Lighting Depth

Lighting Depth

The Woolly Mammoth Theatre Company is a very unique group. They have a mission to provide new and edgy productions to the community. Therefore, when designing their first permanent facility, the "personality" of the building must go along with who they are. The architectural concept for the building is a 'transparent theatrical laboratory". Throughout the building, spaces normally hidden from patrons, including rehearsal halls, classrooms, offices and other support spaces are open to be seen. This will give the patrons a "behind-the-scenes" look at making a live theater production.

The lighting concept in the Woolly Mammoth Theatre must enhance the architectural theme. The lighting design concept throughout the building will be to make the spaces **Come Alive**. The finishes in the space are very grim, being white painted walls, concrete floors and ceilings, and concrete block walls. There are only a few select colors in each space. The lighting design will add pizzazz to the spaces, making them new, edgy and provocative as the theatre company's productions are. The lighting design will highlight the architectural elements and make them stand out. All of the redesigned spaces will come alive in their own way.

There is a hierarchy of the spaces throughout the building. Three public spaces were redesigned, and one private space. The public versus private space design criteria is very different. The lobby is the most important public space in the redesign. It is the most edgy and eye-catching. The next public space is the entrance. It foreshadows for patrons what is to come inside the building. The last public space is the theatre space. The house lighting was redesigned. It is the most subdued public space because in the theatre itself, the production is what is important and should not be outdone. The private space that was redesigned was the office suite. This space is only for the employees of the theatre. The office will come alive in a softer way.

Color

Awake

Dynamic

Vibrant

Flashy

Energetic

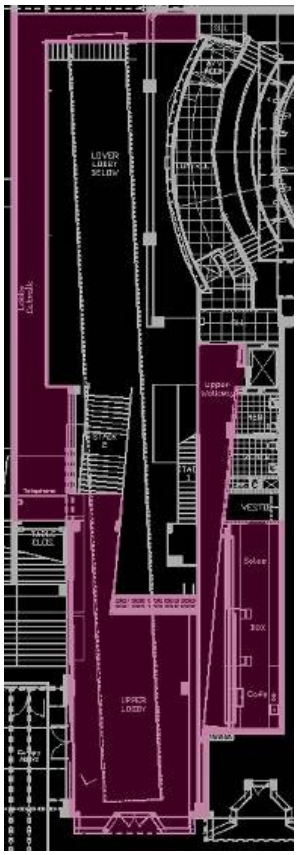
Hi-Tech

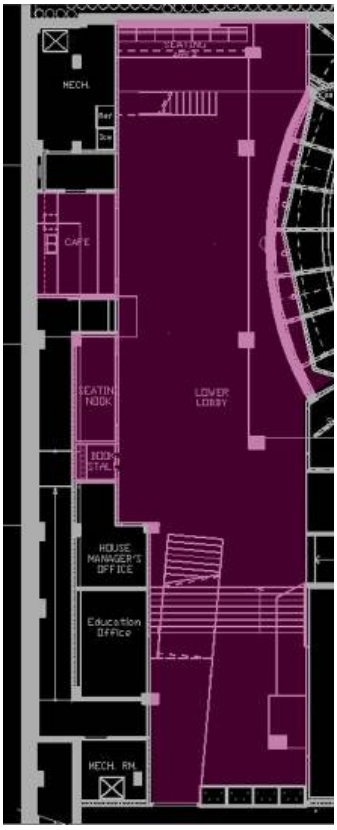
Lobby

Space Overview

As patrons enter the lobby, they are in for a huge surprise. The theater is said to get lost in the cityscape; but once you are inside everything becomes clear. Entering from street level, patrons come in on the second floor. The lobby has a tunnel like feel, extending 130' back and varying widths between 20'-40'. The finishes are unfinished, looking industrial and edgy. There are only a few key colors in the space. On this level there are a ticket booth and café. There is a long balcony, referred to as the "lobby catwalk", descending the entire length of the space where seating is available and art is on display. Also extending the length of the space is a white gypsum board ceiling panel. This helps to draw the eye to the back of the space.

Moving further into the space, stairs will take patrons down to the first level where the lobby is a double-heighted space. The stairs and bridges are cleverly placed to invite movement between the first and second levels of the lobby. On this level there are seating areas, a book stall, a café and the entrances to the orchestra seating. When inside the space, there is no mistake where the theater is. A 22' high curved polycarbonate wall stands between the lobby and theater. This semi-translucent wall has a layer of mylar behind it.





Materials in the Space

- concrete slab ceiling- clear finish — reflectance = 20%
- white painted gypsum wall board ceiling panel — reflectance = 90%
- concrete slab floor- clear satin finish — reflectance = 35%
- masonry block walls- clear finish — reflectance = 25%
- white painted gypsum walls — reflectance = 95%
- polycarbonate translucent wall- ice color
- wood paneling on ticket booth and both café fronts
- plastic laminate counter tops
- blue painted gypsum walls around ticket booth — reflectance = 65%
- orange painted gypsum wall at entry seating area — reflectance = 65%

Glazing

- 2 sided glazing system with vertical joints
  ½" thick clear laminated glazing
- Multi-walled structured polycarbonate glazing
  Polygal: translucent extruded polycarbonate sheet with internal ribbing and smooth flat exterior surface, Color Ice

Daylighting

Above the two story high lightwall, the curve continues with glass. This curved third story glass wall (wall to the office suite) faces an exterior glass façade wall, with a gap of three to eight feet. This gap is open to the lobby space. This technique provides daylight to shine through the third story glass façade and down into the lobby during the daytime. A daylight study was not performed because all of the direct sunlight entering the lobby space hits the light wall. The daylighting does provide ambient light for the daytime, and therefore the theatre company can dim the lighting during those hours.

Design Criteria

General

In this lobby many tasks will be taking place. Tickets, programs and souvenirs will be bought; and snacks will be eaten. The lobby will provide a space for patrons to wait before and after performances. Glare should be completely avoided.

Color rendering and facial modeling are all very important in the lobby. Patrons will be spending time in this space and should look beautiful. There should be points of visual interest and sparkle in the room. This will lead the eye through the space and keep patrons interested.

Illuminance and Luminance Values

According to the IESNA, between 15 and 20 footcandles of horizontal illuminance is desirable for lobbies and foyers in theaters of live productions. The artwork and posters in the space should range from 70 to 350 cd/m^2, depending on surrounding brightness.

Power Density

According to Ashrea 90.1 (2004), using the space by space method for a lobby of a performing arts building, 3.3 W/SF are allowed.

Schematic Design/Design Intent

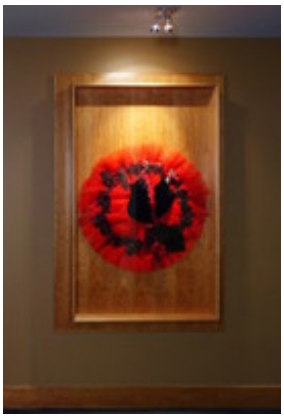
Design Goals

- Color
- Sparkle
- Rhythmic - Invites Movement and Flow
- Most Exciting Space

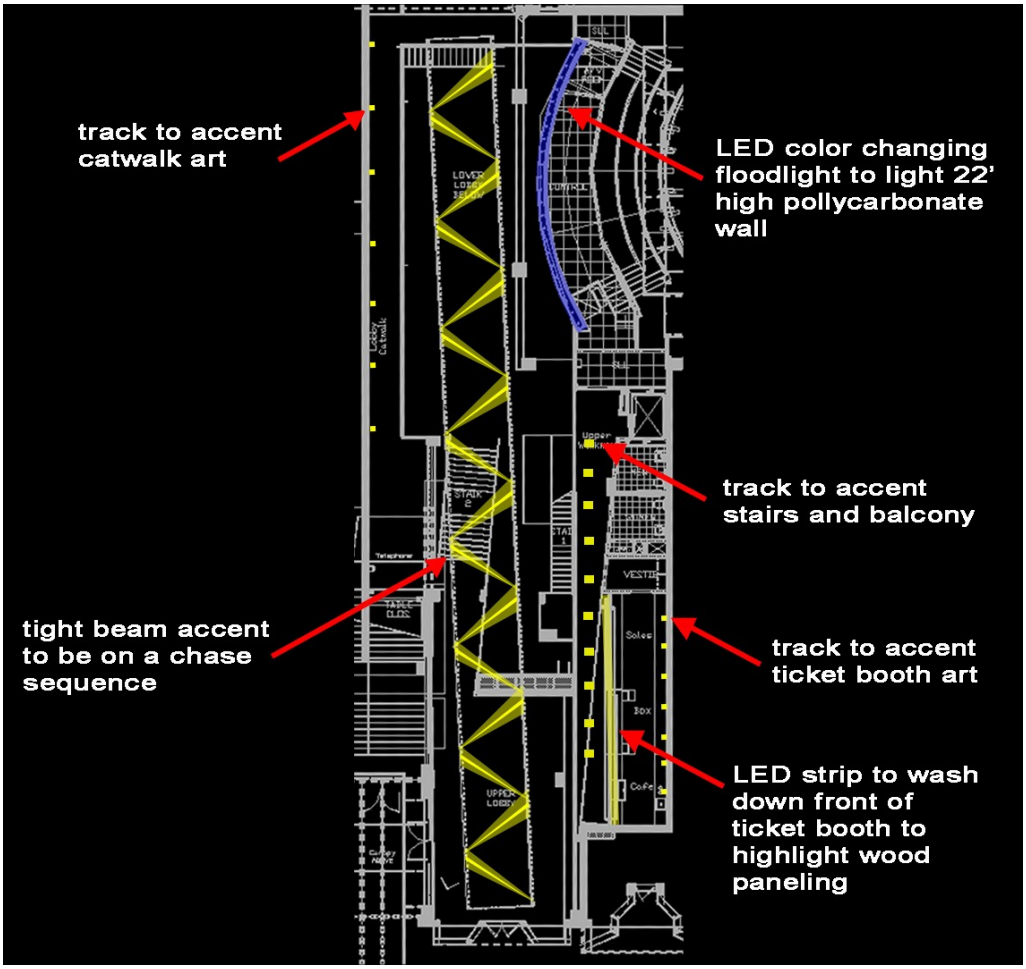
The lobby of the Woolly Mammoth Theatre will be the first interior space patrons will see. The appearance should be pleasing to the eye, feeling inviting and exhilarating. Its edgy design will draw people into the space. Because the majority of the finishes are white and unfinished concrete, colored light will help the space come alive. This light will spread throughout the space giving the lobby a glow of color. The lobby's main character comes from its architecture: the way the stairs are placed, the balconies over looking the lower floor, the small nooks and book stalls, and the gypsum panel extending into the space. These architectural features will be highlighted and be made to sparkle wherever possible.

The architecture also lends itself to movement, and therefore the lighting will keep with that theme. The lighting should be very rhythmic, which will encourage flow and movement. The space will have brightness patterns that attract the eye, as well as influence flow through the space. There should be many layers of light throughout the space, with visual clues as to where to go. This will guide patrons through the tunnel-like dimensions. This space will be the height of experience for the theatre, until the patrons actually see the performance in the theatre.

Concept Photos

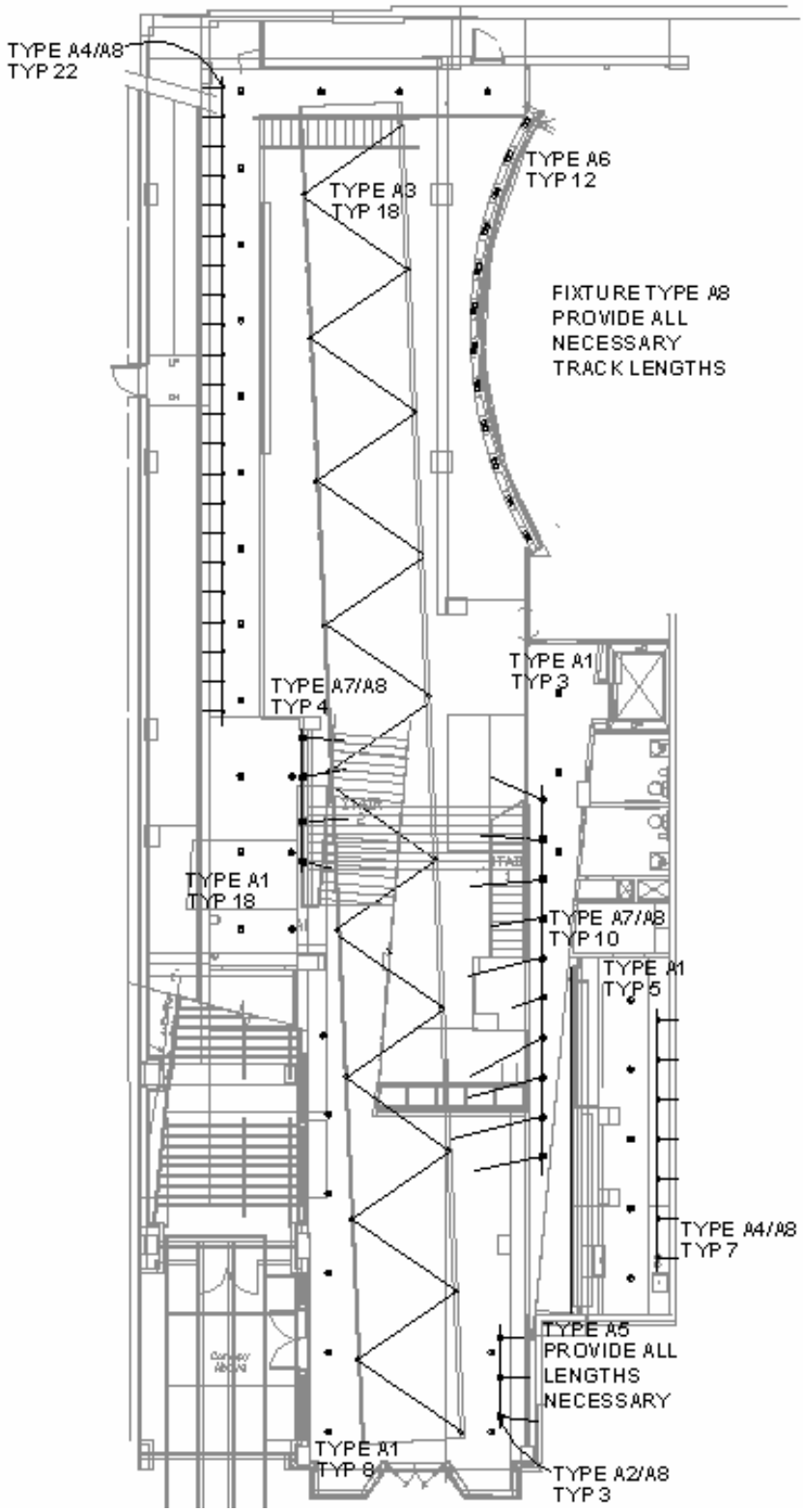


Concept Diagram

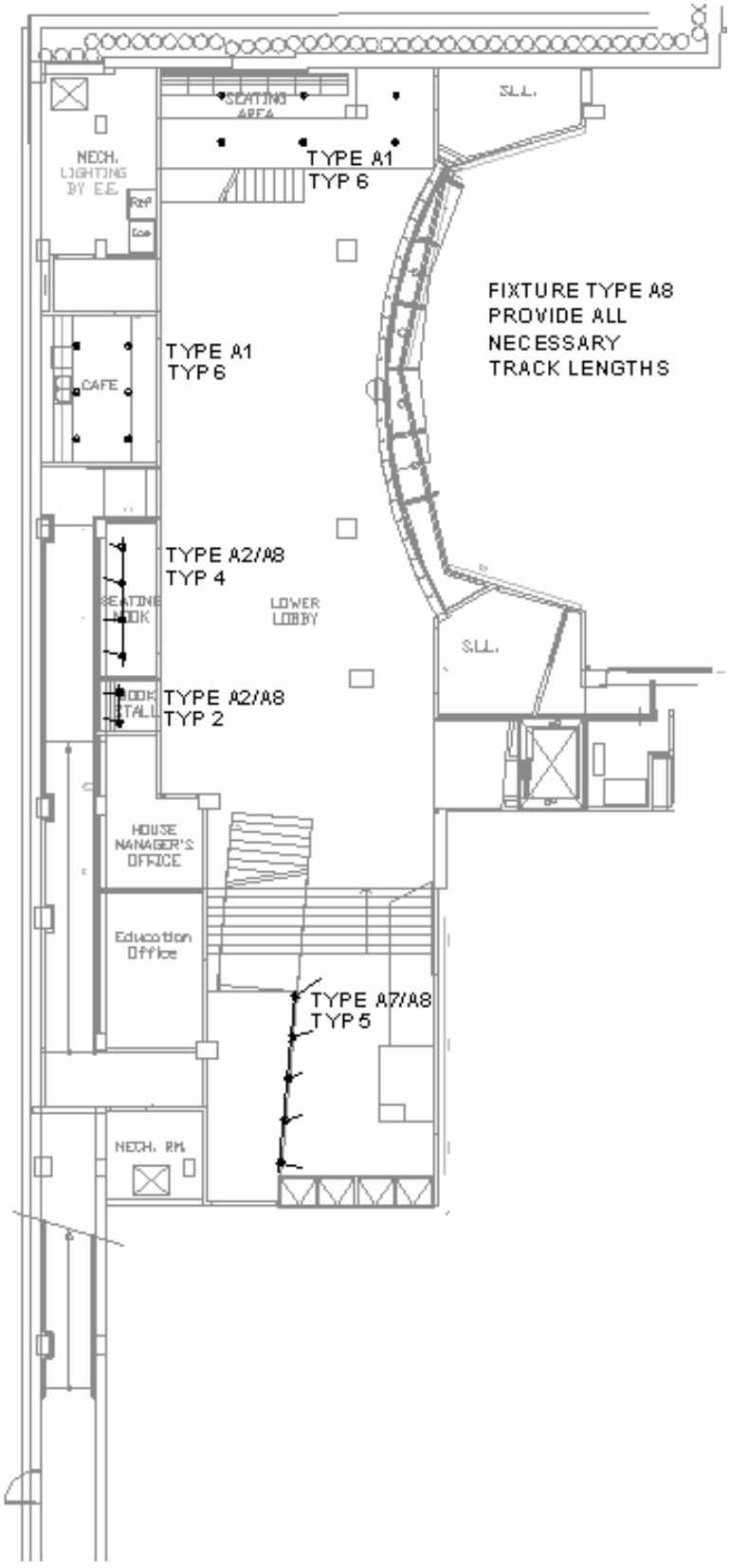


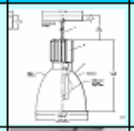
Final Design

Second Floor (Street Level) Lighting Plan



First Floor Lighting Plan



LOBBY LUMINAIRE SCHEDULE						
FIXTURE TYPE	PICTURE	DESCRIPTION	LAMP	MANUFACTURER	CATALOG NUMBER	NOTES
A1		CFL PENDANT	SYLVANIA CF32DT/E/IN/835/ECO	LIGHTOLIER	406U2-416SR	LOCATION: LOBBY DESIGN A
A2		PAR TRACK FIXTURE	SYLVANIA 50PAR36/HAL/WFL30	LSI	236-00-S	LOCATION: LOBBY DESIGN A
A3		GYPSUM PANEL MONO POINT FIXTURE	GE Q71MR16/C/NSP15	LSI	260-5E	LOCATION: LOBBY DESIGN A
A4		ART ACCENT TRACK FIXTURE	GE Q50MR16/C/FL40	LSI	260-00	LOCATION: LOBBY DESIGN A
A5		LED STRIP	1 WHITE LEDS INCLUDED	ARDEE	WW2A LAMPING PR SERIES MOUNTING	LOCATION: LOBBY DESIGN A
A6		LED COLOR CHANGING FLOOD LIGHT	36 RGB LEDS INLCUDED	COLOR KINETICS	COLORBLAST 12 116-000012-02	LOCATION: LOBBY DESIGN A
A7		PAR TRACK FIXTURE	SYLVANIA 100PAR38/CAP/IP/FL40	LSI	290-00	LOCATION: LOBBY DESIGN A
A8		TRACK	N/A	LSI	LSI 120/250V TRACK SILVER FINISH	LOCATION: LOBBY DESIGN A

Fixture, lamp and ballast cut-sheets can be found in Appendix A.

Light Loss Factors							
Fixture	Cleaning Interval	Category	BF	LLD	LDD	RSDD	LLF
A1	12 months (clean)	IV	1.00	0.86	0.94	0.97	0.78
A2	12 months (clean)	IV	1.00	0.90	0.94	0.97	0.82
A3	12 months (clean)	IV	1.00	0.90	0.94	0.97	0.82
A4	12 months (clean)	IV	1.00	0.90	0.94	0.97	0.82
A5	12 months (clean)	IV	1.00	1.00	0.94	0.97	0.91
A6	12 months (clean)	IV	1.00	1.00	0.94	0.97	0.91
A7	12 months (clean)	IV	1.00	0.90	0.94	0.97	0.82
RCR Calculated to be 3.1 Space Assumed to be Very Clean							

The cleaning interval for the lobby was assumed to be 12 months since the building is owned and maintained by the theatre company directly. The space was assumed to be a clean environment because there are no surrounding spaces where adhesive or ambient dirt would be generated.

Power Density					
Fixture	Quantity	Wattage	Total Wattage	SF	W/SF
A1	46	39	1794		
A2	9	50	450		
A3	18	71	1278		
A4	29	50	1450		
A5	230	1	230		
A6	12	50	600		
A7	19	100	1900		
			7702	5182	**1.49**

Using the input wattages for the specified ballast and lamps, the power density for the lobby is 1.49 W/SF. This is significantly under the 3.3 W/SF allowed for the lobby of a performing arts building.

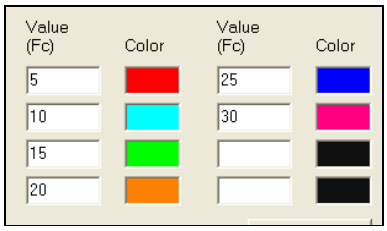
Calculation Grids

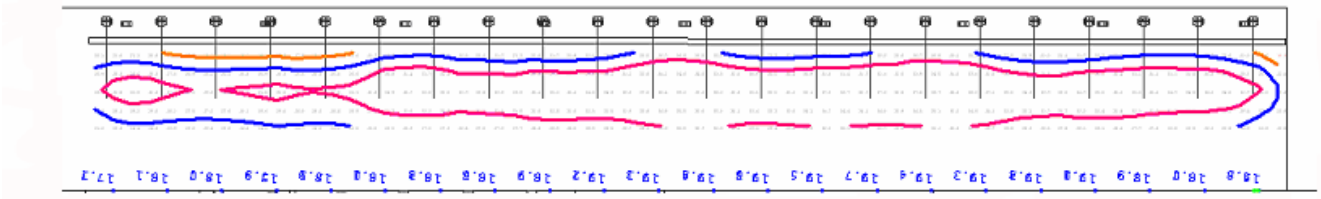
Value (Fc)	Color	Value (Fc)	Color
5		25	
10		30	
15			
20			

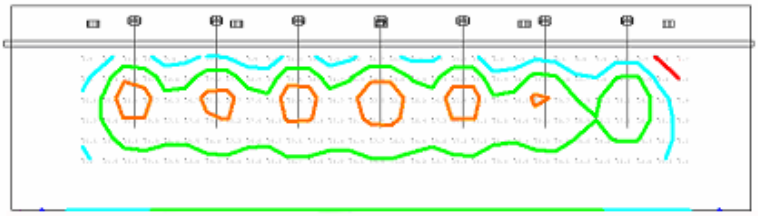
Numeric Summary						
Label	CalcType	Units	Avg	Max	Min	Avg/Min
Lower Level B_Floor	Illuminance	Fc	17.36	32.1	10.5	1.65
Lower Level_Floor	Illuminance	Fc	17.47	29.4	5.0	3.49
Upper Level_Floor	Illuminance	Fc	14.86	28.1	4.8	3.10

The average illuminance of the second floor (street level) of the lobby is 15 fc, with a maximum of 28 fc and a minimum of 5 fc. The area with the lowest light levels, about 10 fc, is directly near the entrance. This is acceptable because the entrance wall and front façade are both glass. Therefore during the day, daylight will illuminate this area. During the evening, the canopy lighting will illuminate this area. The balcony catwalk has an even distribution of 17 fc. The second floor should be slightly dimmer than the first, because there should be more contrast with the accenting of the art and gypsum panel.

The first floor illuminance is slightly higher than the second floor, having an average of 17 fc. Having the first floor illuminance level higher will encourage patrons too look up at the gypsum panel and art running through the space.







Numeric Summary						
Label	CalcType	Units	Avg	Max	Min	Avg/Min
Catwalk_Art	Illuminance	Fc	29.07	39.2	16.2	1.79
Ticket Booth_Art	Illuminance	Fc	14.62	23.0	2.7	5.41

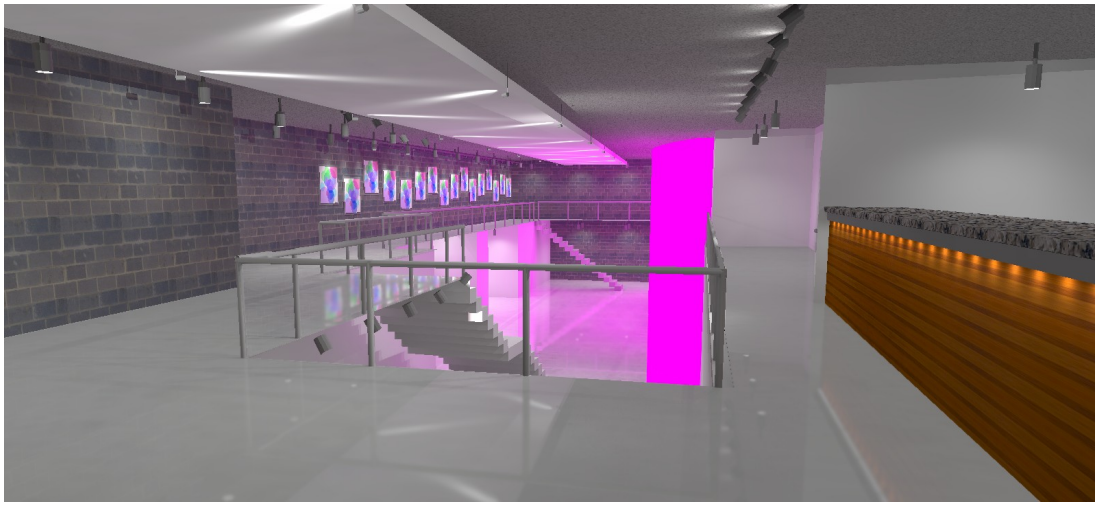
The catwalk are has an average of 30 fc, with a very even distribution of 1.79 average to minimum fc. This is important because the art of the catwalk is not constant. The even distribution will let the theatre company place any type or size art display on the wall. The ticket booth art has a lower illuminance average of 15 fc, because the ticket booth floor has a lower illuminance than the catwalk floor. The art lighting is not completely evenly distributed. There are seven permanent pictures hanging on the wall, each fixture is accent one picture. These pictures are never removed, and therefore each one can be highlighted more dramatically.

Control

The lobby lighting will be on a standard theatrical dimming rack controlled by an architectural interface. The lobby lighting will be zoned according to type of fixture and area of the room. All lobby fixtures will be controlled by this system. The accent fixtures lighting the gypsum ceiling panel will be on a chase sequence (first fixture will fade to a higher level, then second, then third and so on). The sequence will run slow, being subtle. This will make the space have a dynamic feel and will guide patrons into the tunnel like room. The LED floodlights lighting the polycarbonate wall will be color changing, so they can be set on one color, or a color changing sequence. When they are color changing, the sequence will be very slow, so it does not compete with the accents on the gypsum panel.

The lobby will have many different lighting scenes for different circumstances. Four typical preset scenes useful to the theatre company would be night performance, day performance, day ambient and night ambient. These presets could also be altered for specific needs of the event as well.

Renderings



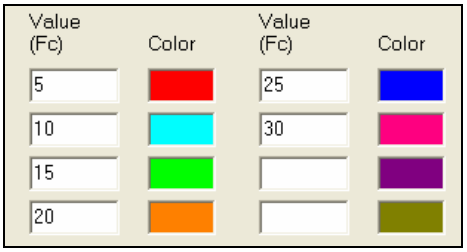
Conclusion

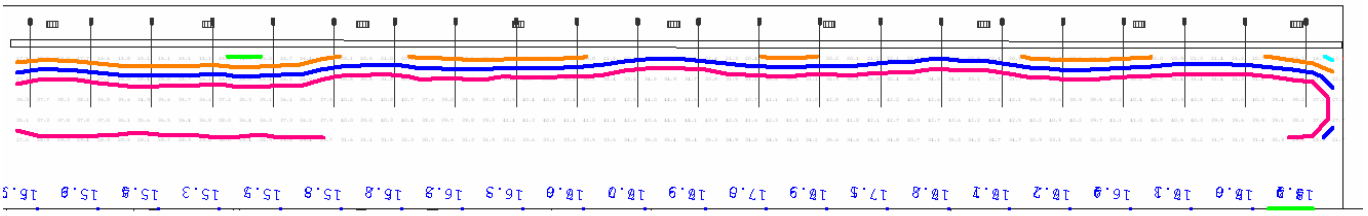
The lobby is an architecturally complex space. The lighting design must work with the architecture to enhance the space. The suspended gypsum panel is one of the most important features in the lobby. The accent lighting on the stark white panel will guide patrons into the space. Once led to the back of the lobby, patrons will see the 22' high light-wall. The panel and this wall are completely contrasting, adding dimension to the space. The panel is white, long and narrow, straight, and unevenly lit with accents. The light wall is robust, colored, curved and evenly distributed. These two elements are very prominent and define the space. The track used throughout the space highlights many unique features of the architecture including stairways, walls, balconies and artwork. The orange accent wall and the wood paneling on the ticket booth were lit to draw attention to their color and texture. The new design for the lobby is aesthetically pleasing, as well as fulfills the design criteria and its purpose. The lobby is a very exciting space, and with the new lighting design the space comes alive.

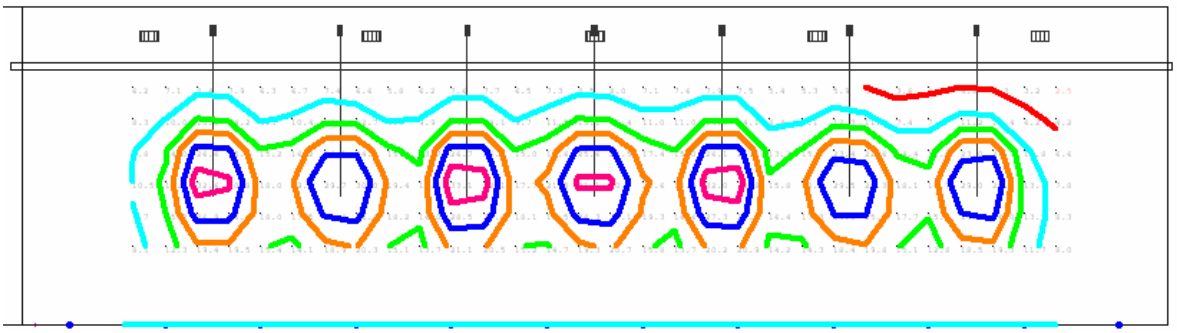
Lobby Design 2

In the second design for the lobby, the track fixtures accenting the catwalk and the ticket book art were changed from 50 W MR16 fixtures to 35 W LED fixtures. The LED fixture is fixture type A8. The fixture cut-sheet can be found in Appendix A. The design will be critiqued on performance and cost/efficiency.

Performance







Numeric Summary						
Label	CalcType	Units	Avg	Max	Min	Avg/Min
Catwalk_Art	Illuminance	Fc	32.11	44.6	13.7	2.34
Ticket Booth_Art	Illuminance	Fc	16.17	33.1	2.5	6.47

The average illuminance on both the catwalk art and the ticket booth art is only about 1 fc to 2 fc higher using the LED fixture. This is because the LED fixture's rated lumens are 100 lumens more that the MR16 fixture. Due to this fact, the LED fixture could actually be compared with a 71 W MR16. The LED fixture provides a very even distribution on the catwalk art, and a diverse distribution on the ticket booth art, just as the MR16 fixture does. The LED fixture has 100% lumen maintenance, whereas the MR16 only has 90%. The CCT and CRI of both fixtures are equivalent.

Efficiency and Cost

The rated lamp life for the LEDs is 50,000 hours. This is much longer than the lamp life of 6,000 hours for the MR16. The wattage of the LED fixture is also less, 35W compared to the 50 W for the MR16. Below is a calculation of the money saved on electricity with the new design, using the LED track versus the MR16 track.

* Average number of hours on per year:	2496
* Electric cost per kilowatt hour:	0.08

Lamp 1

Lamp name:	MR16
* Watts (fixture watts/# of lamps):	50
* Cost (including disposal cost):	$ 7
* Life in hours:	6000
* Cost of labor to replace lamp:	$ 0
Mean lumens:	900

Lamp 2

Lamp name:	LED
* Watts (fixture watts/# of lamps):	35
* Cost (including disposal cost):	$ 0
* Life in hours:	50000
* Cost of labor to replace lamp:	$ 0
Mean lumens:	1000

CALCULATE

Results

	Lamp 1	Lamp 2
Lamp name:	MR16	LED
Cost over lamp life:	$31	$140
Cost per 1,000 hours:	$5.17	$2.8
Cost per year:	$12.9	$6.99
Cost per million lumen hours:	$5.74	$2.8

Savings with Lamp 2: $5.91 /year

According to this energy analysis, every LED fixture saves about $6.00 per year. For the lobby design there are 29 fixtures. This would give a total savings of $174 per year. This does not take into account the initial cost of the fixture (at least $200 more than the MR 16 fixture).

In the calculation below, the initial cost of the LED fixture is taken into account, and a payback is generated for the new system.

* Required

* Number of fixtures:	29
* Average number of hours on per year:	2496
* Your electric cost per kilowatt hour:	$ .08
* Watts per fixture used in current system:	50
* Watts per fixture used in proposed system:	35
Cost to upgrade each fixture*:	$ 200

CALCULATE

Results

Cost of Electricity			Energy Savings (with proposed system)		
Current system:	$289.54	per year	Each fixture:	$3	per year
Proposed system:	$202.68	per year	Total:	$86.86	per year

Using only your energy savings, you will get your full investment back in **800 months (66.67 yr.)**

In this calculation, the efficiency of the fixture does not outweigh the extra cost. A payback of 67 years is too long of a payback. If there were more fixtures being replaced in the space, or if the MR16 fixtures were using 71 W lamps, the benefits would have been greater.

Conclusion

LEDs are the newest technology in lighting design. They are getting better and better every day, with more options for fixtures, brighter lamps and better dimming solutions. Yet they are not the best solution in every case. In this design, the LEDs would save a small amount of money on electricity, but the payback of the initial cost is probably longer than the system will even be installed. Therefore the LEDs should not be used. The reliable, cheap and versatile MR16 should be kept for the track lighting of the catwalk and ticket booth artwork.

Canopy

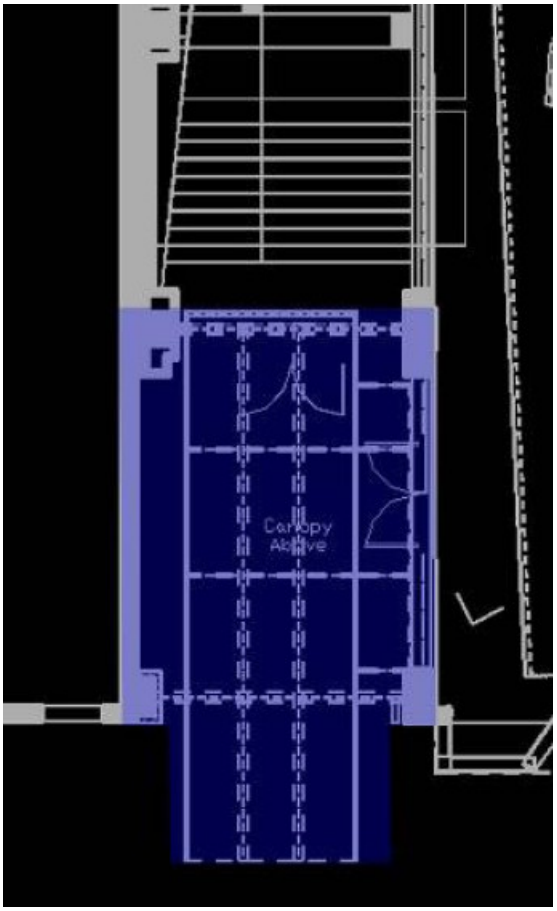
Space Overview

The Woolly Mammoth Theatre sits on a busy street in downtown DC. It has a historic brick façade facing this street and remains very low-key. The doors to this storefront remain closed. To enter the theatre, patrons must go around the corner.

The alley does have a canopy to make it more apparent. The canopy is made of black steel columns/beams and a plastic glazing panel. There is also an area to hang advertisements for upcoming shows. Yet this canopy is not glitzy or glamorous. It has an industrial feel, which will prevail throughout the space.

The canopy will direct patrons to the entrance of the theatre. The appearance of the luminaires will foreshadow what will be seen throughout the building. There should be accent lighting on the wall of the adjacent building where posters are being displayed. This area should have sparkle and be eye-catching. The steel and glass surfaces should appear to be beautiful.

The majority of the theatre company's shows are in the evening hours. The theater should blend in to the cityscape during the "work day". Once it becomes dusk, the full view of the theatre should become apparent from the outside.



Materials in the space

- black steel structure — reflectance = 20%
- brick walkway — reflectance = 35%
- brick and glass façade of theatre on one side
- brick adjacent building facade

Glazing

- polycarbonate panel
  Polygal: translucent extruded polycarbonate sheet with internal ribbing and smooth flat exterior surface, Color Ice

Horizontal Illuminance

According to IESNA Handbook there should be 5 footcandles of horizontal illuminance on the ground. There should also be at least 3 footcandles of vertical illuminance.

Power Density

According to the ASHREA 90.1 (2004), using the Space- By- Space method, the power density allowed for an entrance canopy is 1.25 W/SF.

Schematic Design/Design Intent

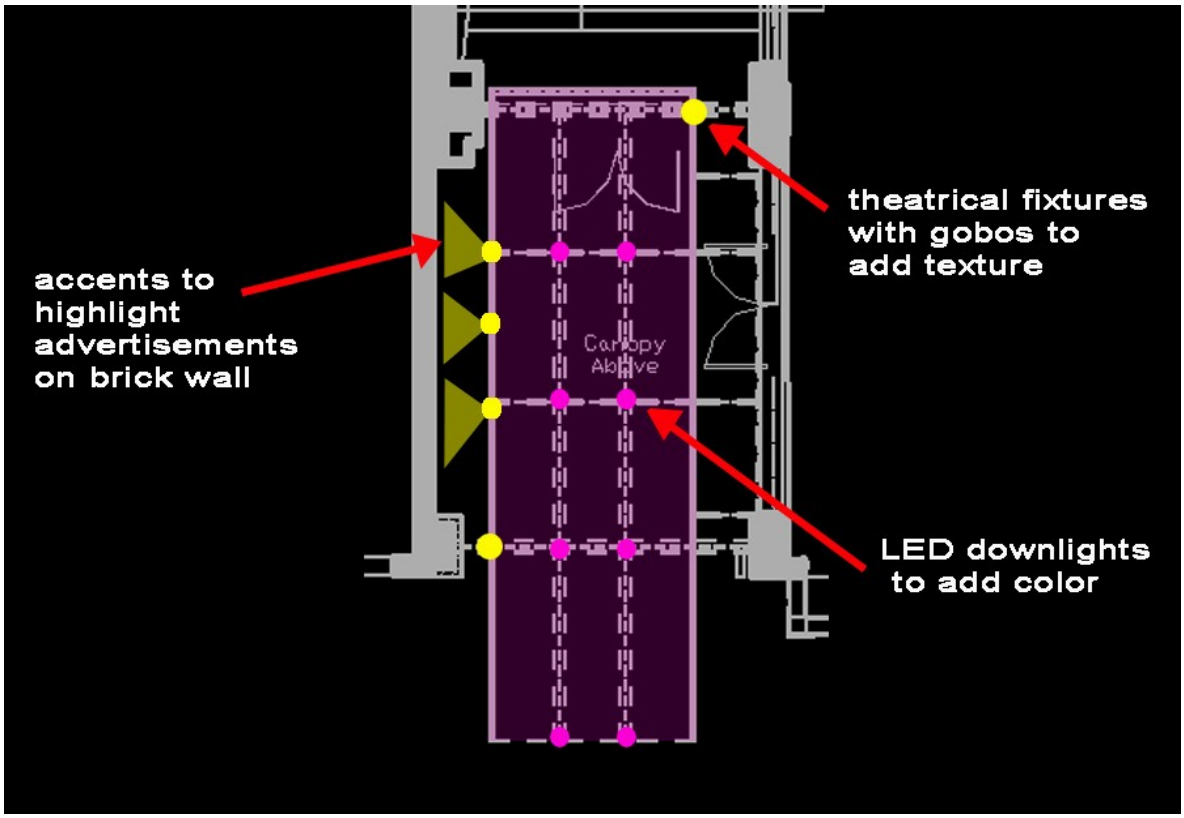
Design Goals

- Eye-catching
- Peeks Interest
- Depth
- Foreshadow What Is Inside

The entrance to the Woolly Mammoth Theatre is located in an alleyway. To make the canopy eye-catching during hours of operation, color and texture were used. The RGB LED downlights will be able to be a variety of colors. This will peek the interest of on-lookers. They will want to know what is inside the building. The two theatrical fixtures will be very close to white light. They will have gobos to add texture to the canopy floor. The layering of light will give the space depth. All of these features will foreshadow the color and texture to be seen once entering the building.

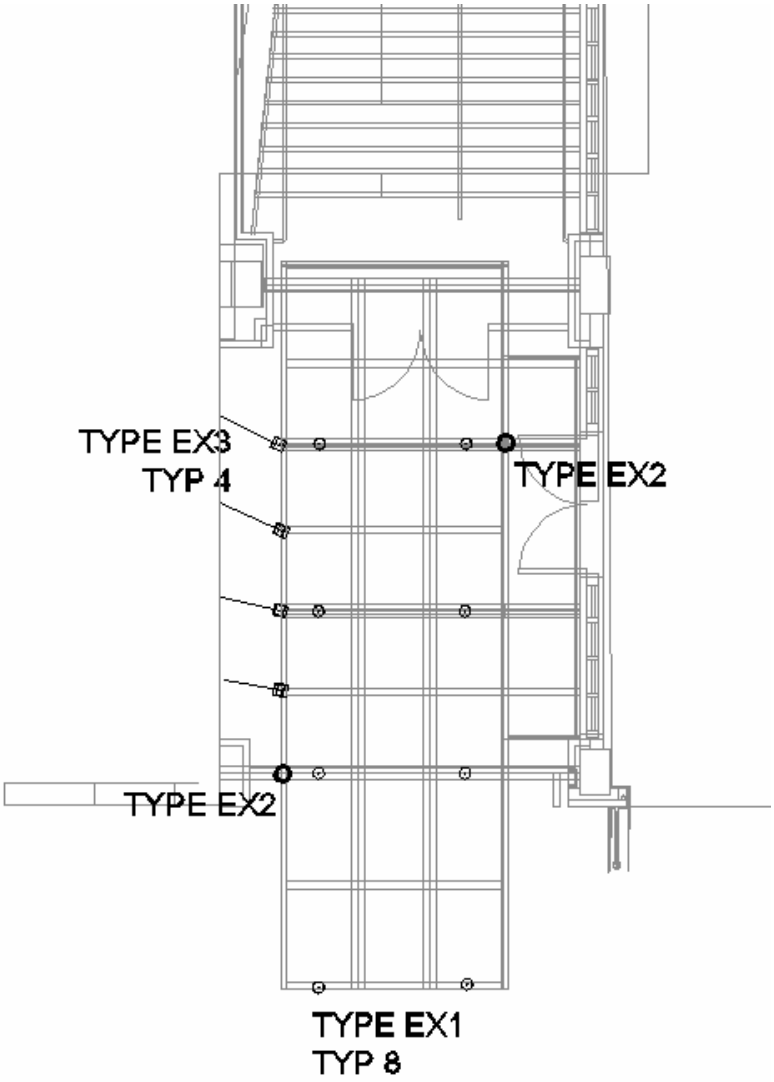
Concept Photos

Concept Diagram



Final Design

Lighting Plan



CANOPY LUMINAIRE SCHEDULE						
FIXTURE TYPE	PICTURE	DESCRIPTION	LAMP	MANUFACTURER	CATALOG NUMBER	NOTES
EX1		RGB LED SPOTLIGHT	31 LUXEON HIGH LUX LEDS	TIR	DES-30-RGB-BLK-DMK	LOCATION: CANOPY
EX2		THEATRICAL FIXTURE PROVIDE WITH SPECIFIED GOBO	SYLVANIA HPL375	ETC	426J-400PH-M	LOCATION: CANOPY
EX2A		ROSCO	N/A	ROSCO	DOT BREAKUP 77053-0660	LOCATION: CANOPY
EX3		YOKE MOUNTED HALOGEN CYLINDER	SYLVANIA 50PAR30CAPIRNFL25	LSI	FB-30-B	LOCATION: CANOPY

All fixture, lamp and ballast cut-sheets can be found in Appendix A.

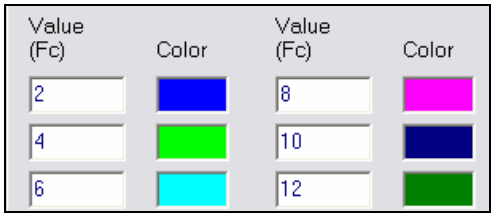
Light Loss Factors							
Fixture	Cleaning Interval	Category	BF	LLD	LDD	RSDD	LLF
EX1	12 months (medium)	IV	1.00	1.00	0.89	0.94	0.84
EX2	12 months (medium)	IV	1.00	0.90	0.89	0.94	0.75
EX3	12 months (medium)	IV	1.00	1.00	0.89	0.94	0.84
RCR Calculated to be 5.6 Space Assumed to be Clean							

The cleaning interval for the canopy was assumed to be 12 months since the building is owned and maintained by the theatre company directly. The space was assumed to be a medium environment. The canopy is an exterior space, but is in between two large buildings in an alley. Therefore the amount of dirt would generated is not high.

Power Density					
Fixture	Quantity	Wattage	Total Wattage	SF	W/SF
EX1	8	35	280		
EX2	2	375	750		
			1030	550	**1.87**
EX3	4	50	200	550	**0.36**

Using the input wattages for the specified ballast and lamps, the power density for the canopy is 1.87 W/SF. This is slightly over the allowed 1.25 W/SF. Taking into account the power allowances of the other redesigned spaces, all of which were significantly under the allowed power density, the canopy being over is acceptable. Fixture type EX3 is an exception in the power density calculation because it is an integral part of advertising.

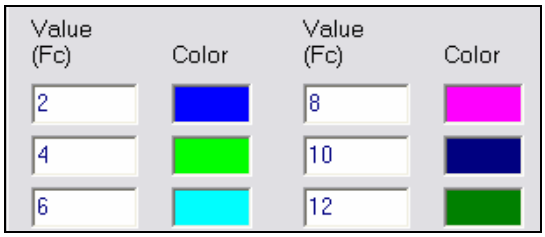
Calculation Grids

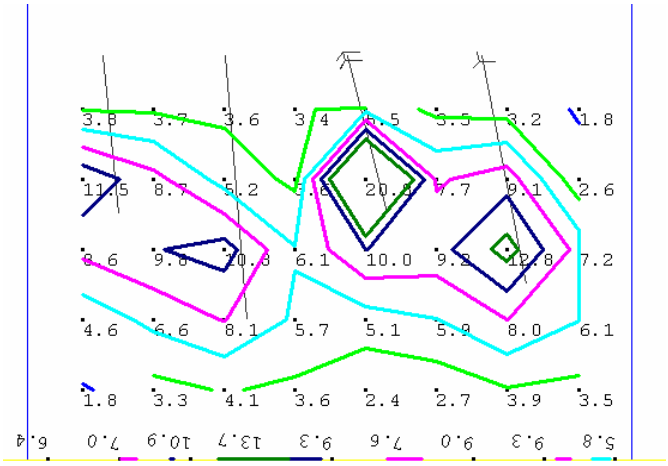


Numeric Summary						
Label	CalcType	Units	Avg	Max	Min	Avg/Min
Wall	Illuminance	Fc	6.19	20.8	1.8	3.44
Ground	Illuminance	Fc	6.24	13.7	2.0	3.12

The average illuminance of the canopy floor is 6 fc, which fulfills the suggested value of 5 fc. The lighting is evenly distributed over the canopy floor with a average to minimum fc ratio of 3.12. This is ideal because the colored light should be as even as possible to give the canopy space a glowing feel. The theatrical fixtures with gobos were not taken into account in this calculation. They will add light to the space, but will be used strictly for texture.

Advertisements on Brick Facade



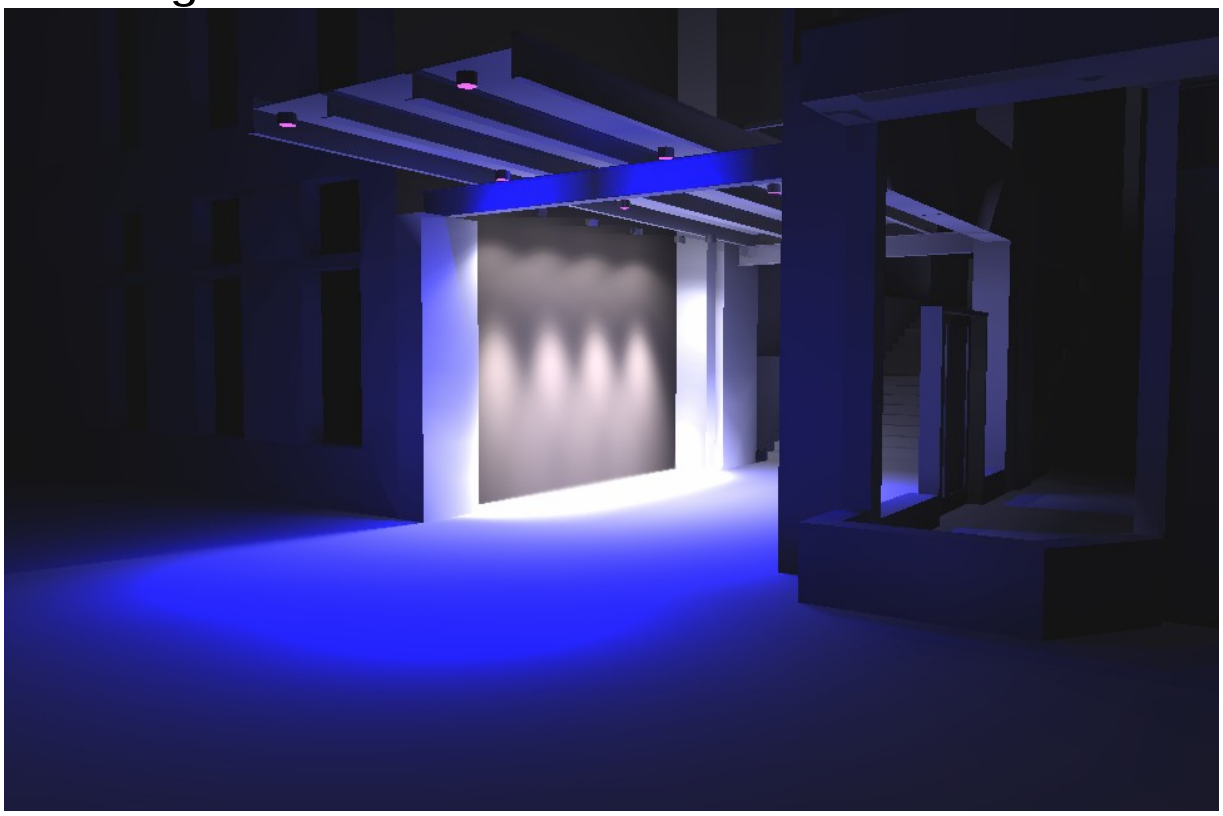


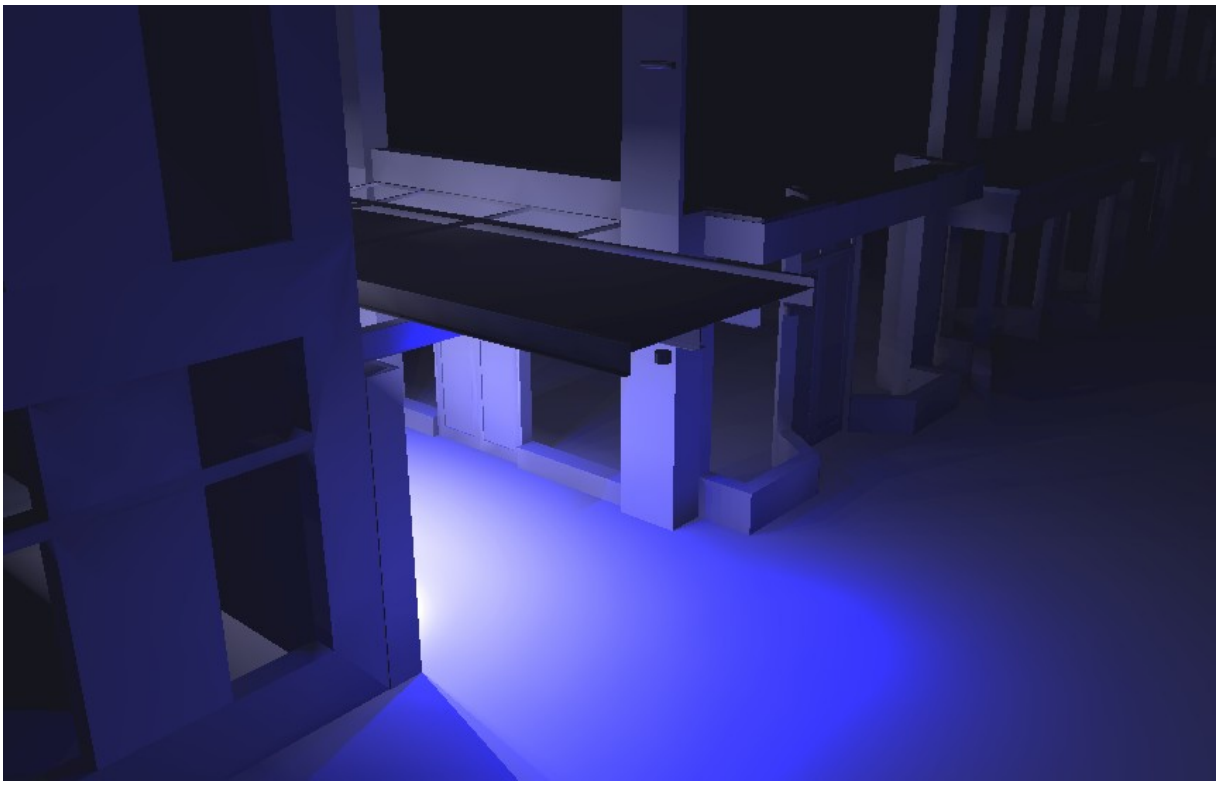
The aiming of the accents on the brick façade is adjustable, and can be changed with the size of the advertisement. In this calculation the accents were arbitrarily aimed as if there were two advertisements. This façade has significantly more illuminance than the canopy area itself. This will direct the patron's attention to the advertisement.

Control

The canopy lighting will be controlled by the same system as the lobby. This will allow the LED fixtures to be color changing on a sequence. Also the accents for the advertisements and the theatrical fixtures can be dimmed. The exterior zones will not be on during the day, unless it is a very dark day. If necessary the advertisement lighting can be used to add light to the space during daytime hours. All the exterior fixtures will be turned on at dusk.

Renderings





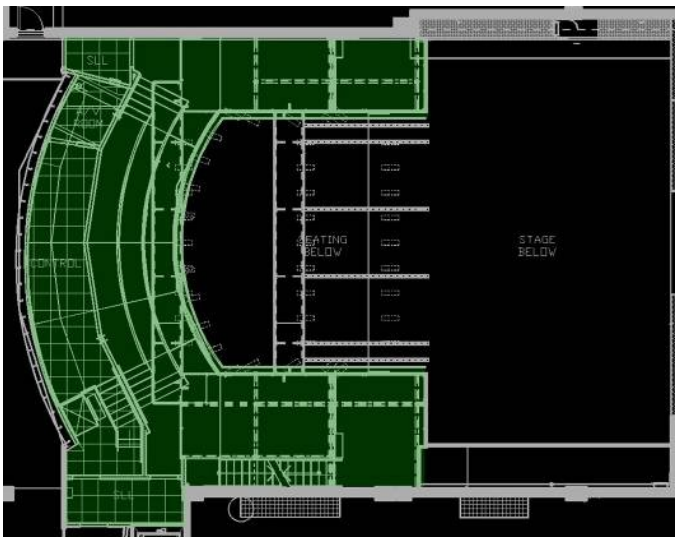
Conclusions

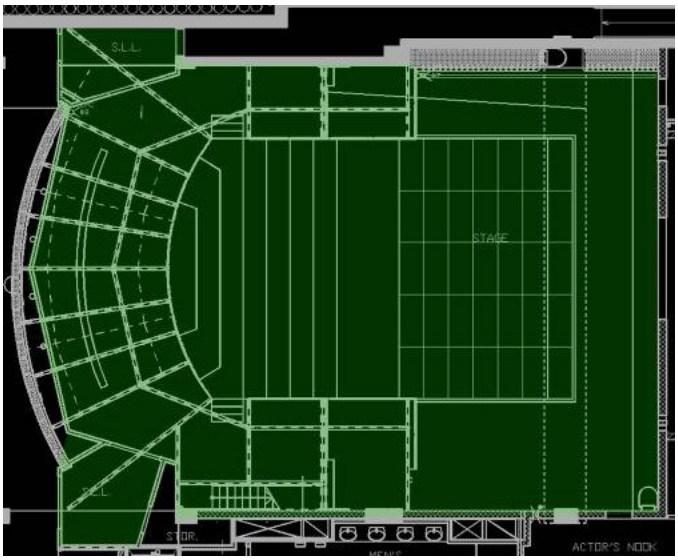
The canopy of the Woolly Mammoth Theatre is located in an alley off of the main road. This adds to the mystery of the theatre, because it is almost lost in the cityscape. During the day the theatre will blend in with the surrounding buildings, but at night the space will come alive. The lighting design for the canopy is edgy, using high-tech fixtures and control. Color and texture are used to grab the attention of outsiders. The space shows people a glimpse of what can be seen inside the building. The new design for this space fulfills the design criteria as well as embraces the lighting design concept.

Theatre

Space Overview

Entering the theatre through the main entrance on the orchestra floor, there is no grand entrance. The doors are awkwardly placed behind a concrete column. The theme of the theatre is to be intimate and edgy. It is a 6,000 SF space with seating on two levels, 187 orchestra and 78 balcony plus standing room. The theatre has a courtyard configuration designed to connect the audience and actors in this cozy setting. The space is high and deep, making it very flexible. The main finish throughout the theatre is black. The only color in the space is the maple seat backs, the wood slats on the balcony fronts and the red accent wall at the back of the theatre.





Materials in the Space

- concrete slab ceiling- clear finish — reflectance = 20%
- concrete block walls- clear finish — reflectance = 20%
- concrete block walls- black stained finish — reflectance = 10%
- concrete wall- clear finish — reflectance = 20%
- concrete wall- black stained finish — reflectance = 10%
- red painted gypsum wall — reflectance = 30%
- concrete slab floor- clear satin finish — reflectance = 30%
- carpet- dark gray — reflectance = 10%
- light wood paneling on balcony fronts
- black upholstered seats
- black metal catwalks
- metal railings

Design Criteria

General

Before and after a performance, the theatre house lighting will be on. This lighting should be diffuse and comfortable. In this time patrons will be entering and exiting the theatre, finding their seats, reading programs and waiting for the performance to begin.

The lighting should have some accenting or visual interest, as patrons may be waiting lengths of time in their seats. The space should appear to be at a high quality in appearance. Color rendering and facial modeling are very important to achieve this.

The general lighting should be on dimming control. Also “panic” switches independent of dimmers and switches should be provided to bring on selected house lights in case of an emergency. Emergency house lighting, exit lighting, and aisle lighting are all necessary.

Illuminance and Luminance Values

A minimum of 10 to 20 footcandles should be maintained throughout the seating area when a performance is not taking place. Higher illuminances of 30 footcandles are required to perform visual tasks, such as rehearsals, cleaning and maintenance of the space. During performances emergency light levels must be 0.2 footcandles.

Power Density

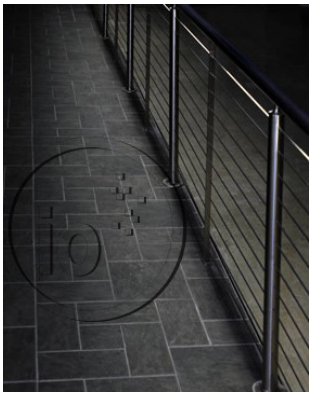
According to Ashrea 90.1 the power density for an audience/seating area in a performance space is 1.8 watts/sq. ft.

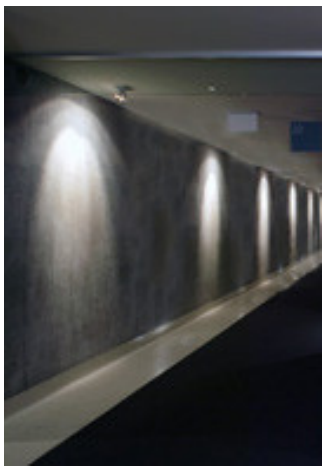
Schematic Design/Design Intent

- Intimate
- Subdued
- Sparkle

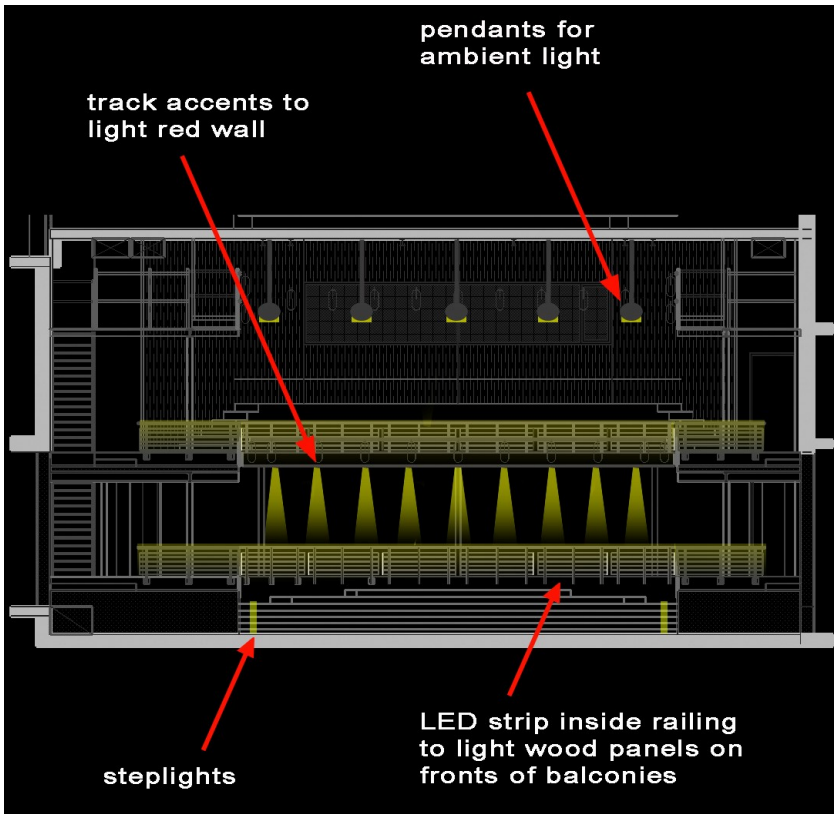
The lighting for the theatre must come alive in a different way than the previously discussed spaces. The main function of the theatre is to hold the performance. For that reason the lighting before and after the show should not compete with the show itself. The house lighting should prepare the audience for the production. Staying with the architectural concept of the theatre, the lighting should enhance the intimate feeling of the theatre. Sparkle should be added to the space. This will be accomplished by expressing the equipment and the actual theatre mechanics to enhance the space and add sparkle. The lighting of the theatre will be subtle, yet still make the space come alive.

Concept Photos



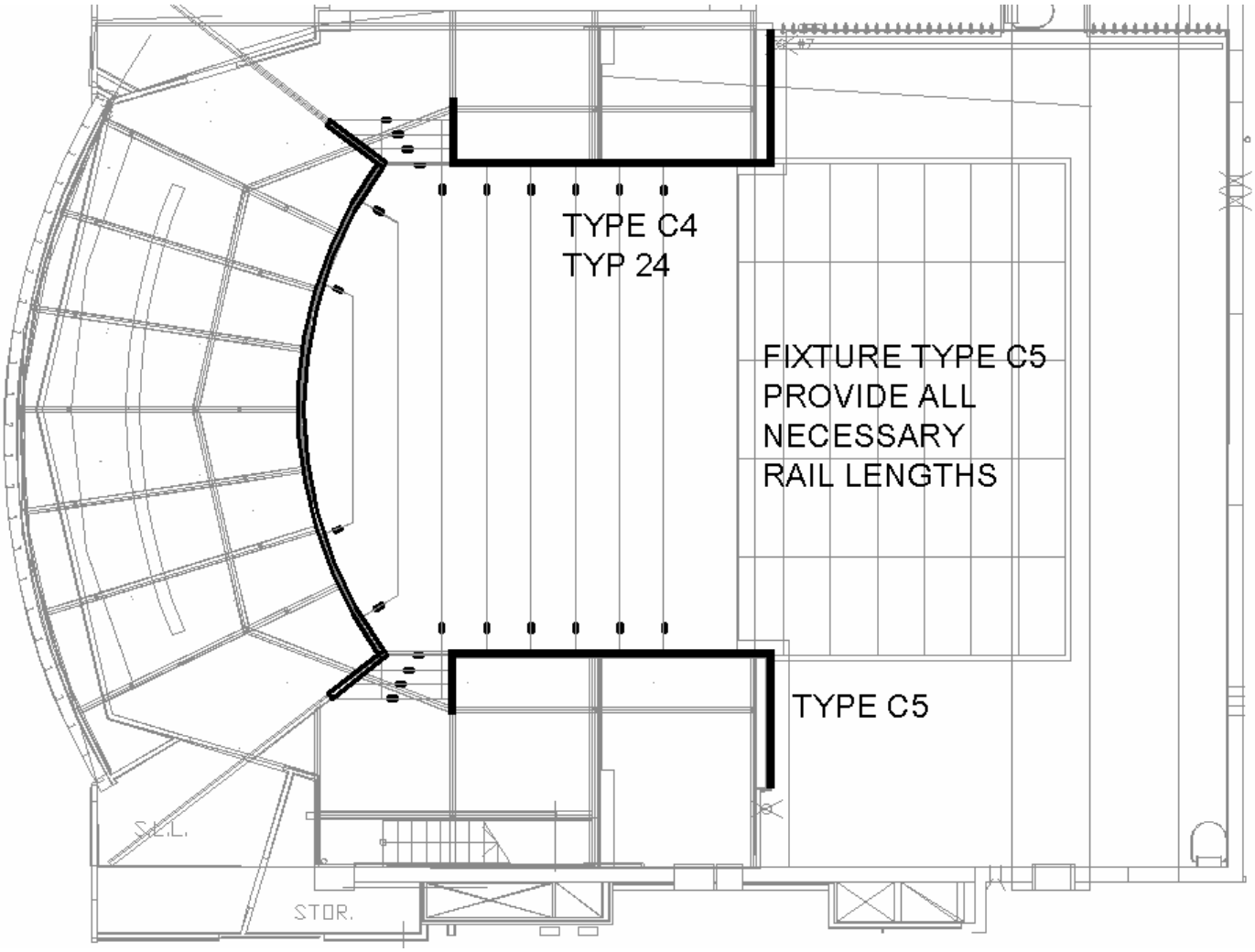


Concept Diagram

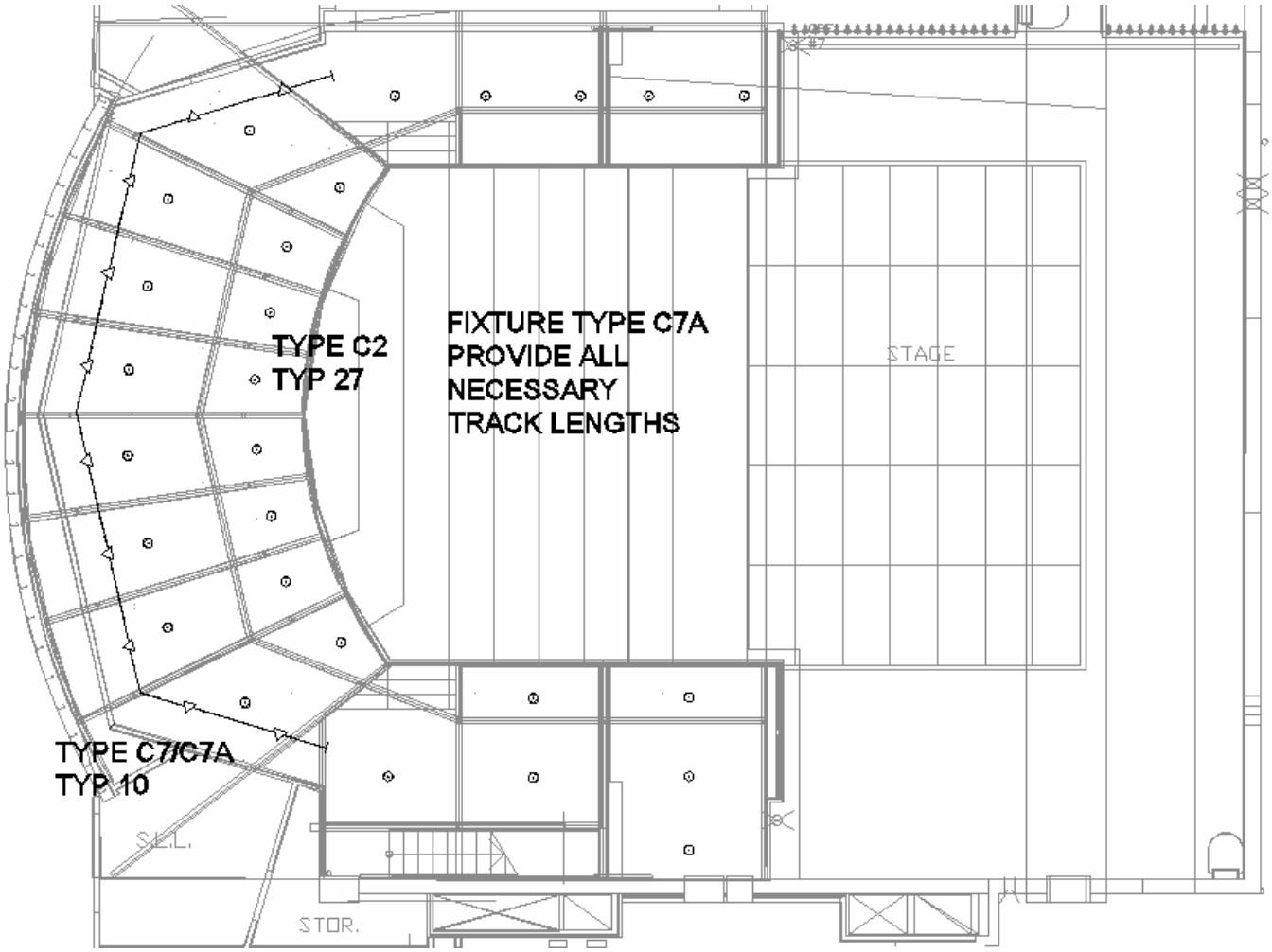


Final Design

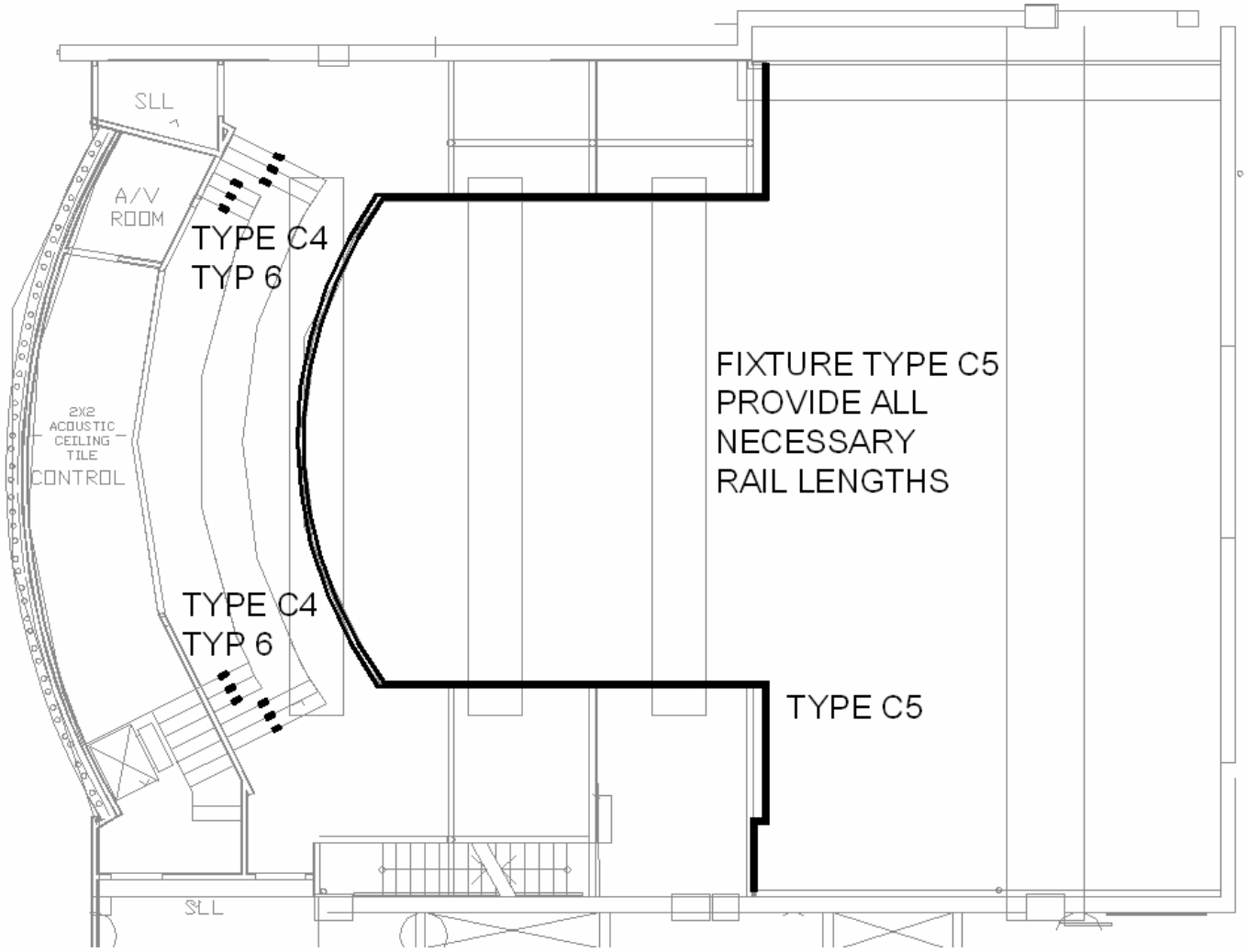
Orchestra Level Lighting Plan



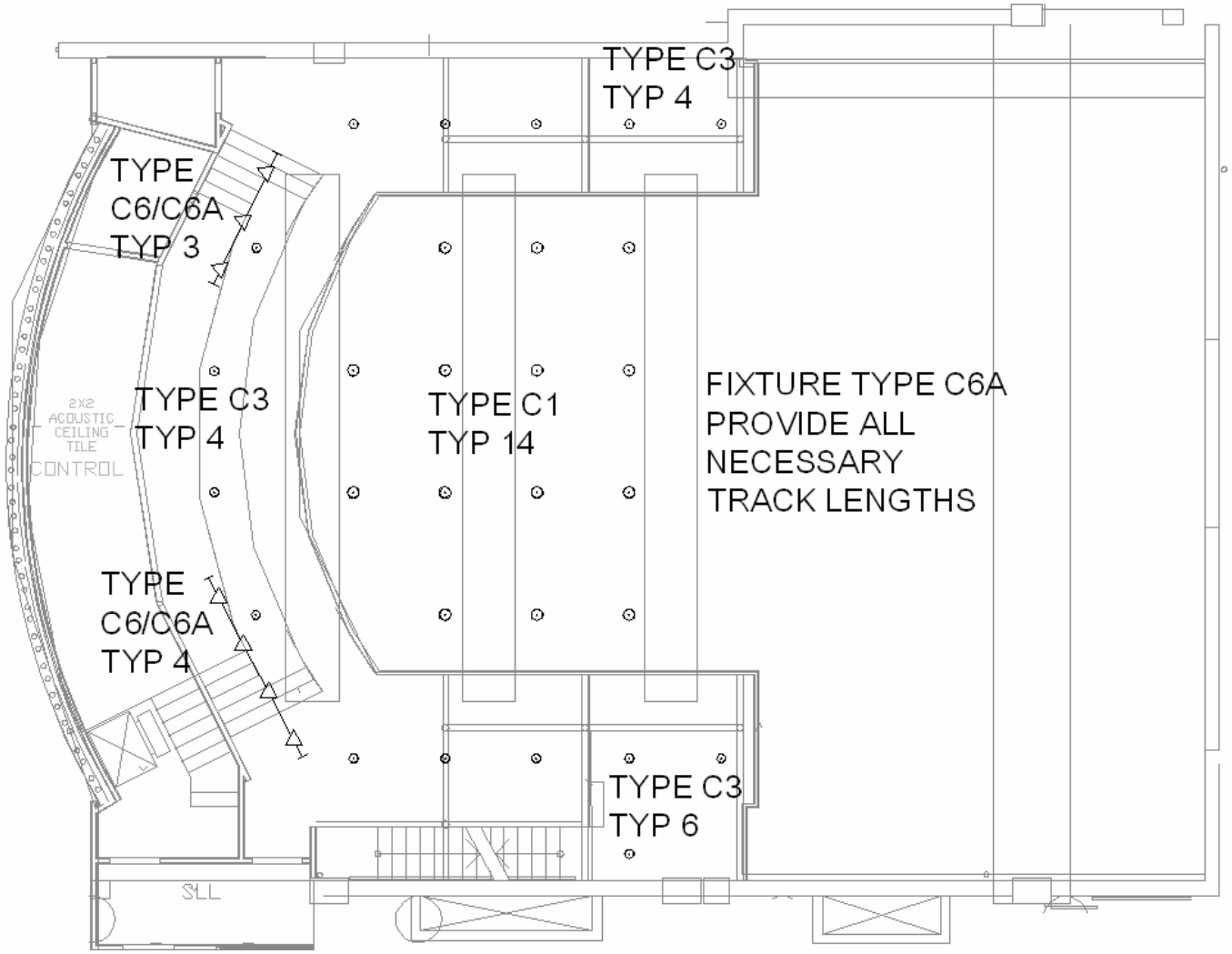
Orchestra Level Lighting RCP

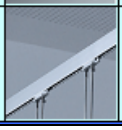


Balcony Plan



Balcony Level RCP



THEATRE LUMINAIRE SCHEDULE						
FIXTURE TYPE	PICTURE	DESCRIPTION	LAMP	MANUFACTURER	CATALOG NUMBER	NOTES
C1		LARGE CFL PENDANT	SYLVANIA CF42DT/E/IN/835/ECO	DELRAY	7713342	LOCATION: THEATRE
C2		CFL SURACE CYLINDER	SYLVANIA CF32DT/E/IN/835/ECO	KURT VERSEN	P913-DM	LOCATION: THEATRE
C3		CFL PENDANT CYLINDER	SYLVANIA CF42DT/E/IN/835/ECO	KURT VERSEN	P914-DM-ES 6' STEM	LOCATION: THEATRE
C4		STEPLIGHT	SYLVANIA 20T4Q/CL/AX	LUMIERE	1201-LA	LOCATION: THEATRE
C5		RAILING LIGHT	LED 2W/FT	IO LIGHTING	LUXRAIL PROVIDE ALL NECESSARY LENGTHS	LOCATION: THEATRE
C6		SUSPENDED TRACK FIXTURE	SYLVANIA 120PAR38/HAL/NFL25	ERCO	7746.000 BLACK	LOCATION: THEATRE
C6A		TRACK	N/A	ERCO	ERCO 2- CIRCUIT TRACK PROVIDE ALL NECESSARY LENGTHS	LOCATION: THEATRE
C7		ACCENT WALL TRACK	GE Q50MR16/C/FL40	BUSCHFELD DESIGN	SHOP V-15 35703	LOCATION: THEATRE
C7A		TRACK	N/A	BUSCHFELD DESIGN	SHOPT V-15 PROVIDE ALL NECESSARY LENGTHS	LOCATION: THEATRE

All fixture, lamp and ballast cut-sheets can be found in Appendix A.

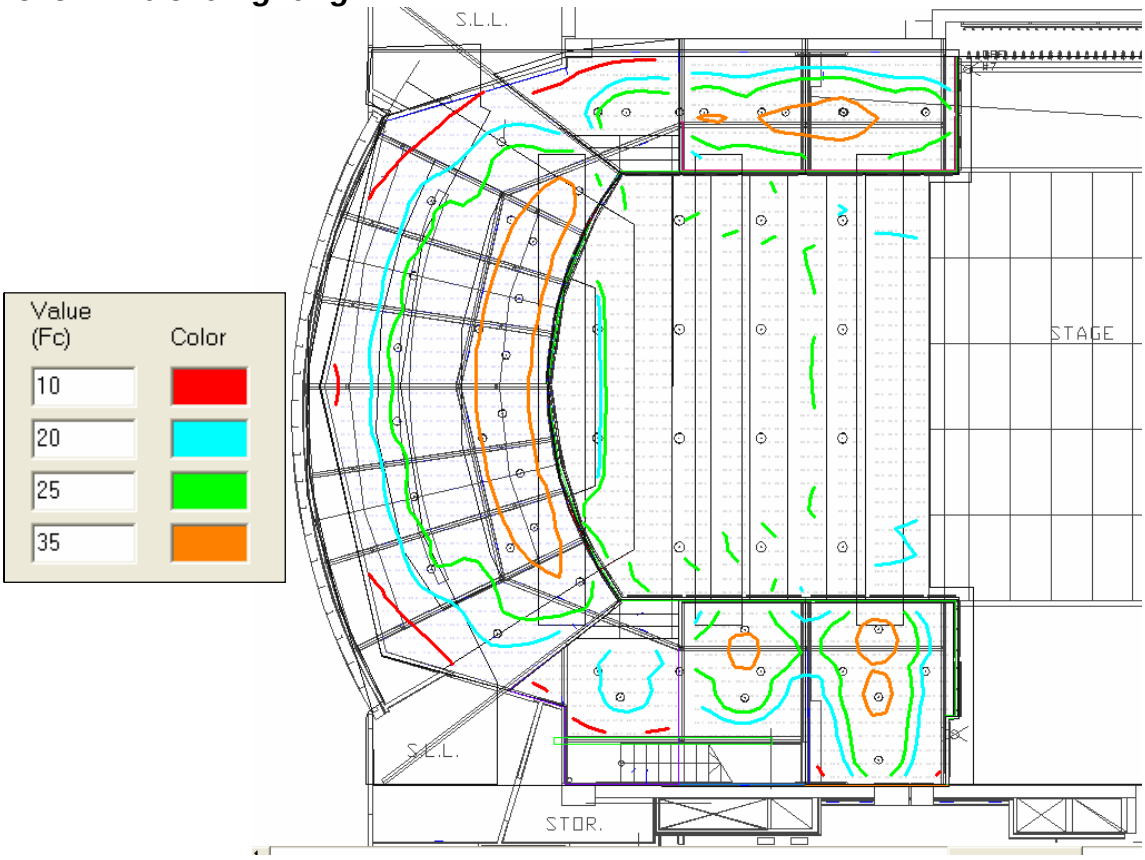
Light Loss Factors							
Fixture	Cleaning Interval	Category	BF	LLD	LDD	RSDD	LLF
C1	12 months (clean)	IV	1.00	0.86	0.95	0.97	0.79
C2	12 months (clean)	IV	1.00	0.86	0.95	0.97	0.79
C3	12 months (clean)	IV	1.00	0.86	0.95	0.97	0.79
C4	12 months (clean)	IV	1.00	0.90	0.95	0.97	0.83
C5	12 months (clean)	IV	1.00	1.00	0.95	0.97	0.92
C6	12 months (clean)	IV	1.00	0.90	0.95	0.97	0.83
C7	12 months (clean)	IV	1.00	0.90	0.95	0.97	0.83
RCR Calculated to be 4.1		Space Assumed to be Very Clean					

The cleaning interval for the lobby was assumed to be 12 months since the building is owned and maintained by the theatre company directly. The space was assumed to be a clean environment because there are no surrounding spaces where adhesive or ambient dirt would be generated.

Power Density					
Fixture	Quantity	Wattage	Total Wattage	SF	W/SF
C1	14	148	2072		
C2	27	39	1053		
C3	15	50	750		
C4	24	20	480		
C5	240	2	480		
C6	7	120	840		
C7	10	50	500		
			6175	6000	**1.03**

Using the input wattages for the specified ballast and lamps, the power density for the lobby is 1.03 W/SF. This is under the 1.8 W/SF allowed for audience seating areas of a performing arts building.

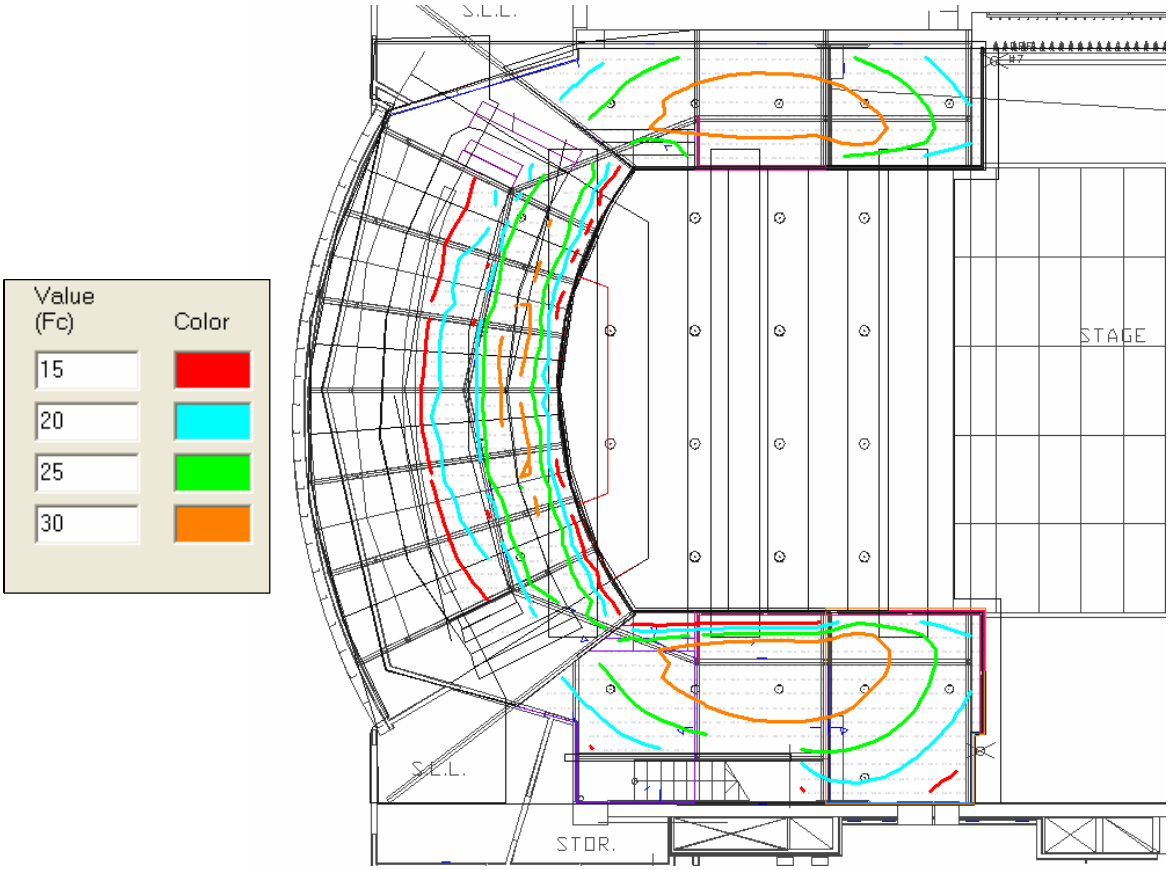
Calculation Grids
Orchestra Level Ambient Lighting



Numeric Summary						
Label	CalcType	Units	Avg	Max	Min	Avg/Min
First Floor_Row K, L, M	Illuminance	Fc	25.26	43.3	6.8	3.71
First Floor_Row C	Illuminance	Fc	23.76	25.6	19.8	1.20
First Floor_Row A	Illuminance	Fc	20.68	24.0	16.5	1.25
First Floor_Row B	Illuminance	Fc	22.75	24.4	19.8	1.15
First Floor_Row D	Illuminance	Fc	25.33	27.0	21.9	1.16
First Floor_Row E	Illuminance	Fc	25.88	27.8	21.3	1.22
First Floor_Row F	Illuminance	Fc	27.01	28.8	22.8	1.18
First Floor_Row J	Illuminance	Fc	28.27	30.9	25.1	1.13
First Floor_Row H	Illuminance	Fc	27.29	32.7	16.5	1.65
First Floor_Row G	Illuminance	Fc	27.88	30.5	20.8	1.34
First Floor_North Entrance	Illuminance	Fc	18.43	34.6	5.2	3.54
First Floor_South Entrance	Illuminance	Fc	16.19	22.6	5.8	2.79
First Floor_North Boxes	Illuminance	Fc	26.82	42.8	10.6	2.53
First Floor_South Boxes	Illuminance	Fc	24.37	39.8	8.3	2.94

The average illuminance on the orchestra level floor is between 25 and 30 fc in the seating areas. The entrance areas have an average illumination of 17 fc. These illumination levels satisfy the design criteria requirements. Before and after performances, the lighting will be dimmed to an average of 10 to 15 fc. The lighting will be on 100% when cleaning the theatre, and during rehearsals. The orchestra level has a very diffuse illumination across the space. The largest average to minimum fc ratio is 3.71, which is still an even distribution to the eye. This calculation did not take into account accent lighting.

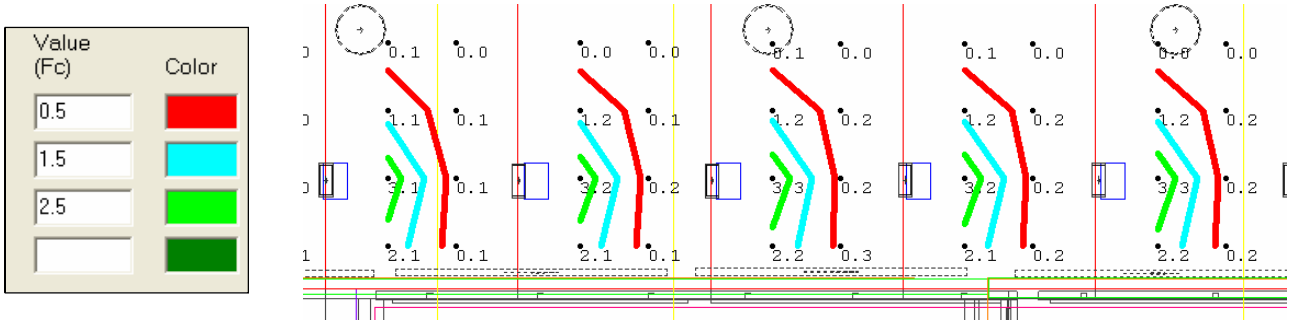
Balcony Level Ambient Lighting



Numeric Summary						
Label	CalcType	Units	Avg	Max	Min	Avg/Min
Balcony_Row B	Illuminance	Fc	23.41	30.6	6.1	3.84
Balcony_Row C	Illuminance	Fc	17.68	23.7	8.5	2.08
Balcony_Row A	Illuminance	Fc	23.17	32.4	10.0	2.32
Balcony_North Entrance and Boxes	Illuminance	Fc	26.71	34.6	15.5	1.72
Balcony_South Entrance and Boxes	Illuminance	Fc	25.12	34.6	11.9	2.11

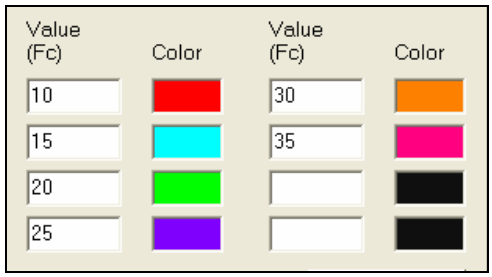
The average illuminance on the balcony level floor is between 23 and 26 fc. These illumination levels satisfy the design criteria requirements. Before and after performances, the lighting will be dimmed to an average of 10 to 15 fc. The lighting will be on 100% when cleaning the theatre, and during rehearsals. The balcony level has a very diffuse illumination across the space. The largest average to minimum fc ratio is 3.84, which is still an even distribution to the eye. This calculation did not take into account accent lighting. Therefore the average illumination of Row C will be higher.

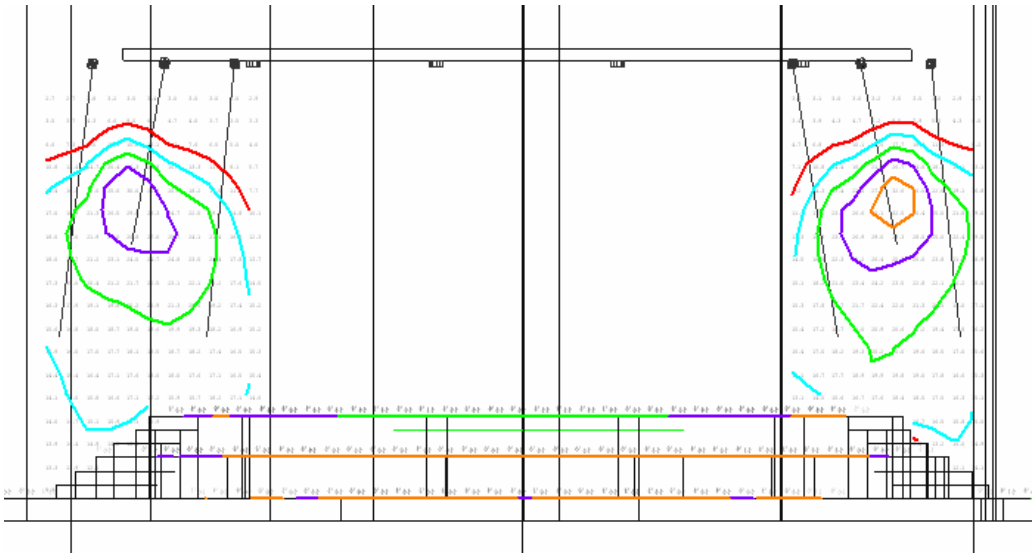
Aisle: Step lighting



The step lights in the aisle will be on during performances. They provide the necessary 0.2 fc illumination for emergency lighting.

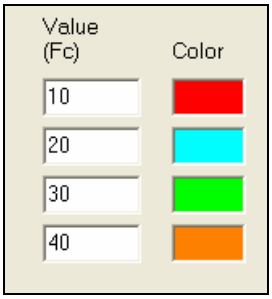
Balcony Level: Back Wall Metal Acoustical Baffles

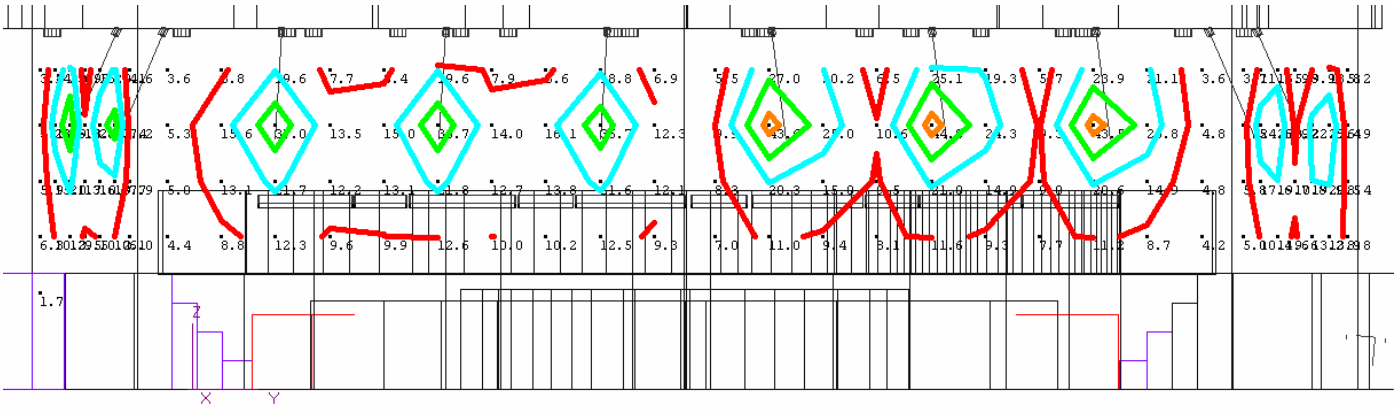




The back wall of the balcony level is metal acoustical baffle. The finish has a high quality look, and therefore is accented with track. This adds layering of light to the space, which add depth. The wall has an uneven distribution to keep with the concept of intimate. The track fixtures are on the theatrical control system and can be dimmed.

Orchestra Level: Back Red Wall





The back wall of the orchestra level is a red painted gypsum board wall. Track is run along the wall to add small scallops of light. The track is spaced far enough apart so the wall is not uniformly lit. This accenting adds subtle visual interest and sparkle to the space. The track also gives an intimate feeling to the space.

Renderings

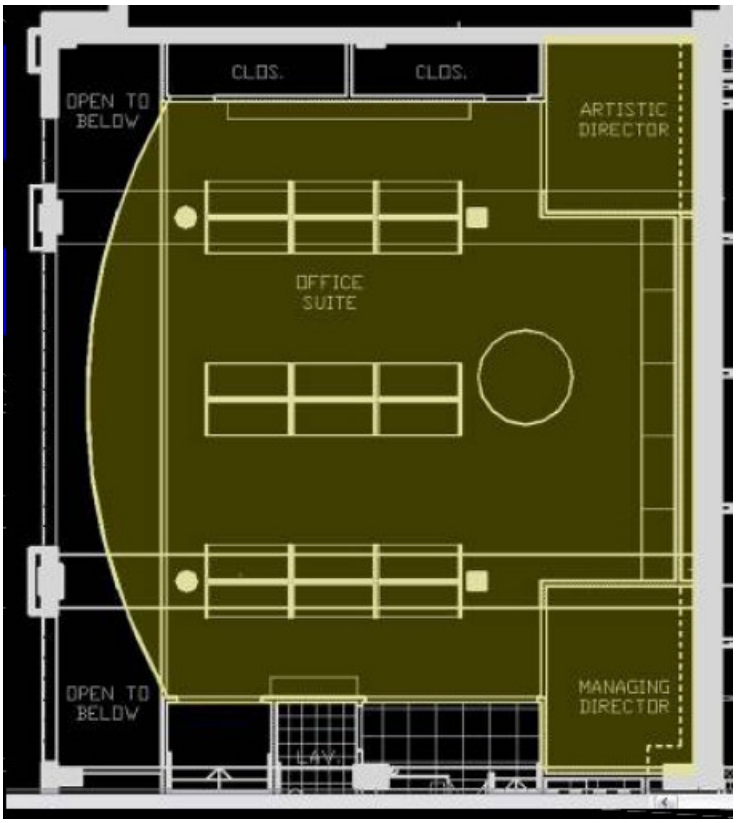
Conclusion

The theatre's architecture lends itself to an intimate atmosphere. The courtyard configuration establishes a strong connection with the audience and actors. The lighting of the theatre must not disrupt that connection. The lighting must also be subtle, so it does not compete with the production. In keeping with these goals, the theatre comes alive in a different way than the lobby and canopy. A low level of diffuse ambient light is provided for circulation needs. Track is used to accent the back walls of the orchestra and balcony levels, which both have finishes that are high quality and add visual interest. The metal acoustical baffles, when accented, add sparkle by highlighting the theatre mechanics. The wood panels on the fronts of the balconies are lit with a LED railing light, accenting the beautiful wood finish and bringing the focus away from the outer walls. This also keeps the space intimate. The lighting design parallels with the architectural concept of the theatre space, therefore enhancing the theatre environment.

Office

Space Overview

The office has an open plan with two private offices for the artistic director and the managing director. There are movable cubicles set up in three sections. It is a comfortable environment for the key personnel of the theatre to do work. The space is rather small but has a spacious feel. This was achieved by using glass for the surrounding interior walls connecting the office to the vestibule, hub area and exterior.



Material in the Space

- concrete slab ceiling- clear finish — reflectance = 20%
- orange painted gypsum walls — reflectance = 55%
- carpet- medium gray — reflectance = 25%
- cubicle partitions- light — reflectance = 60%

Glazing

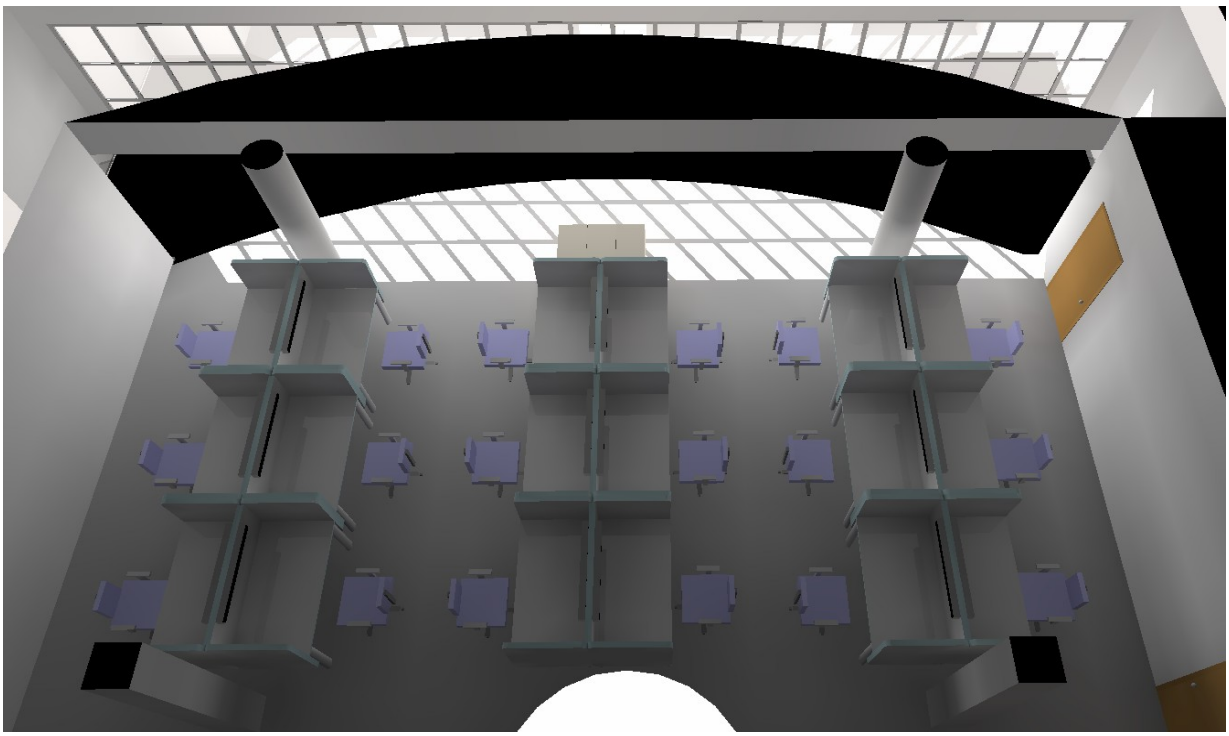
- ½" tempered glass — transmittance = 80%
- 3/8" clear laminated glazing faceted wall — transmittance = 80%

Daylighting Study

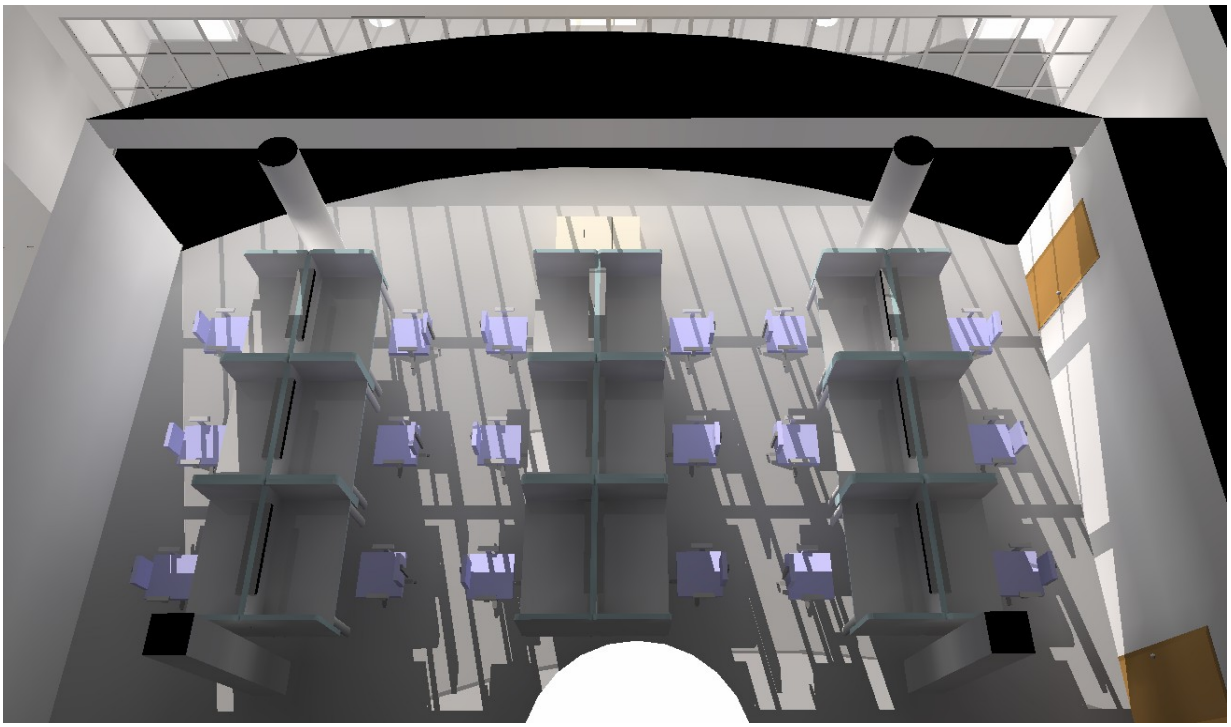
A daylighting study was conducted for the days of June 21, December 21 and March 21. These three dates are when the sky is at its highest point, its lowest point, and in the middle. The office has a full glazed wall facing west. The curved wall is 3/8" thick clear laminated glazing faceted wall. This wall is adjacent to another glass wall. The straight wall is ½" thick tempered glass. The office also has one diffuse skylight dome in the other half of the office area. This dome provides ambient lighting to the office with no direct sunlight entering the space.

The daylighting analysis was studied for two criteria, direct light hitting the work plane and ambient light levels. It is very important direct daylight does not hit the task surface in the office space. This will cause poor visibility and discomfort. Yet direct sun when used cautiously, where non-critical task occur can be a good design feature. Patterns of light and shadows from the sun add a dynamic feature to the space. They give the occupants a sense of well-being, time and orientation.

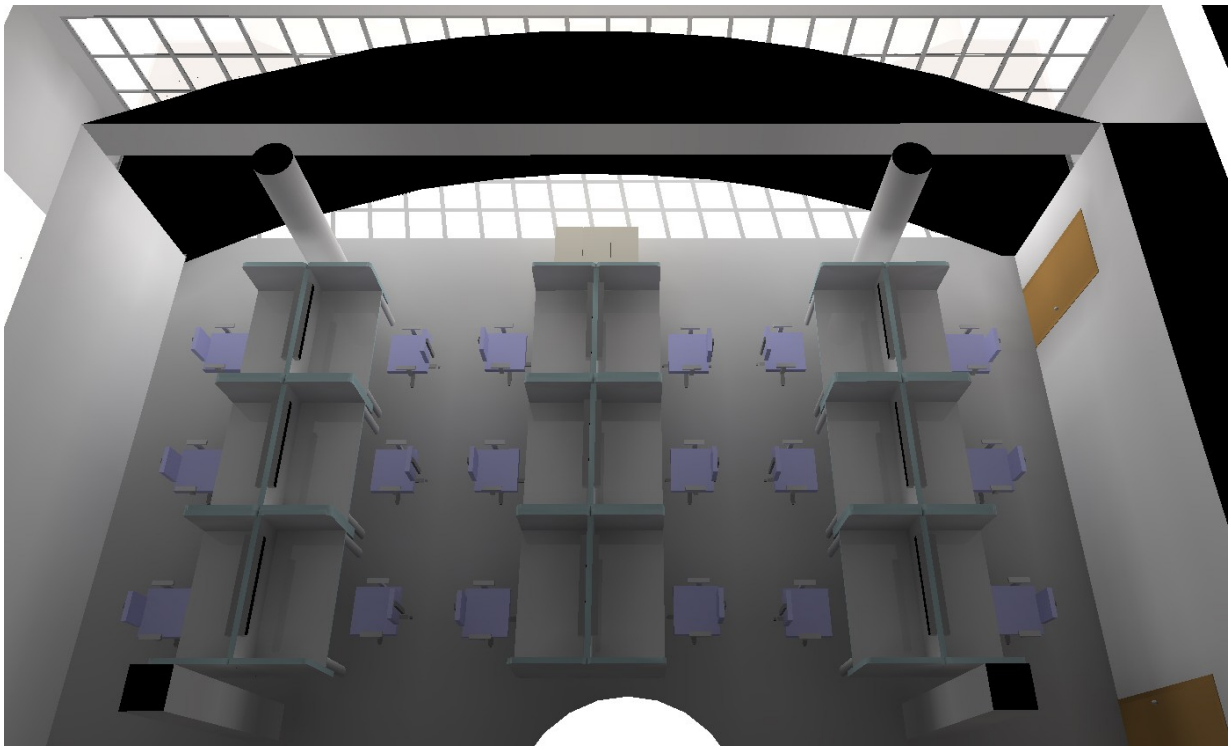
Direct Glare
March 21 3:00 PM



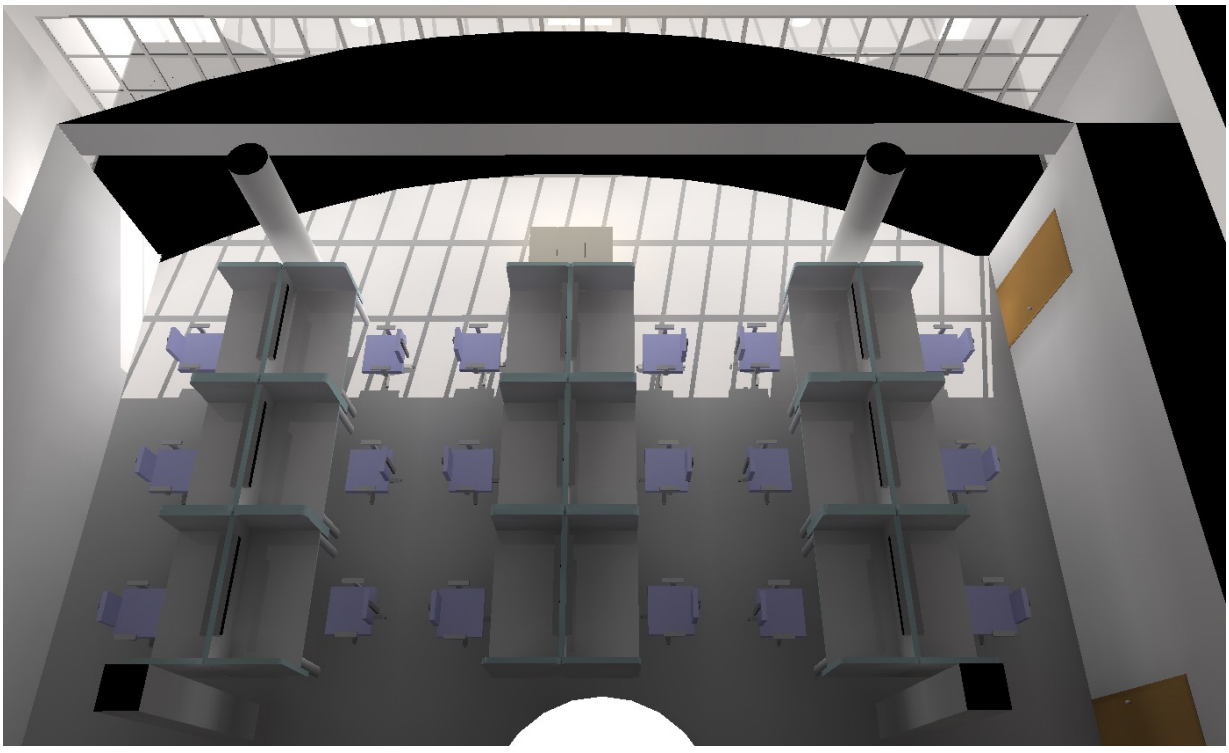
March 21 5:00 PM



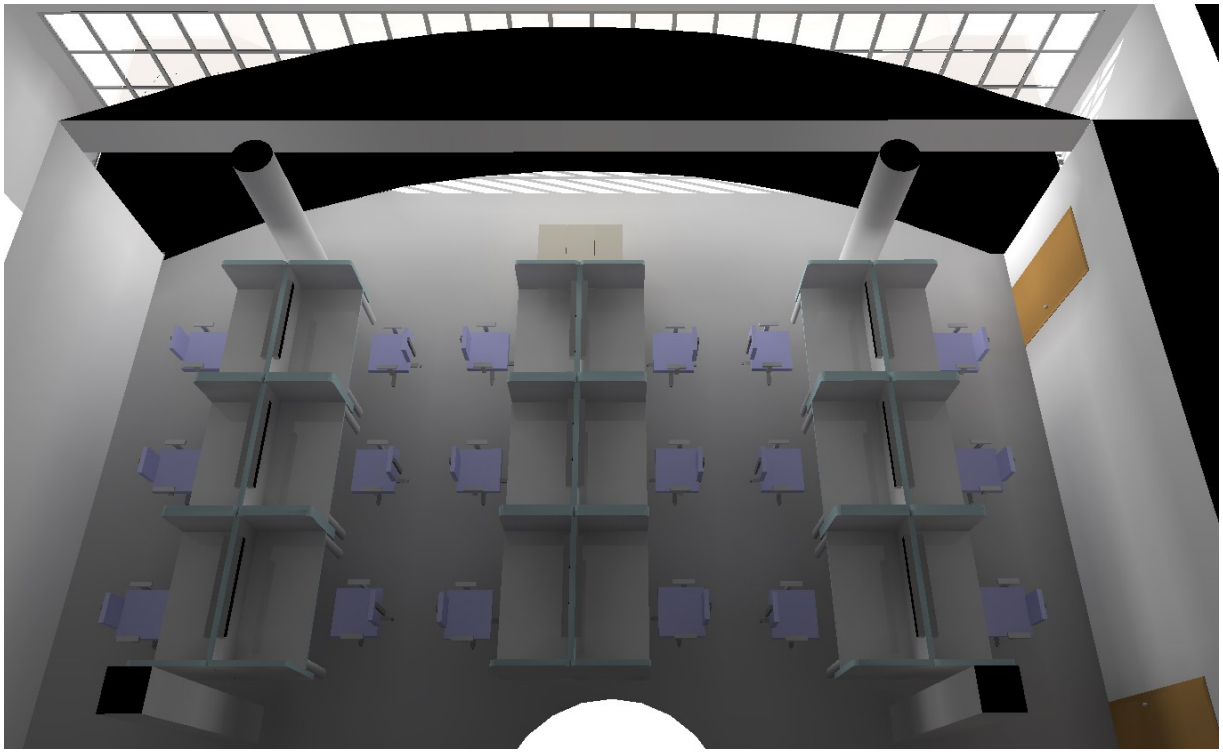
June 21 3:00 PM



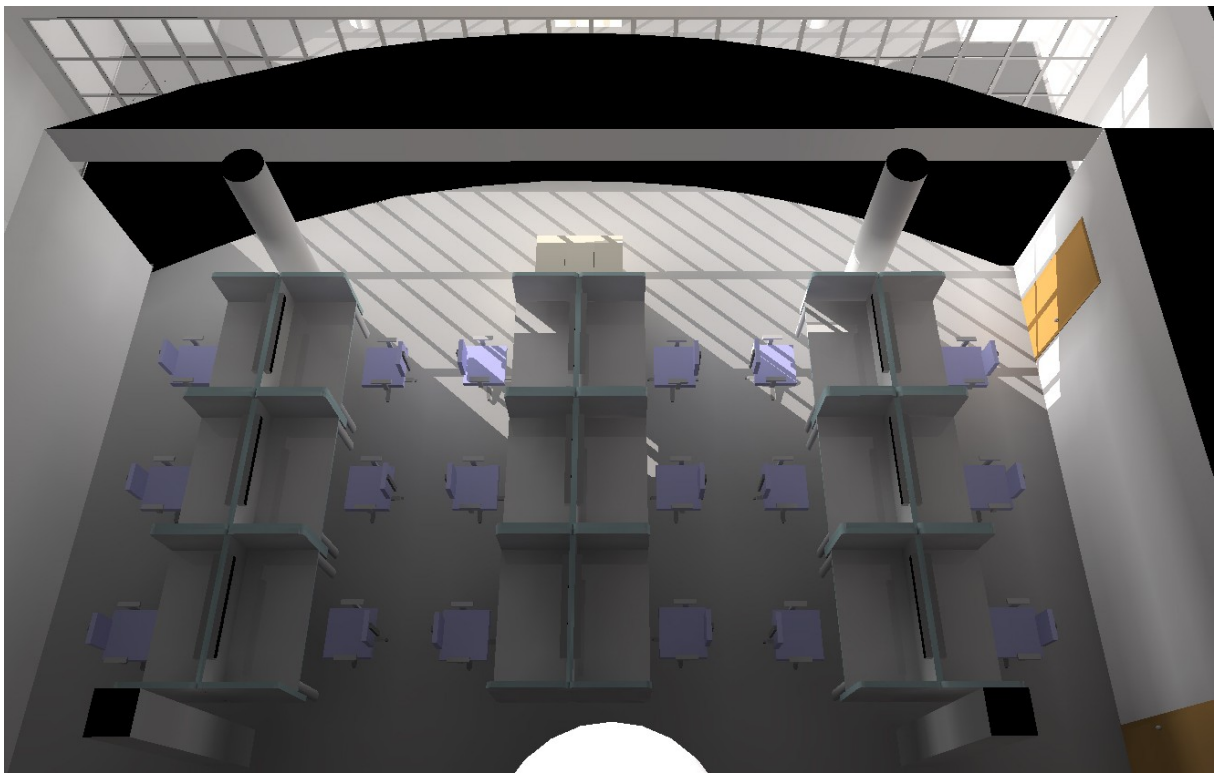
June 21 5:00 PM



December 21 1:00 PM



December 21 3:00 PM



As seen in the previous renderings, direct glare is not a major problem in the office suite. The furniture layout of the cubicles was well thought out. The walls of the cubicles closest to the glazing block the direct glare most of the time. The few instances that the direct sunlight does hit the task surface, it did not cover much area. The direct sunlight did add a dynamic effect to the office suite, adding patterns and shadows from the mullions.

The daylight in the office suite provided a large amount of ambient light to the space. The problem is the light provided is not evenly distributed. The desks closest to the window receive daylight in most conditions. The daylight does not reach far into the space during most months out of the year. The skylight provides low levels of diffuse light to the space.

Conclusion

With the current furniture layout, direct glare is not a problem in the office suite. The direct sunlight does add a dynamic aspect to the space. Therefore the glazing does not need to be altered from the current glazing, clear with 80% transmittance. Daylight does provide a sufficient amount of light into the office suite. Yet the majority of the light is not evenly distributed over the task surface. Also only the cubicles closest to the glazing have enough illumination. It would be possible to specify a dimming system for this office suite, but it was not necessary for the space. When personal cubicles are universally controlled and dimmed, many people are unhappy. After speaking with the employees of the Woolly Mammoth Theatre Company, they did not want to install a dimming system. They workers wanted a very bright work environment. Therefore the office suite is not dimmed.

Design Criteria

General

The lighting in the office should be very comfortable. The work surfaces should be uniformly lit. In the office there is intermittent use of VDTs. Direct and reflected glare should be avoided completely. It is important to avoid having direct sunlight hit the work surface, creating glare. Also the luminances of surfaces and contrast must be carefully analyzed. The open plan office has moveable cubicles, and therefore the lighting should be flexible.

Illuminance and Luminance Values

According to the IESNA Lighting Handbook the illuminance on the work plane for an open office with intense VDT work should be 30 footcandles. The vertical illuminance should be 5 footcandles. When using VDTs, the luminance ratio of screen to paper task should be 3:1. For screen to far background the luminance ratio should be 10:1.

Power Density

According to Ashrea 90.1, the Space- By- Space Method, the power density allowed in an open plan office is 1.1 W/SF.

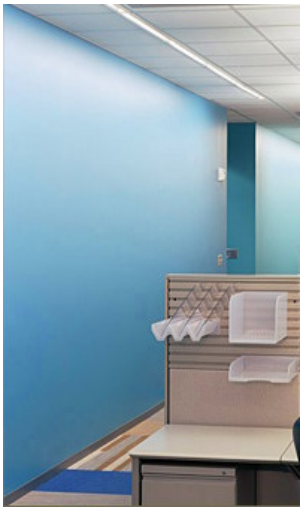
Schematic Design/ Design Intent

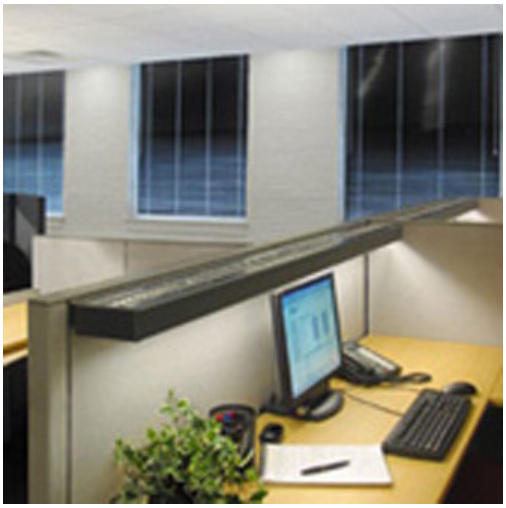
Design Goals

- Spacious
- Comfortable
- Energetic

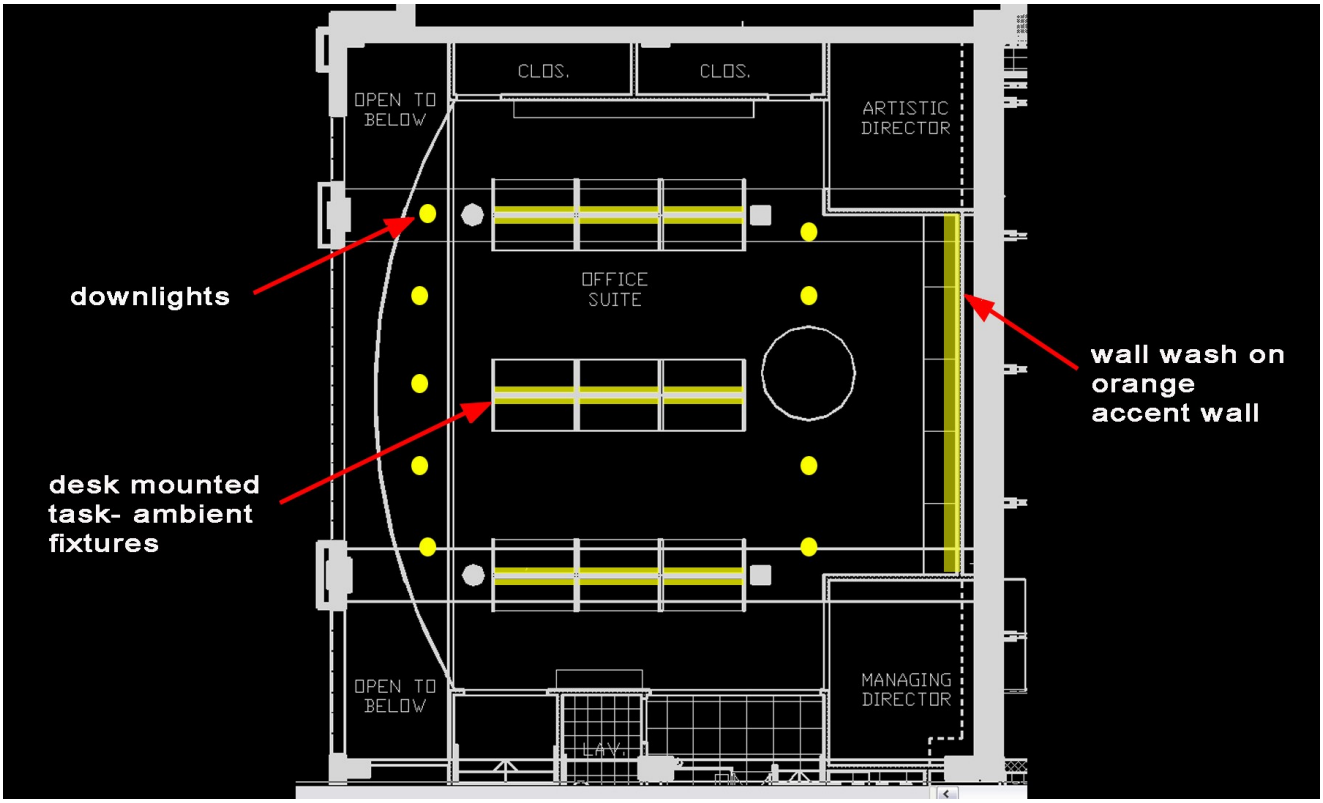
These goals were achieved in the office space by using many techniques. The office is small in square footage, and rather cramped with cubicles throughout it. Two of the four walls are made of glass, which helps to expand the feeling of the space. In the lighting of the space, the orange accent wall is washed with light. This will keep the space feeling spacious. To keep the office comfortable for the employees, direct and reflected glare must be avoided completely. This was accomplished by using a desk mounted fixture with direct and indirect light. The energetic feeling was achieved by using indirect light to stop the “cave” effect. Also there are differing light levels away from task areas to give depth.

Concept Photos



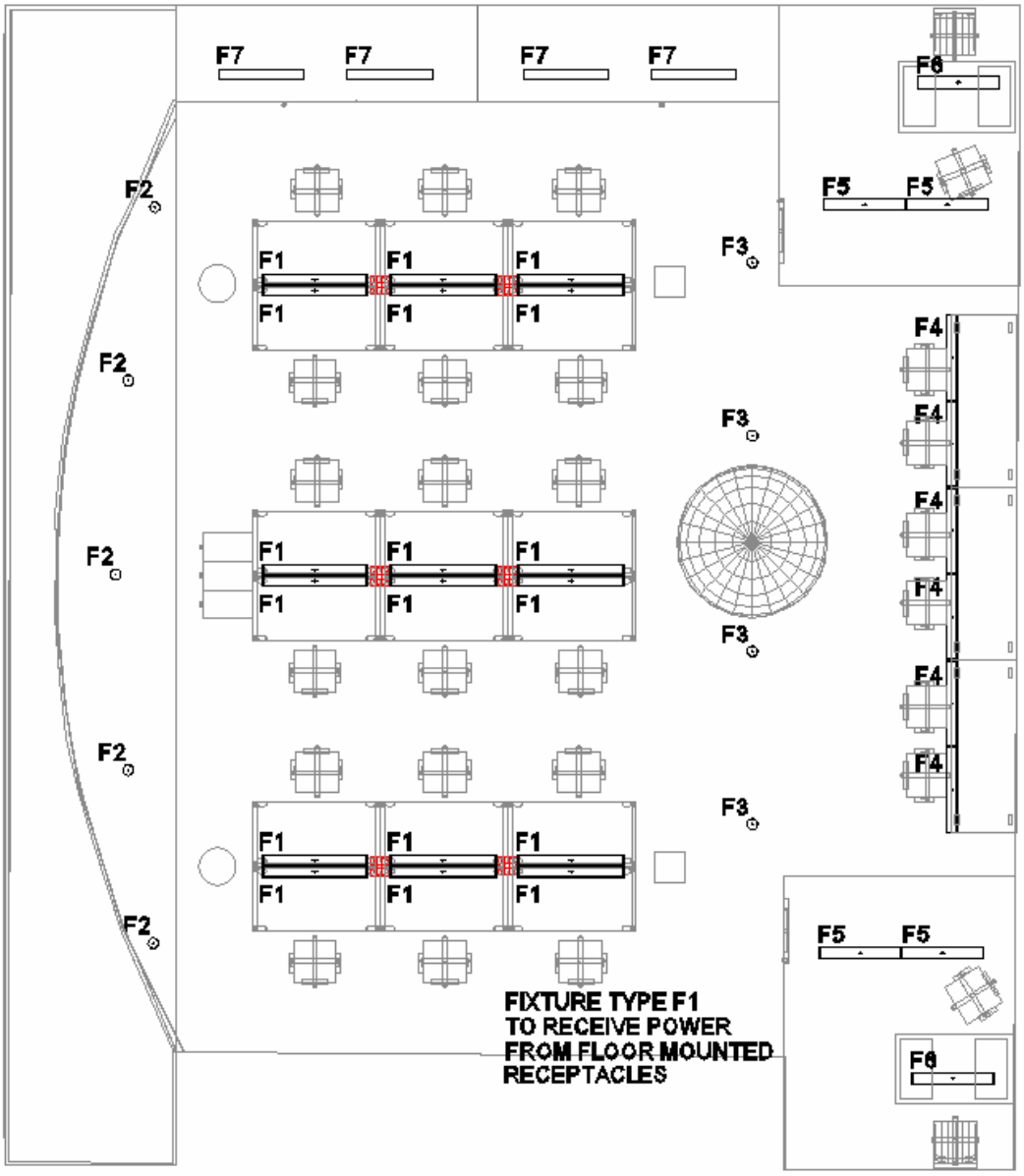


Concept Diagram

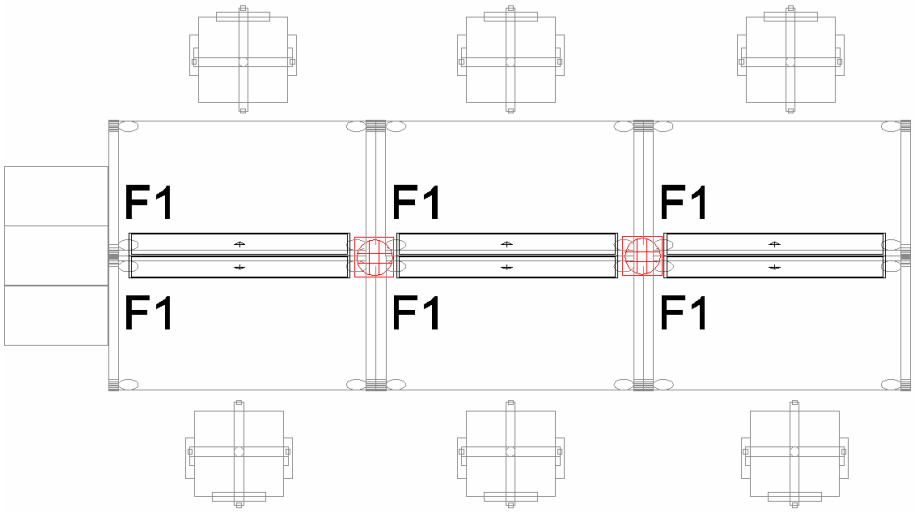


Final Design

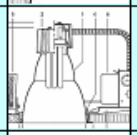
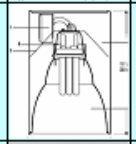
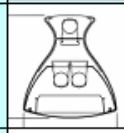
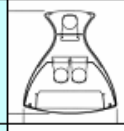
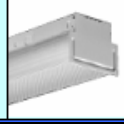
Lighting Plan



Luminaire Detail



Fixture Type F1 task- ambient fixtures will are plug in fixtures. They will receive power from the floor mounted receptacles showed in red.

OFFICE LUMINAIRE SCHEDULE						
FIXTURE TYPE	PICTURE	DESCRIPTION	LAMP	MANUFACTURER	CATALOG NUMBER	NOTES
F1		DESK MOUNTED TASK AMBIENT FLUORESCENT	SYLVANIA FP35/835/ECO	TAMBIENT	STYLE L201	LOCATION: OFFICE
F2		RECESSED DOWNLIGHT	SYLVANIA CF26DT/E/IN/835/ECO	LIGHTOLIER	8021-CCLP	LOCATION: OFFICE
F3		SURFACE MOUNTED COMPACT FLUORESCENT CYLINDER	SYLVANIA CF26DT/E/IN/835/ ECO	LIGHTOLIER	CS6132	LOCATION: OFFICE
F4		SURFACE MOUNTED FLUORESCENT WALL WASH	SYLVANIA FP28/835/ECO	ELLIPTIPAR	F144-T128-S-22-T-00-0	LOCATION: OFFICE
F5		SURFACE MOUNTED FLUORESCENT DIRECT PENDANT	SYLVANIA (2) FP54/835/HO/ECO	METALUMEN	C6B4NXUK	LOCATION: OFFICE
F6		SURFACE MOUNTED FLUORESCENT DIRECT PENDANT	SYLVANIA (1) FP54/835/HO/ECO	METALUMEN	C6A4NXUK	LOCATION: OFFICE
F7		CLOSET FLUORESCENT STRIP	SYLVANIA FO32/835/ECO	LIGHTOLIER	JS4C132	LOCATION: OFFICE

Fixture, lamp and ballast cut-sheets can be found in Appendix A.

Light Loss Factors							
Fixture	**Cleaning Interval**	**Category**	**BF**	**LLD**	**LDD**	**RSDD**	**LLF**
F1	12 months (clean)	II	1.01	0.93	0.98	0.89	0.82
F2	12 months (clean)	IV	1.10	0.86	0.94	0.96	0.85
F3	12 months (clean)	IV	1.10	0.86	0.94	0.96	0.85
F4	12 months (clean)	IV	1.04	0.93	0.94	0.96	0.87
F5	12 months (clean)	IV	0.99	0.93	0.94	0.96	0.83
F6	12 months (clean)	IV	0.99	0.93	0.94	0.96	0.83
F7	12 months (clean)	IV	0.92	0.92	0.94	0.96	0.76
RCR Calculated to be 2.2 Space Assumed to be Very Clean							

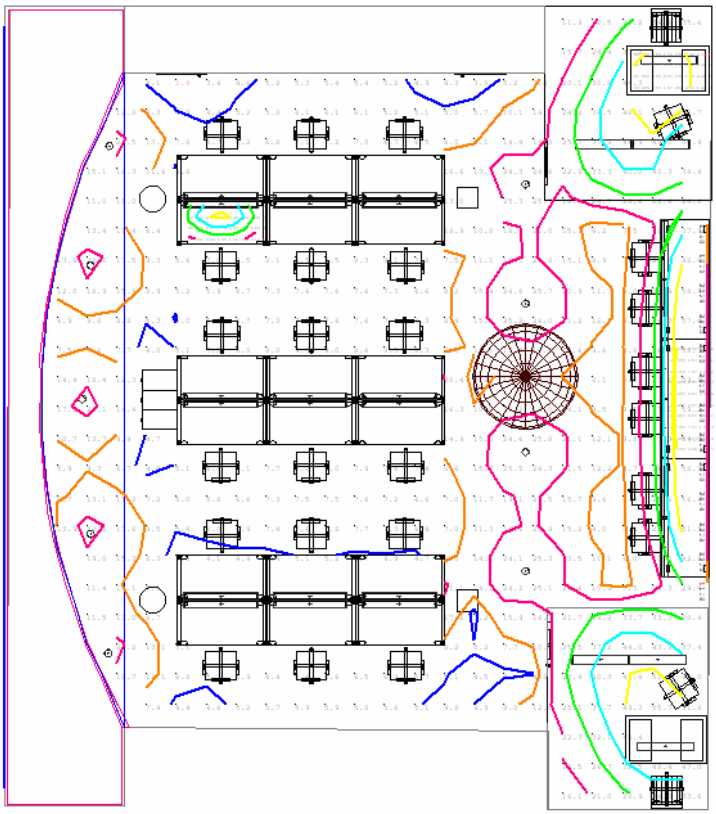
The cleaning interval for the office suite was assumed to be 12 months since the building is owned and maintained by the theatre company. The space was assumed to be a clean environment. The office suite is small area on the third floor on the theatre. It is not near any spaces that would generate large amounts of dirt.

Power Density					
Fixture	**Quantity**	**Wattage**	**Total Wattage**	**SF**	**W/SF**
F1	18	41	738		
F2	5	29	145		
F3	4	29	116		
F4	6	33	198		
F5	4	62	248		
F6	2	118	236		
F7	4	32	128		
			1809	2145	**0.84**

Using the input wattages for the specified ballast and lamps, the power density for the lobby is 0.84 W/SF. This is under the allowed 1.1 W/SF allowed for an open office.

Calculation Grids

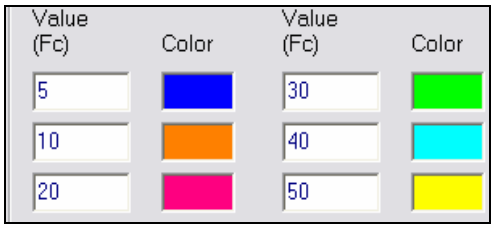
Value (Fc)	Color	Value (Fc)	Color
5		30	
10		40	
20		50	

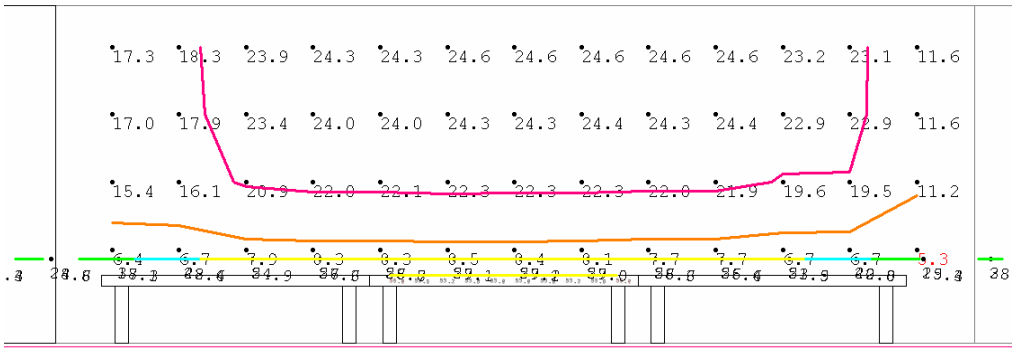


Numeric Summary						
Label	CalcType	Units	Avg	Max	Min	Avg/Min
Orange Wall	Illuminance	Fc	17.86	24.6	5.3	3.37
Office_Desk	Illuminance	Fc	52.89	57.4	45.4	1.16
Office_Cubicle	Illuminance	Fc	33.08	52.5	14.4	2.30
Private Office_Desk	Illuminance	Fc	51.87	57.1	43.1	1.20
Workplane	Illuminance	Fc	16.07	59.2	2.4	6.70

The average illuminance of the work plane is 16 fc. This is an ideal level for the areas that are not work surfaces. The average to minimum fc ratio is 6.7. The office having slightly different levels of light in the space will make the space comfortable and add visual interest for the employees. Due to the task component of the task-ambient fixtures on each cubicle, the average cubicle illuminance is 33 fc, very evenly distributed with a 2.30 average to minimum fc ratio. The ambient component of the task-ambient fixtures used will illuminate the ceiling, to make the space feel energetic and not like a cave. The fixtures also eliminate direct and reflected glare because the source is mounted on each cubicle. Another advantage of the task-ambient fixtures is they are mounted to the cubicles, and therefore can move with the cubicle if the office is rearranged or more cubicles are added.

Orange Accent Wall



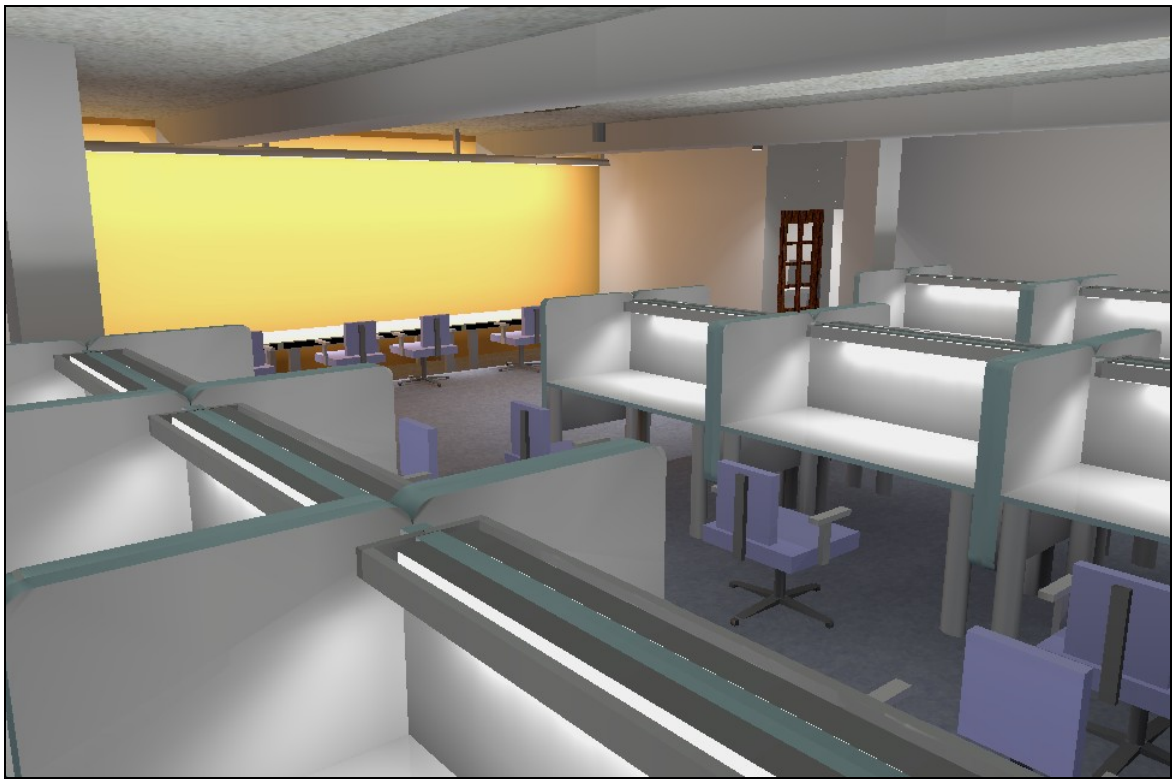


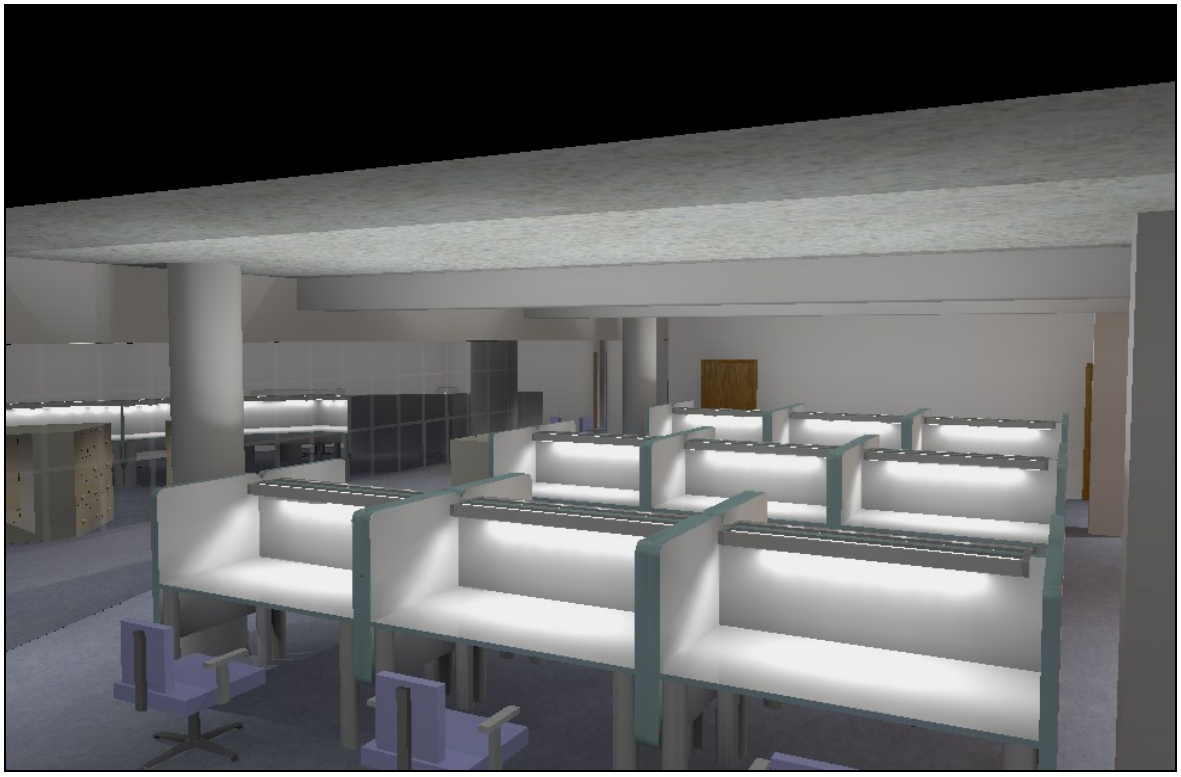
The orange accent wall has an average illuminance of 18 fc, with an average to minimum fc ratio of 3.37. The wall is evenly distributed, giving the office a spacious feel while highlighting the spectacular color of the wall.

Control

The office suite will be standard switched control. Dimming of the design was unnecessary. The zones of fixtures are switched separately, giving the office suite some control. During most days the recessed downlights adjacent to the glass wall will not need to be on. The cylinders near the skylight will also not be needed on a number of days. All of the cubicle lights will be switched together. This is because if they are separately switched, the ambient component of light would be a very uneven distribution on the ceiling, having some lights on and some off. Also, after speaking with employees in the space office, they all agreed they would like a very bright environment. This environment will be an energetic space that leads to productivity.

Renderings





Conclusion

The office suite is a private space for the employees at the Woolly Mammoth Theatre. The workers spend long hours each week performing their duties in the space. Due to this, the lighting must be designed for comfort. The office should feel spacious and energetic, to encourage production in the space. All employees in the office suite use VDTs. The task-ambient light used in the design eliminates reflected and direct glare from the ceiling. This fixture also makes the design flexible with the movable cubicles. The task component provides the necessary illumination on the work surface, and the ambient component provides illumination on the ceiling to brighten the space. The wall washers accent the vibrant orange wall and give an energetic feel to the space. The office suite is controlled by standard switching, but zoned with the ability to switch areas off separately. The lighting design for the office is feasible, and