

Boston University · Arena and Recreation Center
2007 Senior Thesis
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Advisor: Dr. Mistrick
Architectural Engineering
Lighting and Electrical Emphasis

Presentation Outline

Building Overview

Lighting Depth

Club Room

Lobby

Gymnasium

Exterior

Electrical Depth

Branch Circuit Re-Design

Copper vs Aluminum Feeder Study

Energy Efficient Transformers

Protective Device Coordination Analysis

Construction Management Breadth

Mechanical Breadth

Summary

Acknowledgements

Questions and Comments?



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Building Overview

Name: Boston University
Arena and Recreation Center

Location: Boston, MA

Architects and Engineers:
CANNON Design

Size: 822,000 sq ft

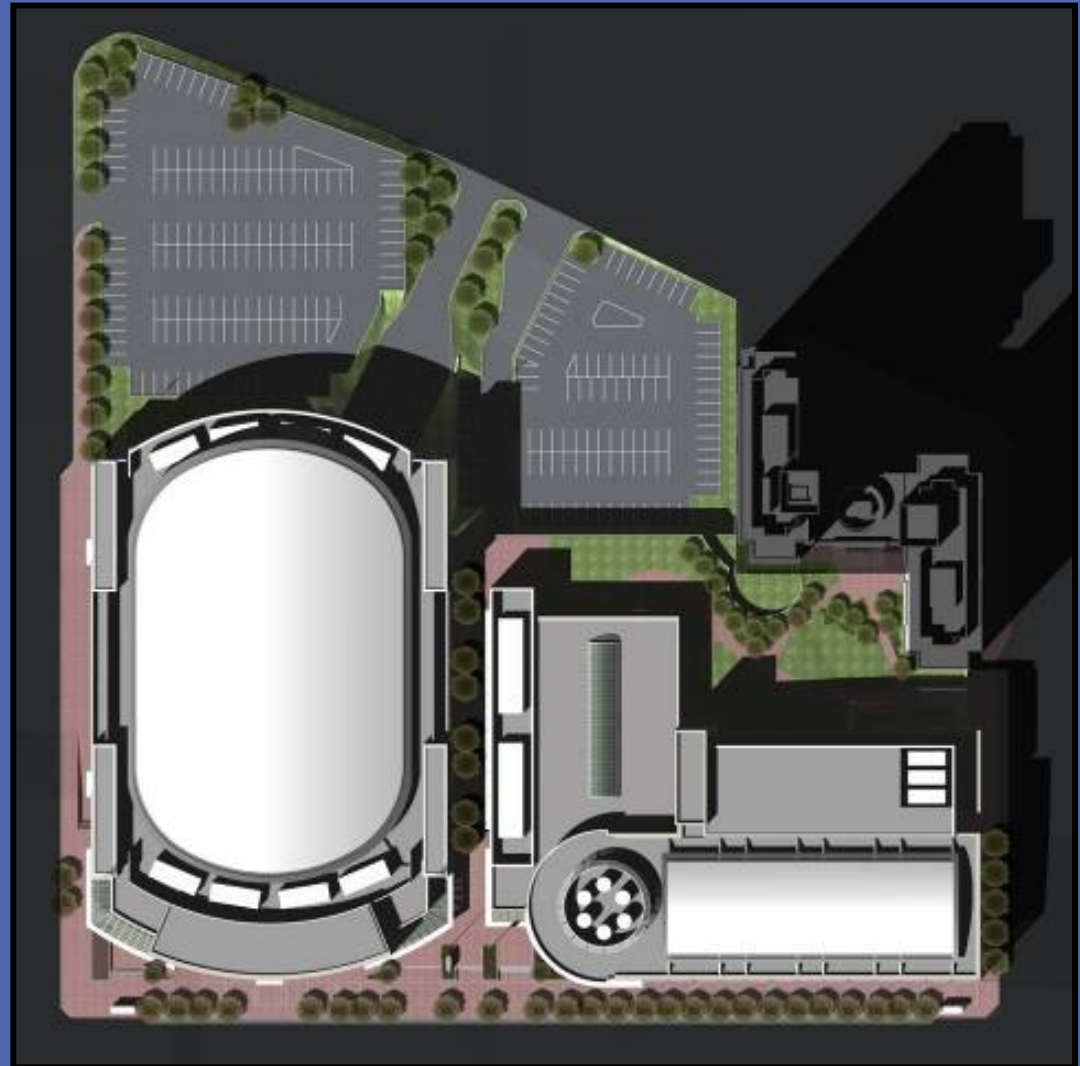
Arena: 264,635 sq ft

Rec Center: 267,995 sq ft

Underground Parking: 289,370 sq ft

Construction Dates: May 2002-
April 2005

Cost: \$185,000,000



Building Features

Recreation Center

- 18,000 sq ft weight & cardio room
- 2 swimming pools
- 2 gymnasiums
- 1/8 mile elevated track
- 35' climbing wall
- Multipurpose activity/classrooms
- Dance theater



Arena

- State of the Art ice hockey rink
- Portable basketball floor
- Seating for 6,300 and 20 suites
- Exclusive Club Room
- Black Box Theater
- Concession stands throughout concourse



Executive Club Room

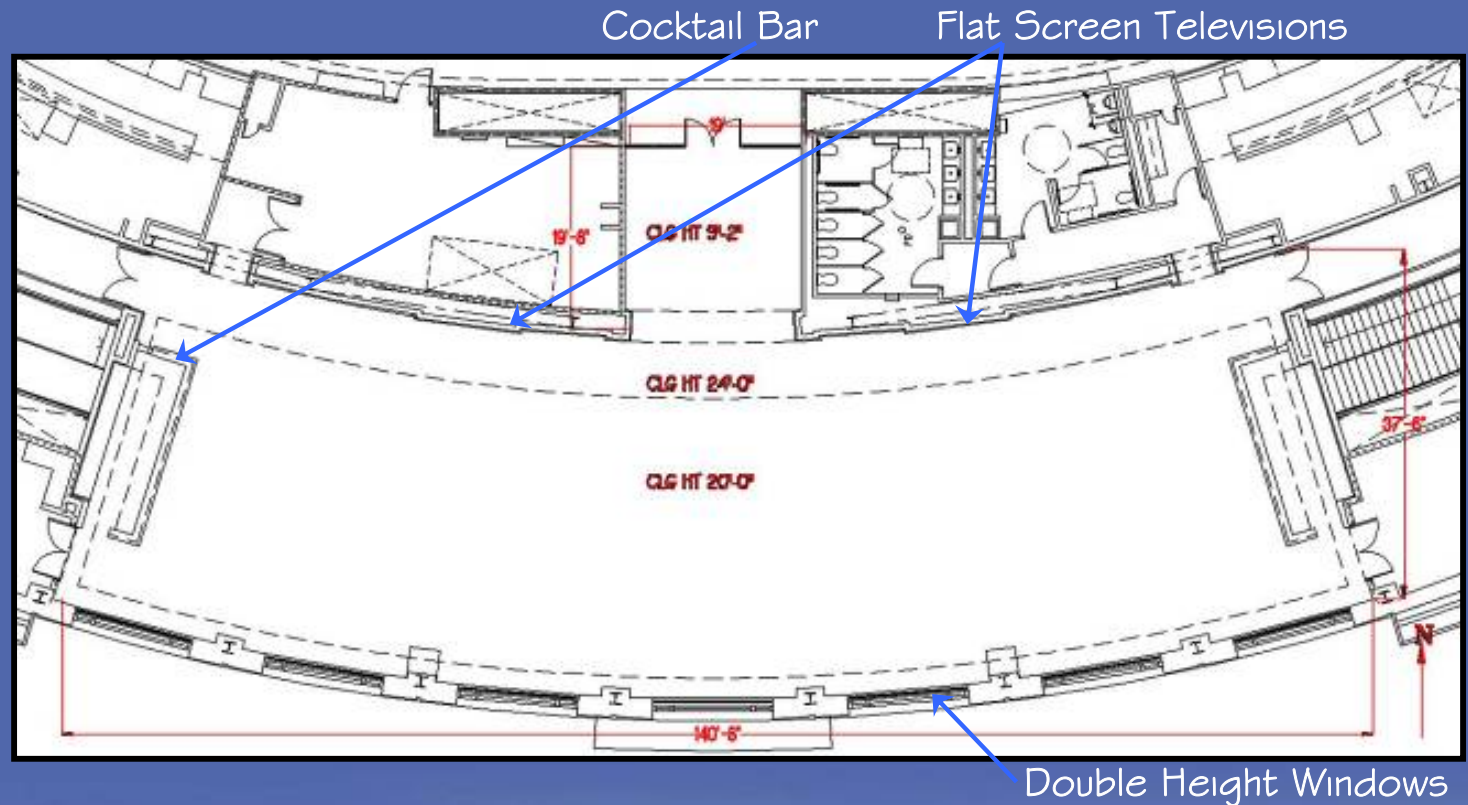
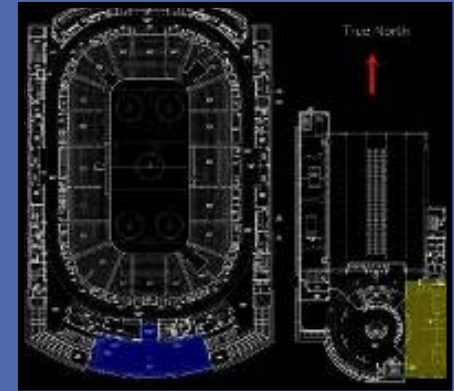
Lighting Redesign

Lighting Depth

Executive Club Room

Functions:

- VIP Lounge
- Social Gatherings
- Formal Events
- Conference Space



Lighting Depth

Executive Club Room

Design Goals:

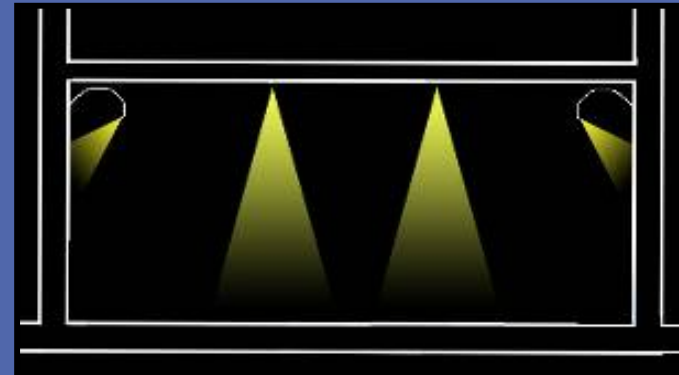
- Highlight Architecture
- Create a comfortable and elegant atmosphere
- Provide flexibility to accommodate the different uses

Schematic Sketches:

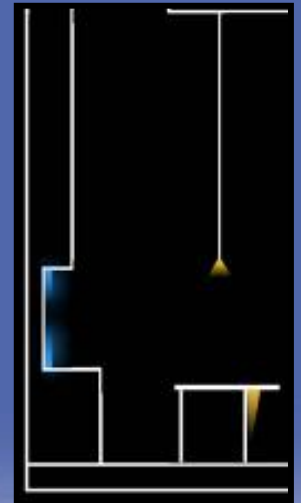


Illuminance Values:

- Entrance Corridor- 15fc
- Lounge/Conference Lighting- 30fc
- Evening/Formal Event Lighting- 10fc



Entrance Detail

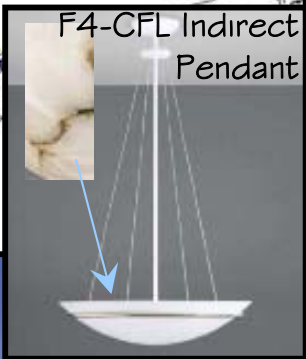
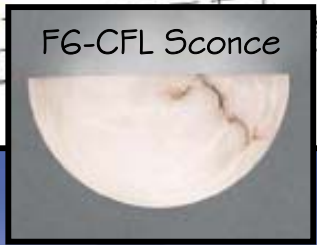
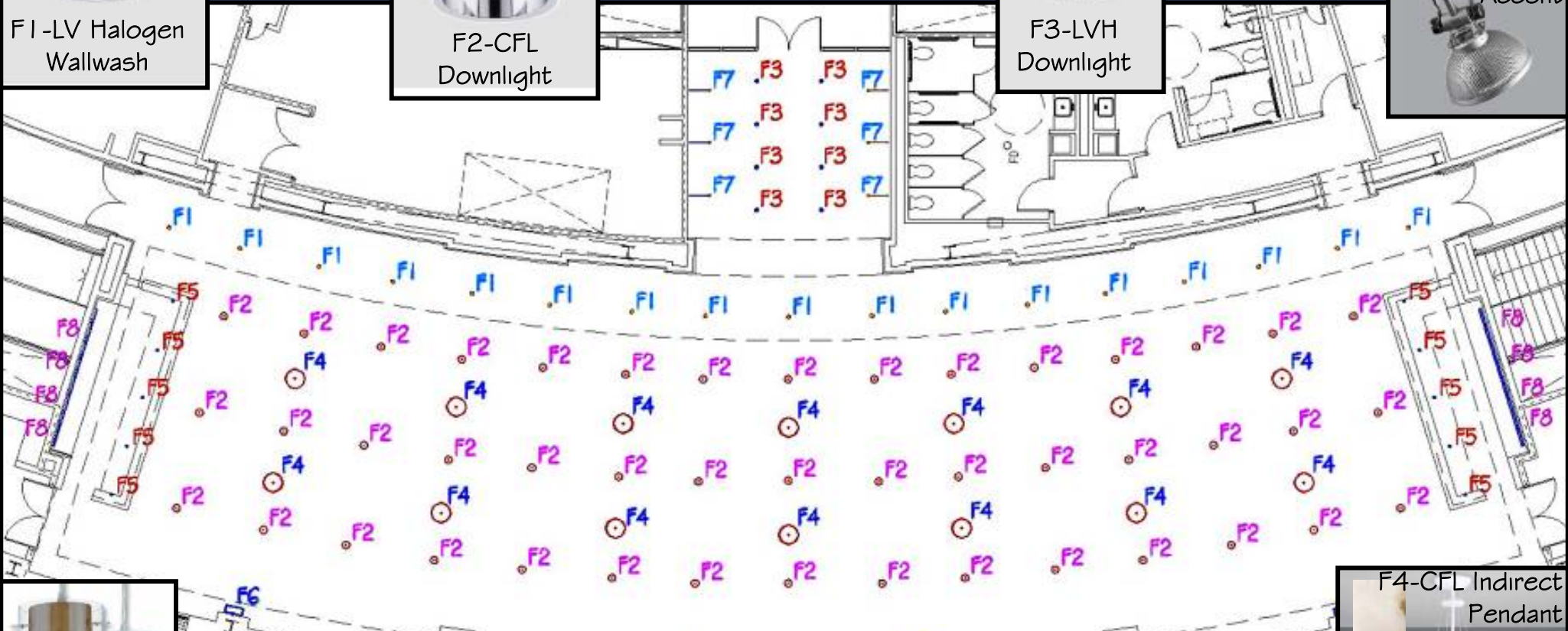


Bar Detail

Lighting Depth

Executive Club Room

Fixture Layout:



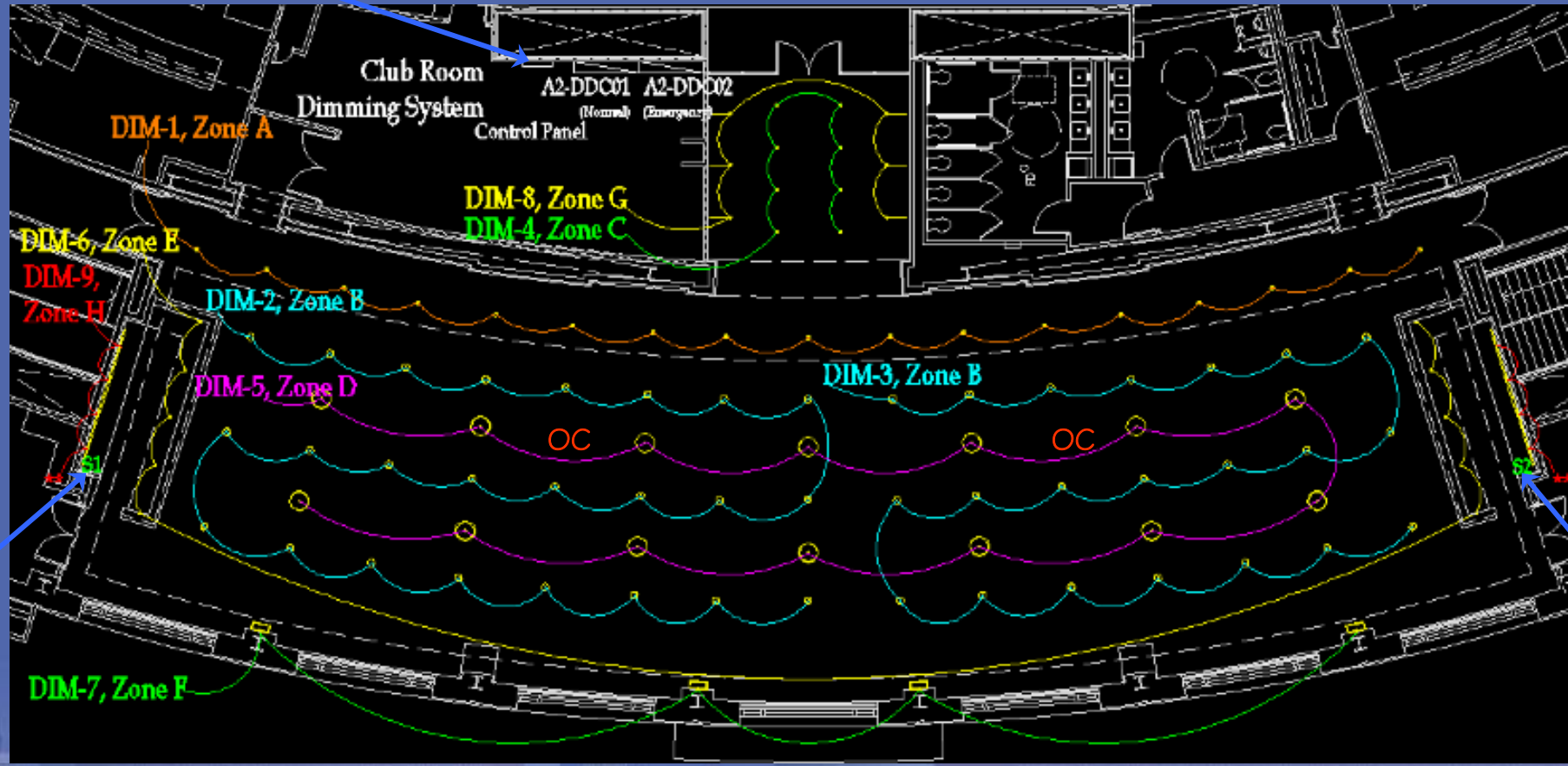
Lighting Depth

Executive Club Room

Controls and Circuiting



Club Room Scenes				
Scene	Name	Zones	Fixtures	Dimming
Scene 1	General Purpose/Lounge/Conference	A, B, C, D, E, G	F1, F2, F3, F4, F5, F7	D(10%)
Scene 2	Television Event/Black Out Shades	B, C, D, E, F, G, H	F2, F3, F4, F5, F6, F7, F8	B(25%)
Scene 3	Formal Events/ Social Gatherings	A, C, D, E, F, G, H	F1, F3, F4, F5, F6, F7, F8	D(25%), E(25%)



Lighting Depth

Executive Club Room

Solution Summary:

Label	Description	Lamp			Ballast			Voltage	Fixture Qty.
		NO.	Type	Watts	Type	Lamps	Watts		
F1	Recessed wallwash, Low Voltage Halogen	1	T4 75W 12V GY6.35 2850K Min CRI 82	75	N/A	N/A	N/A	120/12	17
F2	Recessed Compact Fluorescent Downlight	2	CFM 32W GX24q-3 3000K Min CRI 82	32	Electronic Dimming	2	67	120	45
F3	Recessed Low Voltage Halogen Downlight	1	T4 50W 12V GY6.35 3000K Min CRI 82	50	N/A	N/A	N/A	120/12	8
F4	Compact Fluorescent Pendant with a Natural Spanish Finish	2	F39BX/SPX30 3000K Min CRI 82	39	Electronic Dimming	2	80	120	14
F5	Compact Fluorescent Decorative Pendant	1	CFQ13T35/G24Q 3500K Min CRI 82	13	Electronic Dimming	1	18	120	10
F6	Compact Fluorescent Decorative Wall Sconce	2	F13BX/ECO/GX23 3000K Min CRI 82	13	Electronic Dimming	2	32	120	4
F7	Accent Picture Lights	1	20W MR16 12V 2900K Min CRI 82	20	N/A	N/A	N/A	120/12	6
F8	Recessed LED Strip Accent Lights	45/ft= 150/fixt.	Red, Green, & Blue LEDs	3.5/ft= 11.67/fixt	N/A	N/A	N/A	120	8

Average Illuminance Values

Entrance- 19.05fc

Lounge/Conference Lighting- 28.95fc

Evening/Formal Event Lighting- 11.5fc

ASHRAE 90.1 Allowable Power Density: 1.5 w/sqft

Achieved Power Density: 1.13 w/sqft

25% Below ASHRAE

Label	Qty	Watts	Total Watts
F1	17	75	1275
F2	45	67	3015
F3	8	50	400
F4	14	80	1120
F5	10	18	180
F6	4	32	128
F7	6	20	120
F8	8	11.67	93.36
Total Watts:			6331.36
Sq Ft:			5600
Power Density w/sqft:			1.1306

Lighting Depth

Executive Club Room



Lighting Depth

Executive Club Room



Recreation Center Lobby

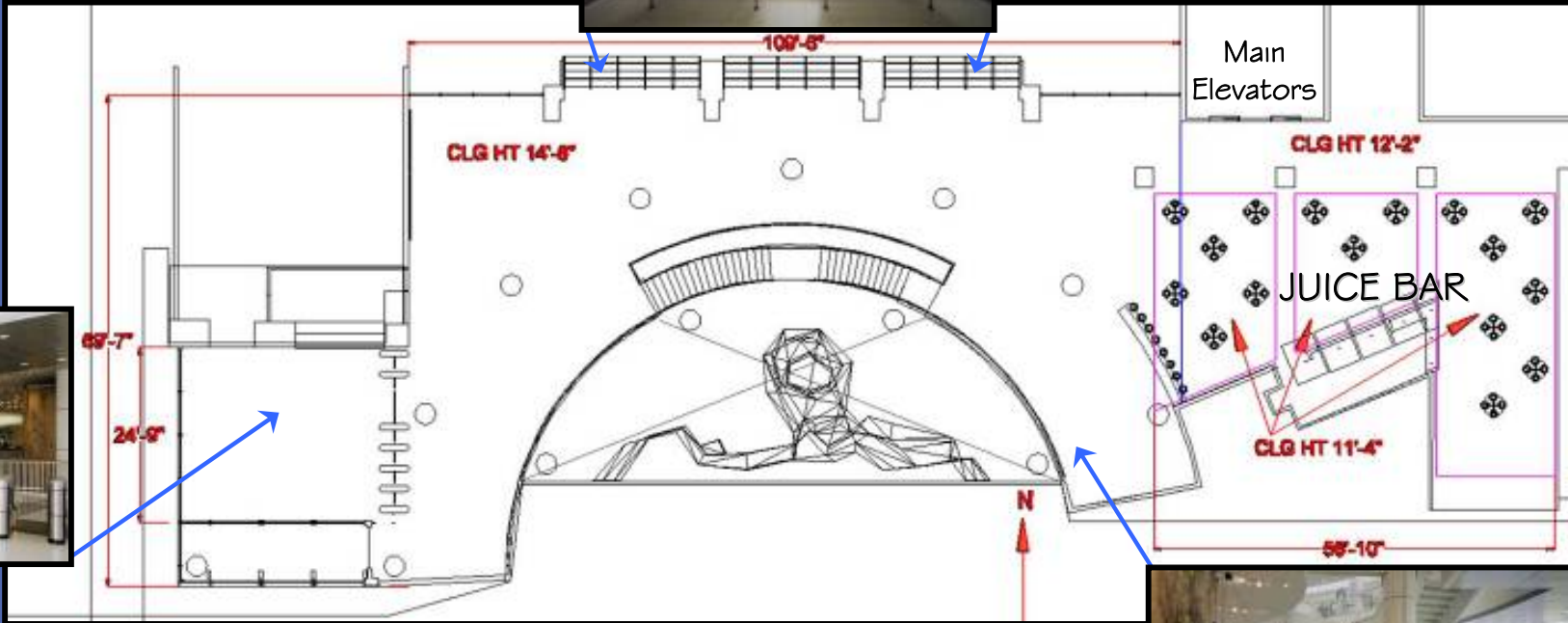
Lighting Redesign

Lighting Depth

Lobby

Functions:

- Main Entrance to Recreation Center
- Main Circulation Area
- Juice Bar



Lighting Depth

Lobby

Design Goals:

Highlight Spatial Characteristics

Guide people through the Space

Create an environment that represents energy and pride within the campus setting through the use of light in motion and B.U.'s school colors

Highlight Points of Interest

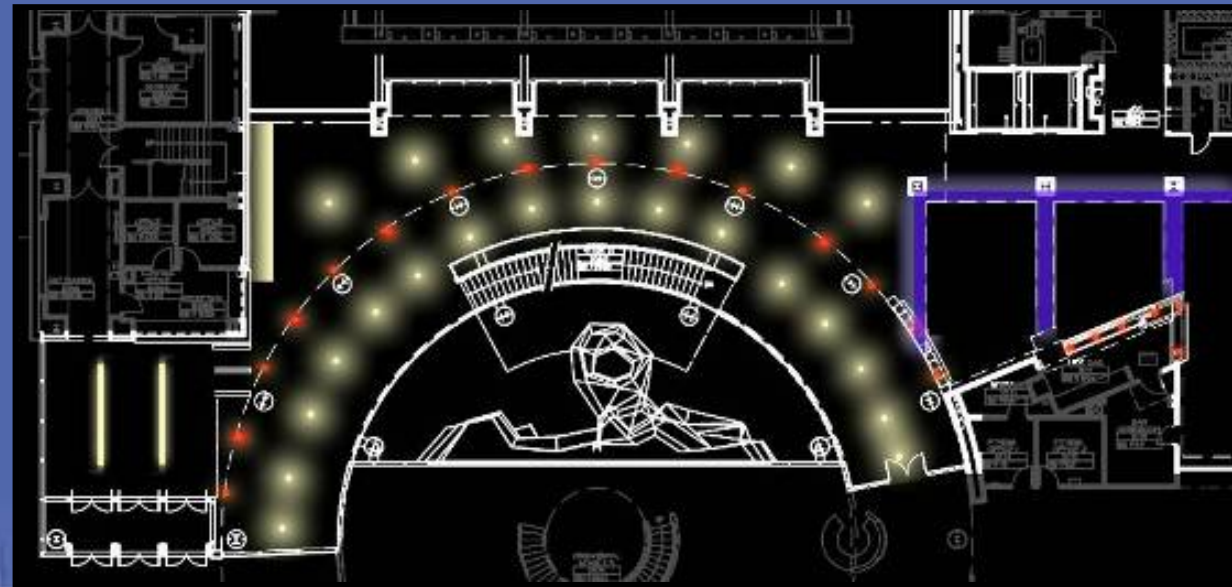
Illuminance Values:

Entrance Corridor- 15fc

Main Circulation Area- 10fc

Juice Bar- 30fc

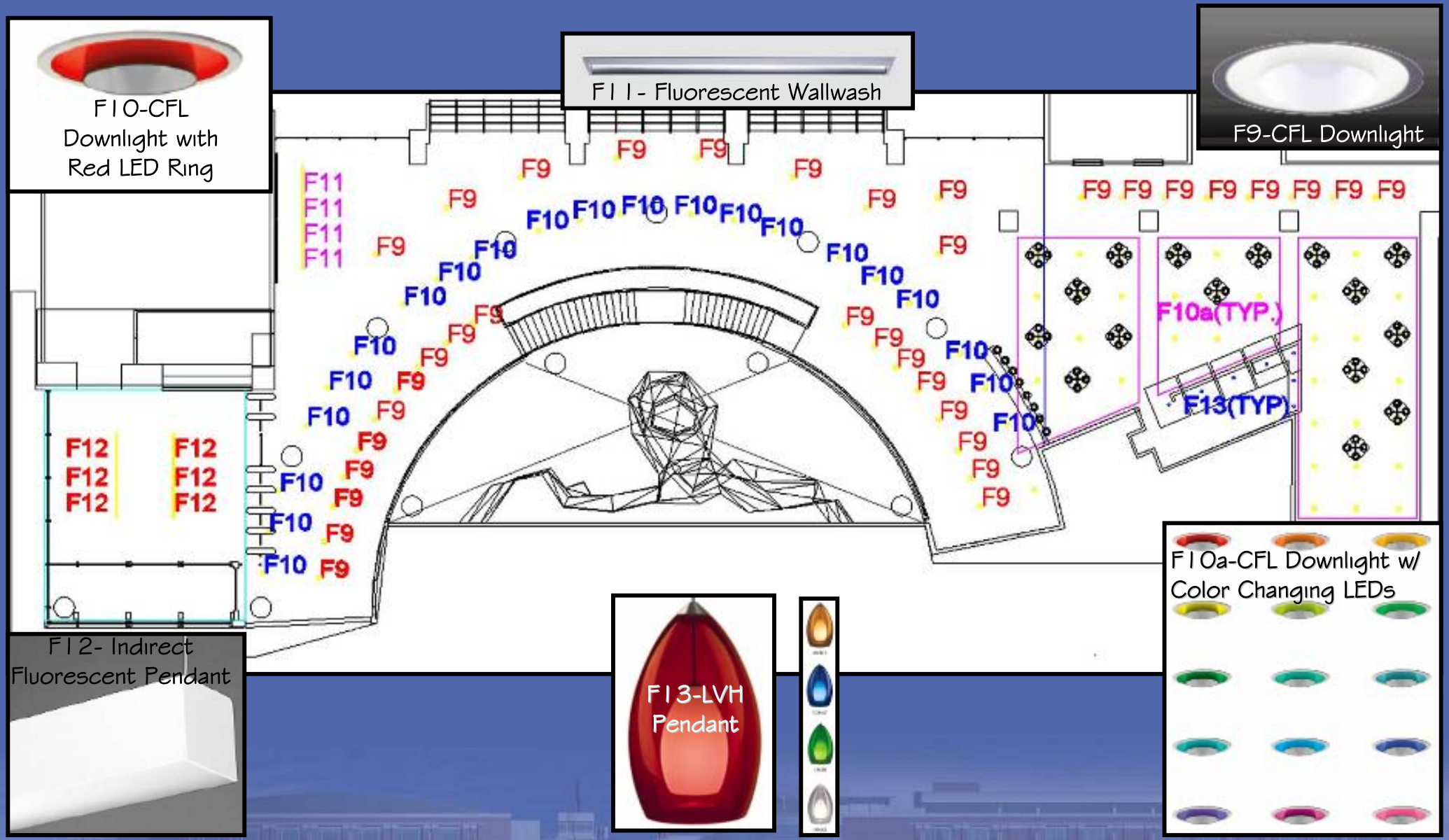
Schematic Sketch:



Lighting Depth

Lobby

Fixture Layout:



Lighting Depth

Lobby

Solution Summary:

Label	Description	Lamp			Ballast			Voltage	Fixture Qty.
		NO.	Type	Watts	Type	Lamps	Watts		
F9	Recessed Compact Fluorescent Downlight with Candeo Clear	1	CF32WTRT	32	Electronic	1	36	277	35
F10	Recessed Compact Fluorescent Downlight with Red LED Ring	1	CF32WTRT + LEDs	32	Electronic	1	38	277	22
F10a	Recessed CFL Downlight with Color Changing LED Ring	1	CF42TRT + LEDs	42	Electronic	1	48	277	42
F11	Recessed Linear Fluorescent Wallwash	1	F28T5 Min Bipin	28	Electronic	1	33	277	4
F12	Linear Fluorescent Indirect Pendant	1	F54T5HO	54	Electronic Dimming	1	62	277	6
F13	Halogen Decorative Pendant	1	40W T4 G9 Pin Base	40	N/A	N/A	40	120	6

Average Illuminance Values

Entrance Corridor- 21.25fc

Main Circulation Area- 11.98fc

Juice Bar- 31.19fc

ASHRAE 90.1 Allowable Power Density: 1.8 w/sqft

Achieved Power Density: 0.75 w/sqft

58% Below ASHRAE

Label	Qty	Watts	Total Watts
F9	35	36	1260
F10	22	38	836
F10a	42	48	2016
F11	4	33	132
F12	6	62	372
F13	6	40	240
Total:			4896
Sq Ft:			6500
Power Density w/sqft:			0.753231

Lighting Depth

Lobby



Lighting Depth

Lobby



Copper vs. Aluminum Wire Study

Electrical Analysis

Electrical Depth

Copper vs Aluminum Wire Analysis

Issue:

Volatile cost of copper metal
 Heavy material to transport and install

Solution:

Research another form of electrical wiring, such as aluminum

FDR ID	OCPD	Length (ft)	Copper			Aluminum		
			Phase Wires	Cost/L.F	Cost	Phase Wires	Cost/L.F.	Cost
A4	30	80	(3) 10	\$4.70	\$376.00	(3) 8	\$3.95	\$316.00
A5	30	92	(3) 10	\$4.70	\$432.40	(3) 8	\$4.20	\$386.40
B4	40	56	(3) 8	\$6.70	\$375.20	(3) 6	\$4.20	\$235.20
C4	50	5	(3) 6	\$5.10	\$25.50	(3) 4	\$4.80	\$24.00
D4	60	10	(3) 4	\$6.35	\$63.50	(3) 4	\$4.80	\$48.00
E4	70	12	(3) 4	\$6.35	\$76.20	(3) 2	\$5.30	\$63.60
F4	90	6	(3) 2	\$8.15	\$48.90	(3) 1	\$5.95	\$35.70
G4	100	200	(3) 2	\$8.15	\$1,630.00	(3) 1 / 0	\$7.25	\$1,450.00
H4	125	168	(3) 1 / 0	\$12.25	\$2,058.00	(3) 2 / 0	\$7.55	\$1,268.40
J4	150	125	(3) 2 / 0	\$14.50	\$1,812.50	(3) 4 / 0	\$9.95	\$1,243.75
K4	175	178	(3) 3 / 0	\$16.75	\$2,981.50	(3) 4 / 0	\$9.95	\$1,771.10
L4	200	5	(3) 4 / 0	\$19.00	\$95.00	(3) 300	\$12.75	\$63.75
M4	225	10	(3) 250	\$21.50	\$215.00	(3) 350	\$13.90	\$139.00
N4	250	300	(3) 250	\$21.50	\$6,450.00	(3) 400	\$15.30	\$4,590.00
P4	300	250	(3) 350	\$28.00	\$7,000.00	(3) 500	\$16.70	\$4,175.00
Q4	350	90	(3) 500	\$35.25	\$3,172.50	(6) 4 / 0	\$19.90	\$1,791.00
R4	400	10	(6) 3 / 0	\$33.50	\$335.00	(6) 300	\$25.50	\$255.00
S4	500	30	(6) 250	\$43.00	\$1,290.00	(6) 400	\$30.60	\$918.00
T4	600	150	(6) 350	\$56.00	\$8,400.00	(6) 500	\$33.40	\$5,010.00
U4	700	20	(6) 500	\$70.50	\$1,410.00	(9) 350	\$41.70	\$834.00
V4	800	20	(9) 300	\$74.25	\$1,485.00	(9) 500	\$50.10	\$1,002.00
W4	1000	20	(9) 400	\$94.85	\$1,897.00	(12) 400	\$61.20	\$1,224.00
X4	1200	10	(12) 350	\$112.00	\$1,120.00	(12) 500	\$66.80	\$668.00
Y4	1500	10	(12) 500	\$141.00	\$1,410.00	(15) 500	\$83.50	\$835.00
Z4	1600	10	(15) 400	\$158.00	\$1,580.00	(18) 500	\$100.20	\$1,002.00
TOTAL:					\$45,739.20			\$29,348.90

Cost Difference: \$16,390.30

Aluminum is **36%** cheaper than Copper

Electrical Depth

Copper vs Aluminum Wire Analysis

Copper Characteristics:

- Higher electrical conductivity
- Ampacity is 1.6 times that of aluminum
- Harder and stronger material which can stand much more abuse over time and installation
- Can withstand tighter twists, harder pulls, and more bends at junction and termination boxes without stretching or breaking

Aluminum Characteristics:


- Softer material, lower modulus of elasticity
- Need more critical installation procedures in order to secure bad connections
- Thermal expansion coefficient is much larger than copper
- Aluminum alloys are more active metals that make them more susceptible to corrode around moisture causing a shorter life span.

For the Same Ampacity	Copper	Aluminum
Weight (lb)	100	48
Cross Sectional Area (circular mills)	100	160
Tensile Strength (psi)	55000	40000

Recommendation: Continue installing copper wire for building electrical distribution systems. Save the owner reinstallation issues and money, avoid fire hazards from poor aluminum connections, while increasing constructability.

Lobby Ceiling Redesign

Construction Management Breadth

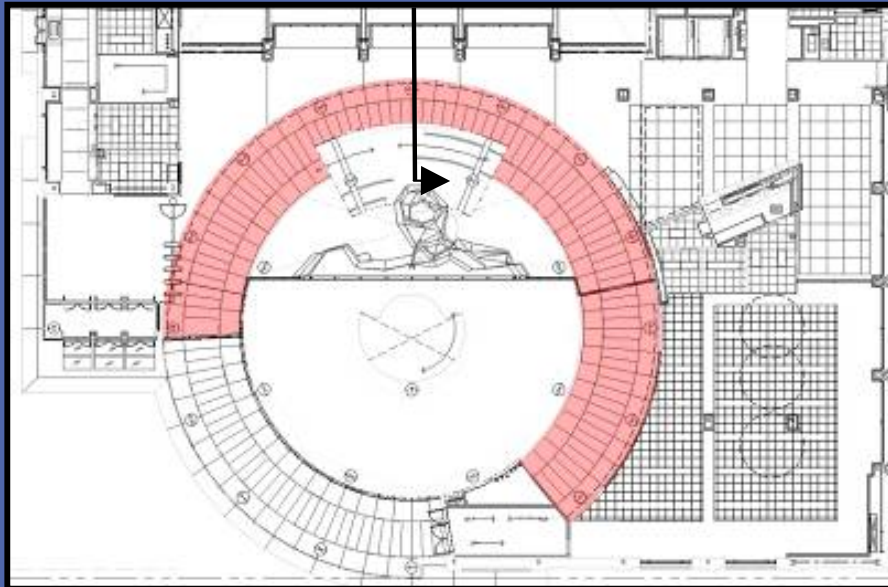


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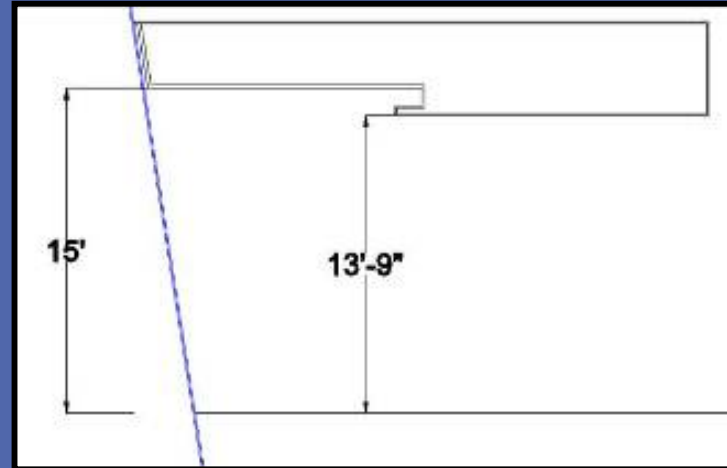
Construction Management Breadth

Lobby Ceiling Redesign

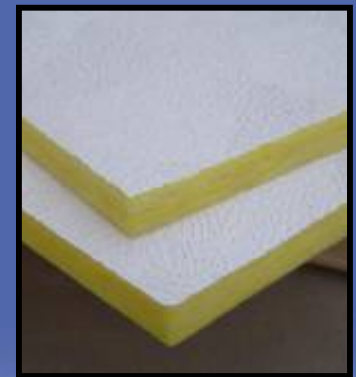
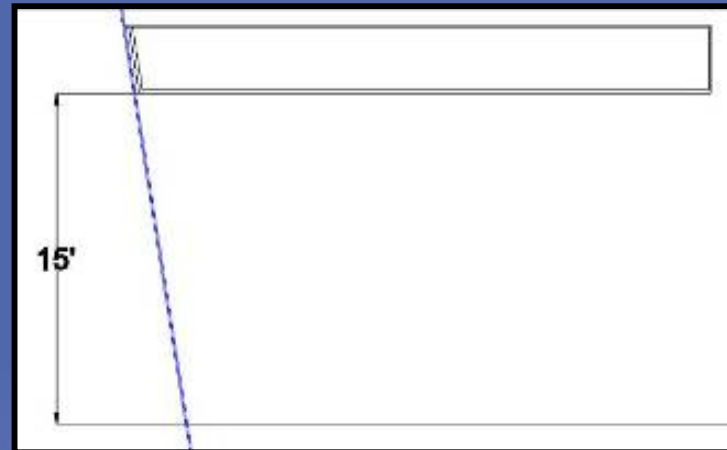
Existing Conditions:



Construction Issue: Radius metal ceiling panels long and difficult to install



Solution: Replace with acoustical ceiling panels to decrease schedule and costs while improving constructability



Construction Management Breadth

Lobby Ceiling Redesign

Labor Cost Impact:

Position Title	Number of Workers per Crew	Number of Crews	Cost (\$) per hour	Duration of Installation		Total Labor Cost (\$)	
				Metal Panels	Acoustic Ceiling Panel	Metal Panels	Acoustic Ceiling Panel
Carpenter Foreman	1	1	\$77.00	180	110	\$13,860.00	\$8,470.00
Carpenter Journeyman	3	1	\$72.00	180	110	\$38,880.00	\$23,760.00
Labor Foreman	1	1	\$60.00	180	110	\$10,800.00	\$6,600.00
Labor Journeyman	1	1	\$44.00	180	110	\$7,920.00	\$4,840.00
Total Labor Cost (\$):						\$71,460.00	\$43,670.00

Material Cost Impact:

Material Type	Cost (\$) per Square Foot	Total Sqaure Ft	Total Material
Metal Panel	\$40.00	5000	\$200,000.00
Acoustic Ceiling Panel	\$5.50	5000	\$27,500.00

**All material and labor costs as well as scheduling information provided by Scott Mull, PM for Barton Malow on BU's Arena and Rec Center Project

Total Cost Impact:

Material Type	Total Material	Total Labor Cost	Total Cost (\$)
Metal Panel	\$200,000.00	\$71,460.00	\$271,460.00
Acoustic Celing Panel	\$27,500.00	\$43,670.00	\$71,170.00
Savings (\$):			\$200,290.00

Schedule Impact:

Material Type	Activity Duration (hr)	Hours Worked	Activity Duration
Metal Panel	180	8	23
Acoustic Ceiling Panel	110	8	14
Schedule Savings (days):			9

Recommendation: Redesign the lobby ceiling from metal panels to ACT.

Conclusions

Lighting Depth

Club Room Lighting- Provides flexibility for a multifunctional space and user friendly controls, while providing an elegant yet comfortable atmosphere.

Lobby Lighting- Unique lighting scheme that follows the architectural characteristics while adding color and highlights to a very white space

Electrical Depth

Although aluminum proves to be a cheaper metal, electrically speaking copper will out perform aluminum and save the owner money in the long run.

Construction Management Breadth

Because the lighting kept the circular aesthetic in tact, the new acoustical ceiling tile will save the owner money as well as construction schedule days, and improves the constructability of the project.

Acknowledgements

Thank you!

AE Department
Scott Mull of Barton Malow
Boston University
Cannon Design
Friends and Family
AE Classmates



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Questions?



Comments?