
LL2	Philips	F54T6/830/HO/ALTO	54	5000

Table 20: Library Lamp Specifications

Light Loss Factors

When calculating light loss factors for this space, I am assuming that it is a very clean environment with a twelve-month cleaning cycle. I am also assuming a cavity height of 8'-6" and a perimeter of 136' to get a room cavity ratio of 1.85. These calculations are in table Table 21: Library Light Loss Factors.

Fixture Label	Ballast Factor	LLD	Luminaire Maintenance Category	LDD	RSDD	Total LLF
LF1	1.03	0.95	V	0.93	0.98	0.890
LF2	1.00	0.95	IV	0.94	0.98	0.875
LF3	1.04	0.95	V	0.93	0.98	0.900

Table 21: Library Light Loss Factors

Power Density

The power density according to ASHRAE 90.1-2004 vary according to the spaces in a library. The total number of watts available to be used is calculated in Table 22: Library

Allowable Power Density. The power used in my design is calculated in Table 23: Library Designed Power Density. The designed wattage exceeds the allowable wattage negligibly, and the power density was reduced throughout the rest of the building.

Area	Square Footage (ft^2)	Allowed Power Density (w/ft^2)	Allowed Wattage
Stacks	600	1.7	1020
Reading Area	960	1.2	1152
		TOTAL	**2172**

Table 22: Library Allowable Power Density

Ballast Label	Lamps	Input Watts	Ballast Quantity	Watts per Ballast Type
LB1	2	64	20	1280
LB2	3	182	4	728
LB3	1	33	5	165
			TOTAL	**2173**

Table 23: Library Designed Power Density

Luminaire Locations and Controls

The luminaire locations are given in Figure 19: Library Luminaire Locations. The section mounting detail of fixture type LF3 above the inspection tables, and within the millwork, is given in Figure 20: LF3 Mounting Location. Controls for the general illumination system would be located at both doors to the library. Individual controls for the inspection tables would be located at each table. Please see the Electrical Depth section for additional control and circuiting information.

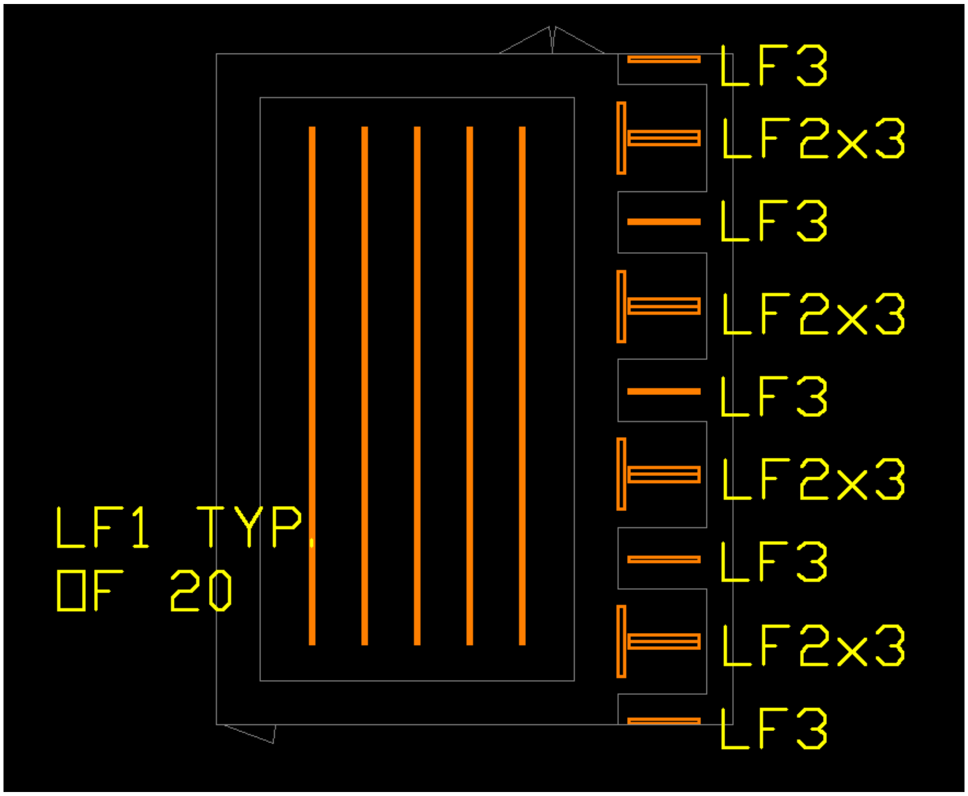


Figure 19: Library Luminaire Locations

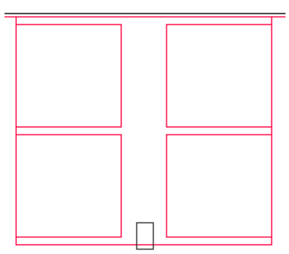


Figure 20: LF3 Mounting Location

System Performance

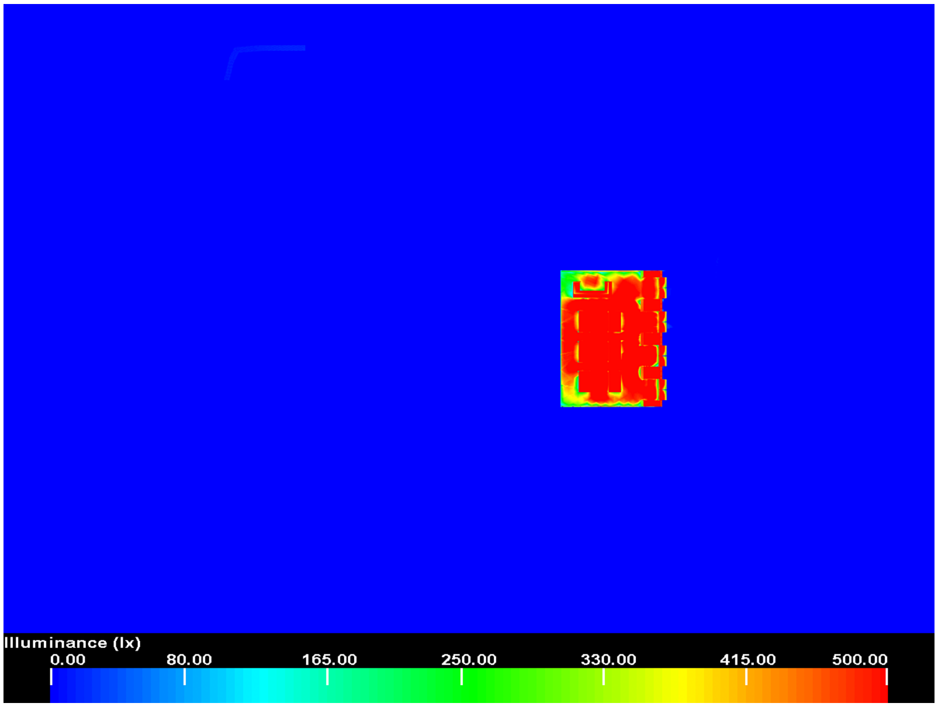


Figure 21: Library Horizontal Illumination

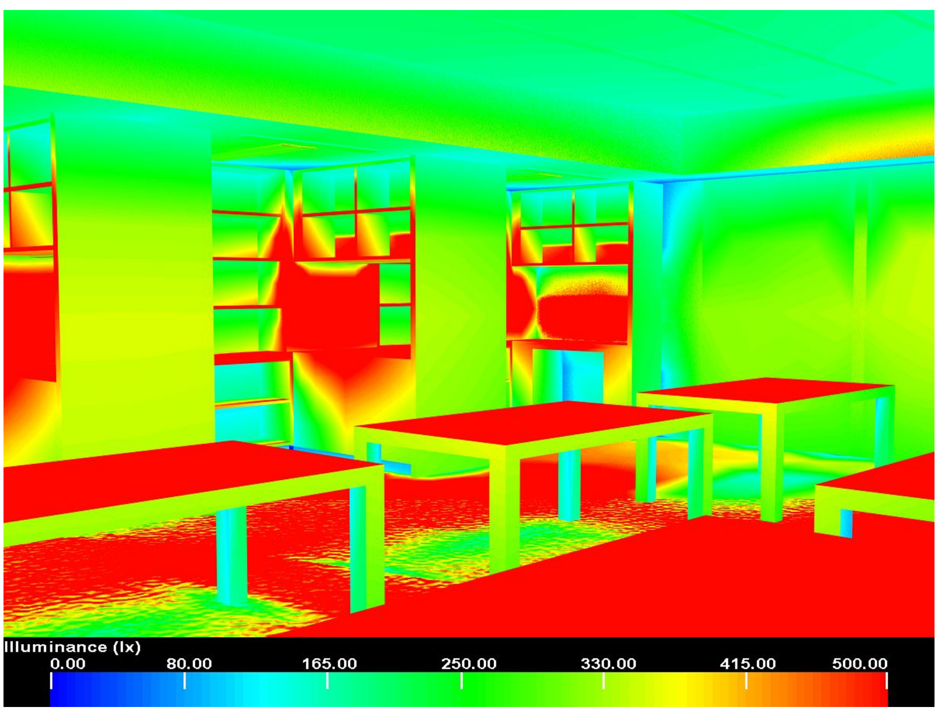


Figure 22: Library Pseudocolor Rendering

Figure 23: Library Rendering

Figure 24: Rendering of Library Ceiling

Figure 25: Rendering from Hallway to Library

Alternate Design: Equipment

This design will use diffuse indirect light to avoid visual clutter and distraction so that the focus can remain on the task of music and text reading. The lighting equipment specifications can be cross-referenced through Table 24: Alternate Library Lighting Specification Cross-Reference in Table 25: Alternate Library Luminaire Specifications, Table 26: Alternate Library Ballast Specifications, and Table 27: Alternate Library Lamp Specifications. The catalog pages for these products are provided in Appendix D: Alt. Library Lighting Equipment.

Image	Fixture Label	Type	Lamp	Lamp Quantity	Ballast	Fixture Quantity
	LF1ALT	Downlight	LL1ALT	1	LB1ALT	12
	LF2ALT	Wallwasher	LL2ALT	1	LB2ALT	24
	LF3ALT	Downlight	LL3ALT	1	LB3ALT	5

Table 24: Alternate Library Lighting Specification Cross-Reference

Fixture Label	Manufacturer	Catalog Number
LF1ALT	Prudential	SC-1T5HO-04-120
LF2ALT	Omega	S632PLT-U-T6WW-CS
LF3ALT	se'lux	M6R1-1T5-SD-RC-004-WH

Table 25: Alternate Library Luminaire Specifications

Ballast Label	Manufacturer	Catalog Number	Lamps	Input Watts	Ballast Factor
LB1ALT	Advance	ICN4S5490C2LS	2	118	0.99
LB2ALT	Advance	ICF-2S42-M2-BS	2	68	0.98
LB3ALT	Advance	ICN-132-MC	1	33	1.04

Table 26: Alternate Library Ballast Specifications

Lamp Type	Manufacturer	Catalog Number	Nominal Wattage	Initial Lumen Output
LL1ALT	Philips	F54T6/830/HO/ALTO	54	5000
LL2ALT	Sylvania	CF32DT/E/IN/830/ECO	32	2400
LL3ALT	Philips	F28T5/830/ALTO	28	2900

Table 27: Alternate Library Lamp Specifications

Alternate Design: Light Loss Factors

As with the original design,, I am assuming that it is a very clean environment with a twelve-month cleaning cycle. I am also assuming a cavity height of 8'-6" and a perimeter of 136’ to get a room cavity ratio of 1.85. These calculations are in table Table 28: Library Light Loss Factors.

Fixture Label	Ballast Factor	LLD	Luminaire Maintenance Category	LDD	RSDD	Total LLF
LF1ALT	0.99	0.95	VI	0.85	0.90	0.719
LF2ALT	0.98	0.95	IV	0.94	0.98	0.776
LF3ALT	1.04	0.95	V	0.93	0.98	0.900

Table 28: Library Light Loss Factors

Alternate Design: Power Density

The total number of watts available to be used was calculated in Table 22: Library Allowable Power Density. This design exceeds the allowed power by 225 watts. Since the tasks in this space require a higher level of illumination and because the other spaces throughout the building have been well below their allowed power densities, this is very justifiable.

Ballast Label	Lamps	Input Watts	Ballast Quantity	Watts per Ballast Type
LB1ALT	2	118	12	1416
LB2ALT	2	68	12	816
LB3ALT	1	33	5	165
			TOTAL	**2397**

Table 29: Library Designed Power Density

Alternate Design: Luminaire Locations and Controls

The alternate design uses a T5HO cove system to light the reading area. Each three-sided bookshelf alcove is lit with six compact fluorescent wallwashers, two facing each shelf. The alternate luminaire locations are given in Figure 19: Library Luminaire Locations. The section mounting detail of fixture type LF3 above the inspection tables, and within the millwork, is given in Figure 20: LF3 Mounting Location. Controls for the general illumination system would be located at both doors to the library. Individual controls for the inspection tables would be located at each table. Please see the Electrical Depth section for additional control and circuiting information.

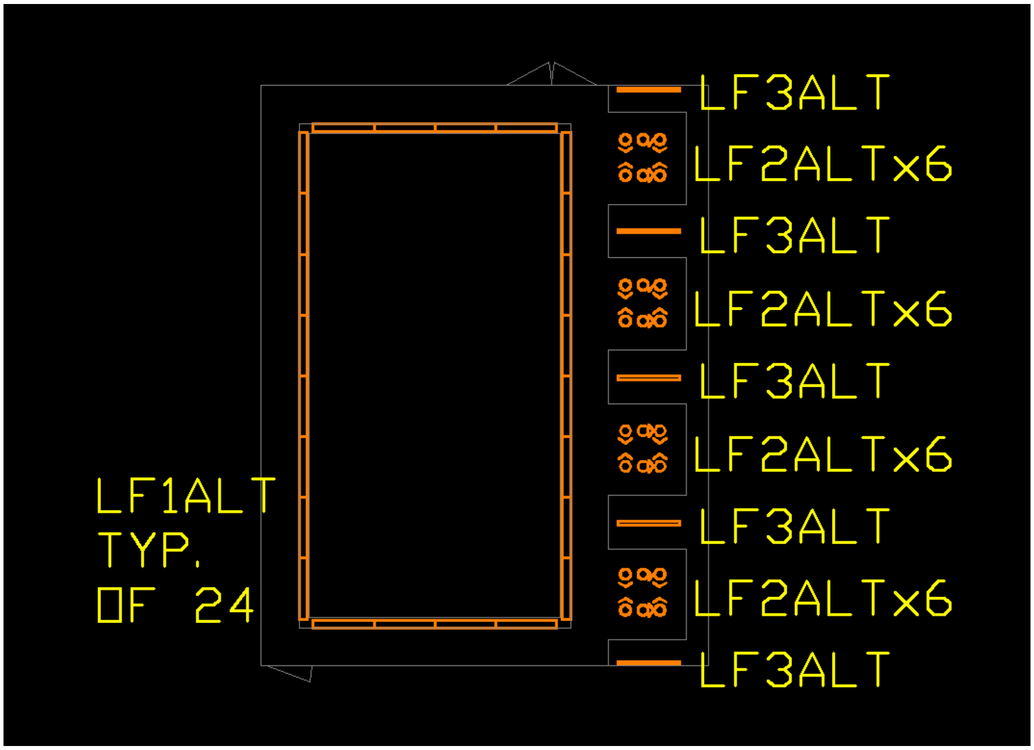


Figure 26: Alternate Library Luminaire Locations

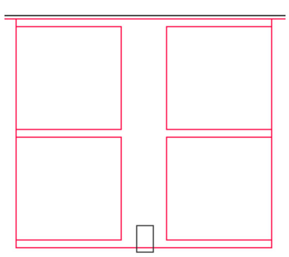


Figure 27: LF3 Mounting Location

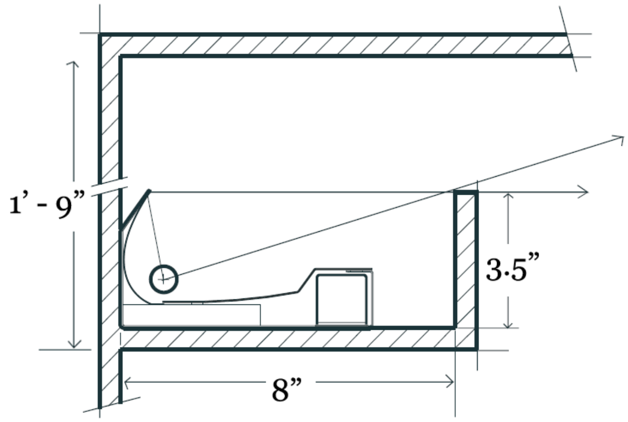


Figure 28: LL1ALT Cove Construction Detail

System Performance

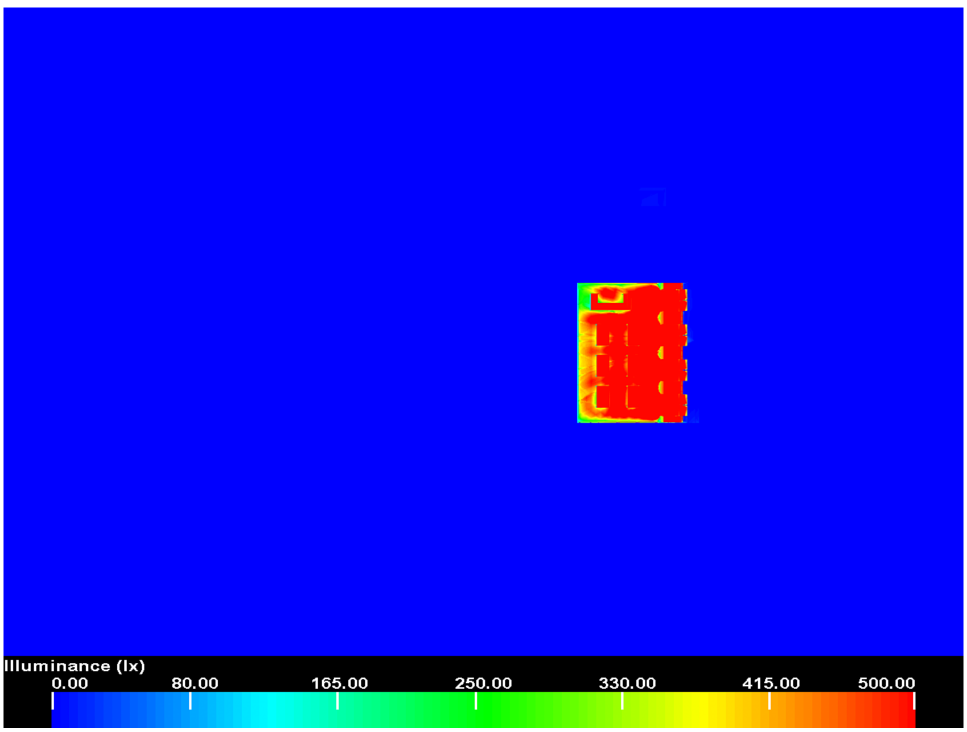


Figure 29: Library Alternate Horizontal Illumination

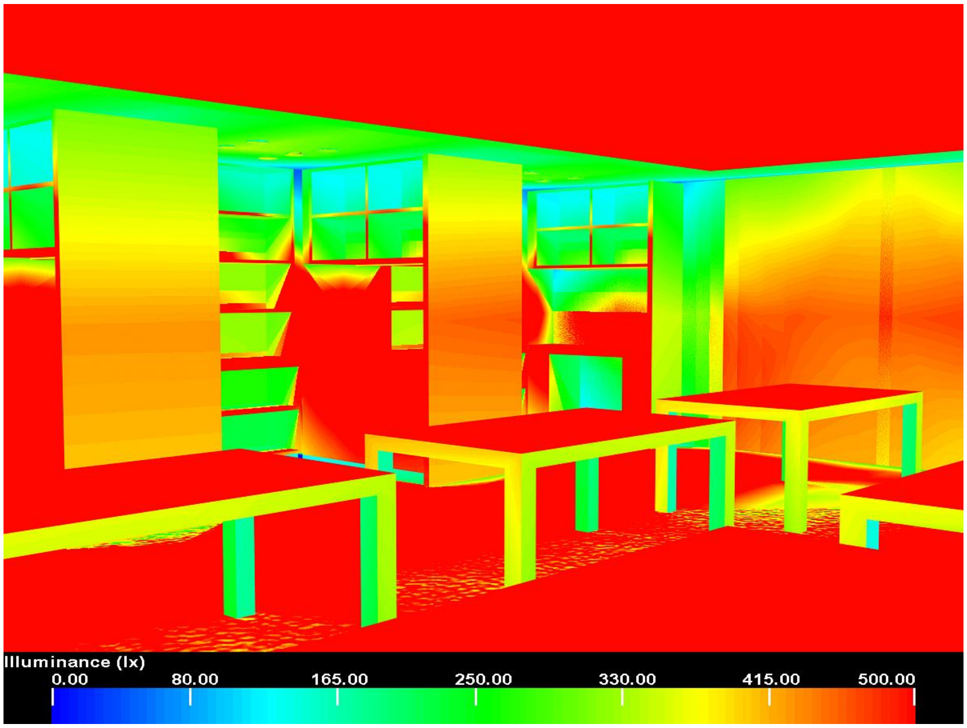


Figure 30: Library Alternate Pseudocolor Rendering

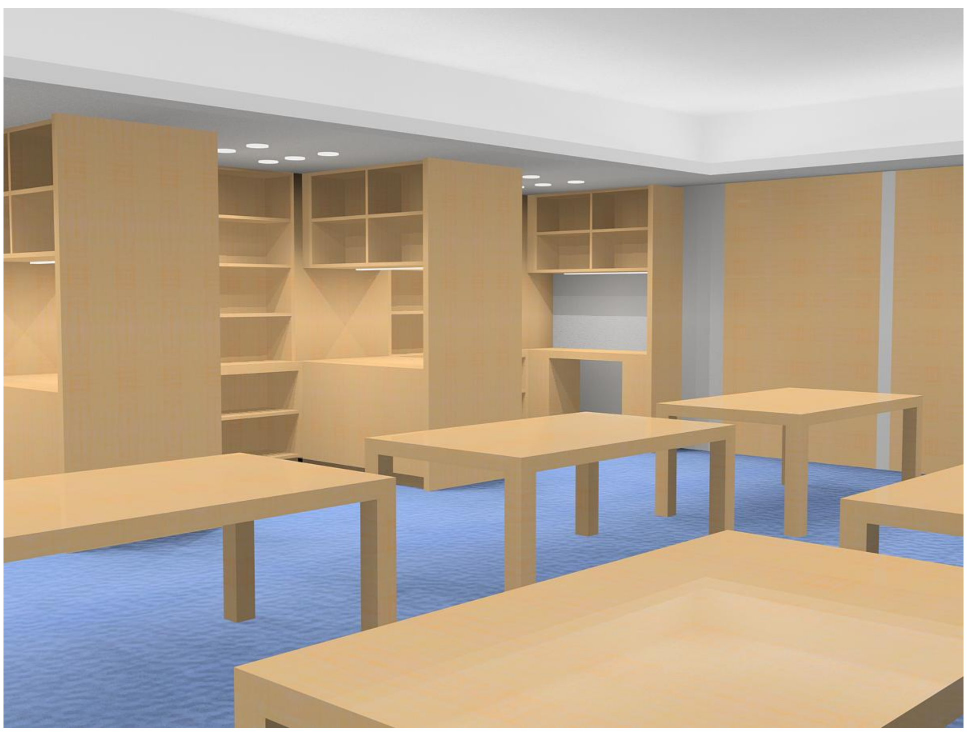


Figure 31: Library Alternate Rendering

Figure 32: Rendering of Library Alternate Ceiling

Figure 33: Rendering from Hallway to Library Alternate

Conclusions

Both of these lighting schemes meet the design goals of the space. In each design, the horizontal illuminance values on the desks peaks at about 700 lux, and the minimum is above 500 lux. Since both designs have approximately the same performance, I am partial to the first design because it uses fewer watts than the second design.

ROOF TERRACE LIGHTING DEPTH

Design Intent

The Roof Terrace will be a flexible space used for concerts, classes, special events, and as a general gathering space. The Pergola that I have designed in my Architectural Breadth will play host to a small outdoor venue for intimate concerts as well as a performance area for nighttime events. Because the lights in this space would typically only be used at night, even illumination in this area will end up being more important than the quantity of illumination. This is due to the adaptability of the eye to low light levels and the responsibility of minimizing light pollution.

I propose to illuminate the space from the columns located throughout the space. The columns on the Pergola create a location to mount lights in the center of the space, and the columns around the space provide additional mounting positions. This scheme would create an even illumination around the Pergola as well as creating a virtual wall of light around the Pergola to create a more intimate experience. Additional lighting will be used in a theatrical manner to light the stage.

Design Criteria

The IESNA recommended illuminance values for a space like this are 50 lux horizontally and vertically. The lighting of the stage area will need to be higher than this, but its level will vary depending on the amount of light borrowed from the spaces around the Roof Terrace. The general illumination will need to be able to be adjusted as well for this same reason.

A summary of the assumed reflectances for this space are given in Table 30: Roof Terrace Reflectances.

Surface	Assumed Reflectance
Limestone	0.50
Glass	0.10
Concrete	0.40
Metal	0.40

Table 30: Roof Terrace Reflectances

Equipment

The lighting equipment specifications can be cross-referenced through Table 31: Library Lighting Specification Cross-Reference in Table 32: Library Luminaire Specifications, Table 33: Library Ballast Specifications, and Table 34: Library Lamp Specifications. The catalog pages for these products are provided in Appendix E: Roof Terrace Lighting Equipment.

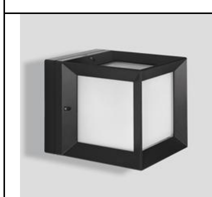
Image	Fixture Label	Type	Lamp	Lamp Quantity	Ballast/ Transformer	Fixture Quantity
	TF1	Sconce	TL1	1	TB1	40
	TF2	Accent	TL2	2	TX1	8

Table 31: Library Lighting Specification Cross-Reference

Fixture Label	Manufacturer	Catalog Number
TF1	se'lux	M6R1S-1T5-OD-RC-008
TF2	Focal Point	FAVA-RL-1T5HO-1C

Table 32: Library Luminaire Specifications

Ballast/ Transfomer Label	Manufacturer	Catalog Number	Lamps	Input Watts	Ballast Factor
TB1	Advance	2639P-BK	1	49	1.00
TX1	BK Lighting	TWS-BK-GG	N/A	300	1.00

Table 33: Library Ballast Specifications

Lamp Type	Manufacturer	Catalog Number	Nominal Wattage	Initial Lumen Output
TL1	Sylvania	CF42DT/E/IN/830/ECO	28	3200
TL2	GE	Q37MR16/HIR/CG40	54	N/A

Table 34: Library Lamp Specifications

Light Loss Factors

Fixture Label	Ballast Factor	LLD	Luminaire Maintenance Category	Assumed Dirt Depreciation	Total LLF
TF1	1.00	0.86	V	0.77	0.662
TF2	1.00	0.97	IV	0.73	0.708

Table 35: Roof Terrace Light Loss Factors

Power Density

As with the power density of the Building Entrance the exterior lighting power density according to ASHRAE 90.1-2004 varies according to what objects are being lit. The total number of watts available to be used is calculated in Table 36: Building Entrance Allowable Power Density. The power used in my design is calculated in Table 37: Building Entrance Designed Power Density. Since the TF2 fixtures are used for theatrical purposes and will be controlled separately from the TF1 fixtures, they do not count toward the allowed wattage in this space.

Item Description	Measurement	Allowable Power Density	Allowed Wattage (w)
Plaza	1332 ft^2	.20 W/ft^2	866.4
Secondary Entrances	46 ft	20 W/ft	920
Canopy (Pergola)	480 ft^2	1.25 W/ft^2	600
		Subtotal	**2386.4**
		Multiplier	x 1.05
		TOTAL	**2506**

Table 36: Building Entrance Allowable Power Density

Ballast/ Transformer Label	Lamps	Input Watts	Ballast Quantity	Watts per Ballast Type
TB1	1	49	28	1372
			TOTAL	**1372**

Table 37: Building Entrance Designed Power Density

Luminaire Locations and Controls

Since fixture TF1 protrudes more than 4" from the wall, it must be mounted at least 7'-6" off of the ground. All of the fixtures in this space will be dimmable. The controls for these fixtures will be located in the teacher's lounge which is adjacent to the roof terrace. Since this system is not integrated with the theatrical control system throughout the rest of the building, a simpler control system was used. For this space, the fluorescent lighting will be controlled by Leviton 26666-31 controls, and the low-voltage incandescent will be controlled by a Leviton 71511 control. Please see the Electrical Depth section for additional control and circuiting information.

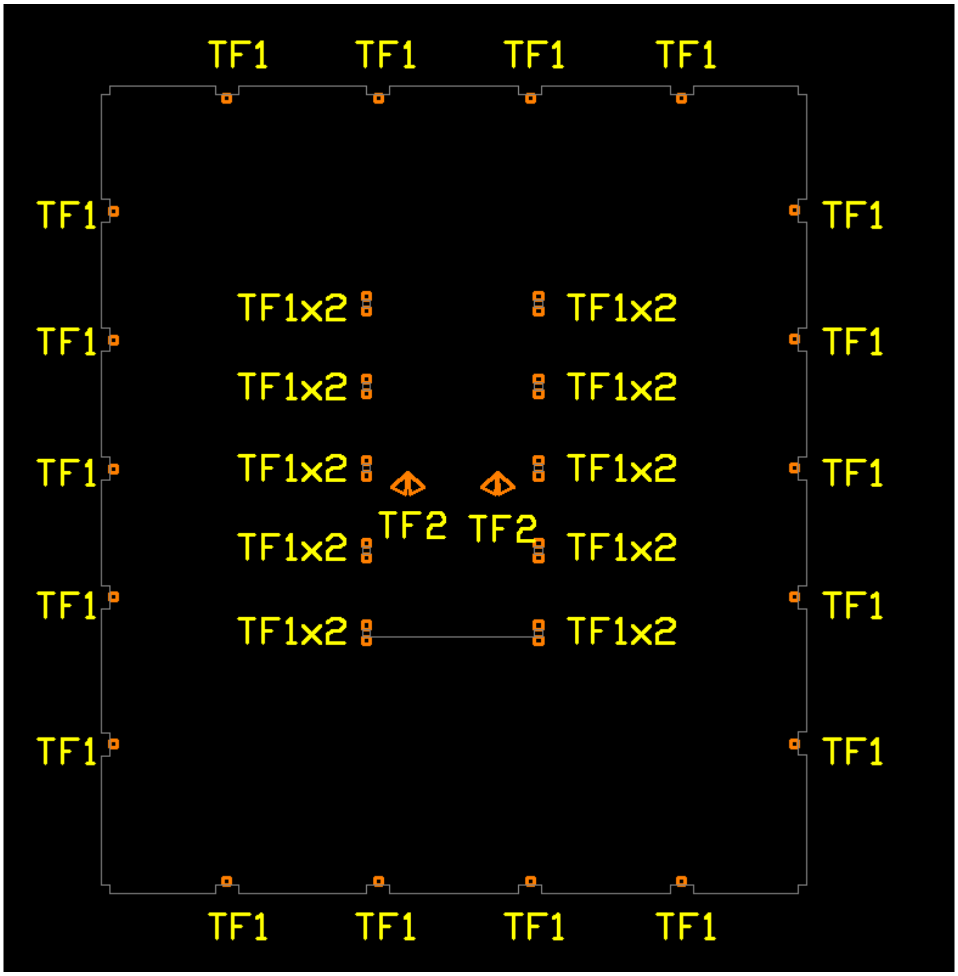


Figure 34: Roof Terrace Luminaire Layout

System Performance

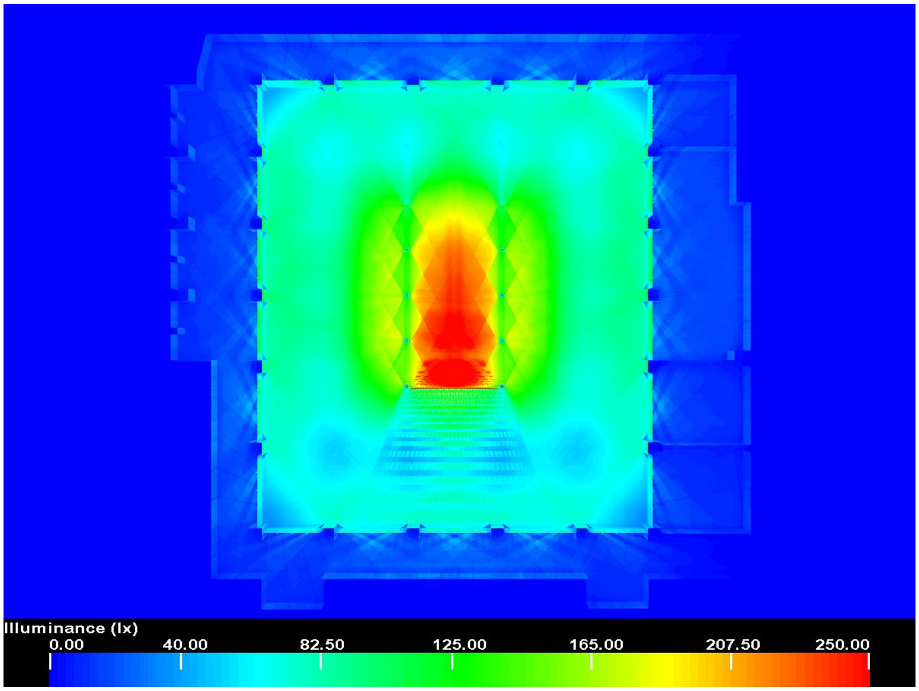


Figure 35: Roof Terrace Horizontal Illuminance

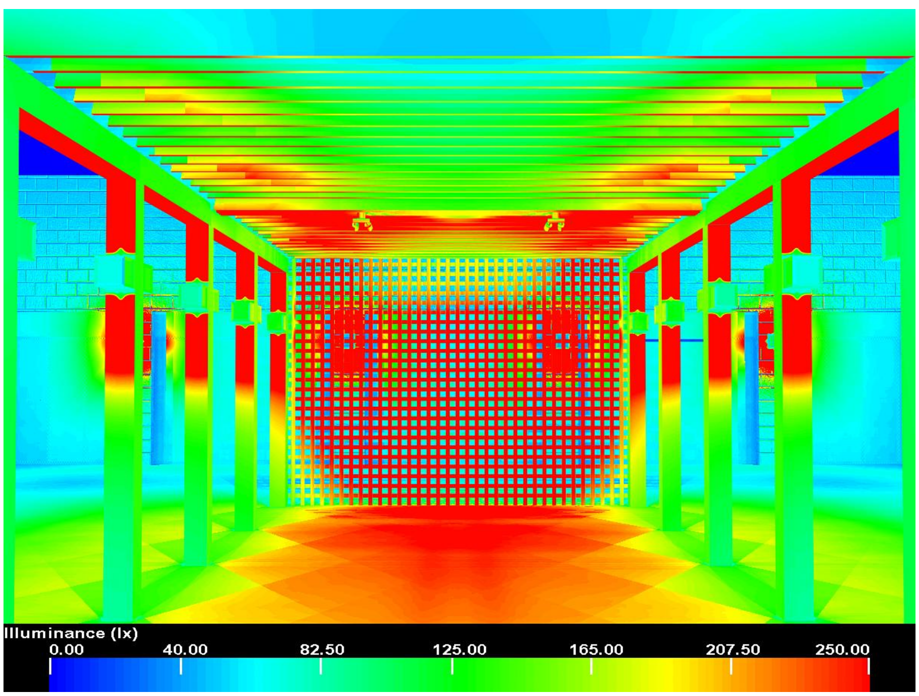


Figure 36: Pseudocolor Rendering of Roof Terrace Pergola Stage Area

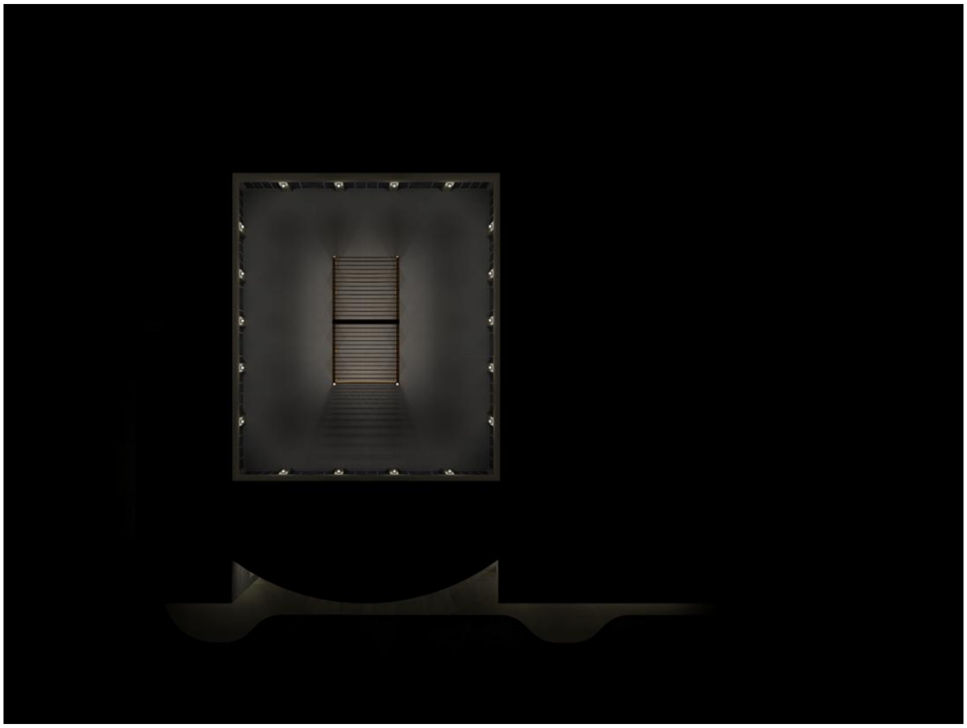


Figure 37: Rendering of Roof Terrace from Above

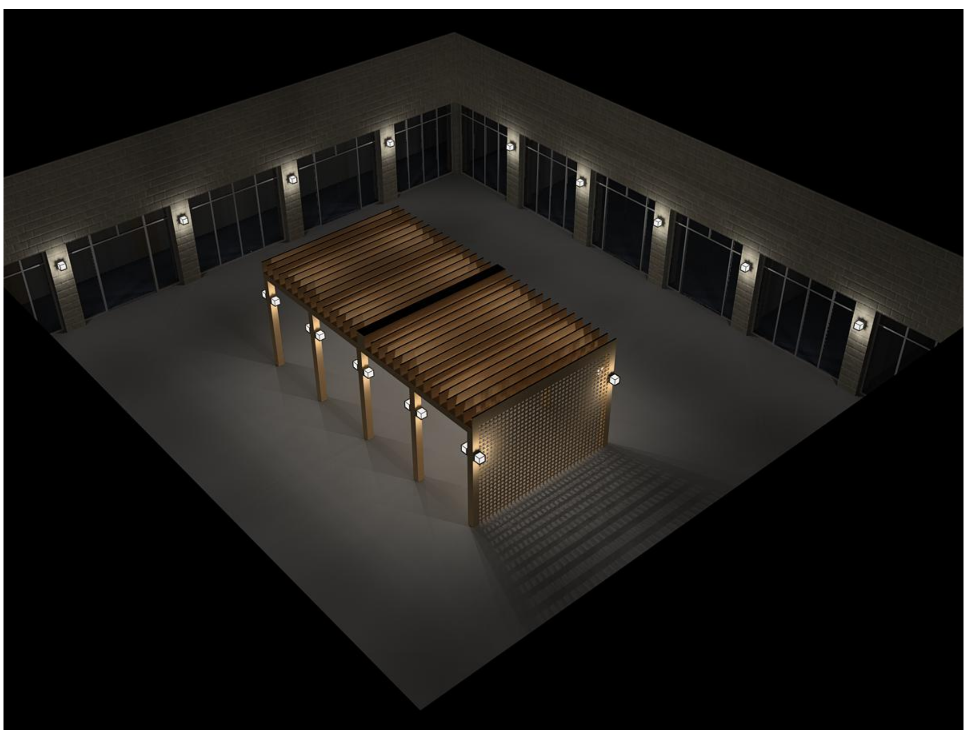


Figure 38: Rendering of Roof Terrace

Figure 39: Rendering of Roof Terrace Pergola

Figure 40: Rendering of Roof Terrace Pergola Stage Area

Conclusions

The quality of the Roof Terrace lighting is enhanced by the availability of the Pergola for mounting luminaires. Without light sources in the central portion of the space, the illuminances in the center of space would drop significantly. This design does emit some uplight to the sky, in this case it is used to accent the vertical members of the space and the top members of the Pergola. The architect and the owner should consider customizing the fixture with a reflective coating on the inside of the top lens so that less uplight is emitted upwards on the fixtures with a direct view of the sky.