Gateway Community College

New Haven, CT

Bradley Sisenwain Lighting/Electrical Option

Introduction

Location:

New Haven, CT

Lat: 41° 19' N

Long: 73° 55' W

Two blocks on Church St. between Frontage Rd., George St., and Crown St.

Introduction

Occupancy or function types:
Educational (E)
Size (total square feet):
369,000 SF
Architects:
Perkins & Will
Dates of construction:
2009 – 2012
Actual cost information:
$147 Million

Introduction

Topics to be presented . . .

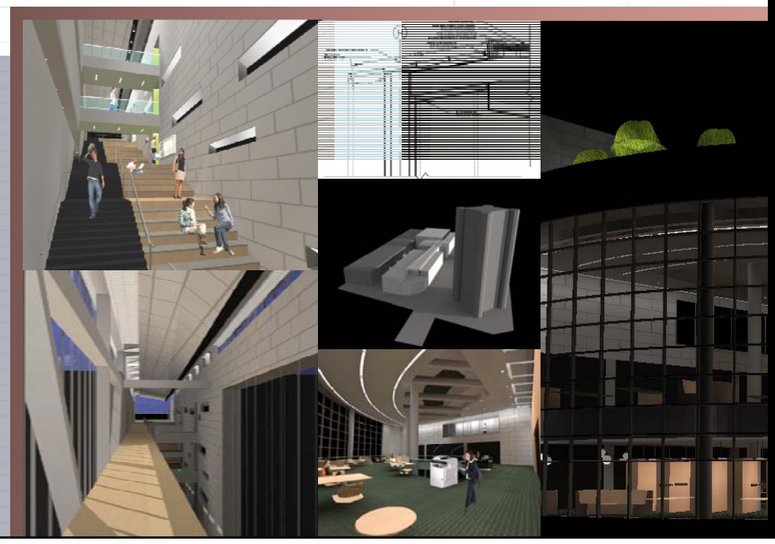
Lighting analyses—
- Library
- Roof Garden
- Student Gathering

Architectural analyses—skylight integration

Mechanical Analyses—cooling load from daylighting

Structural Analyses—skylight structures

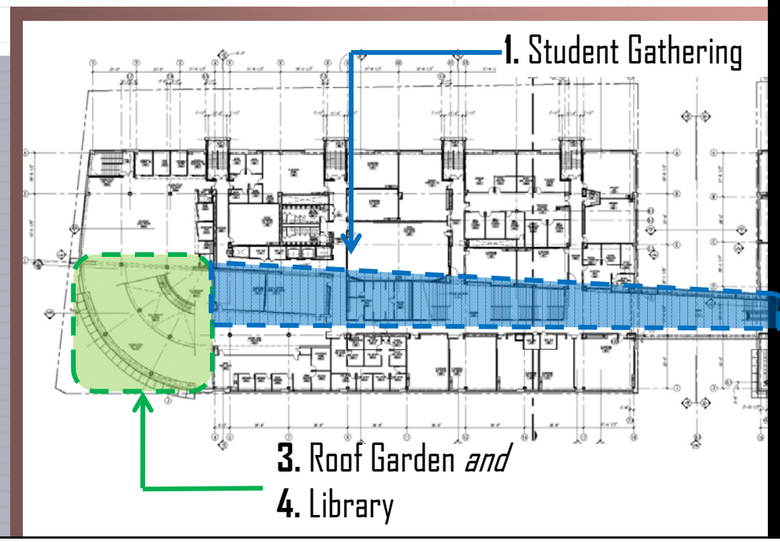
Electrical analysis—photovoltaic analysis



Lighting Depths | Student Gathering

Three Lighted Spaces:

- Student Gathering
- Roof Garden
- Library



Lighting Depths | Student Gathering

Architectural Concept:

P+W's "Interior Street"

Lighting Intent:

To support architecture through connecting occupant to outdoors through imagery and daylight integration

Recommendations and Code:

20-25fc Horz - 5-10fc Vert (IESNA)

1.3 W/ft^2 (ASHRAE std. 90.1 for Multi-use)

View south-west

Lighting Depths | Student Gathering

Lighting Implementation:

Task: Downlighting and localized luminaires in handrail.

Design Concept: Wash on "white wall," repetitious organization of luminaires, higher luminances at openings to guide occupants, and LED in window-boxes mimic motion of light outside.

View south-west

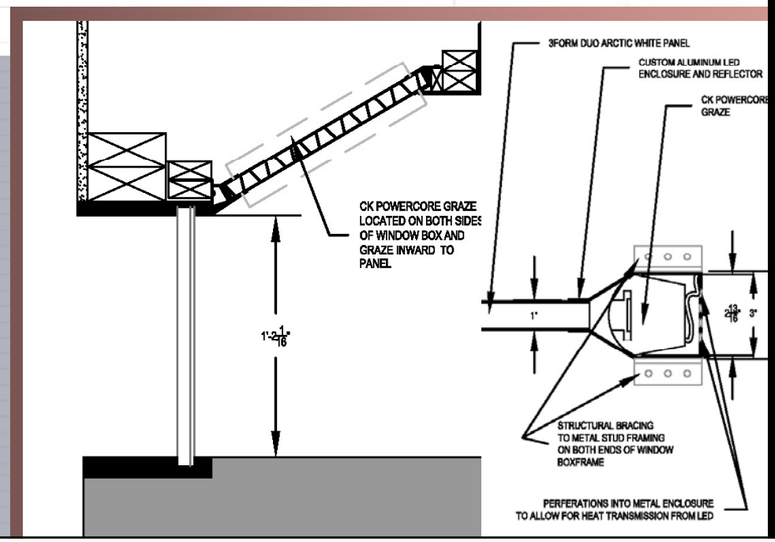
Lighting Depths | Student Gathering

Lighting Implementation:

To create light motion, a custom luminaire was designed using the Color Kinetic Powercore Graze.

This was placed in window boxes.

The roof of the boxes were then slanted to prevent stray light into bordering classrooms.



Lighting Depths | Student Gathering

Lighting Implementation:

View South

View North

Lighting Depths | Student Gathering

Target Illuminance Level Values:

10fc for 1st and 4th floors

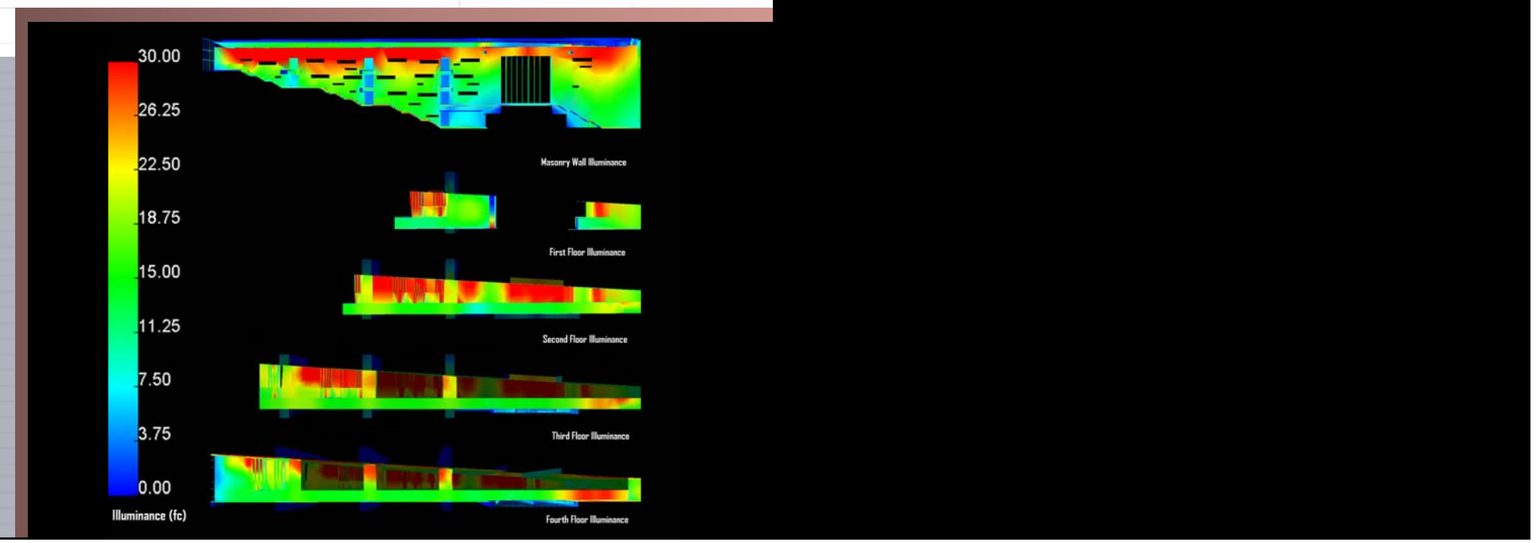
20-25fc for other floors

Illuminance Value for Passage (fc) →
Criteria: 20-25fc average 30" A.F.F.
Criteria: 10fc average on ground-plane

FLOOR	AVG
1	15.82 ✓
2 (bridge)	26.29 ✓
3	25.11 ✓
4	13.26 ✓
Meets Criteria?	YES

Illuminance Values for Face-to-face interaction (fc) →
Criteria: .5-10fc Vertical

FLOOR	AVG
1	8.82 ✓
2	13.05 ✓
3	12.05 ✓
4	5.73 ✓
Meets Criteria?	YES



Lighting Depths | Student Gathering

Lighting Power Density: PASSED

Allowable watts/ft^2 = **1.3**

Actual watts/ft^2 = **1.19**

View south-west

Architectural Breadth

Daylighting within SG:

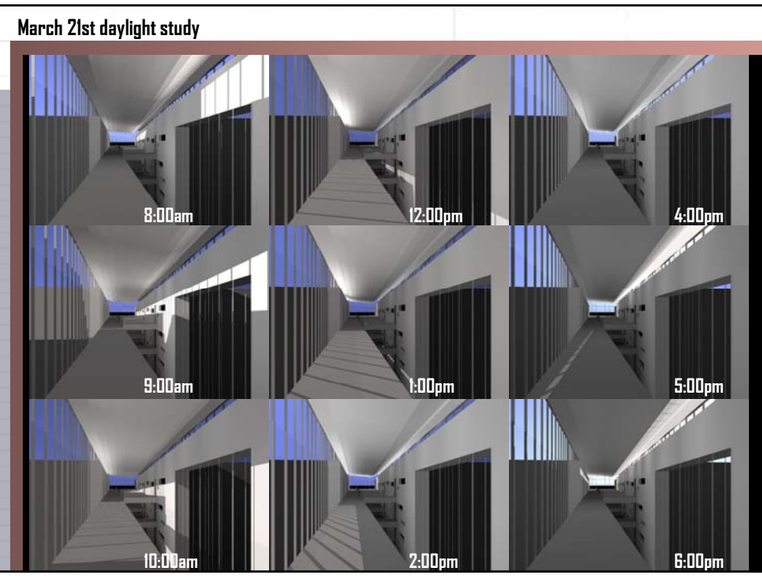
Original design:

Clerestories above fourth level

Curtain walls on east and west sides of walkway bridge

Assumed Properties:

Clerestory glass - .7% trans
East bridge glass - .623% trans
West bridge glass - .23% tans.



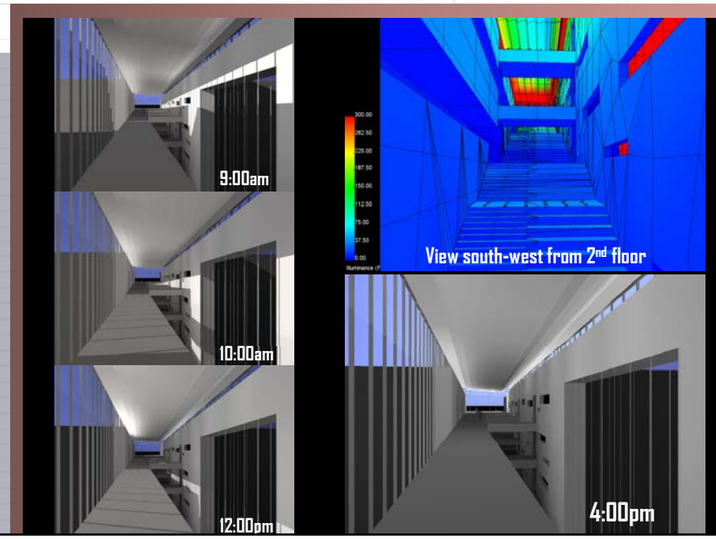
Architectural Breadth

Reflection:

- Distraction in classrooms during hours of occupation
- Unbalanced and illuminance levels
- Penetration is minimal during afternoon hours

Redesign Goals

- Lower overall illuminance level
- Reduce light entering classrooms
- Increase the light deeper in space



Architectural Breadth

Implementation:

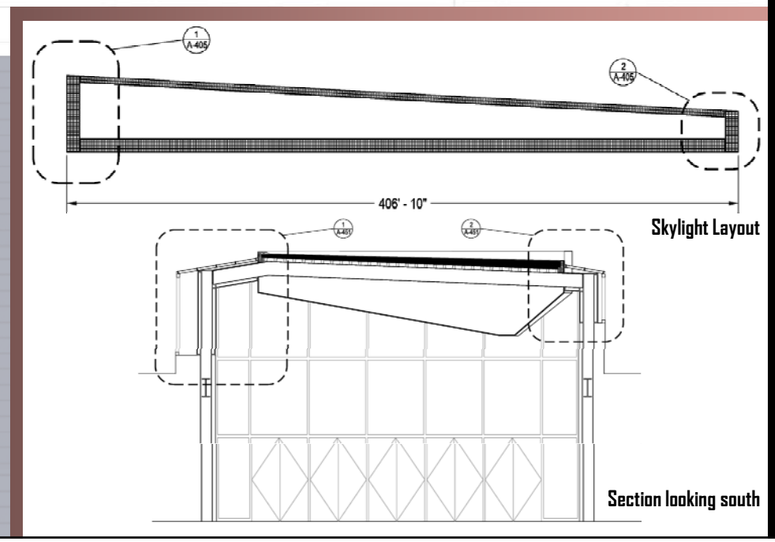
- Lower clerestory transmittances

	Original Glass	Changed
GL-1	Transmittance: .7, SGH Coef:.38	Transmittance: .51, SGH Coef:.25
GL-1A+B	Transmittance: .623, SGH Coef: .31	Transmittance: .454, SGH Coef: .25
GL-2A+B	Transmittance: .23, SGH Coef: .25	Transmittance: .18, SGH Coef: .25

Architectural Breadth

Implementation:

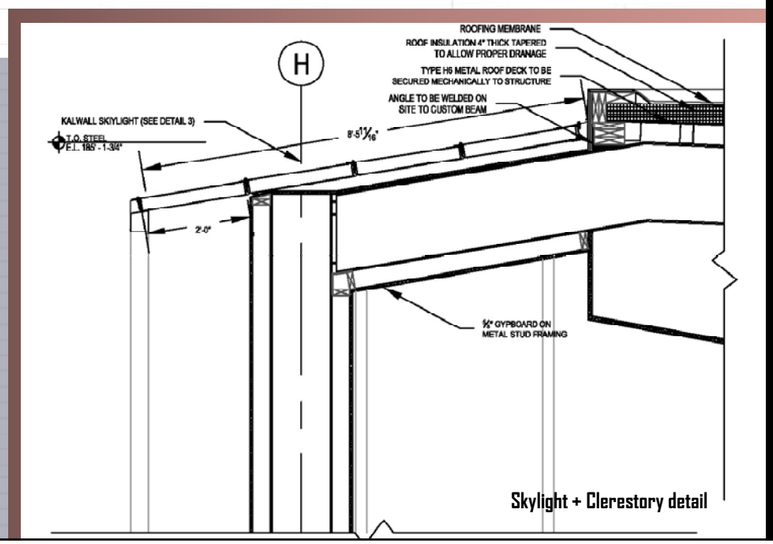
- Skylight addition



Architectural Breadth

Implementation:

- Skylight Addition

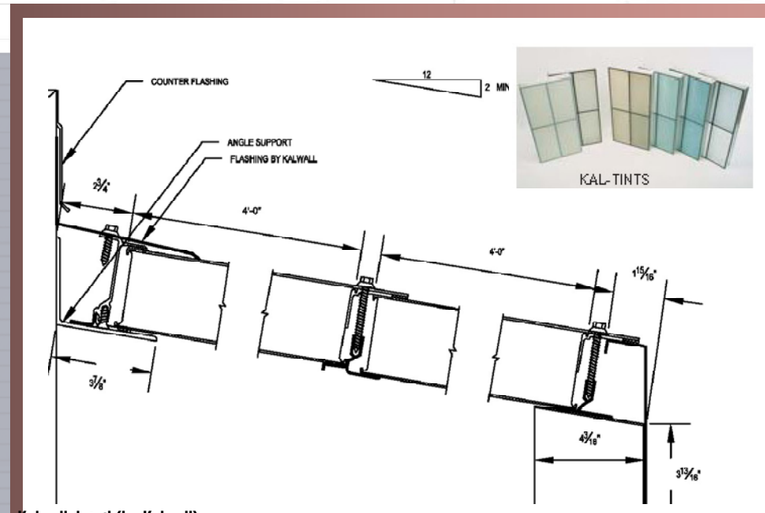


Skylight + Clerestory detail

Architectural Breadth

Implementation:

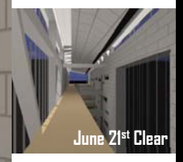
- Skylight Addition



Kalwall detail (by Kalwall)

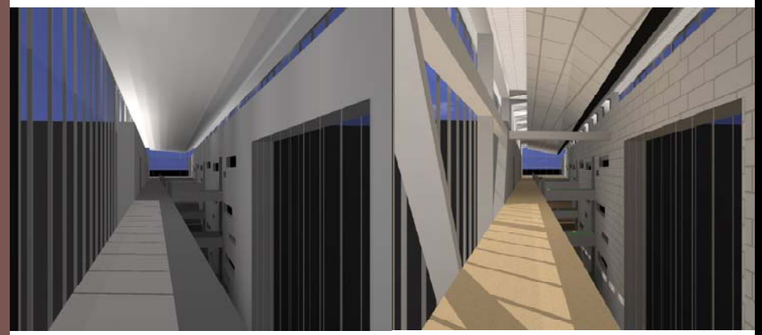
Architectural Breadth

Interior view



Architectural Breadth

Interior comparisons

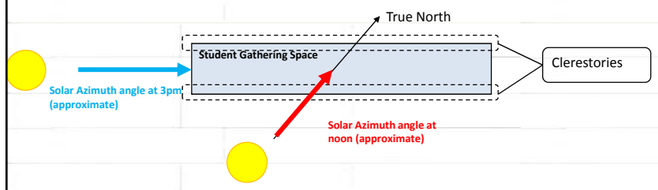


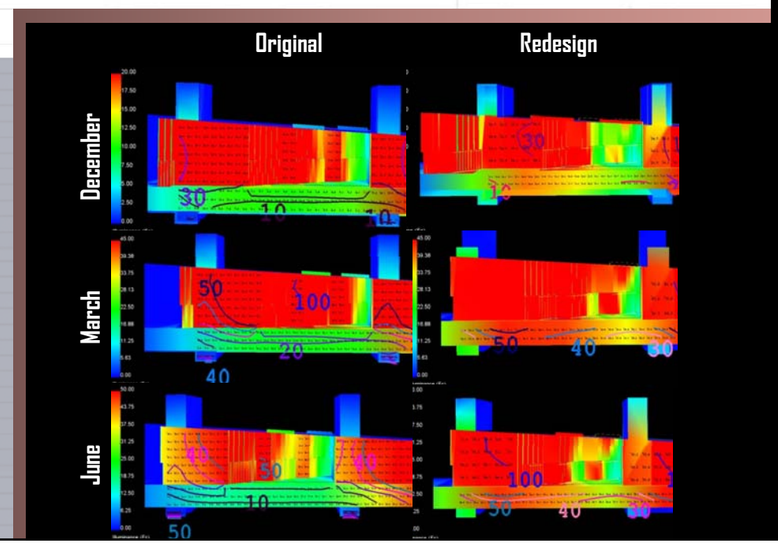
Original Design

Redesign

Architectural Breadth

Advantage: higher illuminance levels in lower floors





Mechanical Breadth

Negative implications:

Possible cooling load increase

Atrium Roof Area (Replaced)

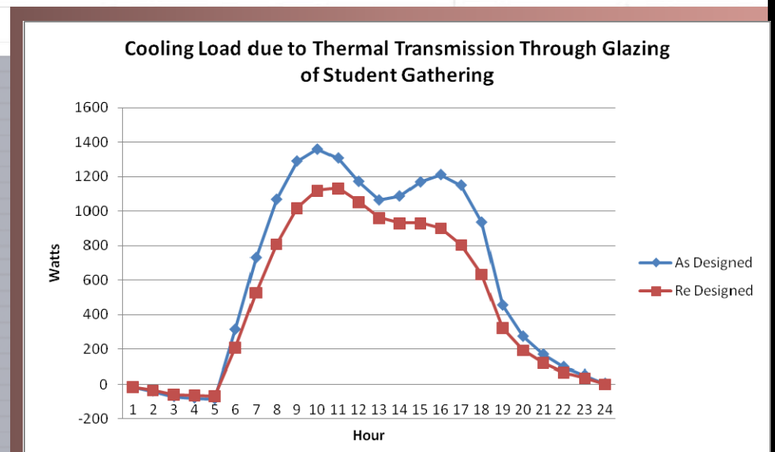
Total Area (ft²)	U	
5258	0.283723	W/m²·°C
	ASHRAE PG 23 (25)	

Atrium Clerestory Glazing Area As Designed

Glazing Type	Façade Direction	Total Area (ft²)	SHGC	U	SC
GL-1	1	3433	0.38	1.55	0.44
GL-1	3	1847	0.38	1.55	0.44
GL-1	2	378	0.38	1.55	0.44
GL-1A+B	1	3507	0.31	1.55	0.4532
GL-1A+B	2	729	0.31	1.55	0.4532
GL-2A+B and GL-INT	3	1873	0.051076	1.55	0.4532

Atrium Clerestory Glazing Area Re Designed

Glazing Type	Façade Direction	Total Area (ft²)	SHGC	U	SC
GL-1	1	3433	0.25	1.220893411	0.2875
GL-1	3	1847	0.25	1.220893411	0.2875
GL-1	2	378	0.25	1.220893411	0.2875
GL-1A+B	1	3507	0.25	1.220893411	0.2875
GL-1A+B	2	729	0.25	1.220893411	0.2875
GL-2A+B and GL-INT	3	1873	0.051076	1.55	0.0587374
Kalwall	5	5258.00	0.09	0.283723	0.10335



Cooling load comparison follows AHSRAE guidelines from chapter 28.

Mechanical Breadth

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Possible cooling load increase

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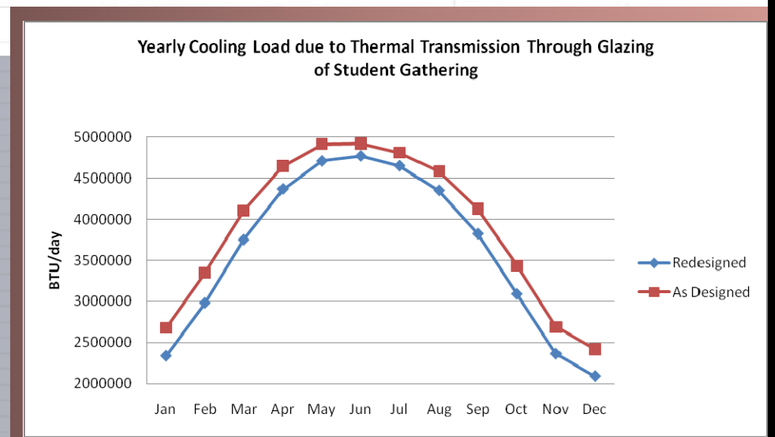


Cooling load comparison with yearly weather data from National Renewable Energy Laboratory

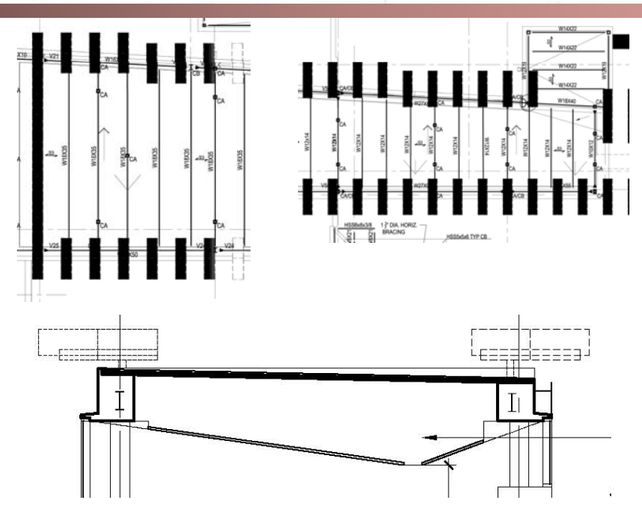
Structural Breadth

Other negative implications:

- Original structural layout may block new skylight
- Various sizes due to tapering roof
- Beam spacing O.C.: 6'

Solution:

- Relocate PV panels and increase member spacing
- Desired Spacing O.C 18'



Structural Breadth

PSF	(sw of deck)		(roof load)	Total lb/ft
1.2		4.5	1.6	20	685.6667
				=[1.2(DL)+1.6(LL)]*Span(f

Span	ft		in	
		18.33333	220	

Lmax	
	35.55

Mu	moment	simple		
	72.21227	108.318	←	Moment Con.= (lb/ft)*(L^2)/(12*1000)
				Simple Con.= (lb/ft)*(L^2)/(8x1000)

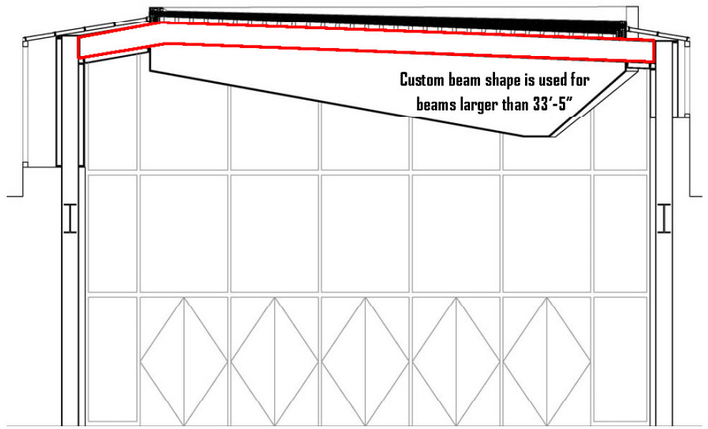
Vu		
12.18773	←	Vu.= (lb/ft)*(L)/(2x1000)

Δ	moment	simple	Pass?	Δ	live	total
live	0.016468	0.08233	PASS		l/360	l/240
total	0.020173	0.10086	PASS		1.18	1.777

Δ live =LL*(L^4)*12^3*/(384*29000*I) =5*LL*(L^4)*12^3*/(384*29000*I) *I is given in table below*

Δ total =(DL+LL)*(L^4)*2^3*/(384*29000*I) =(DL+LL)*(L^4)*2^3*/(384*29000*I) *I is given in table below*

Beam Size	W16x26



Structural Breadth

Outcomes:

- Beam spacing O.C.: 18'
- Similar sizes to original but spaced further, decreasing amount and total weight of steel

Original					Redesign				
Beam Type	#	Avg Length (ft)	Beam lbs/ft	Weight	Beam Type	#	Length (ft)	Beam lbs/ft	Weight
W18x35	14	38.315	35	18774.35	**W18x35**	5	38.315	35	6705.125
W16x31	5	35.6	31	5518	**W16x26**	7	26	26	4732
W16x26	14	32.04	26	11662.56	**W14x22**	6	28.61	22	3776.52
W14*22	7	28.61	22	4405.94	**W12x19**	4	27.065	19	2056.94
W12x19	2	27.065	19	1028.47					
W12x16	4	26.805	16	1715.52					
W12x14	19	23.715	14	6308.19					
			Total	**49413.03**				**Total**	**17270.585**

Electrical Depth

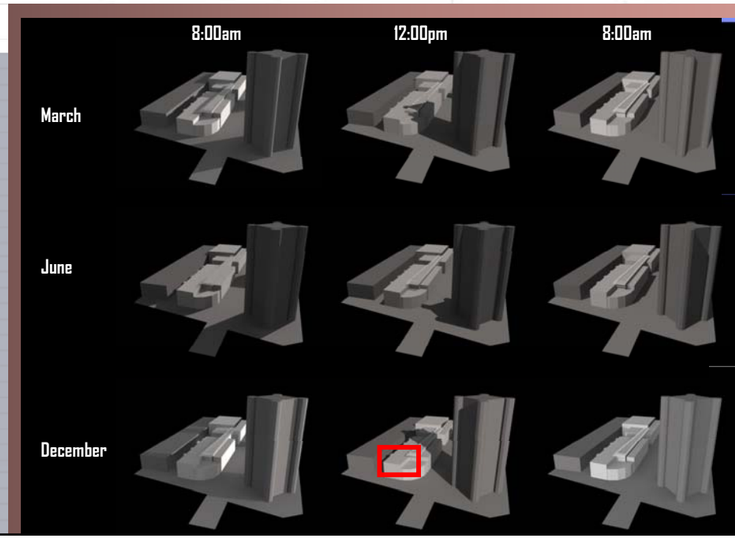
Photovoltaic Panel Analysis

Original Design: 448 Sanyo HIT 190 bifacial PVs specified for GCC, mounted to SG roof.

Moving not just based on skylight, but potential shading of PVs during each month.

I recommend switching to a membrane product, without need for steel support, that can act as roofing membrane.

New location marked by red rectangle.



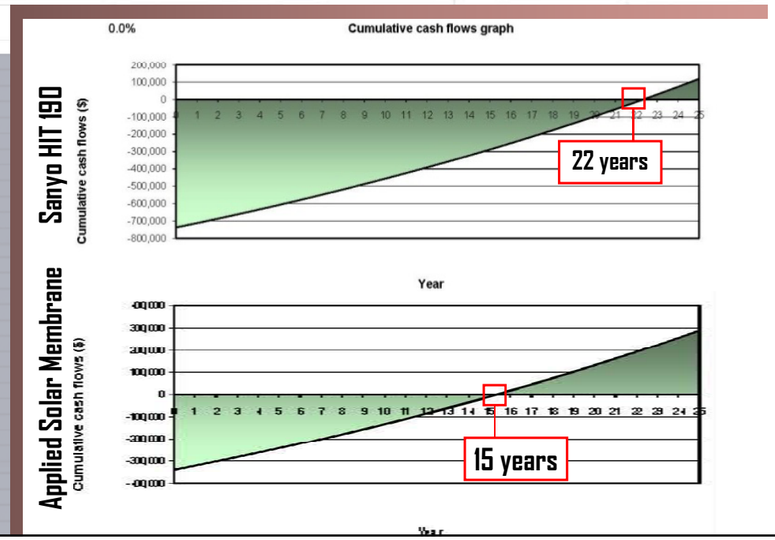
Electrical Depth

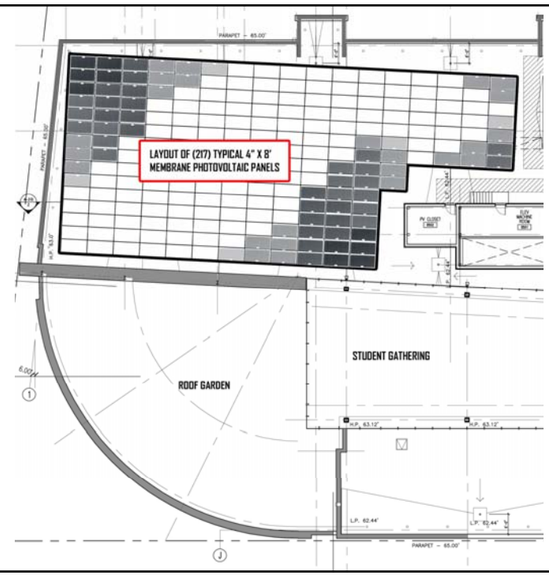
Comparison:

448 Sanyo HIT 190, to **217** Applied Solar Membrane
Sanyo yearly production: $24,467
Applied Solar yearly production: $17,995
After 25 years, Applied Solar produced $300,000 while Sanyo produced $100,000; to catch up with AS, Sanyo would take around 56 years proven by this equation:

$200,000 +$17,995(X) = $24,467(X)
X = $200,000/($24,467 - $17,995)
X = 31

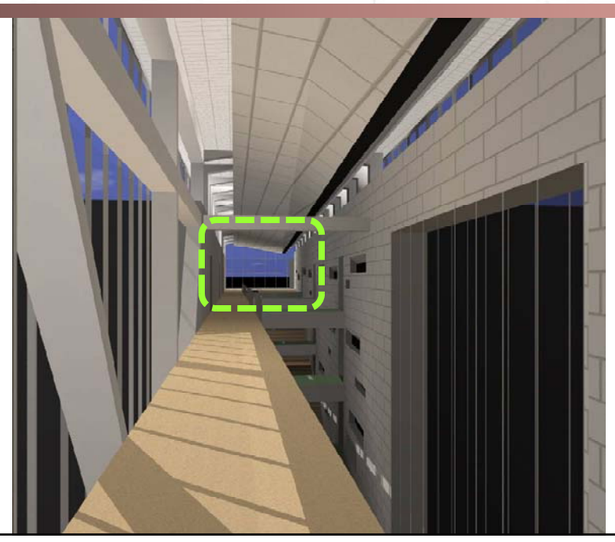
Total comparison payback time = 25 +31 = **56**





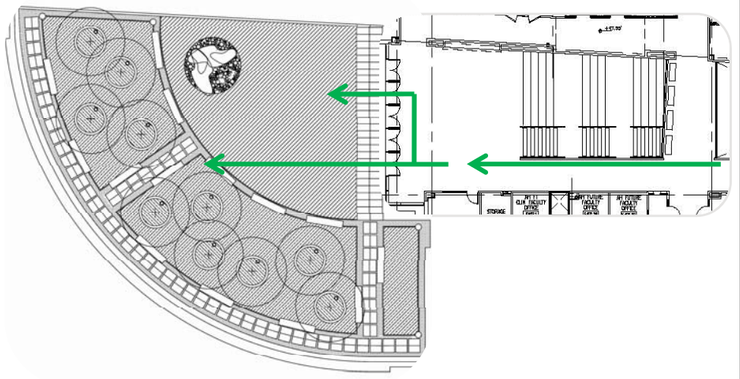
Lighting Depths | Roof Garden

Interior view towards Roof Garden



Lighting Depths | Roof Garden

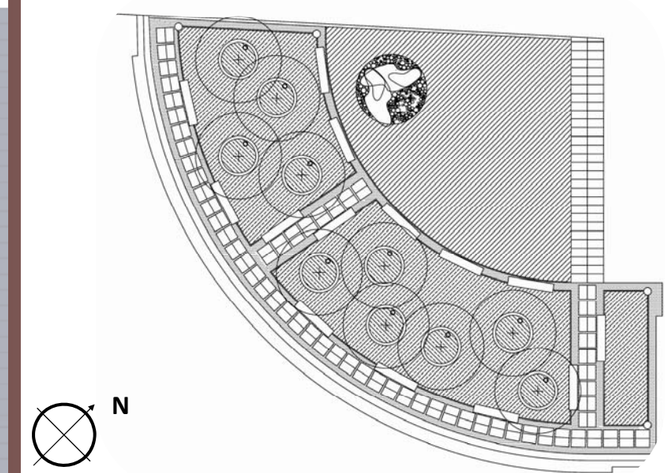
Connection from Student Gathering to Roof Garden



Lighting Depths | Roof Garden

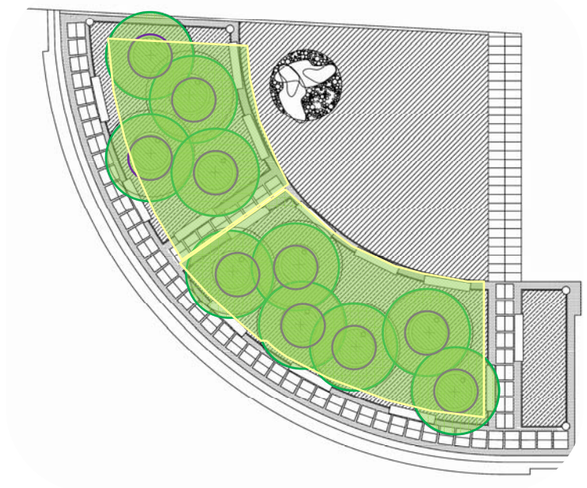
Features:

- Main wood deck outside SG
- Surrounding paver path
- Recessed Gras and Planter area



Lighting Depths | Roof Garden

Roof Garden Planting



Lighting Depths | Roof Garden

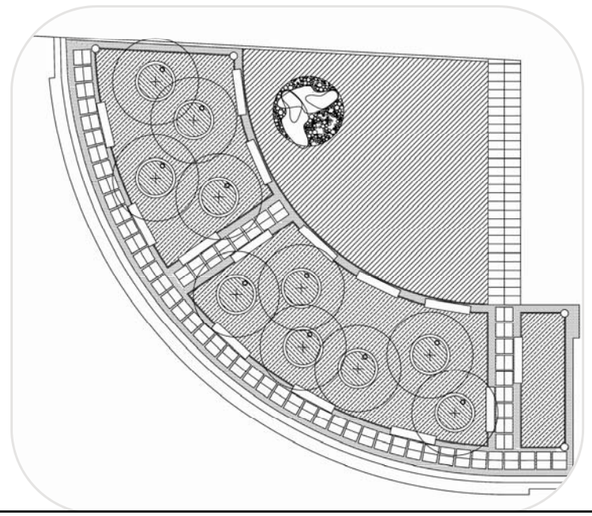
Lighting Intent:

To limit exterior lighting and create a subdued mood.

Recommendations and Code:

.5 fc Horz – 1 fc Vert (IESNA RP-33)

Total allowable (tradable) watts/ft^2 = .25. (per ASHRAE std. 90.1 plazas, walks <10', and building facades)



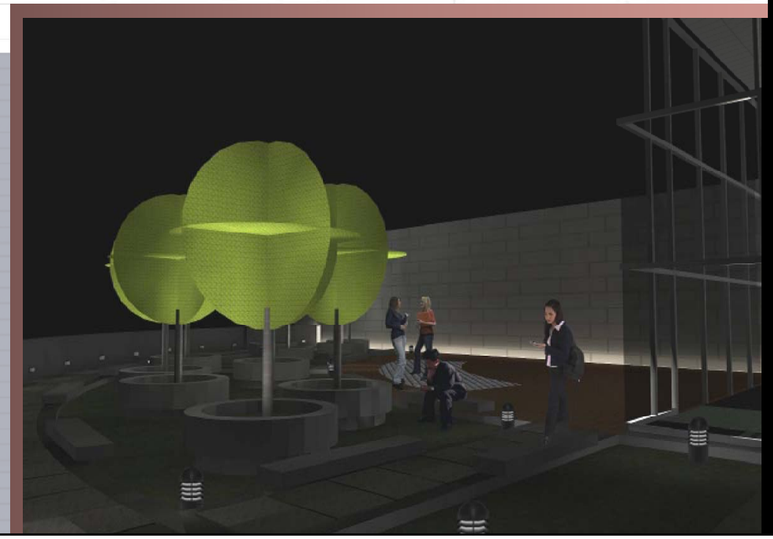
Lighting Depths | Roof Garden

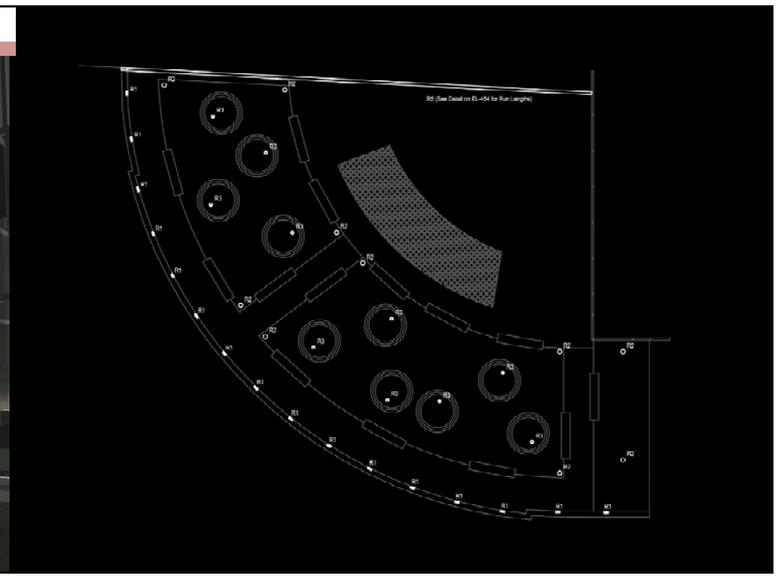
Lighting Implementation:

Luminaires placed lower to ground to limit wattage and light trespass and light pollution.

Louvered apertures are used to limit luminances of luminaires and maintain lower luminances on roof

Trees are the highest luminance to draw attention inward.



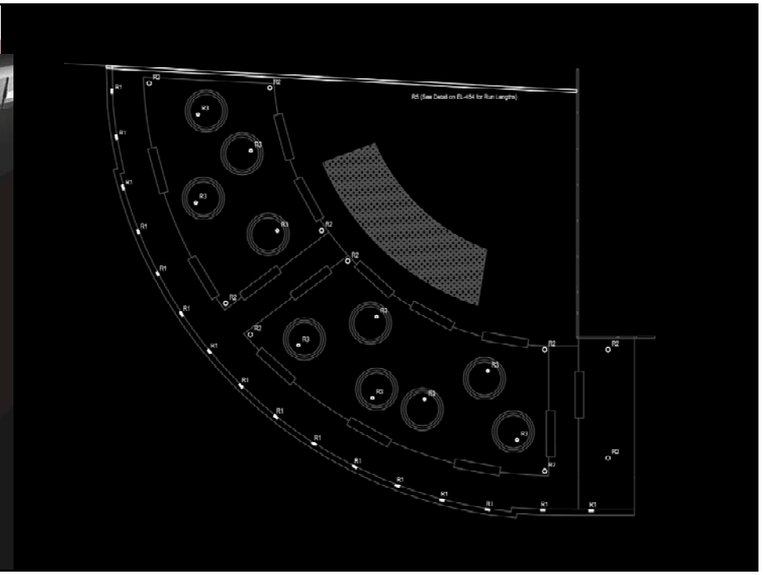


Lighting Depths | Roof Garden

Lighting Implementation:

White masonry wall is highlighted with line of light that separates the form from the rest of the architecture.

Line also leads into the SG, where a different technique is used to illuminate wall.



Lighting Depths | Roof Garden

Target Illuminance Level Values:

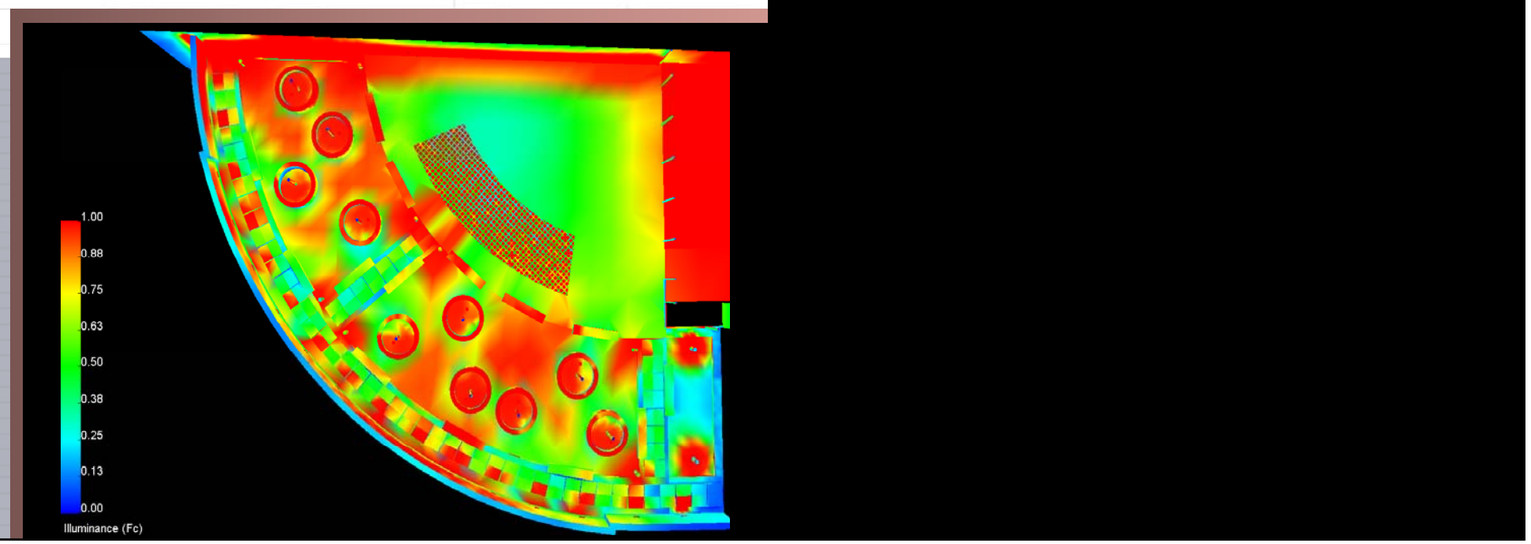
.5fc for floors

Illuminance Value for Paths(Fc) →
Criteria: .5fc average on ground-plane

Wood Deck	
Average	*0.55* ✓
Maximum	1.9
Minimum	0.3
Avg/Min	1.83
Max/Min	6.33
Meets Criteria?	**YES**

Illuminance Values for Paths (Fc) →
Criteria: .5fc average on ground-plane

Paver Path	
Average	*0.87* ✓
Maximum	5.7
Minimum	0.0
Avg/Min	0.00
Max/Min	0.00
Meets Criteria?	**YES**

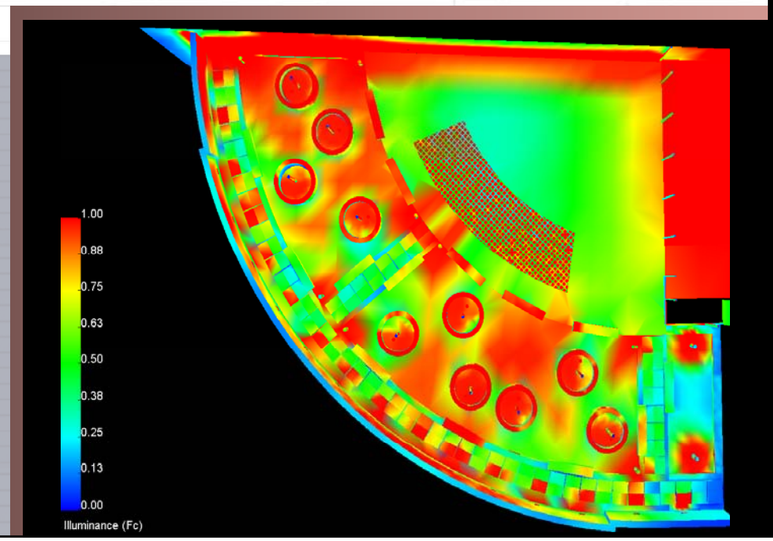


Lighting Depths | Roof Garden

Target Illuminance Level Values:

1fc vertical

Illuminance Value for Paths(Fc) →	
Criteria: 1fc average for vertical illuminance	
Vertical Grid	
Average	***0.94***
Maximum	2.3
Minimum	0.6
Avg/Min	1.57
Max/Min	3.83
Meets Criteria?	**YES!**

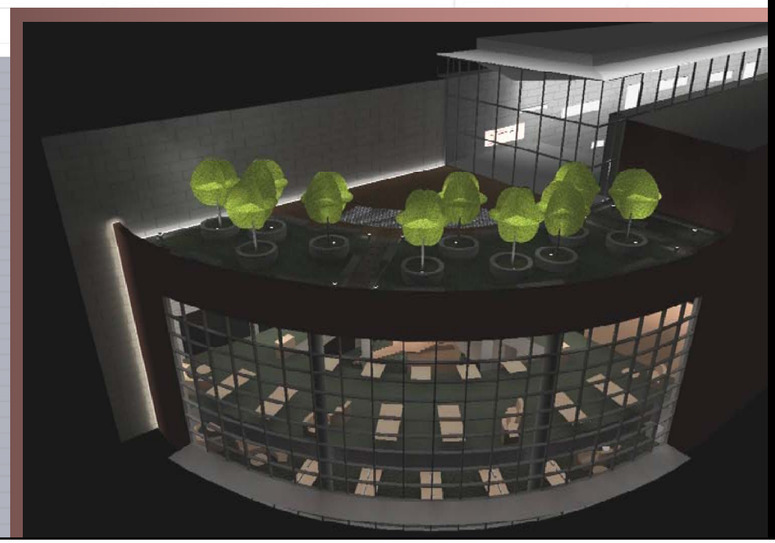


Lighting Depths | Roof Garden

Lighting Power Density: PASSED

Allowable watts/ft^2 = **.25**

Actual watts/ft^2 = **.18**



Lighting Depths | Library

Architectural Features:

- "Quartered" circle plan
- First floor – stacks and reading areas
- Second floor – computer stations and opening to first floor

Architectural Concept:

- P+W's "Gateway"

Lighting Depths | Library

Lighting Intent:

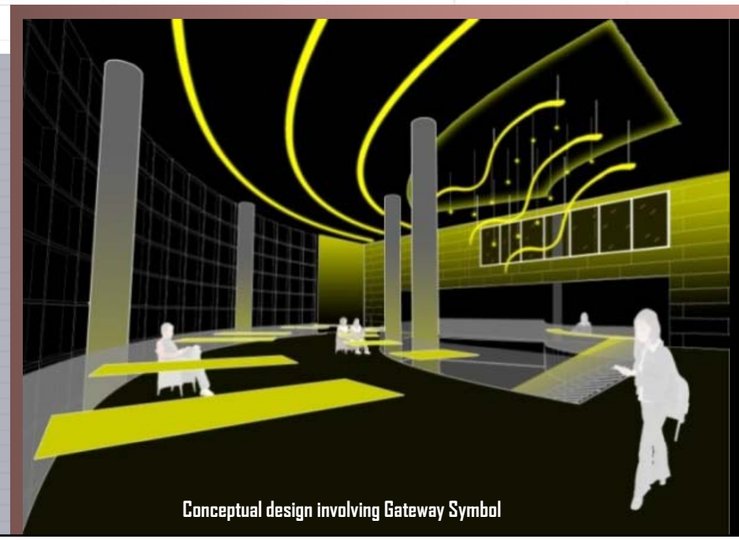
To support architecture through connecting occupant to identity of college, and make inside viewable from outside (providing a "gateway" into the college).

Recommendations and Code:

30fc Horz - 5-10fc Vert (IESNA)

30fc 30" A.F.F. (stacks + IESNA)

Total allowable watts equal 1115W. (per ASHRAE std. 90.1 Library reading and stack areas)



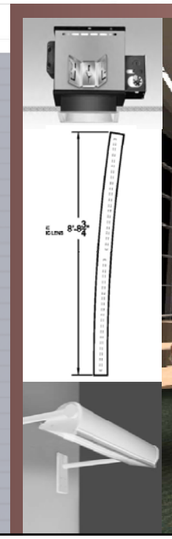
Conceptual design involving Gateway Symbol

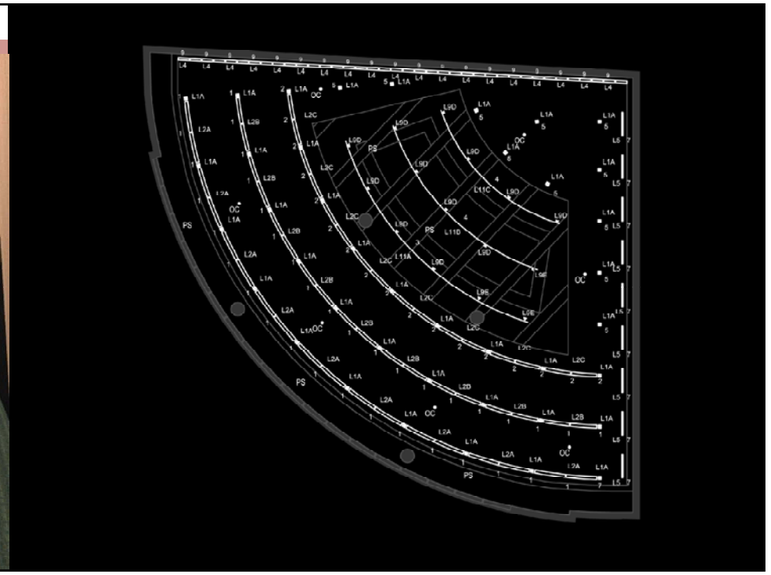
Lighting Depths | Library

Lighting Implementation:

Curve made with combination of square mh downlight and 3 custom luminaires.

North wall highlighted with cantelievered asymmetrical luminaire.



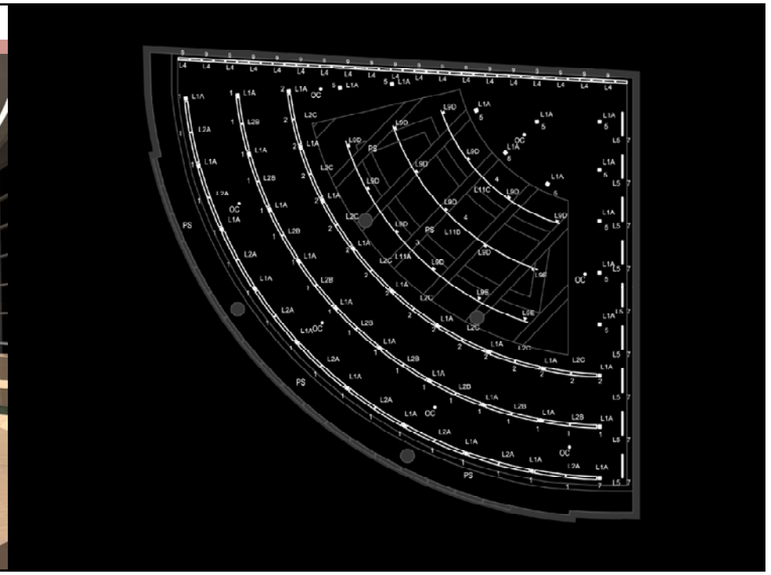


Lighting Depths | Library

Lighting Implementation:

Wall slot creates break between white wall and rest of building, alluding to an absence of space.

Custom shaped track fixture is an abstraction of the Gateway symbol and creates interest over the opening in the second floor.



Lighting Depths | Library

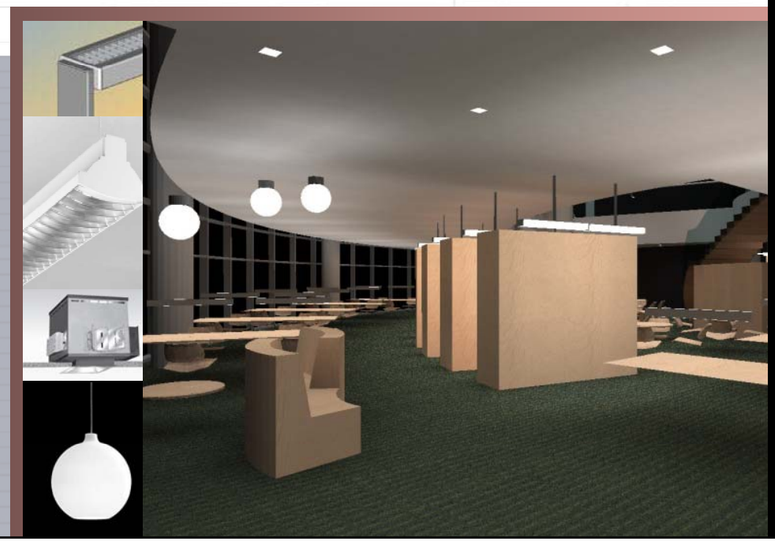
Lighting Implementation:

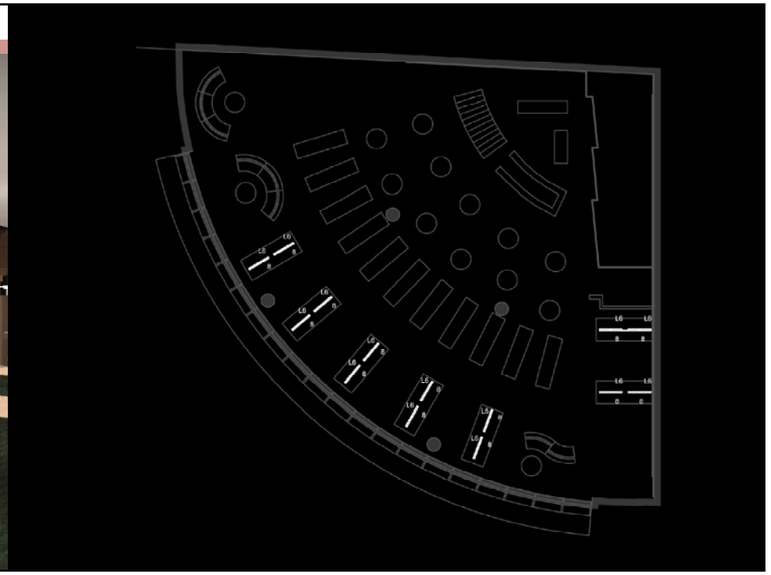
Stack lights utilize one lamp to illuminate opposite stacks, saving wattage and also illuminates the ceiling.

Table mount luminaire also uses one lamp to maintain recommended illuminance level on workplane as well as light the ceiling.

Decorative pendant provides task lighting and separates work areas from relaxing seating.

Downlights provide general task illuminance on the ground.





Lighting Depths | Library

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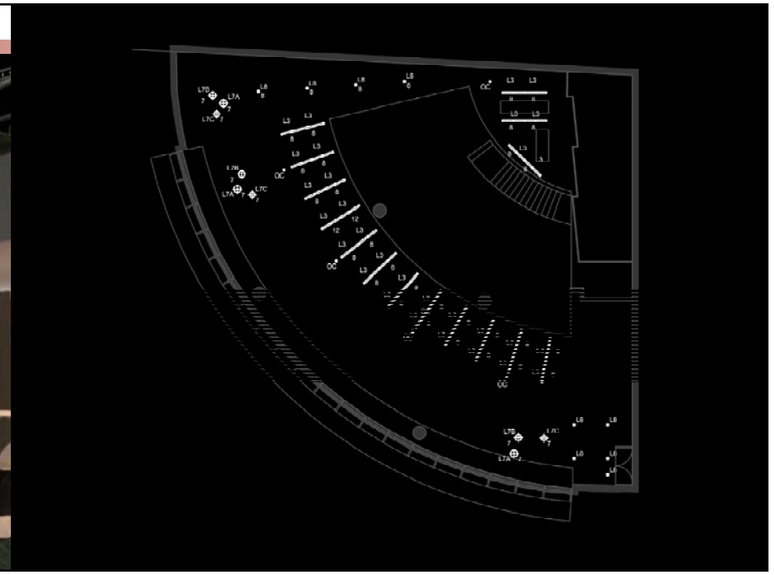
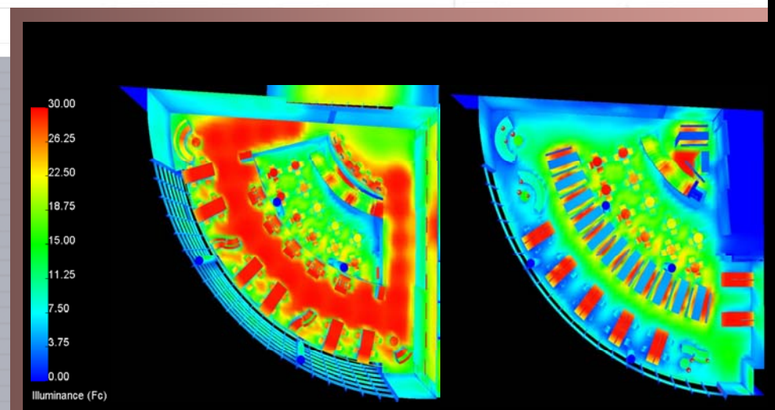


Lighting Depths | Library

Target Illuminance Level Values: ACHIEVED

30fc for table-tops

5fc for passage (floor)



Lighting Depths | Library

Lighting Power Density: PASSED

Allowable watts/ft^2 = **1.245** (combination)

Actual watts/ft^2 = **1.00**

Lighting Depths | Library

Lighting Implementation:

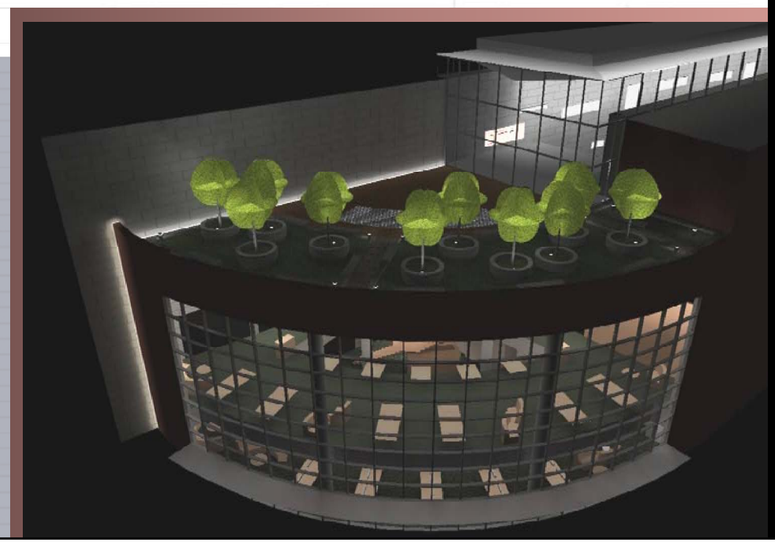
The luminescent tape around the exterior of the wall also helps separate and call attention to the large white masonry wall which extends throughout the building.

Light from interior surfaces, such as the stacks furniture, and most important, the walls helps the Library glow from within at night. Making the space a true "gateway" to passersby at night.

Conclusion

As a whole, I believe that my lighting and architectural designs enhance the quality and integration of systems throughout Gateway Community College.

I feel as though I have met my design goals, as well as meeting existing criteria and codes associated with lighting design.



Acknowledgements

Thank you to all who have lent help and support to me during this endeavor of producing my AE Senior Thesis project:

Dr. Kevin Houser—Faculty Advisor
Dr. Richard Mistrick—Lighting Consultant
Ted Dannerth—Faculty Advisor
Professor Robert Holland—Architecture Consultant and Thesis Adviser
Brian Smith— Project Lighting Designer
Shoshanna Segal— Project Lighting Designer
Grace Tang—Project Architect (Perkins + Will—New York City)
Shelley Einbinder— Project Architect (Perkins + Will—New York City)
Alan Aldag— Project Engineer and Sponsor (BVH Engineering)
Urszula Kryszkiewicz— Project Engineer and Sponsor (BVH Engineering)
Lee Brandt—Lutron Panelist
Sandra Stashik—Lutron Panelist
Zach Zaharewicz—Lighting Manufacturer and Consultant (Elliptipar)
Michael Barber—Lighting Designer and Consultant (TLP)
Lutron Technologies, Inc.—Schematic Design Host

Fellow students, faculty, and friends