Lighting Depth

Introduction

The over-arching theme to the lighting design for Art & Visual Technology building was to design a unique and creative solution to foster imagination and ingenuity among faculty and students, while still meeting the quantitative needs of the space. While many of the designs have a minimalistic feel, they create a dynamic sense of space while still maintaining a simplistic regiment.

Complete lighting analysis of the following spaces will be investigated

1. Main Entrance Courtyard
2. Entry Lobby
3. Typical Painting Studio
4. Exhibit Gallery

In addition to providing the needed documentation to accurately describe the physical appearance of each redesigned space, a discussion of each lighting system will include, but not limited to, the following areas: design criteria, lighting controls, ASHRAE power densities, luminaire schedules and light loss factors and controls.

Main Entrance Courtyard

Space Summary

The main entrance to the building is defined by a curved wall that cuts through the building and the exhibit gallery. This makes the entrance somewhat hidden to pedestrians heading from the north and completely hidden for those approaching from the south. The two main visual cues that this area is the entrance are the department flag/logo which is prominently located at the end of the curved wall and the entrance canopy with the building name on it.

Surface Finishes

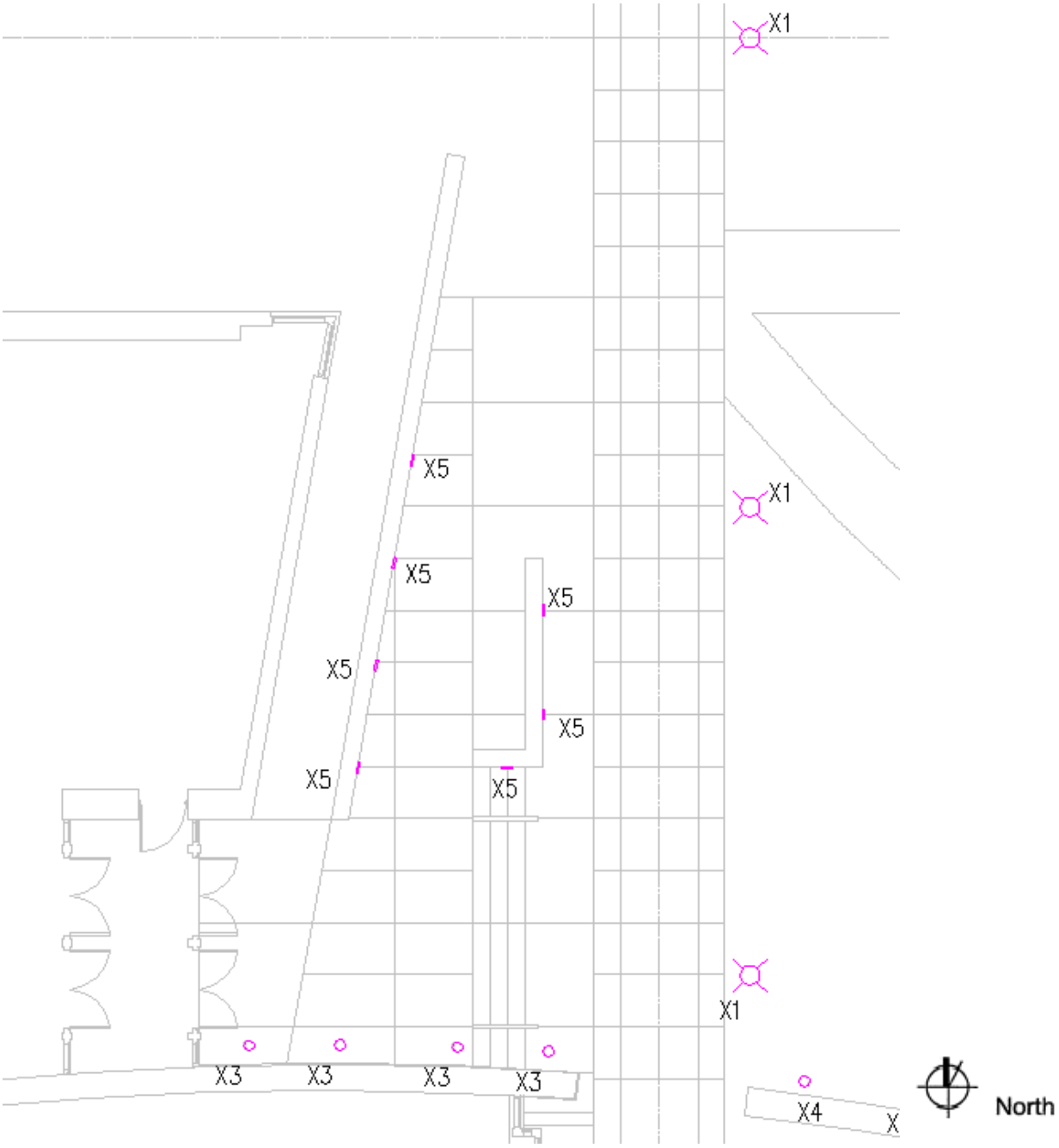
Walkway: Sealed Concrete ρ= .38

Facade: Architectural Concrete ρ= .55

Facade: Aluminum Paneling ρ= .82

Existing Design

The existing design made use of pole mounted fixtures that illuminate the walkway along the length of the building. In-grade and recessed fixtures were utilized for the lighting of the ramp and also the stairs. The existing design had met the safety goals of pedestrians coming to the building but failed to address improving the quality of the space.



Design Criteria

Horizontal Illuminance

The IESNA handbook recommends 5fc on horizontal surfaces at the main building entrance and 0.5fc on pedestrian walkways

Vertical Illuminance

The IESNA handbook recommends 3fc on vertical surfaces at the main building entrance and 0.5 fc on pedestrian walkways.

Appearance of Space and Luminaires

The appearance of space is very important. The lighting design should create a sense of space and for the building. It also should express that the building is for the Art & Visual Technology department.

Light Distribution on Surfaces

Important to help with way finding to help those find their way to the main entrance of the building. This is achieved by having brighter sources as you get closer to the entrance.

Light Distribution on Task Plane

It is important to create a uniform level of light on walkway for safety. In particular, the stairs in front of the main entrance need to be adequately illuminated to prevent a tripping hazard.

Modeling of Faces and Objects

As people walk by the building at night is important for them to feel safe. The modeling of faces and objects puts people at ease because they can see other people and other objects they are approaching.

Points of Interest

Points of interest in the façade courtyard area include the main entrance and the department banner. Another key feature to the entry courtyard is the curved façade which creates the southern boundary to the main entrance space. Both of these features are to be illuminated for aesthetics and way finding. Finally, I would want to illuminate the display banner which is at the end of the curved façade. This is good opportunity to showcase the department and create a "beacon" within this area.

Direct Glare

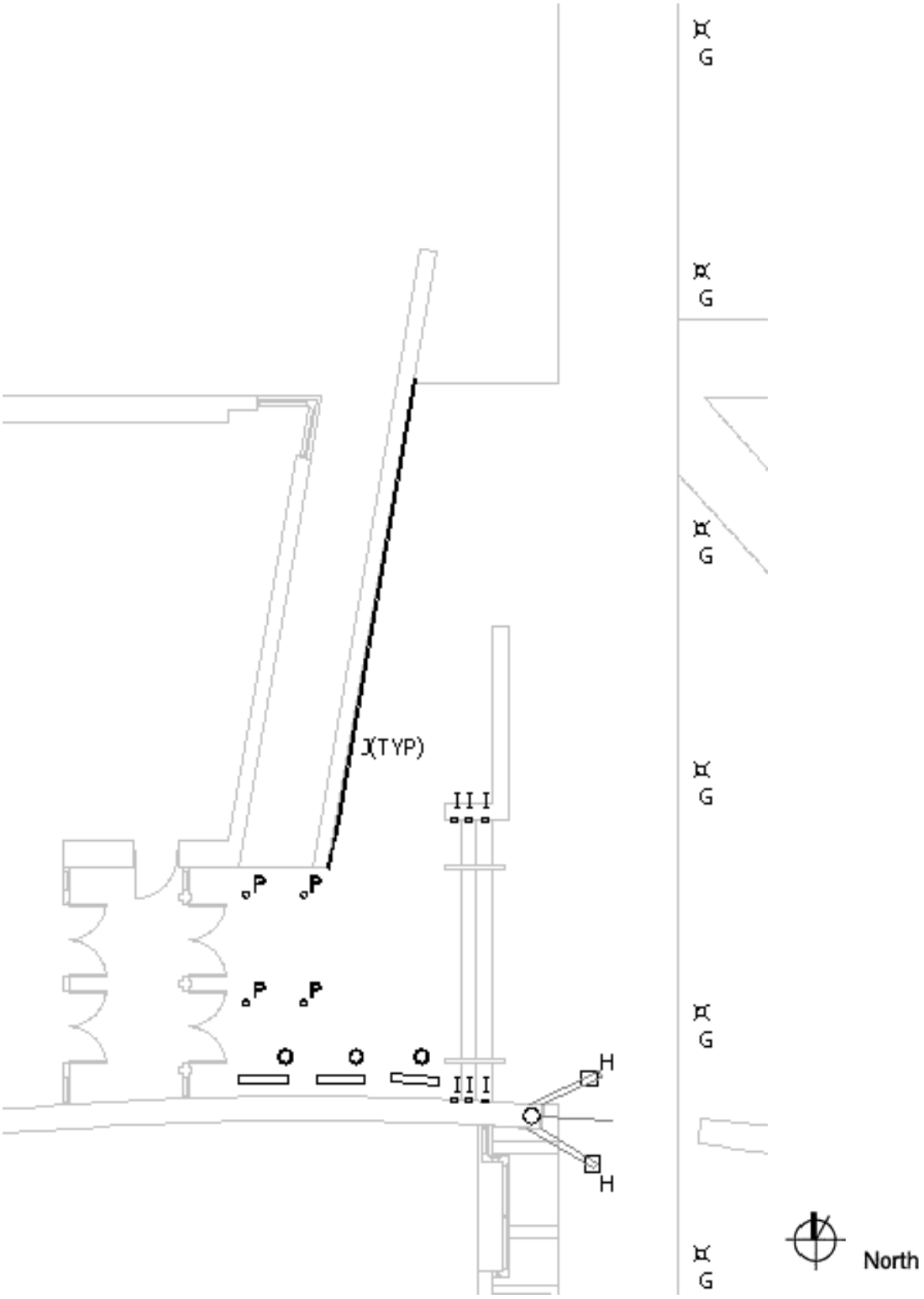
With many people traversing the site without going in the building, it is important to provide adequate lighting along the walkway. All fixtures used to illuminate the walkways should avoid direct views of the lamp as glare is more easily perceived at night.

Design Synopsis

My original concept for the main entrance centered on highlighting the area around the main entrance and also highlighting the department banner logo. After receiving comments from designers at the Lutron presentation during fall semester, I had slightly changed my goals for the lighting of this space. Since this is a building for the Art & Visual Technology department, I decided to do something a little more unique and also a lighting design that defined the building and space. I accomplished this through the use of color changing in grade LEDs that line the ramp up to the building as well as along the curved wall that defines the one edge of the main entrance.

Initial Concept Sketch

Lighting Layout



** Note: See Appendix G for a 1/8" = 1'-0" Plan*

Controls

Lights will be automatically controlled through a astronomical time clock which is integral to the building's existing Lutron Digital Grafik Eye system. The Grafik Eye will also allow for complete user control over the LEDs. This will allow GMU to program the LEDs to change color or during certain times of day or for certain events, etc.

Schedules

Luminaire Schedule

Luminaire Type	Manufacturer	Catalog #	Lamps	Ballast	Volts	Comments
G	Bega	8996MH	(1)CDM100/ 830/ED17	M5	277	Pole area walkway lighting
H	Erco	34105.023	(1)MC39T6/ U/G12/ 835PB (L6)	M6	277	Banner Floodlight
I	Bega	1323	(1)20T3Q/ MINISTAR/S (L7)	-	12v	Step light with integral transformer. Supply 120v to fixture.
J	Light Wild	LW/Tile/FLR/ RECT/ 2.165x11.8/ FROST/RGB/ BOXY	72 LEDs (6W)	-	24V DC	In-grade fixture, integral transformer, supply 120v AC.
O	Color Kinetics	#116/ 000016/ 00/00	144LEDs (280W)	-	120V	Custom in grade housing to accommodate pedestrian traffic load.
P	Prescolite	D4LED/277V/ 4D9/WT	4 LEDS (13W)	-	277V	Surface Mounted Canopy Downlight,

**Note: Please See Appendix A for additional information on luminaires, lamps, and ballasts*

Light Loss Factors

Luminaire Type	Maintenance Category	Room Atmosphere	Cleaning Cycle	Initial Lumens	Mean Lumens	LLD	Ballast Factor	LDD	RSDD	LLF
G	V	Medium	12mo.	8800	6600	.75	.94	.82	-	.58
H	V	Medium	12mo.	3400	2720	.80	1.0	.82	-	.66
I	V	Medium	12mo.	320	-	.90	1.0	.82	-	.74
J	V	Medium	12mo.	132	-	.90	1.0	.82	-	.74
O	V	Medium	12mo.	2282 (White)	-	.9	1.0	.82		.84
P	IV	Medium	12mo.	232	-	.9	1.0	.87	-	.78

ASHRAE Standard 90.1 Power Allowances

Tradable Surfaces

Walkways less than 10 feet Wide: 1.0 W/linear foot

105 linear ft • 1W/linear ft = 105W

Palaza areas: .2W/ft^2

950 ft2 • .2W/ft^2 = 190W

Stairways: 1.0W/ft^2

93ft^2 • 1.0W/ft^2 = 93W

Main entries: 30W/linear foot of door width

12 linear ft • 30W/ft^2 = 360W

Canopies: 1.25W/ft^2

225ft2 • 1.25W/ft^2 = 281W

Total allowable tradable watts =1,029

Non-Tradable Surfaces

Building Facades 0.2W/ft^2 or 5.0 W/linear foot of illuminated wall

52ft• 5.0W/ft = **260W available**

1,760ft * 0.2W/ft^2 = **352W**

= 612W

Tradable Power Consumption

6 “G” fixtures * 118 input watts/fixture = 486 W

2 “H” fixtures * 54 input watts/fixture = 108 W

6 “I” fixtures * 20 input watts/fixture = 120 W

4 “P” Fixtures * 13 input watts/fixture = 52W

Total power consumption = 766W <1,029W

Non-Tradable Power Consumption

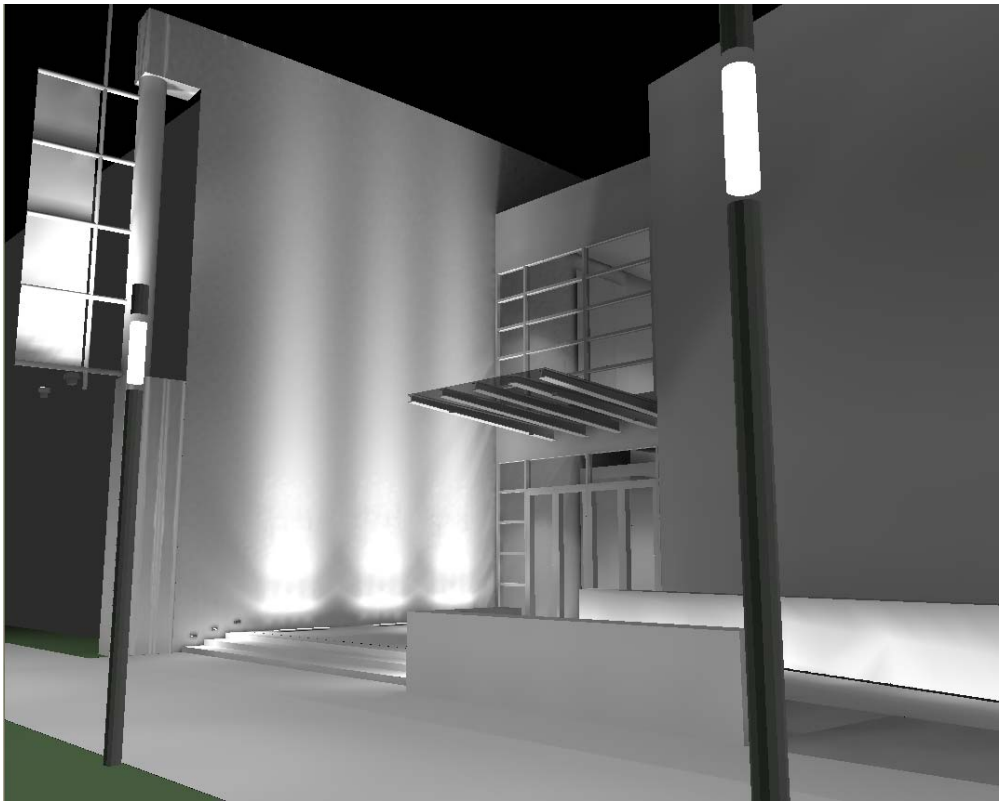
3 “O” Fixtures * 280 input watts/fixture = 840W

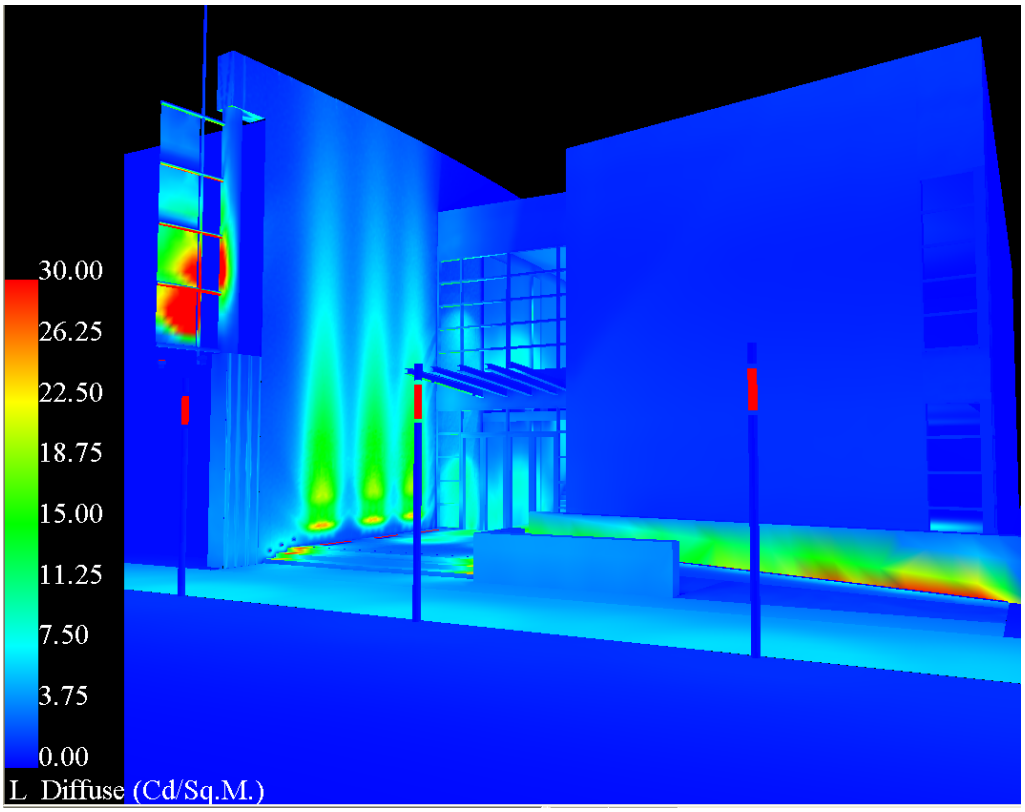
43 “J” fixtures * 6 input watts/fixture = 258 W

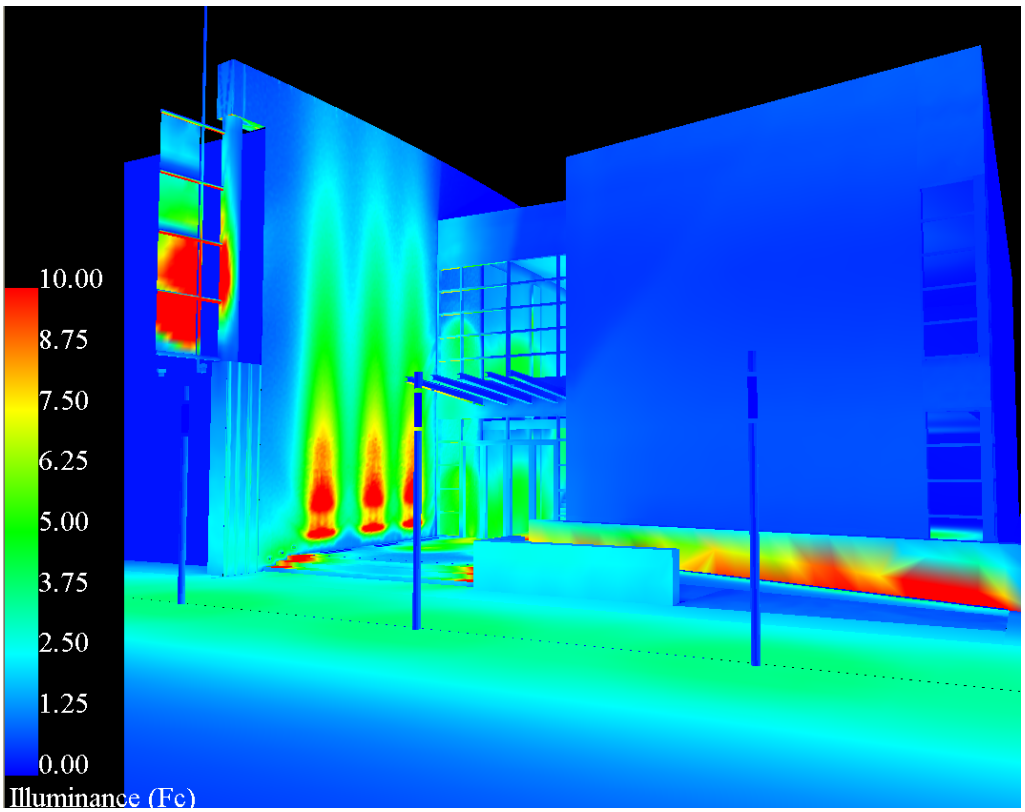
Total power consumption = 1098 W > 612 W

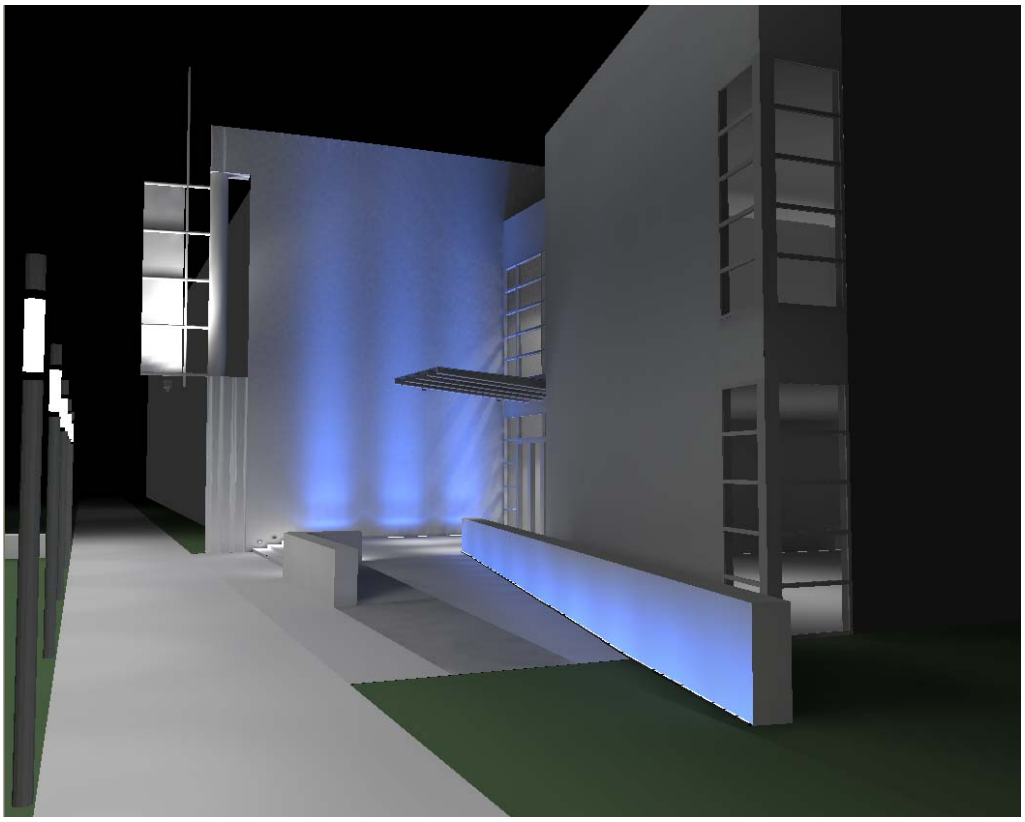
*Though this value is above ASHRAE standards, I feel that the statement that the lighting design makes along with the overall power savings elsewhere in the building justify this design.

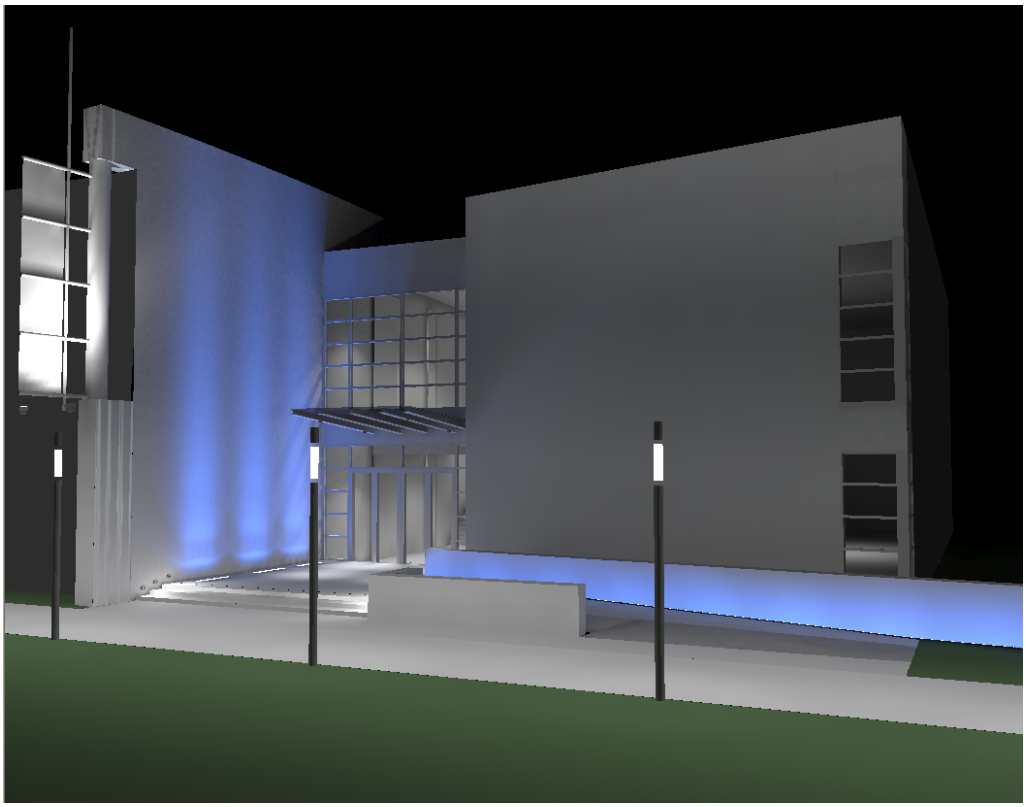
AGI Analysis

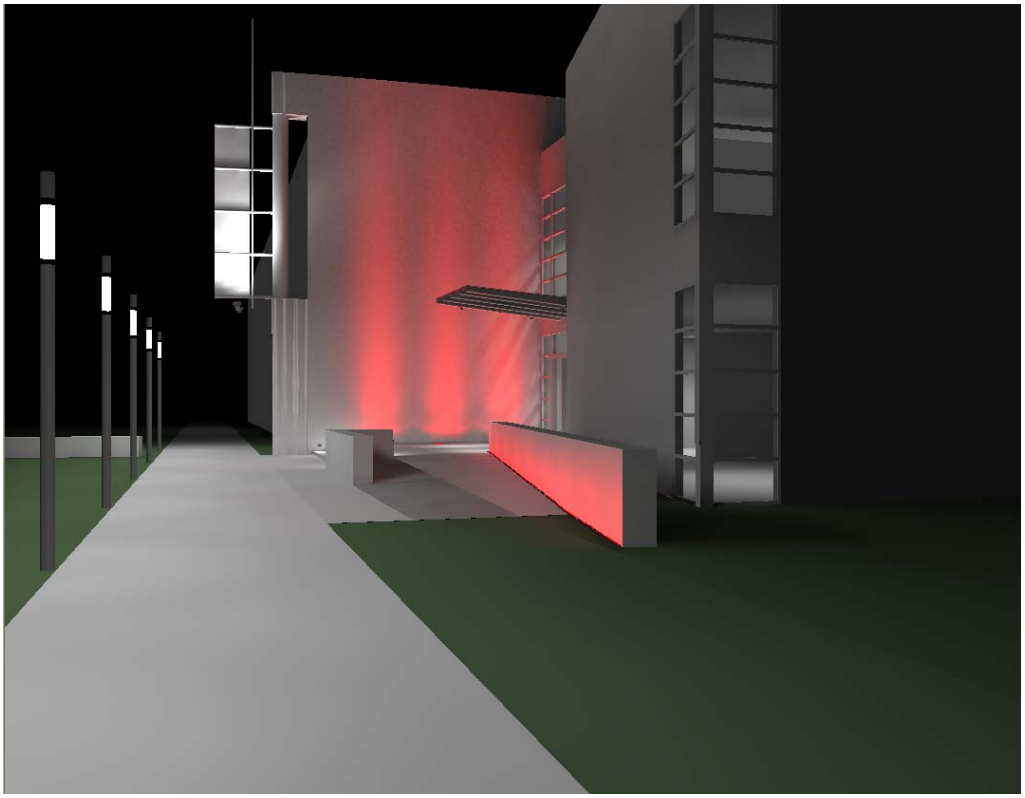



30.00
26.25
22.50
18.75
15.00
11.25
7.50
3.75
0.00
L_Diffuse (Cd/Sq.M.)


10.00
8.75
7.50
6.25
5.00
3.75
2.50
1.25
0.00
Illuminance (Fc)

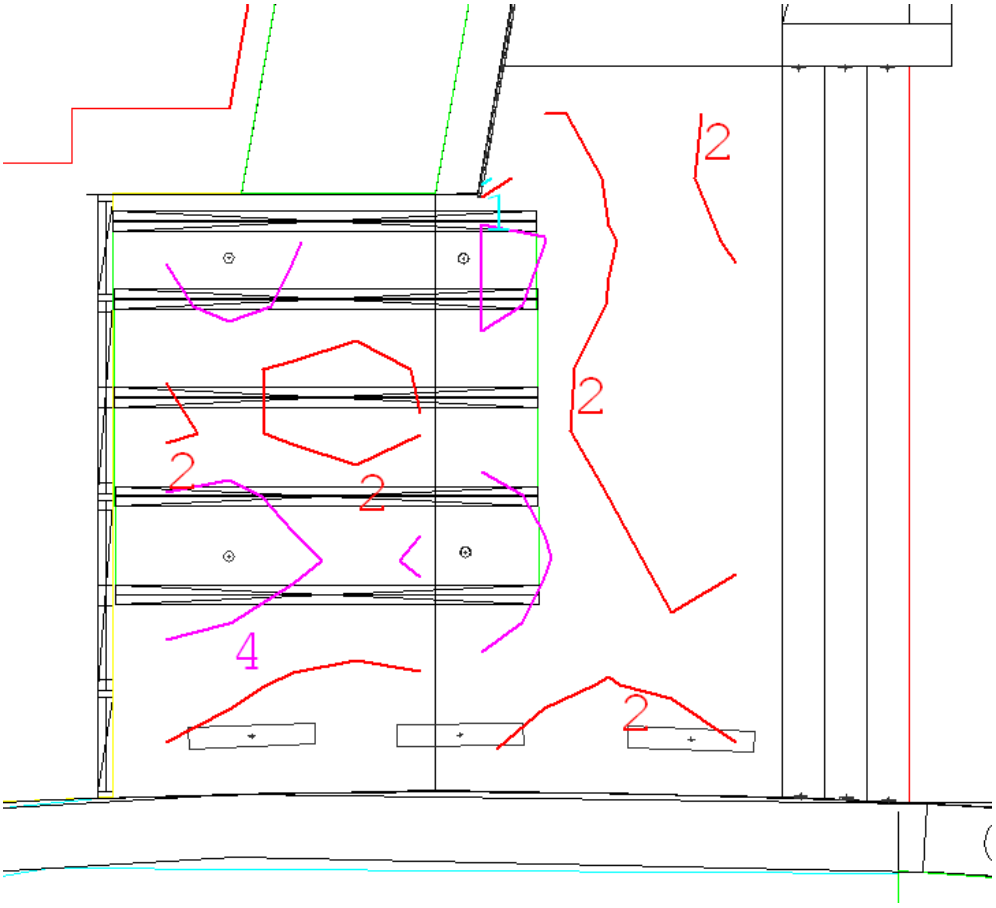






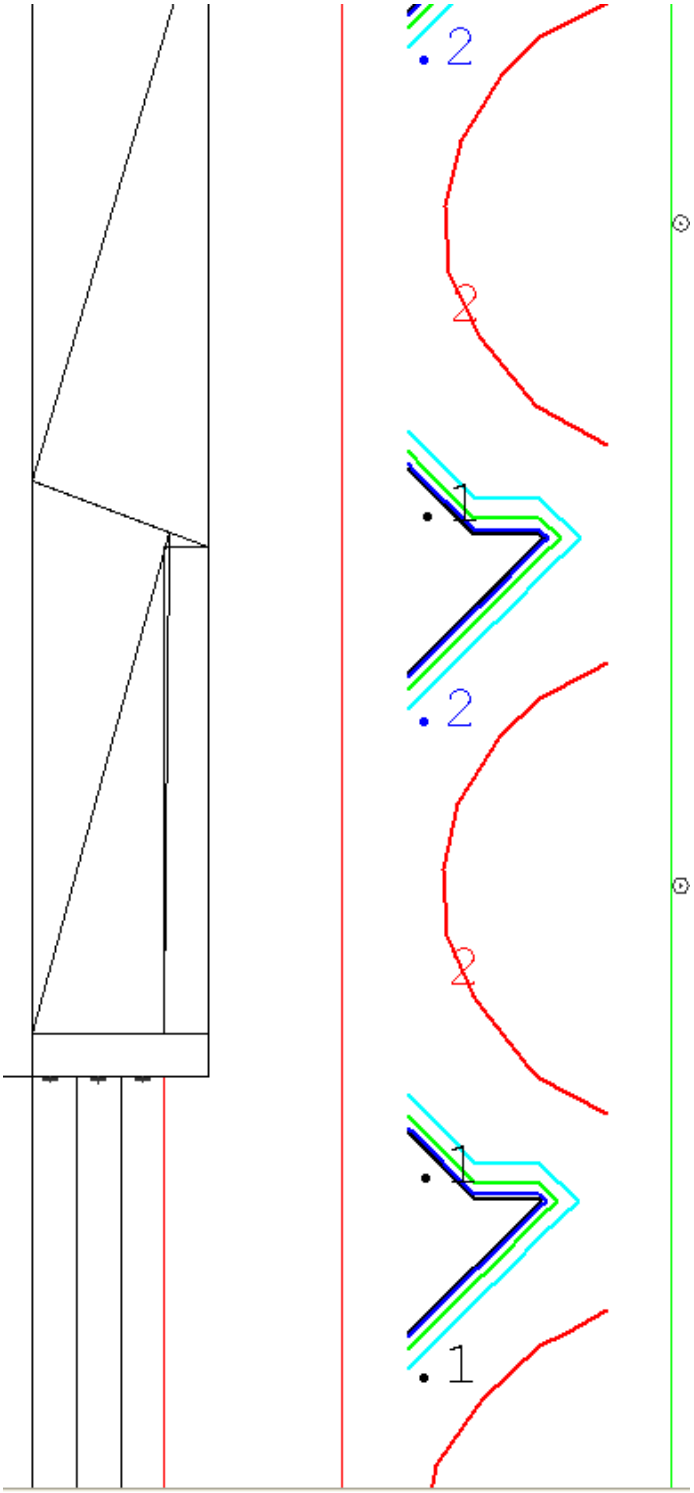
Illuminance Data

Building Entrance Illuminance



CalcPts_1
Illuminance Values(Fc)
Average=2.93 Maximum=5.5
Minimum=1.0 Avg/Min=2.93
Max/Min=5.50

Pedestrian Walkway Illuminance data



CalcPts
Illuminance Values(Fc)
Average=1.78 Maximum=2.8
Minimum=0.0 Avg/Min=N.A.
Max/Min=N.A.

Evaluation

As the icon for the Department of Visual Technology, it is important to make an impressive first statement. The LEDs along the main curved wall and site wall both create a sense of space but also lead people into the building. General area lighting is provided for the pedestrian walkway through pole mounted fixtures (though not accurately depicted due to time constraints). The use of LEDs along the two walls creates a dynamic contrast that defines this building and space as the Art & Visual technology department.

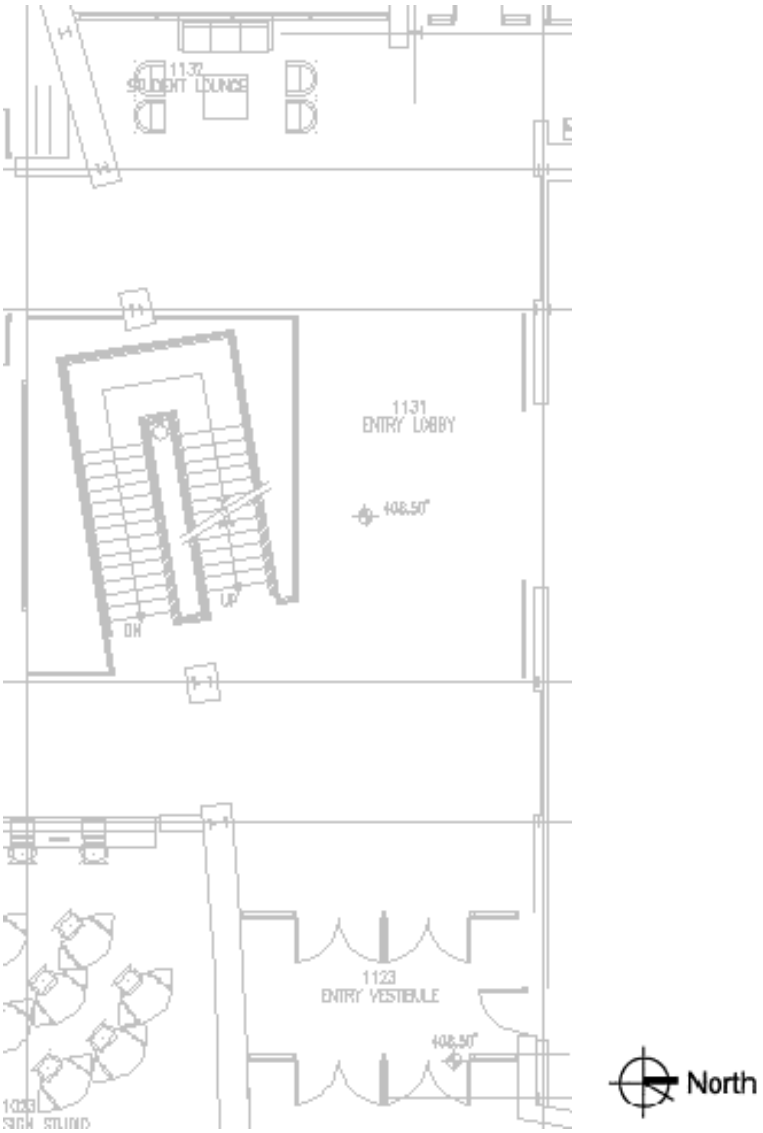
Given more time I feel that this space could be of higher quality. However, I have had many difficulties properly modeling the area luminaries, in particular having the proper photometric center. Another difficulty I encountered was a limitation within AGI, in that it does not allow you to easily align and position fixtures. This was a difficult for the LED fixtures that wash the concrete wall that lines the sloped walkway.

To conclude, I am very pleased with how my lighting design evolved over the course of the year. I feel that my current design achieves the design criteria I set out extremely well. However, I am disappointed in the technical setbacks I faced in depicting my design.

Entry Lobby

Space Summary

The lobby to the main entrance is a long rectangular space that connects the building together. The gallery space is connected to the North of the lobby while the two main corridors come off the lobby to the South. Connected to the west side of the lobby is a small student lounge with seating and a coffee table. The open staircase in the entry lobby spans from the lower level through the upper level. There is a roughly 20'x30'area surrounding the staircase which is open to above and below. The staircase is comprised of a metal handrail & frame with an ornamental wire mesh panel. The ceiling is composed of dry wall at 13 feet above finished floor.



Surface Finishes

Floor/Stairs: Sealed Concrete ρ= .38

Walls: painted gypsum wall board ρ= .80

Handrails: Steel ρ= .38

Ceiling: White Drywall ρ= .80

Existing Design

The existing design made use of a recessed compact fluorescent downlight (type L) and also a direct compact fluorescent pendant fixture (type J). For the illumination of the stairwell a surface mounted direct fixture is mounted to the underside of the stair above.

Design Criteria

Horizontal Illuminance

The IESNA handbook recommends an average of 10fc on the horizontal plane in this space. However, I feel that providing an average of 20fc will make the space feel more welcoming and active.

Vertical Illuminance

The IESNA handbook recommends an average of 3fc on the vertical plane in this space.

Appearance of Space and Luminaires

The main lobby is the first impression for occupants of the Art & Visual Technology building. It is important to provide a visually pleasing space to impress visitors to the building, as well as, set up the creative and innovative atmosphere for students and faculty.

Direct Glare

It is important for those just entering the building to not have any glare hindering their ability to get oriented to the building. Also, this will be a busy area between classes and any glare could cause a disruption in the flow of people in and out of the building.

Luminances of Room Surfaces

I want the design to utilize light distribution on surfaces to help with way finding. High luminances near the stairwell will help guide people to it as well as down the corridor to access the elevators, which are in a remote location.

Modeling of Faces and Objects

The modeling of faces and objects is important as the lobby will be a place of gathering and meeting for many. In addition, having proper modeling of faces and objects will help create a welcoming feeling.

System Control and Flexibility

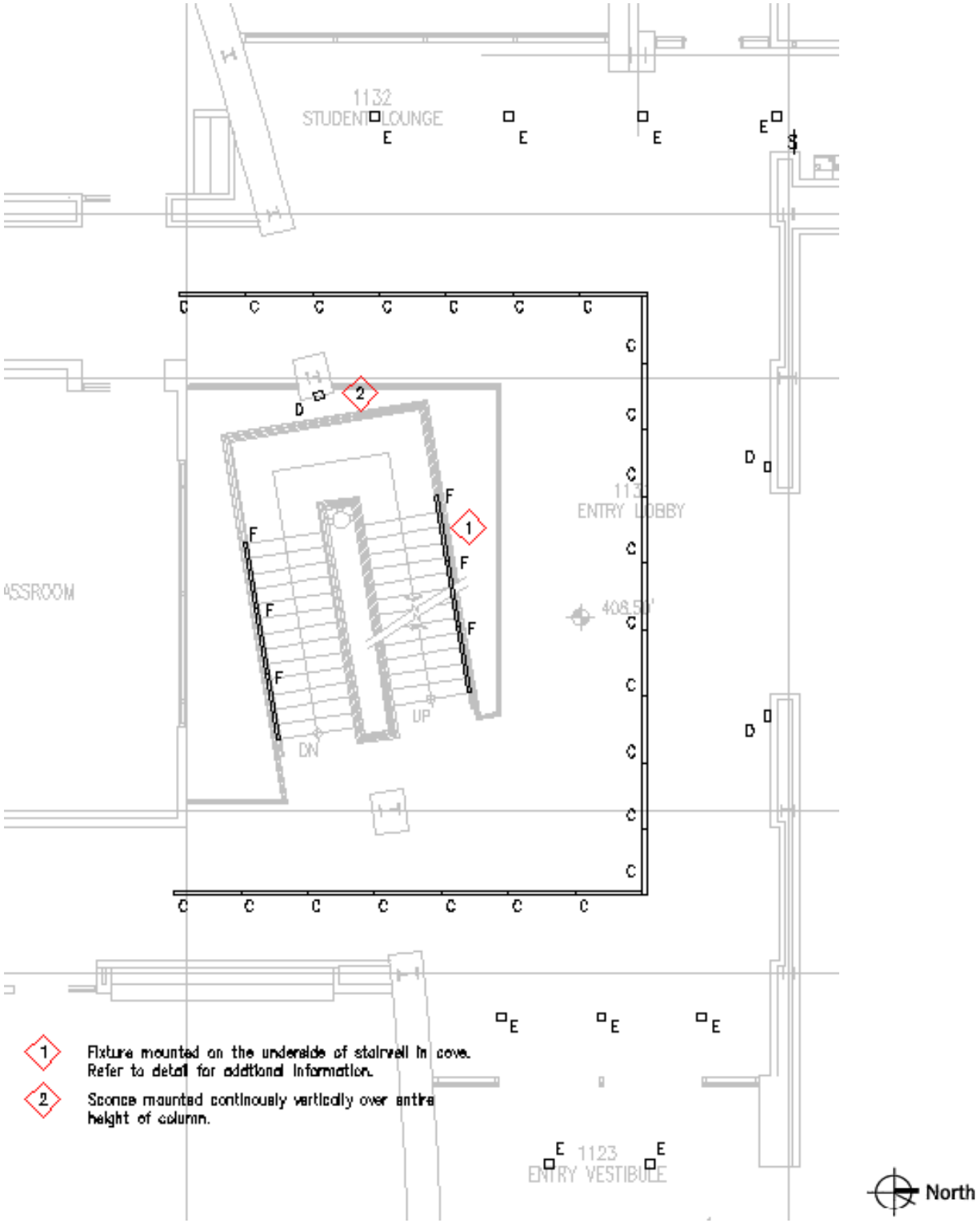
Lighting needs to be integrated with the automated lighting system. Remote manual location of controls is needed to avoid any unintended switching of lights.

Design Synopsis

Based on comments from my presentation at Lutron, I revised my initial design slightly to create a more unified design. The overall concept stayed the same however I changed several things including decreasing the number of rows of slot downlights and also to make them wrap around the corner to continue down the corridors. I also changed from utilizing several wall sconces across the various columns in the lobby to having just one continuous strip on the major column in the stairwell. By making these changes I was able to create a simplistic design that is visually dynamic by expressing the dimensions of the room.

Initial Concept Sketch

Lighting Layout



** Note: See Appendix H for a 1/8" = 1'-0" Plan*

Controls Overview

The primary means of lighting control in the entry lobby will be a time-clock. However, manual operation of the lights is accomplished at the Northwest corner of the lobby. The existing Lutron Digital Graik Eye 7000 has a built in time clock that will automate the control of this space under normal operation.

Schedules

Luminaire Schedule

Luminaire Type	Manufacturer	Catalog #	Lamps	Ballast	Volts	Comments
C	Se'lux	M1B1-1T5-SA-X-SH-004-WH-277	(1)-FP28/835 (L1)	M2	277	Recessed Continuous slot downlight
D	Se'lux	M1N1-TS	(1)-FP28/835 (L1)	M2	277	Recessed continuous sconce with satin diffuse lens
E	Kurt Versen	H8632-WT	(1)-PLT/32W/ 835/ 4P/ ALTO (L3)	M3	277	Recessed 6" Square Downlight
F	Lightolier	CL-1-4-E82	(1)-F032/835/ECO (L4)	M4	277	Stairwell cove fixture. See Proceeding information on mounting details.

**Note: Please See Appendix A for additional information on luminaires, lamps, and ballasts*

Light Loss Factors

Luminaire Type	Maintenance Category	Room Atmosphere	Cleaning Cycle	Initial Lumens	Mean Lumens	LLD	Ballast Factor	LDD	RSDD	LLF
C	IV	Clean	12mo.	2600	2418	.93	.98	.93	.97	.82
D	V	Clean	12mo.	2600	2418	.88	.98	.89	.97	.74
E	IV	Clean	12mo.	3200	2720	.93	.98	.93	.97	.82
F	VI	Clean	12mo.	2950	2710	92	.98	.85	.97	.74

ASHRAE Standard 90.1 Power Allowances:

Lobby = 1.3W/ft^2

Area (~35'x~60') = 2,307 ft^2

Total Allowed Wattage = 2,999.1W

Power Consumption

21 "C" fixtures * 33 input watts/fixture = 693 W

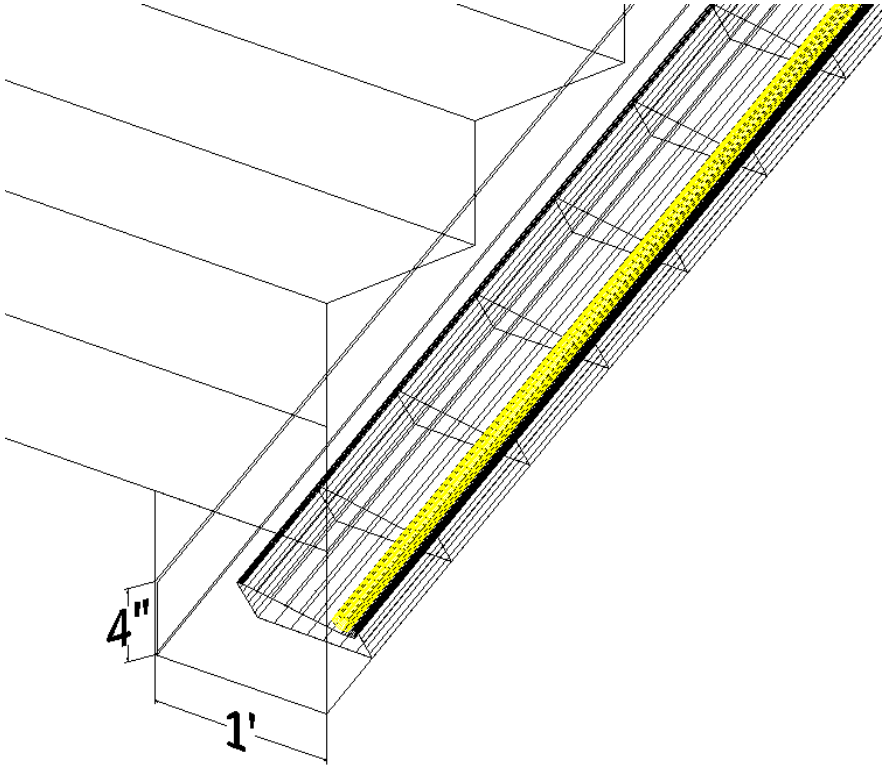
8 "D" fixtures * 33 input watts/fixture = 264 W

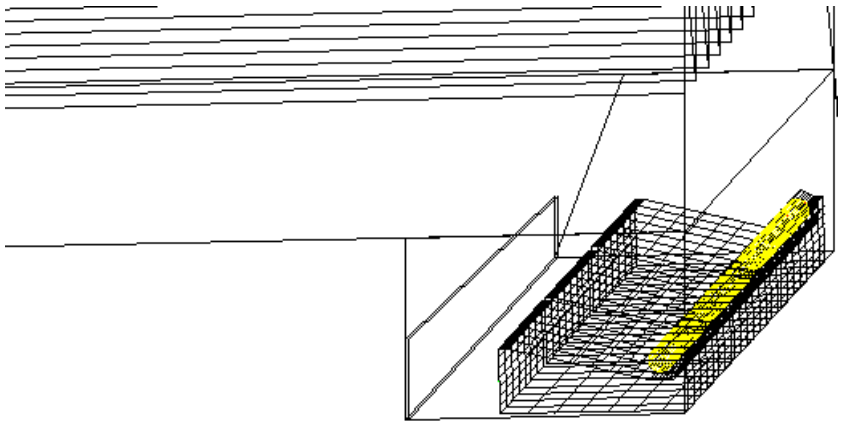
10 "E" fixtures * 36 input watts/fixture = 360 W

6 "F" fixtures * 29 input watts/fixture = 174 W

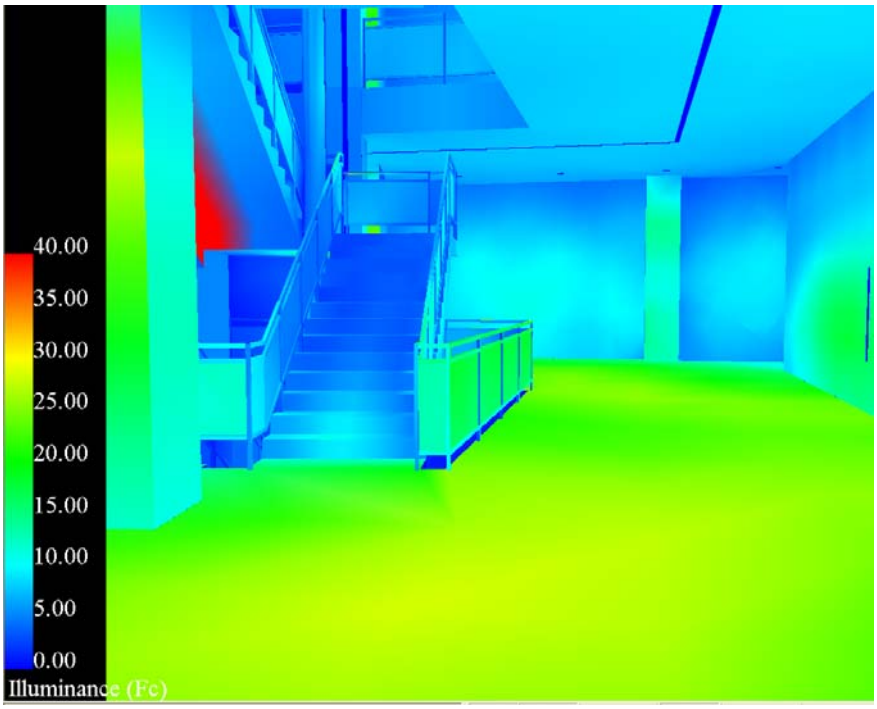
Total power consumption = 1,491 W < 2,999 W

Stairwell Cove Detail





AGI32 Analysis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25.00
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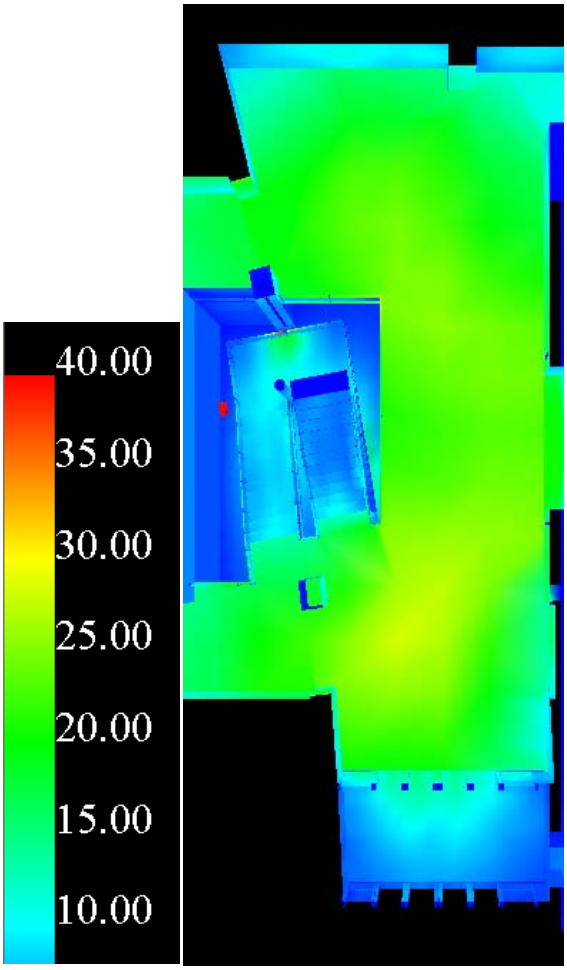
0.00
Illuminance (Fc)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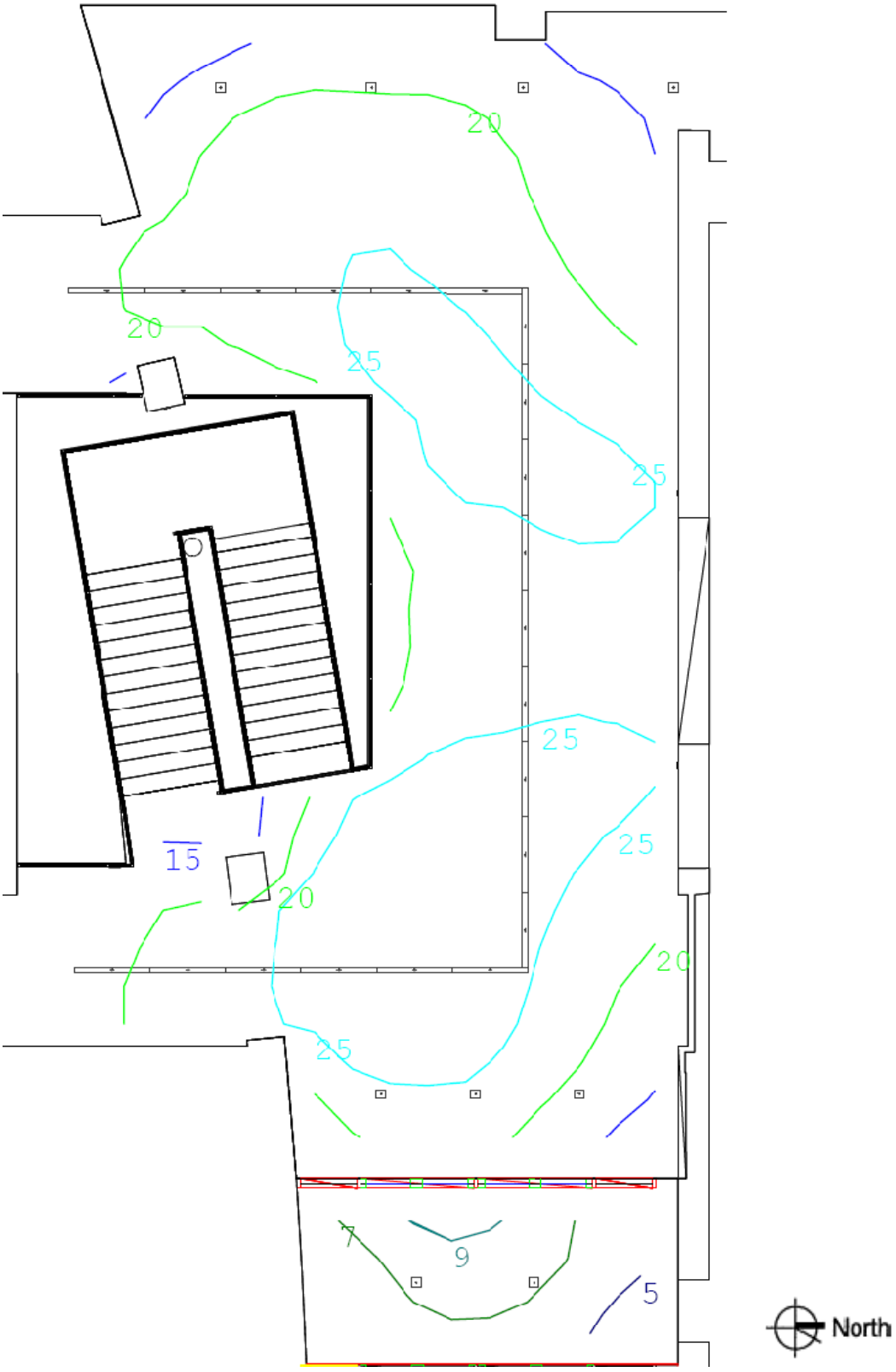
25.00
20.00
15.00
10.00

Illuminance Data



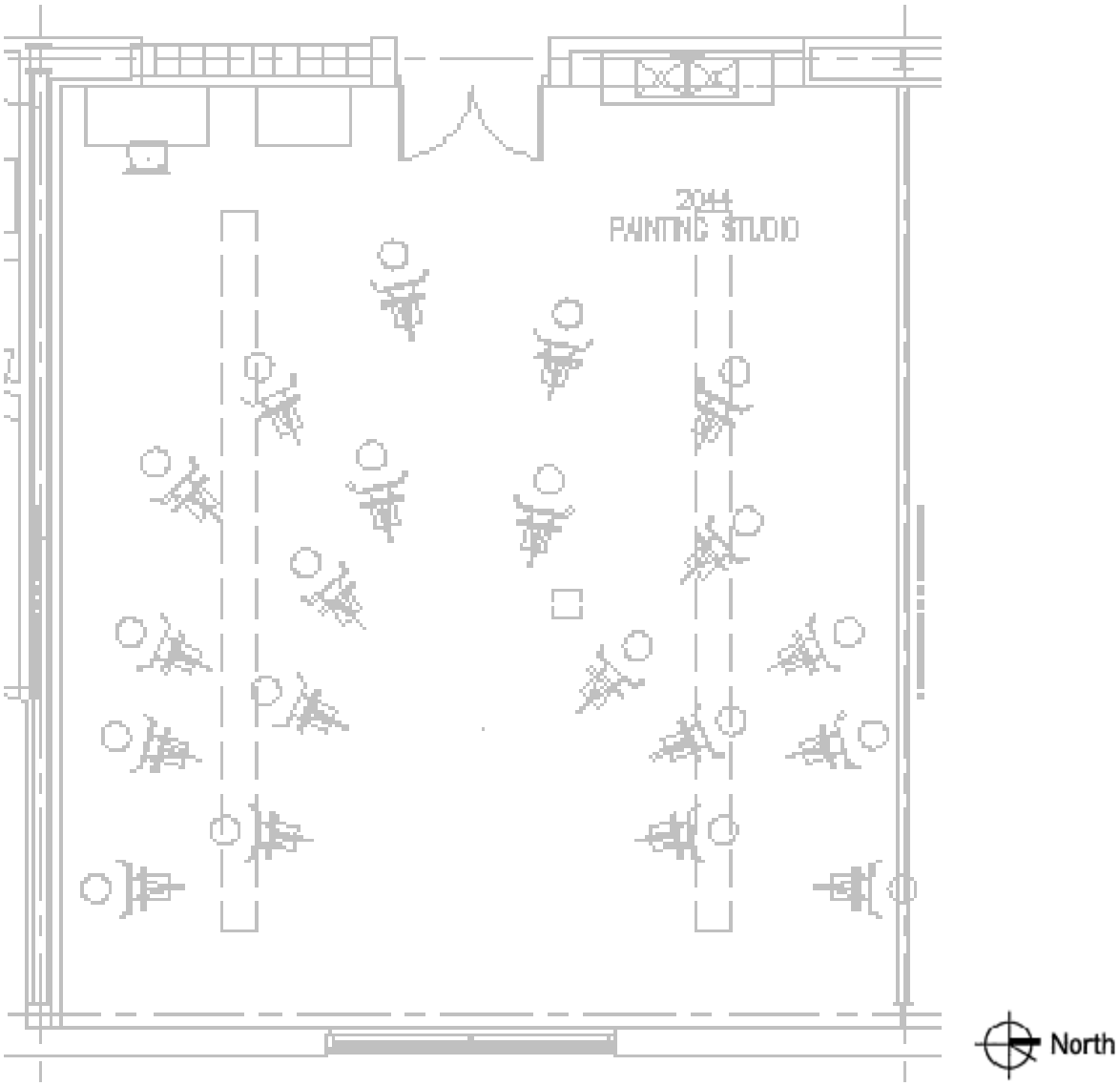
Evaluation

The combination of the slot downlighting and the continuous sconce on the stairwell column creates linearity in all three dimensions of the space. This helps emphasize the volume of the space and also meant to represent how art starts with just one line or brush stroke. In addition, the lighting design helps visitors to the building with way finding by pointing them to the main stairwell and corridors. The cove system creates a unique solution to the lighting of the stairwell area, however due to time limitations I could not refine it as much as I would have liked. Overall, I feel that this design meets my design criteria in an interesting and distinctive way.

Painting Studio

Space Summary

The painting studio is roughly 36'x41' in area with a 17' finished ceiling. In this space the main activity is student's painting. The space is quite open with the main furniture to be movable stools and canvases for painting purposes. There is also a stationary desk along the main wall along with a set of two sinks for cleaning paint supplies. This is one of 4 identical studios on the top floor of the building.



Surface Finishes

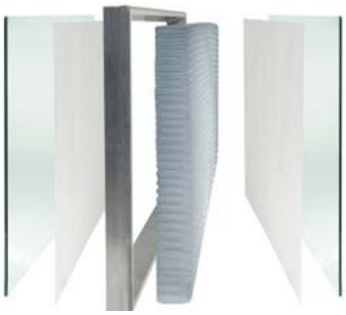
Floor: Sealed Concrete ρ= .38

Walls: painted gypsum wall board ρ= .80

Doors: Finished Wood ρ= .15

Ceiling: White Drywall ρ= .80

Skylight: Skylight: Advcaned Glazings Solera S glazing unit



Internal & External veil 401

Visible Transmittance = 34%

U-Value = 0.2

Solar Heat Gain coefficient = .32

**note: See Appendix B for product cut sheet*

Skylight Wells: painted Drywall ρ= .90

Blackout Skylight Shade (Black in color)

Equinox™ Series 0100
Blackout ShadeCloth
OF: 0%
Stock Width: 100"

Light control Skylight Shade (Black in color)

ThermoVeil® Series 1300
Dense Basket Weave
Approx. OF: 5%
Available in 63", 96" and
126" SuperWide® Widths
(Selected Colors)

Existing Design

The existing design consisted of a suspended uni-strut grid with surface mounted track lighting combined with an indirect/direct pendant fixture. Daylight was achieved through a central clerestory which was roughly the size of the uni-strut grid. The existing design was very energy intensive due

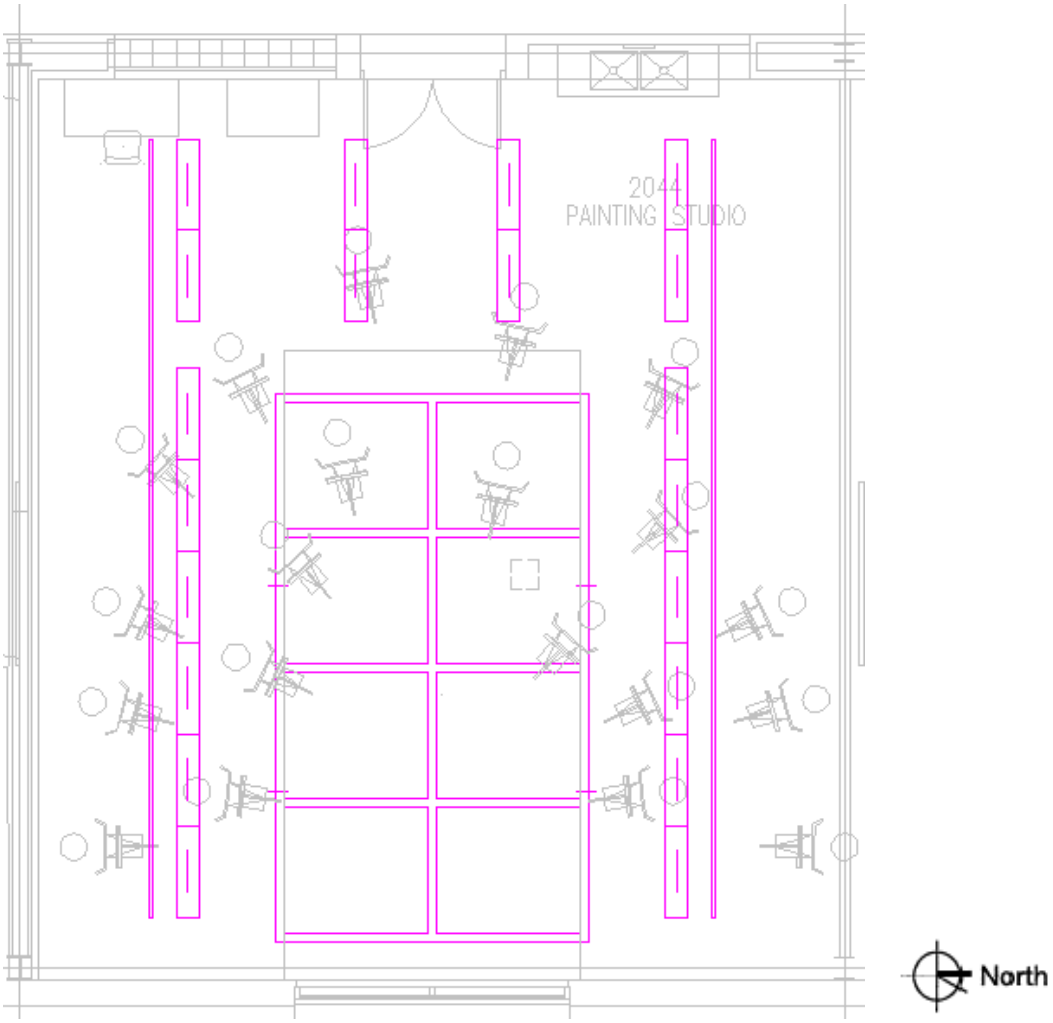
to the large amount of track lighting which was provided. Additionally, the indirect/direct fixtures predominantly lit the ceiling, but left the clerestory a black void during not daylit hours.

Power Consumed with Existing Design

Indirect fixtures 1,280 W

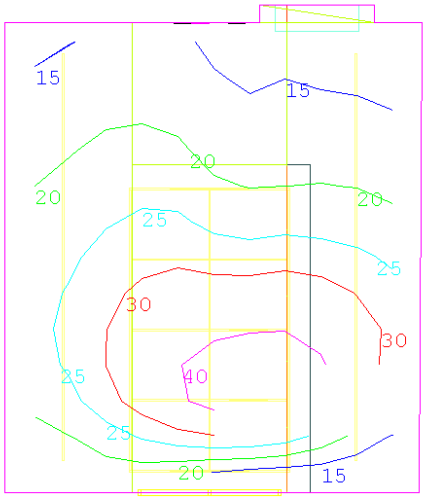
Track Lighting 7,000 W (7 circuits of 10 fixtures at 100W each)

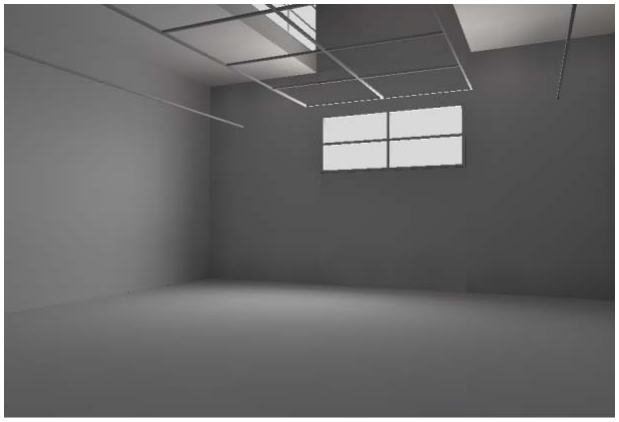
Total power 8,280 W



Electric Lighting with no daylight

Daylight Analysis: September 4, 11:00am





Design Criteria

Horizontal Illuminance

The IESNA handbook recommends 50fc on horizontal surfaces within a painting studio.

Vertical Illuminance

The IESNA handbook recommends 30fc on vertical surfaces within a painting studio

Appearance of Space and Luminaires

It is important that the space is comfortable as students will spend large periods of time in this room. In addition it is important that the space creates a feeling of creativity and ingenuity.

Daylight Integration and Control

This is one of the most crucial criterions for this space. A large window along the east wall and expansive skylights allow a vast amount of daylight into the space. Control of this daylight is necessary to provide a comfortable and efficient working space.

Light Distribution on Task Plane

A uniform and bright distribution of light is required on the task plane(easel) in this space.

Luminances of Room Surfaces

The walls and ceiling need to be bright in order to create a feeling of spaciousness. Lighting these surfaces will "open-up" the space.

Modeling of Faces and Objects

The modeling of faces and objects is paramount to bring out the texture, depth, shape of the objects to be painted

Source/Task/Eye Geometry

Source/Task/Eye geometry is important to consider to avoid shadowing onto the students' easels due to their bodies.

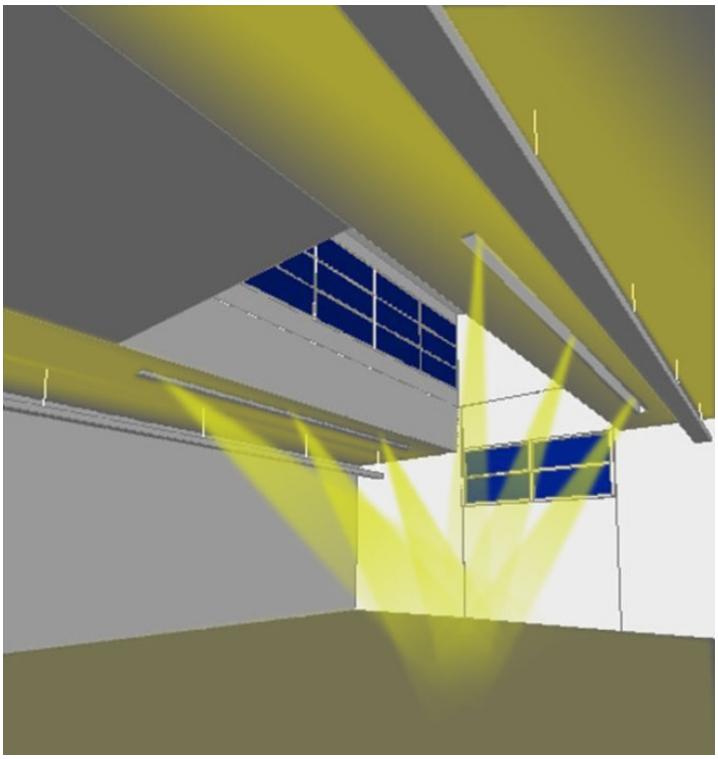
System Control and Flexibility

The lighting system should incorporate daylight sensors to allow automatic dimming during the day to save energy and keep from over lighting the space. Another essential element to the controls is having the capability for manual dimming which gives occupants flexibility to create the desired aesthetic to the space.

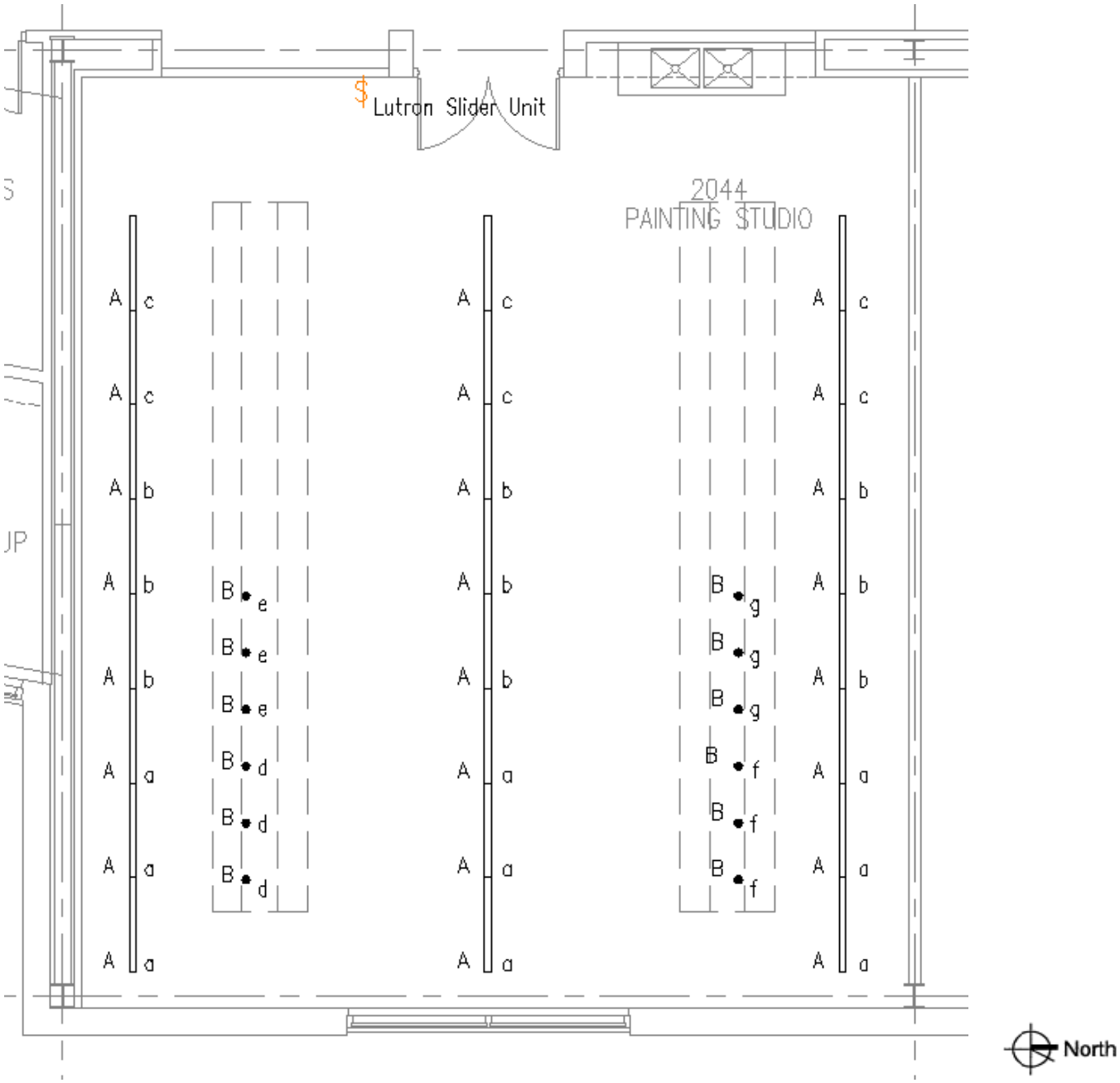
Design Synopsis

The key feature to the original design was a clerestory which allowed natural light into the space. After a daylight analysis, it was found that the clerestory was inefficient and after many design iterations, including the use of SkyCalc and AGI32, it was removed in lieu of a skylight system. Along with the switch to a skylight system, the implementation of mechanical operated shades across both the window and skylights was utilized to allow occupants the flexibility in the appearance of the space. Once the daylighting strategy was in place, the original electric lighting design concept was evaluated and deemed ineffective due to the inefficiencies of using an indirect lighting system in such a tall space with skylights. The lighting design was then switched to a recessed fluorescent slot lighting system. Also, the track lighting moved from a separate recessed channel into mounted on the inside of the skylight well. The final artificial and daylighting systems were then analyzed in SkyCalc and AGI32 to evaluate energy savings and the visual appearance of the space.

Initial Concept Sketch



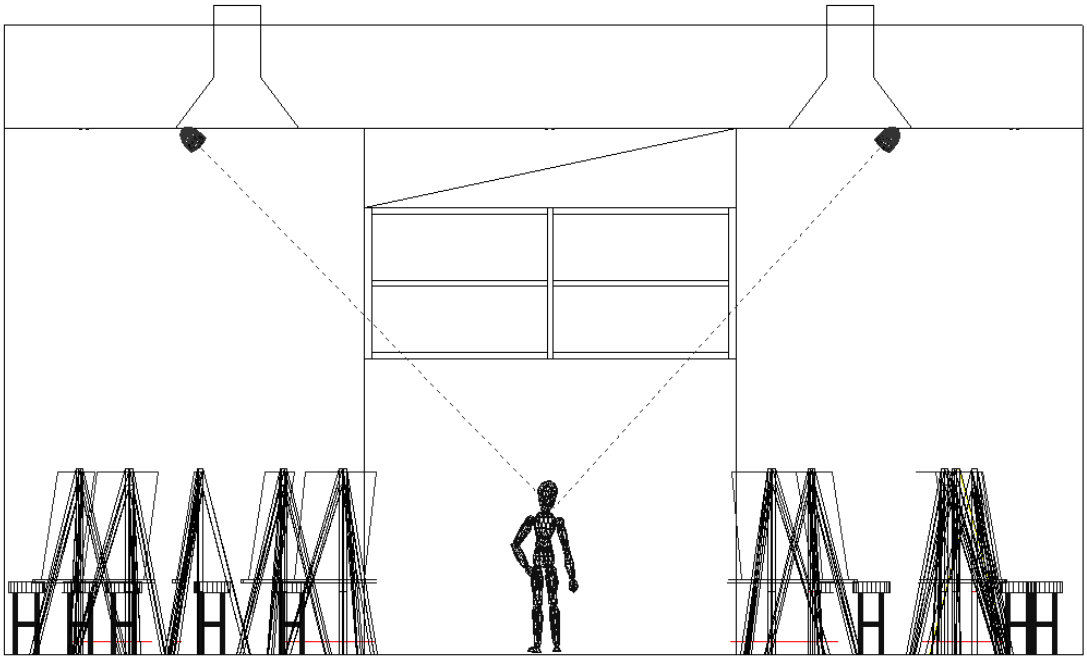
Lighting Layout



** Note: See Appendix I for a 1/8" = 1'-0" Plan*

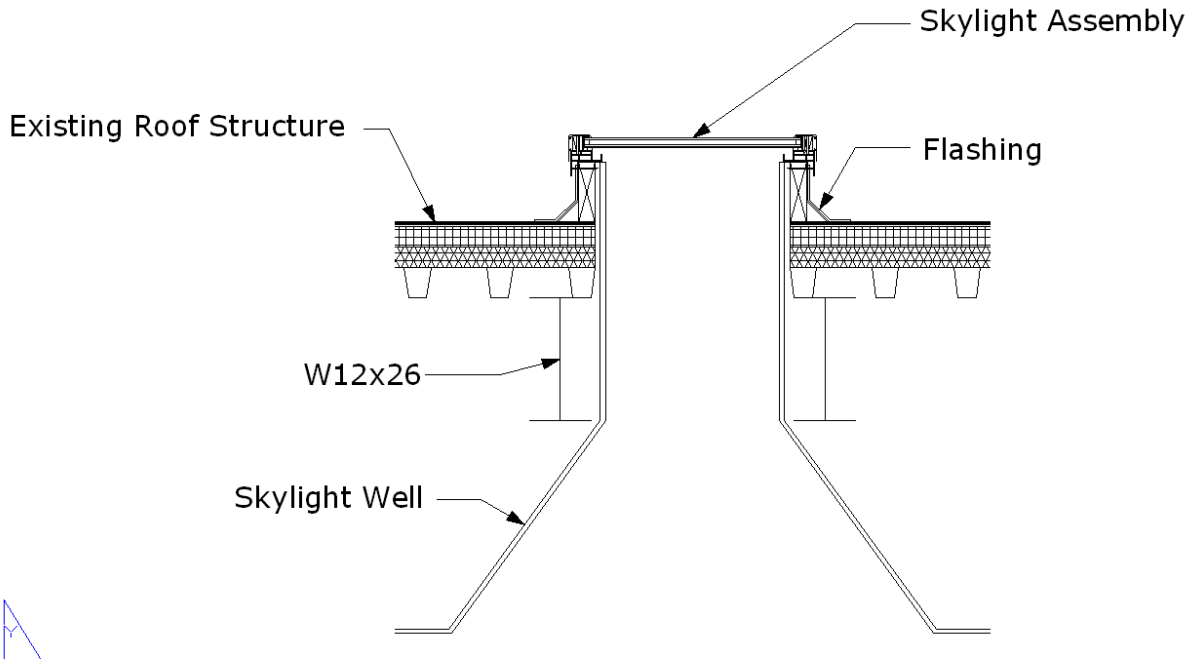
***Note: lower case letters designate zones*

Painting Studio Section



Section thru studio facing east

Skylight Detail



Controls Overview

The painting studio will be integrated into the building's existing Lutron Digital Grafik Eye7000 series. A Lutron slider (product # OMXSL) control unit will be implemented to control the dimming of each individual zone of light. Additionally, shade controls will be integrated into a custom-designed wallbox that houses both lighting and shade controls. Finally, a photocell will be utilized for automatic dimming of the electric lighting under normal daylight conditions.

*****Note: *See appendix C type 1C for a product cut sheet*

Schedules

Luminaire Schedule

Luminaire Type	Manufacturer	Catalog #	Lamps	Ballast Type	Volts	Comments
A	Se'lux	M1B1-2T5-SA-X-SH-004-WH-277-DM	(2) FP28/835 (L1)	M1	120	Recessed slot downlight, Dimming Ballast
B	Lighting Services Inc	C100-00-W	50PAR20-H-SP10 (L2)	n/a	120	Track Lighting Mounted to Skylight Opening

**Note: Please See Appendix A for additional information on luminaires, lamps, and ballasts*

Light Loss Factors

Luminaire Type	Maintenance Category	Room Atmosphere	Cleaning Cycle	Initial Lumens	Mean Lumens	LLD	Ballast Factor	LDD	RSDD	LLF
A	IV	Clean	12mo.	2600	2418	.93	1.0	.89	.96	.79
B	IV	Clean	12mo.	750	-	.95	1.0	.89	.96	.77

ASHRAE Standard 90.1 Power Allowances

Classroom/Lecture/Training = 1.4W/ft^2

Area (37'x41') = 1,517 ft^2

Total Allowed Wattage = 2,123.8W

Power consumption

24 "A" fixtures * 62 input watts/fixture	= 1,488 W
12 "B" fixtures * 50 watts/fixtures	= 600 W
Total power consumption	= 2,088 W < 2,123 W

Motorized Shades

The implementation of MechoShade® motorized shades was necessary to achieve the desired lighting control as well as for overall general comfort of those in the space. While the skylights provide ample daylight under an overcast condition, with average illuminance levels ranging from 30 to 55 footcandles, it provides far too much light in under certain clear sky conditions. The two shade options give the occupants the choice between completely eliminating daylight or just cutting it back to a more comfortable level. The shades will be controlled through an integrated Lutron Grafik-Eye® system which will control the lighting and shades simultaneously.

SkyCalc Analysis

The aim of the SkyCalc analysis was to determine the financial and environmental impact of switching from a clerestory system to a skylight system. SkyCalc was programmed intended towards the analysis of skylight systems and thus the use of it to analyze a clerestory daylighting system or any other system would be not valid. Therefore, it was not possible to get a side by side economic comparison of the clerestory system and skylight system. As mentioned in the design synopsis for the painting studio, the main goal of changing daylighting strategies was to provide daylight more evenly in the space. As such, SkyCalc analysis compares the energy and cost savings of having a skylight system versus not having one at all.

Performance data for the skylight was entered per the specifications of. The electricity rate for the analysis used the off peak charge of $0.00272 per kWh as outlined by the utility rate for the building. While this value seems extremely low, I had spoke with a representative from Dominion Virginia and the confirmed the value of $0.00272 per kWh.

**A copy of the utility rate schedule can be found in appendix D*

As not all options were available to completely tailor the analysis to the Art & Visual Technology building, certain assumptions were made to make this possible. Firstly, weather data for Fairfax, Virginia was not available. Instead, weather data from nearby Washington D.C. was used. Additionally, the cost per thermal of heating was estimated at $1.40/thermal.

SkyCalc: Skylight Design Assistant - Basic Inputs

Company Name: George Mason University
Project Description: Art & Visual Technology Building

Design Skylight to Floor Ratio = 5.9%

Select Location User Generated w/ e-QUE

Climate data loaded = Washington DC.wea3

Climate data needed =

Load Climate Data

Skylights:

Number of skylights 2
Skylight width 1.5 ft
Skylight length 30 ft

At least 4 skylights needed for uniform daylighting

Max skylight spacing = 25.5 ft (1.5 x ceiling ht)

Skylight Description

Glazing type: User Defined
Glazing layers: User Def Lay-3
Glazing color: User Def Col-2

Building

Building type: University 9 mo
Bldg area 1,517 ft^2
Ceiling height 17 ft
Wall color: Off-white paint

Skylight Well

Light well height 3.33 feet
Well color: Off-white paint
Safety grate or screen: ○ Yes, ◉ No

Shelving/Racks or Partitions?

○ Partitions, ○ Shelves/Racks, ◉ None/Open

No data required 7 ft
No data required 8 ft
No data required 8 ft
No data required ft

Heating and Air Conditioning Systems

Air Conditioning: Mechanical A/C
Heating System: Gas/Oil Furnace

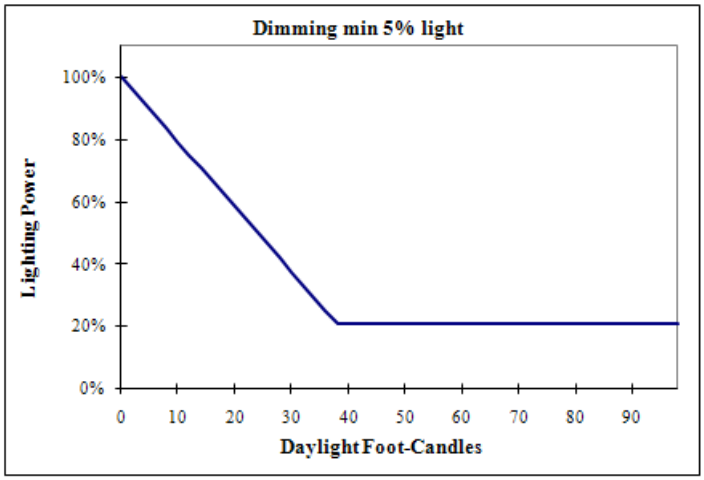
Electric Lighting

Lighting system: Open cell fluorescent
Fixture height 17 ft
Lighting control: Dimming min 5% light

Utilities

Average Elec Cost $0.003 kWh
Heating Fuel Units: Therm
Heating Fuel Cost $1.400 /Therm

Lighting Control Graph - Lighting Setpoint = 40 fc



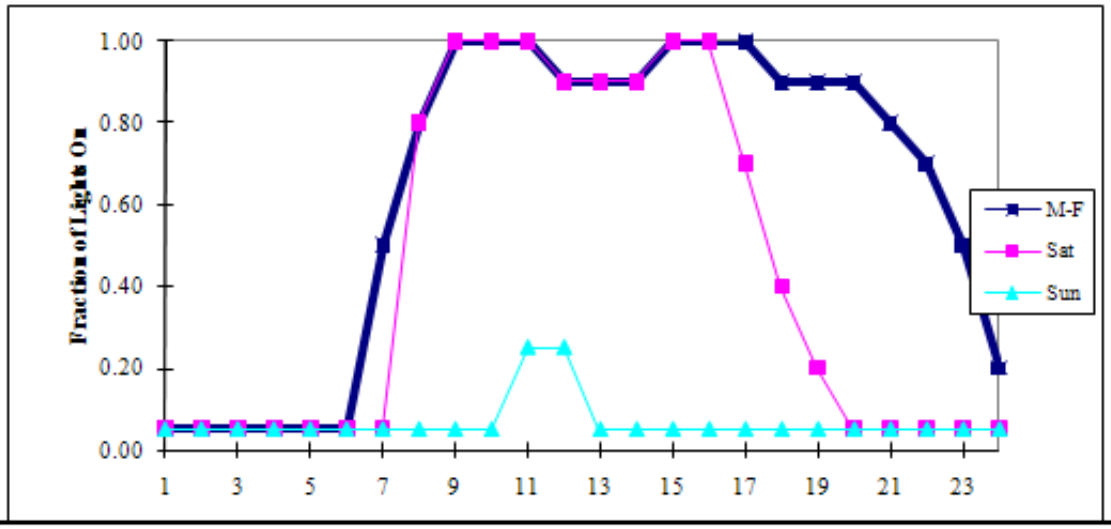
Skylights	Default	User Revisions	Design Input
Skylight shape	Flat	Default	Flat
Height of dome (Rise) (ft)	0		0
Visible transmittance	100%	34%	34%
Solar heat gain coefficient	100%	32%	32%
Curb type	Wood	Default	Wood
Frame type	Metal w/ thermal brk	Default	Metal w/ thermal brk
Unit U-value (Btu/h•°F•ft^2)	1.000	0.200	0.200
Dirt light loss factor	70%		70%
Screen or safety grate factor	100%		100%
Light well reflectance	70%	90%	90%
Well factor (WF)	88%		88%
Bottom of light well:			
Width (ft)	1.50	4.00	4.00
Length (ft)	30.00		30.00
Diffuser on bottom of well?	No	○ Yes, ◉ No	No

Building	Default	User Revisions	Design Input
Building width (ft)	28	37	37
Building length (ft)	55	Change width or area	41
Wall reflectance	70%	80%	80%
Ceiling reflectance	70%	80%	80%
Floor reflectance	20%	29%	29%
Shelving reflectance	40%		40%
Roof U-value (Btu/h•°F•ft^2)	0.063		0.063

Electric Lighting	Default	User Revisions	Design Input
Lighting setpoint (fc)	30	40	40
Task height (ft)	2.50		2.50
Lighting power density (W/ft^2)	0.88	1.40	1.40
Fraction lighting uncontrolled	10%		0.10
Lighting schedule	Class, University	Default	Class, University
Room and luminaire depreciation	80%		80%

Electric Lighting	Default	User Revisions	Design Input
Lighting setpoint (fc)	30	40	40
Task height (ft)	2.50		2.50
Lighting power density (W/ft^2)	0.89	1.40	1.40
Fraction lighting uncontrolled	10%		0.10
Lighting schedule	Class, University	Class, University	Class, University
Room and luminaire depreciation	80%		80%

Lighting Schedule Graph



SkyCalc: Skylight Design Assistant - Graphic Results

Company Name: George Mason University

Project Description: Art & Visual Technology Building

Flat Skylight Effective Aperture = 1.24%, Skylight to Floor Ratio (SFR) = 5.93%

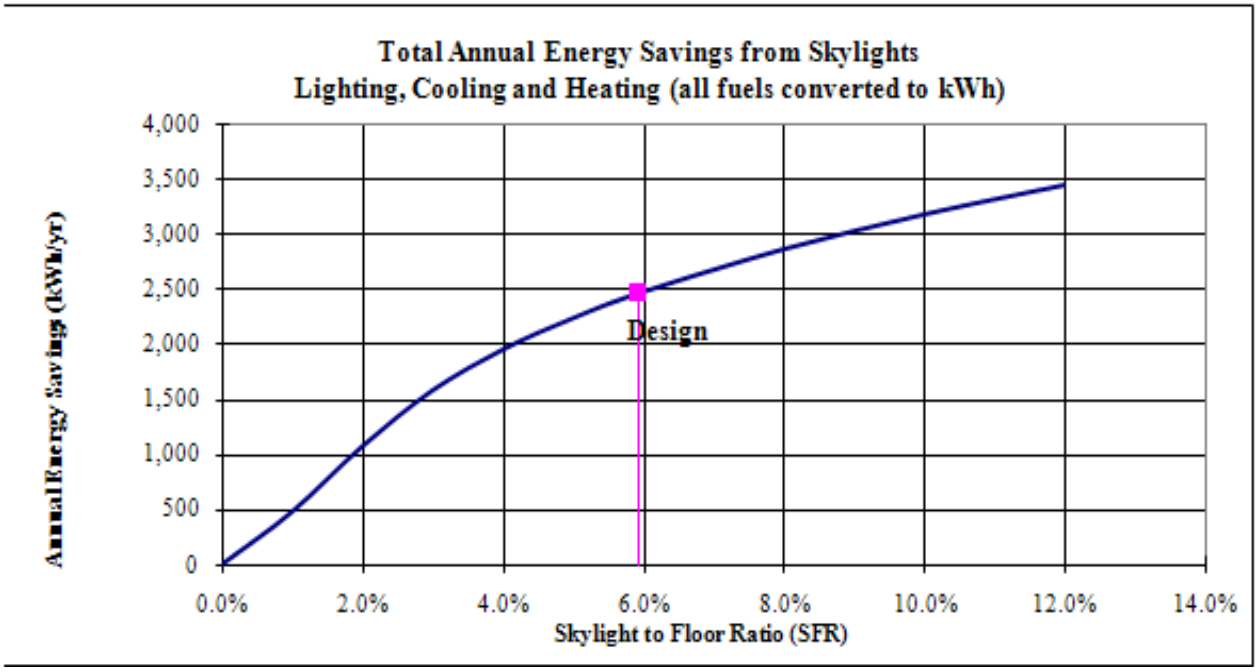
Average daylight footcandles (fc)

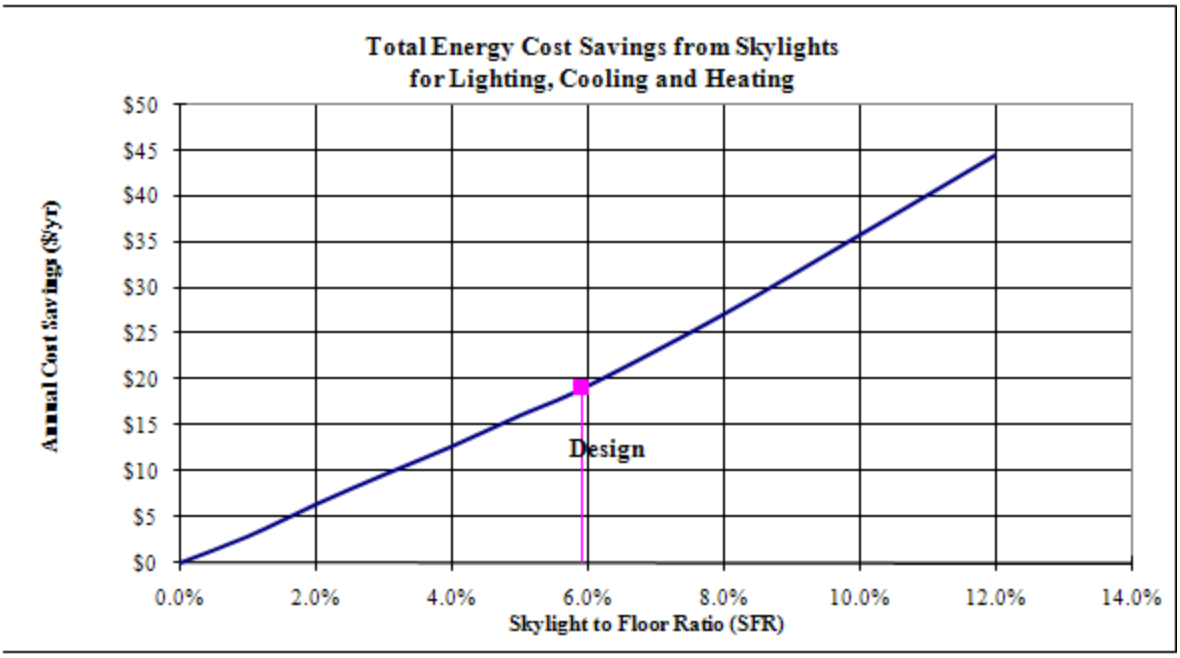
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Jan	0	0	0	0	0	0	0	1	9	18	29	37	39	34	24	14	5	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	0	5	14	26	42	50	53	51	39	23	9	2	0	0	0	0	0	0
Mar	0	0	0	0	0	0	2	12	27	47	63	74	75	68	55	39	21	7	0	0	0	0	0	0
Apr	0	0	0	0	0	1	9	23	46	65	80	85	87	81	72	51	29	12	2	0	0	0	0	0
May	0	0	0	0	0	4	16	34	58	80	90	97	95	90	83	58	38	19	5	0	0	0	0	0
Jun	0	0	0	0	0	5	20	38	63	88	106	113	116	108	89	63	40	21	7	1	0	0	0	0
Jul	0	0	0	0	0	3	15	34	57	78	90	96	96	96	90	73	49	24	7	1	0	0	0	0
Aug	0	0	0	0	0	1	11	28	54	82	100	106	105	94	80	61	34	15	4	0	0	0	0	0
Sep	0	0	0	0	0	0	5	19	40	63	79	92	89	75	59	38	19	5	0	0	0	0	0	0
Oct	0	0	0	0	0	0	2	10	25	43	56	63	64	57	42	23	9	1	0	0	0	0	0	0
Nov	0	0	0	0	0	0	0	5	15	28	38	45	42	36	25	13	3	0	0	0	0	0	0	0
Dec	0	0	0	0	0	0	0	1	7	16	25	30	32	27	18	10	2	0	0	0	0	0	0	0

Design Illuminance = 40 fc

< 1 fc; < 20 fc; < 40 fc; > 40 fc;

Location = Washington DC





SkyCalc: Skylight Design Assistant - Tabular Results

Company Name: George Mason University
Project Description: Art & Visual Technology Building

Electric Lighting Usage	kWh/yr		
Ltg. Energy without Skylights	7,289	Lighting Fraction Saved	30%
Lighting Energy w/ Skylights	5,119	Full daylighting (h/yr)	936

Update Results

Savings from Design Skylighting System			
Savings		Annual Energy Savings (kWh/yr)	Annual Cost Savings ($/yr)
Lighting		2,170	$6
Cooling		9	$0
Heating		275	$13
Total		**2,454**	**$19**

SkyCalc Evaluation

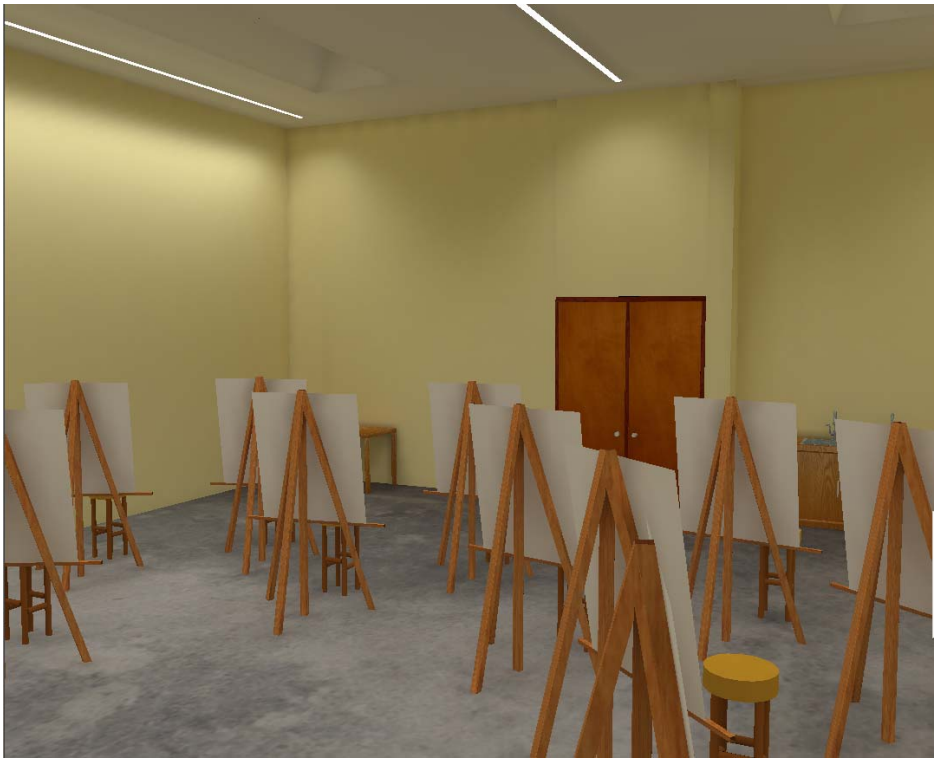
Through the use of SkyCalc it was found that the skylighting system will save up to 2,454 kWh per year or roughly $20 per year for each typical painting studio. There are three additional identical spaces; if the skylights are implemented in these spaces as well the owner could expect to see

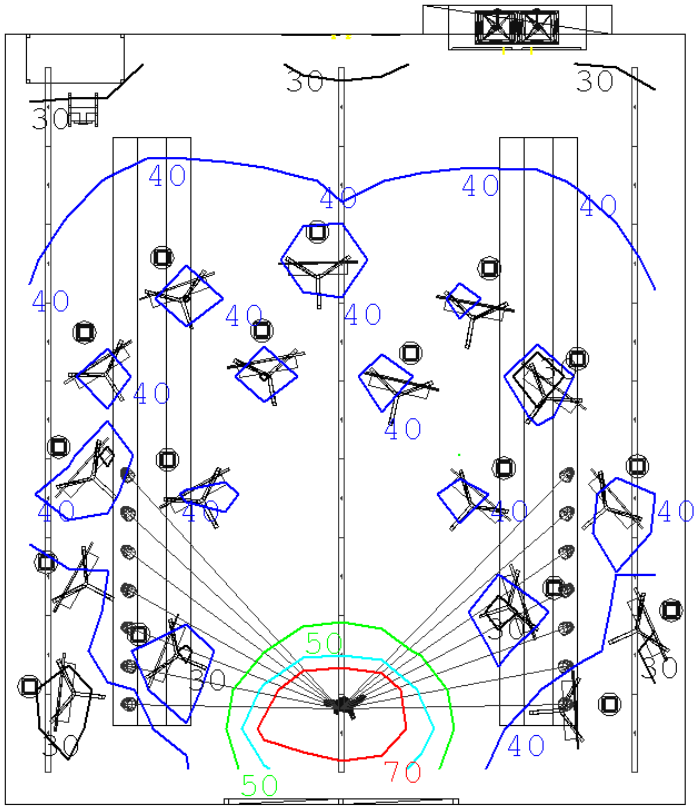
potential annual savings near 10,000 kWh and $80. One thing to note is that these are maximum values as occupants will sometimes close off the skylights to obtain a specific lighting condition for painting purposes.

As noted by graphs, a higher sky to floor ratio could have been utilized for additional energy and cost savings. This was not pursued due to the increasing costs of construction and materials versus the quickly marginalized returns.

Though not within the scope of this report and analysis, the architectural impacts would then need to be addressed, as the clerestories, which were replaced with skylights, provided a rhythm and distinct look for the east façade. Given the improvement of daylight into the space and the fact that it doesn't cost additional money, I would recommend the addition of skylights in the typical painting studio classrooms.

AGI32 Analysis (Electric Only)

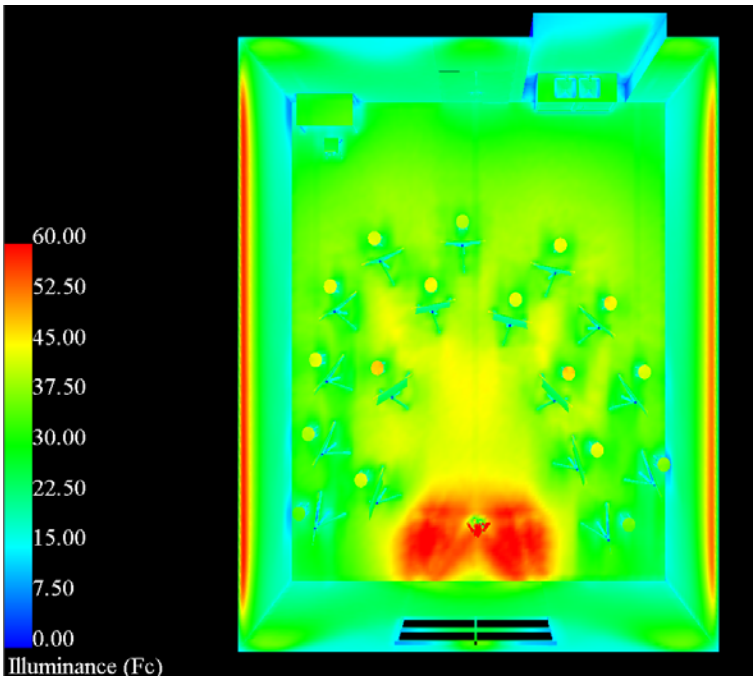




Project_1
Calc Pts

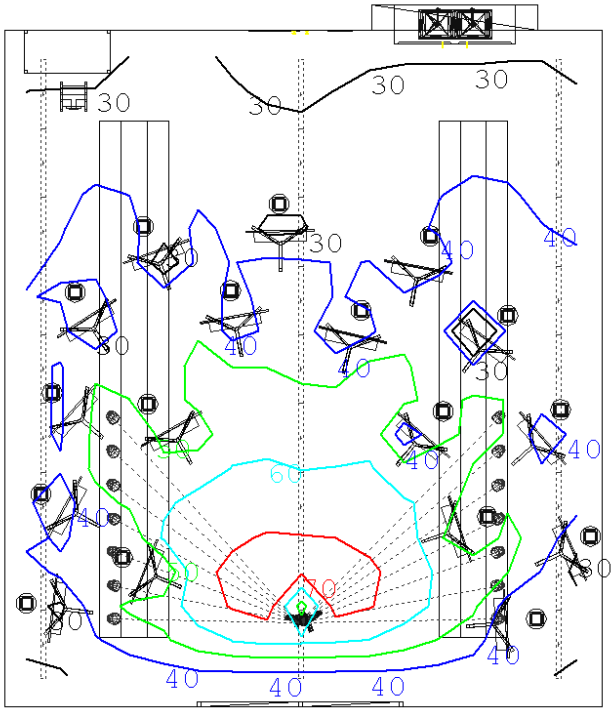
CalcPts
Illuminance Values(Fc)
Average=41.56 Maximum=105
Minimum=0.0 Avg/Min=N.A.
Max/Min=N.A.

North



Illuminance Data (Daylight only)

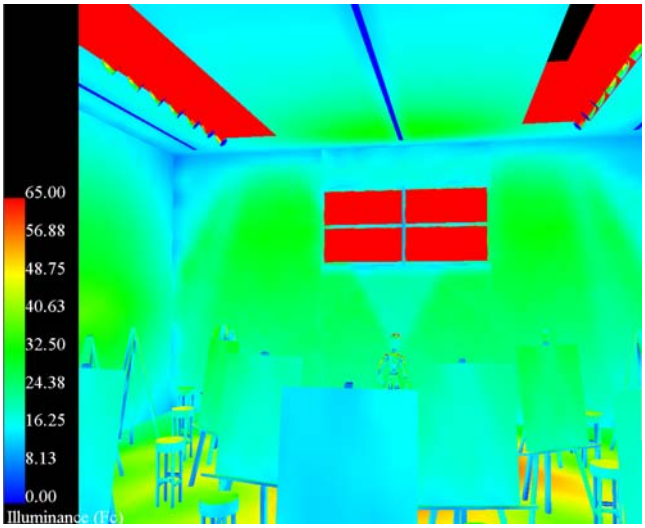
September 4th, 11:00am



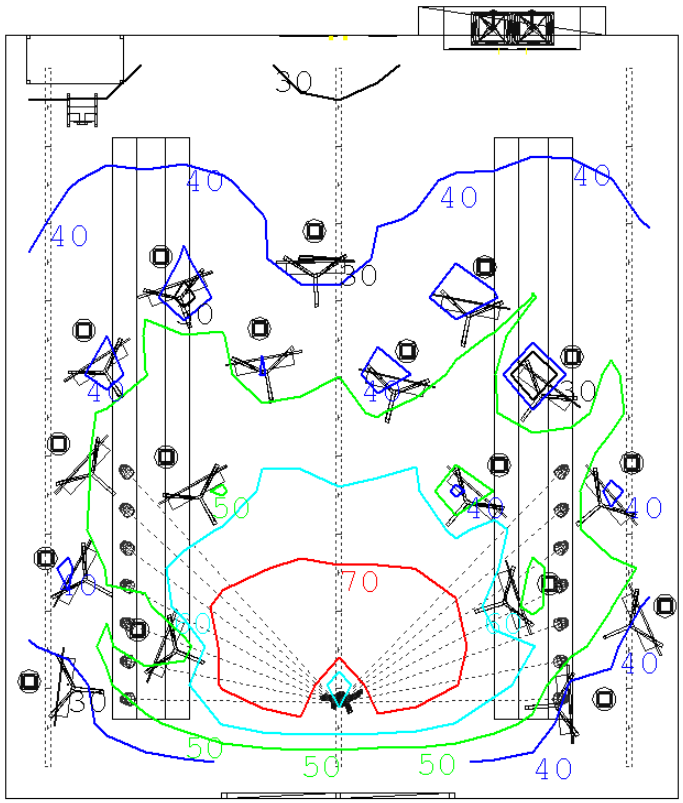
Project_1
Calc Pts

CalcPts
Illuminance Values(Fc)
Average=43.15 Maximum=74.9
Minimum=0.0 Avg/Min=N.A.
Max/Min=N.A.

North



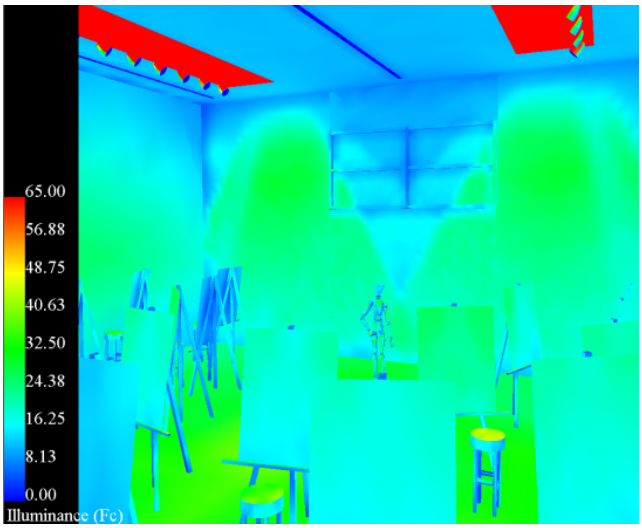
May5th 11:00am



Project_1
Calc Pts

CalcPts
Illuminance Values(Fc)
Average=46.80 Maximum=81.4
Minimum=0.0 Avg/Min=N.A.
Max/Min=N.A.

North



Evaluation

The new lighting design was able to achieve a more uniform distribution of daylight throughout the year. With the addition of a motorized shading system and a photocell, occupants of the space can reap the benefits while still having total control of the environment they paint in. The creation of the splayed skylight wells allowed for the track lighting to be mounted at the edge of the well, unifying the daylight and electric lighting systems. The electric lighting system creates a sleek, unique feel to the space through the linear slot downlighting. These design goals were met while still meeting ASHRAE and IESNA standards and recommendations.

Exhibit Gallery

The exhibition gallery is located directly off the main lobby of the building. This space is roughly 72'x35' with the East wall angled outward. The exhibit gallery is to display student work for students and professionals. Art of all mediums will be displayed in this space, therefore flexibility is a must. One key note to this space is that there is very little natural light in the space, as the only window is on the North East corner of the space. Therefore, limiting UV light on exhibits should not be an issue.

Surface Finishes

Floor: Sealed Concrete ρ= .38

Walls: painted gypsum wall board ρ= .85

Doors: Finished Wood ρ= .15

Ceiling: Wood Paneling ρ= .30

Existing Design

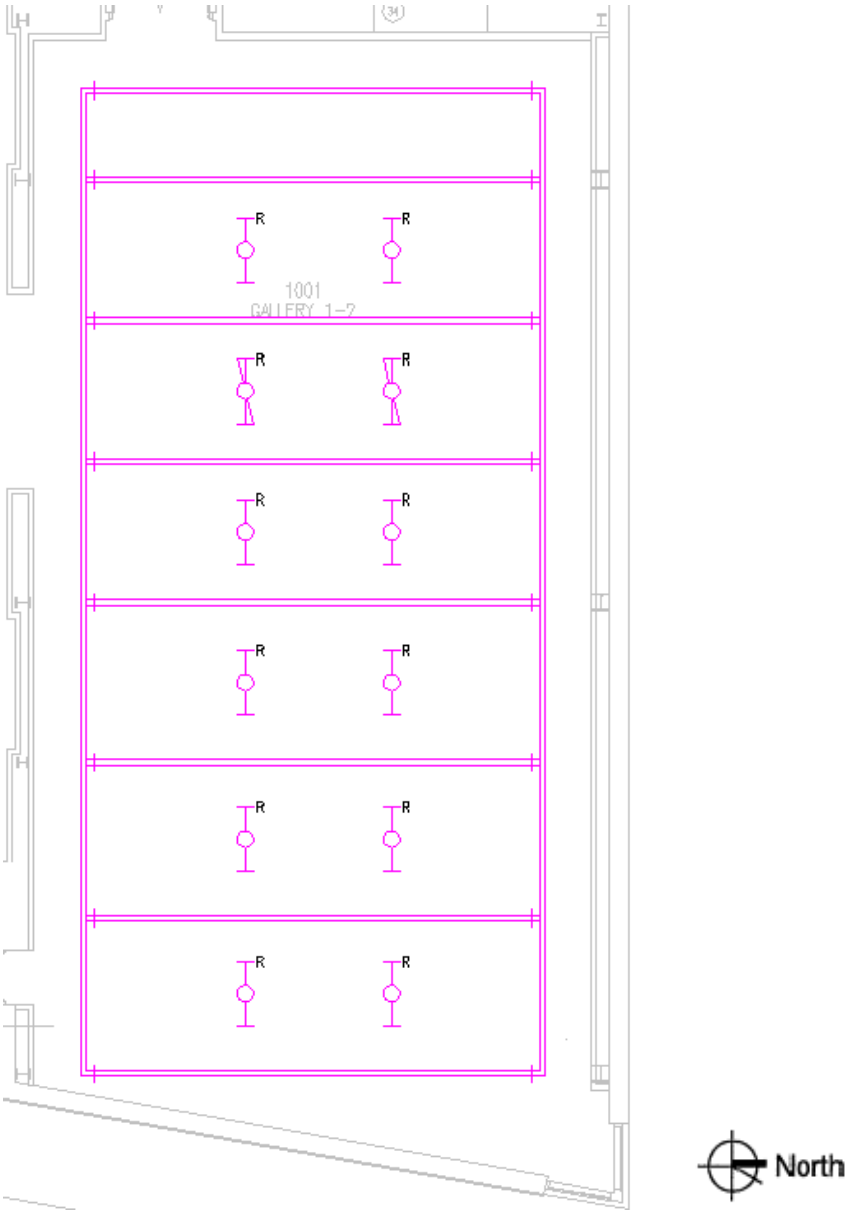
The existing designed used a suspended uni-strut grid to attach the track lighting system. The grid hangs from 12' above the finished floor. Meanwhile, pendant direct/indirect fixtures provided the ambient light for the space.

Power Consumed with Existing Design:

Direct/Indirect Fixtures 768W

Track Lighting 8,000W (8 circuits of 10 fixtures at 100W each)

Total wattage used 8,768W >> 2,345W



Design Criteria

Horizontal Illuminance

The IESNA handbook recommends 30fc on horizontal surfaces within an art exhibit. However, I feel that this would take away from the ambiance of the space, thus I am targeting 15 fc.

Vertical Illuminance

The IESNA handbook recommends 5fc on vertical surfaces within an art exhibit.

Appearance of Space and Luminaires

The fixtures within the art gallery should draw as little attention to the actual fixture themselves. The main purpose of a gallery is to look at the exhibit and the lighting system should embrace this notion rather than try and steal attention away.

Direct Glare

It is important to keep the spotlights out of direct view. As long as fixtures are aimed properly this should be easily achievable.

Light Distribution on Surfaces

Uniformity of light distribution on the painting and other two-dimensional displays is of the utmost importance. However, for any three-dimensional displays crisp, distinct shadows can help the display have a clear distinct view.

Luminances of Room Surfaces

Luminances of non display surfaces should be low to not draw attention away.

Modeling of Faces and Objects

The modeling of objects is extremely important to bring out the texture, depth, shape of the displays whether they are anything from paintings to sculptures. These features are what make many art pieces interesting and unique.

Reflected Glare

This will be an issue dependent on the finish of the display (especially glossy and glass encased). In these situations aiming will need to be done to avoid reflections of source in the display.

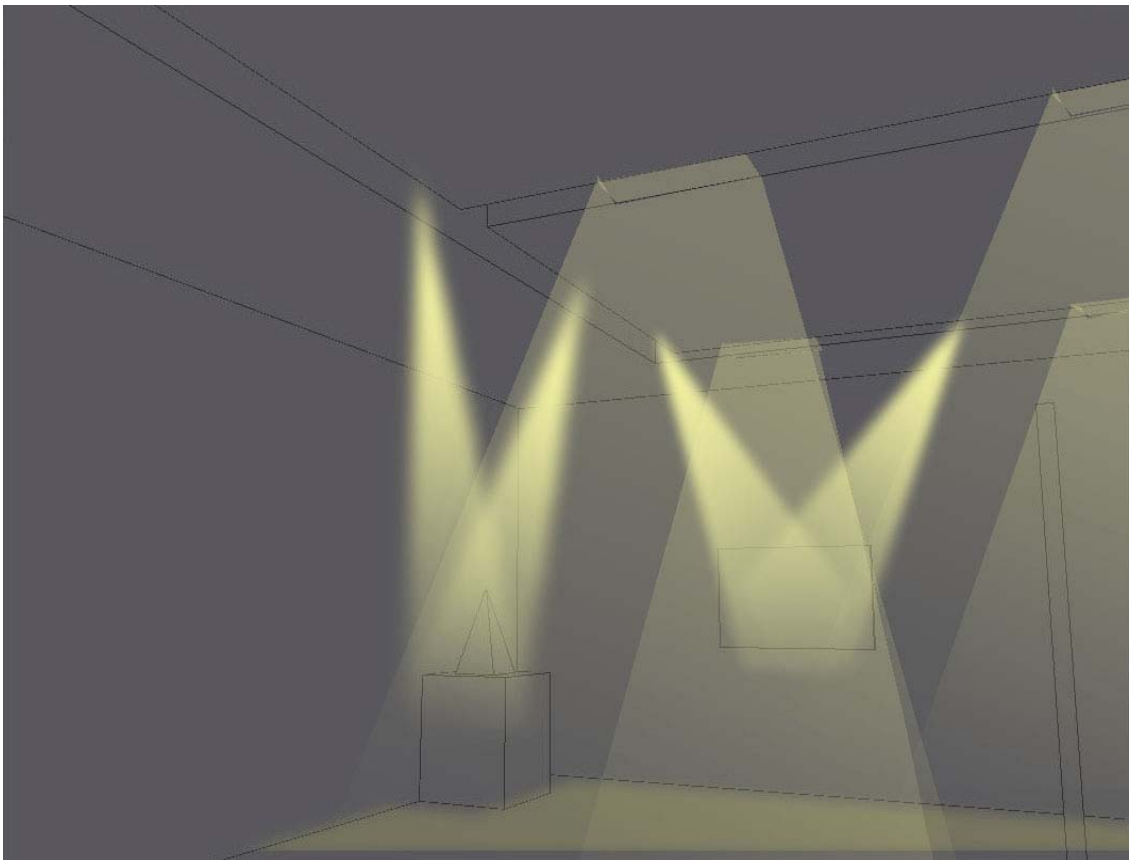
System Control and Flexibility

Flexibility within this space is crucial to be able to effectively light all types of work and layouts for the space. Control of fixtures is very important to have the ability to turn on and off fixtures and dim them as needed. Also, the ability to easily re-aim fixtures for new displays will keep the lighting design working as intended.

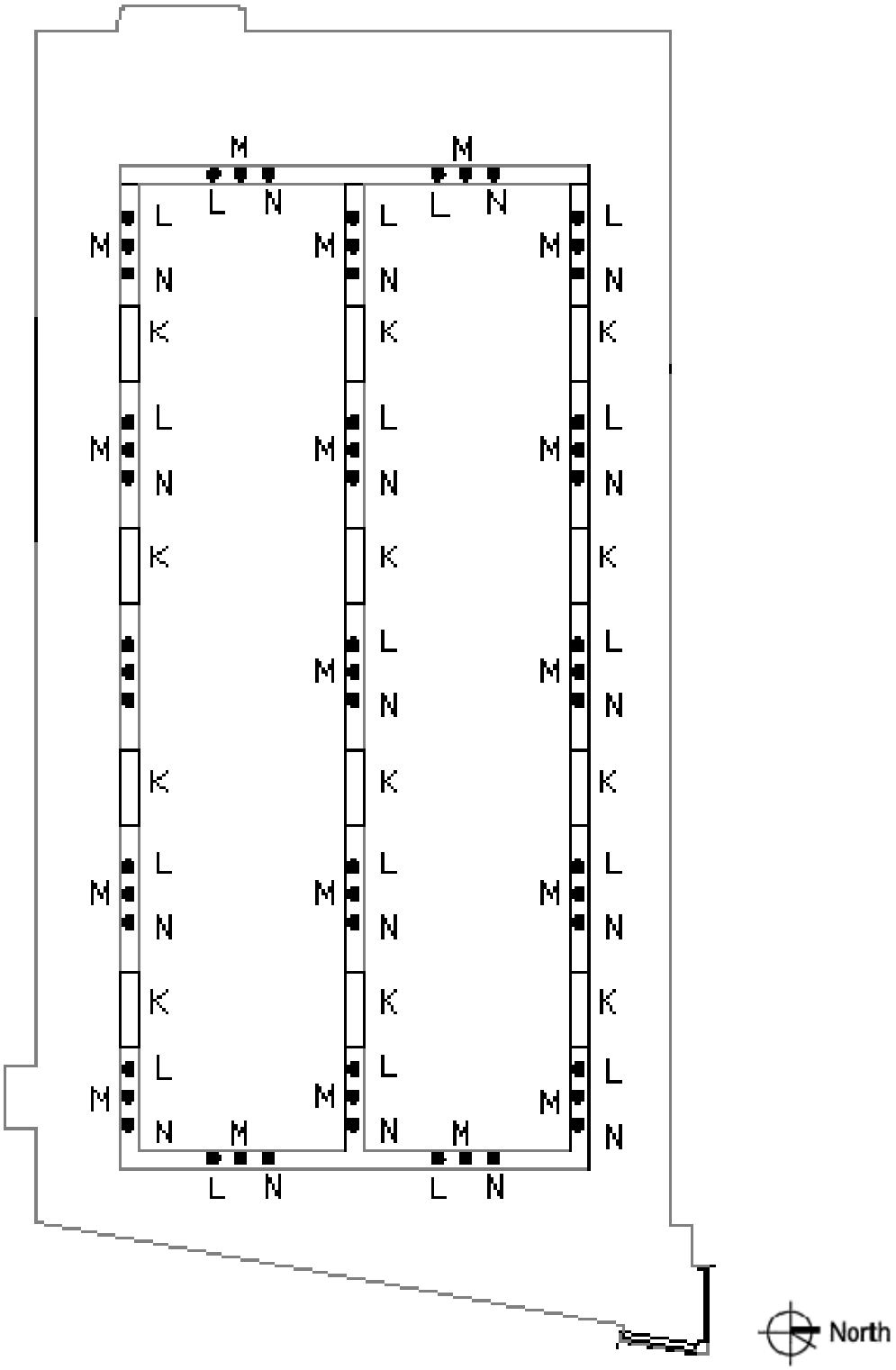
Design Synopsis

My final lighting design for the exhibit gallery was very similar to my schematic design presented at Lutron during fall semester. However, there has been much iteration to finalize fixture selections, especially on what track fixtures to provide. As part of my design, I wanted to provide the maximum amount of flexibility to the lighting system while keeping an extremely low profile for the lighting design. I wanted to keep a very low profile to keep the focus on the exhibits. To help with this goal I selected black baffled video-conference fixtures for the general purpose 1'x4's. These were selected because they will disappear in the black channels I have created to house the lighting design. Then the track lighting will also be recessed in the channel and will have a black finish. I ended up choosing a 10°, 25° and 35° lamps to provide a wide range of distributions for each display.

Initial Concept Sketch

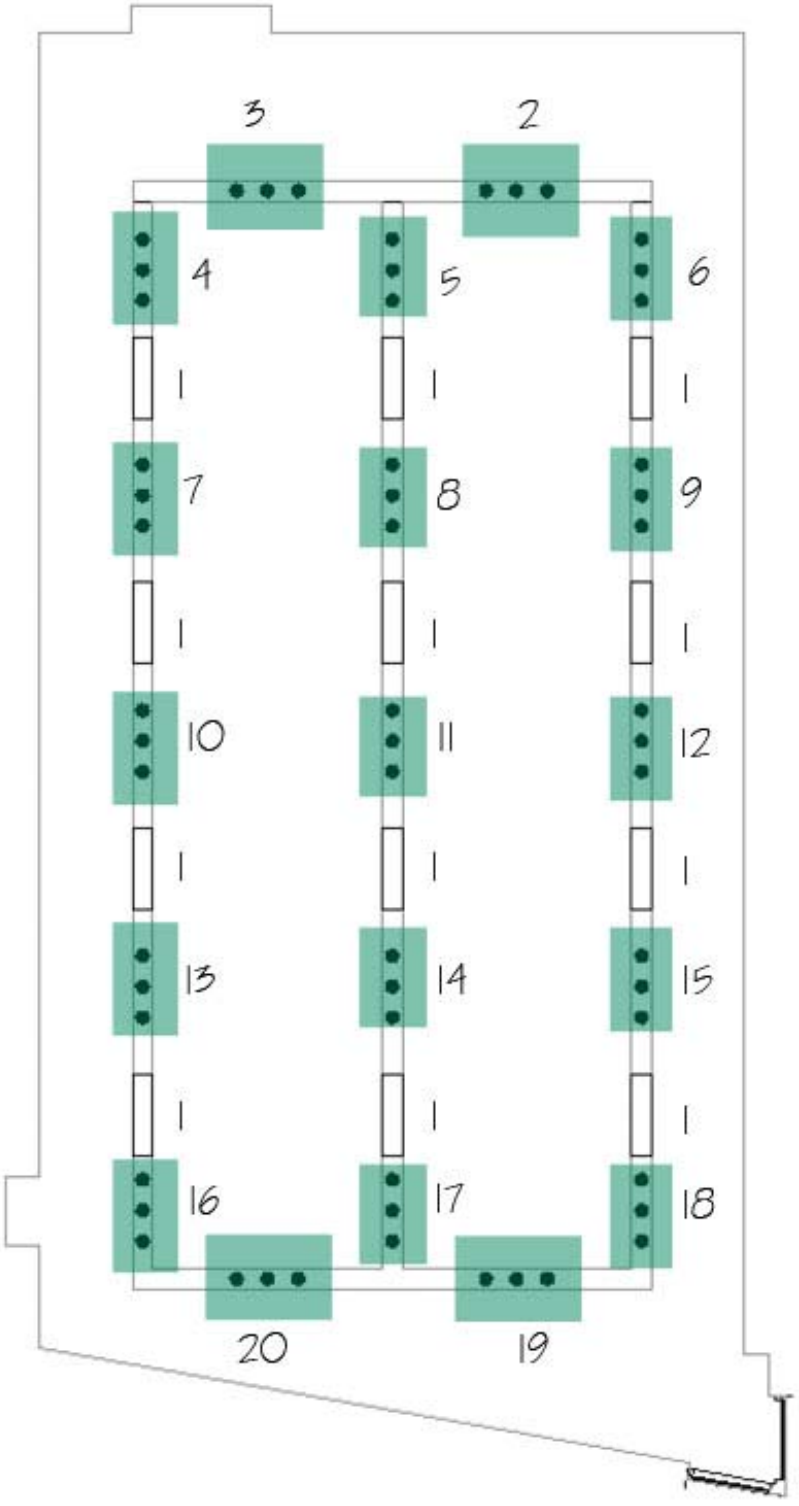


Lighting Layout



** Note: See Appendix J for a 1/8" = 1'-0" Plan*

Lighting Zone Plan



Controls

Control of this space will incorporate the use of Lutron's OMX-4600 unit that has the capability to have 4 predetermined scenes and can control up to 24 zones of light. The first scene would be an all on condition for cleaning and maintenance purposes. The second would have all the type K fixtures off leaving just the accent lights on. The third and fourth scenes would be programmed based on the owners' desire for the appearance of the current display. This gives the owner the flexibility to highlight specific pieces of art work or control overall light levels in the room.

**See appendix C type 2C for the controls cut sheet*

Schedules

Luminaire Schedule

Luminaire Type	Manufacturer	Catalog #	Lamps	Ballast	Volts	Comments
K	Focal Point	FTV/14/D/ 2/T5/E/277/ G/PB/DF/BK	(2) FP28/835 (L1)	M1	120	Recessed 1'x4' troffer, black matte finish louvers. Dimmable Ballast. To be mounted flush with bottom of channel.
L	Lighting Services Inc.	C100-00-B	(1)50PAR20/ H/FL25 (L8)	n/a	120	Recessed Track mounted at top of channel. Black finish housing. 25 degree beam spread.
M	Lighting Services Inc.	C100-00-B	(1)50PAR20/ H/SP10 (L2)	n/a	120	Recessed Track mounted at top of channel. Black finish housing 10 degree beam spread.
N	Lighting Services Inc.	C110-00-B	(1)50PAR30/ HIR/FL35 (L9)	n/a	120	Recessed Track mounted at top of channel. Black finish housing 35 degree beam spread.

**Note: Please See Appendix A for additional information on luminaires, lamps, and ballasts*

Light Loss Factors

Luminaire Type	Maintenance Category	Room Atmosphere	Cleaning Cycle	Initial Lumens	Mean Lumens	LLD	Ballast Factor	LDD	RSDD	LLF
K	IV	Very Clean	12mo.	2600	2418	.93	1.0	.93	.98	.85
L	IV	Very Clean	12mo.	570	498	.87	1.0	.93	.98	.79
M	IV	Very Clean	12mo.	750	-	.9	1.0	.93	.98	.82
N	IV	Very Clean	12mo.	630	-	.9	1.0	.93	.98	.82

ASHRAE Standard 90.1 Power Allowances

Museum – General Exhibition 1.0W/ft^2

Area 35'x67' =2,345ft^2

Exception 9.6.3 (a) "For spaces in which lighting is specified to be in addition to the general lighting for the purpose of decorative appearance, such as chandelier-type luminaires or sconces or for highlighting art or exhibits, provided that the additional lighting power shall not exceed 1.0W/ft^2 or such spaces.

Exception allowed wattage = 2,345W

Total allowed wattage = 4,690W

Power Consumption

12 "K" fixtures * 62 input watts/fixture = 744 W

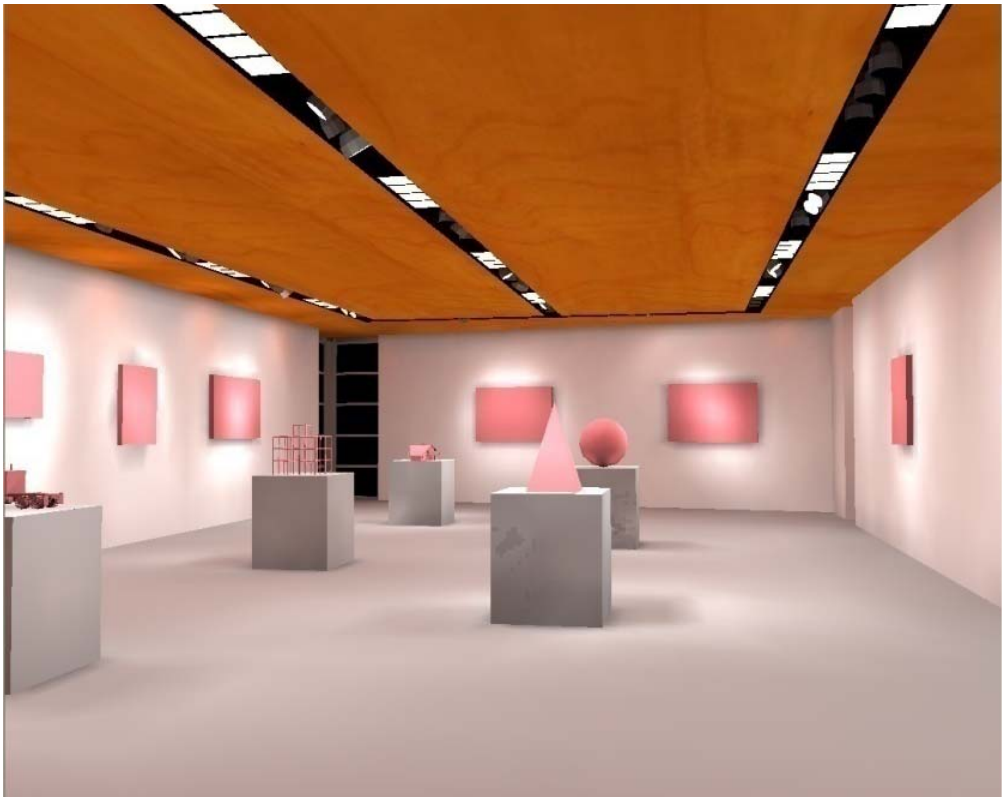
19 "L" fixtures * 50 input watts/fixture = 950 W

19 "M" fixtures * 50 input watts/fixture = 950 W

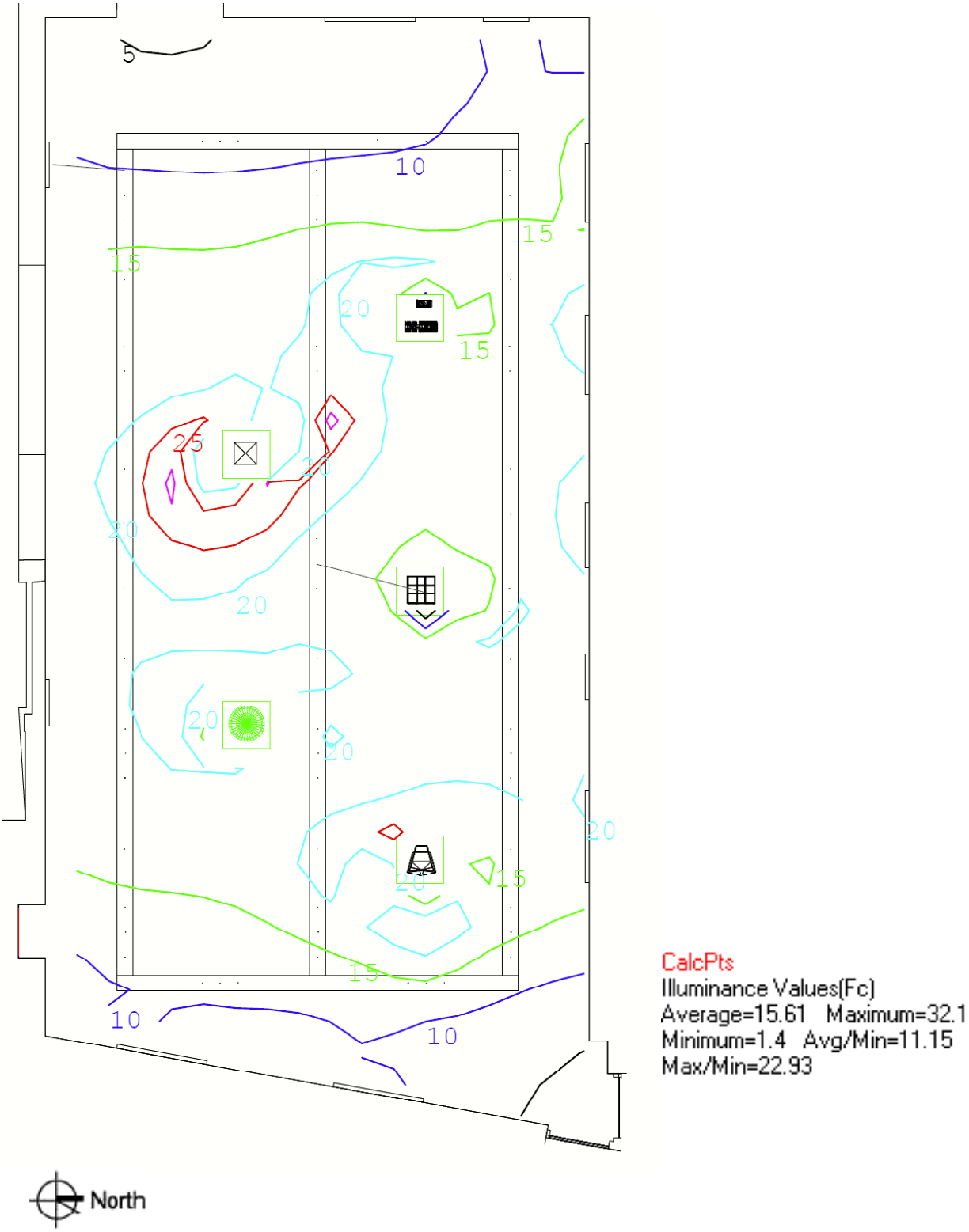
19 "N" fixtures * 50 input watts/fixture = 950 W

Total power consumption = 3,594W <4,690W

AGI Analysis (All On condition)

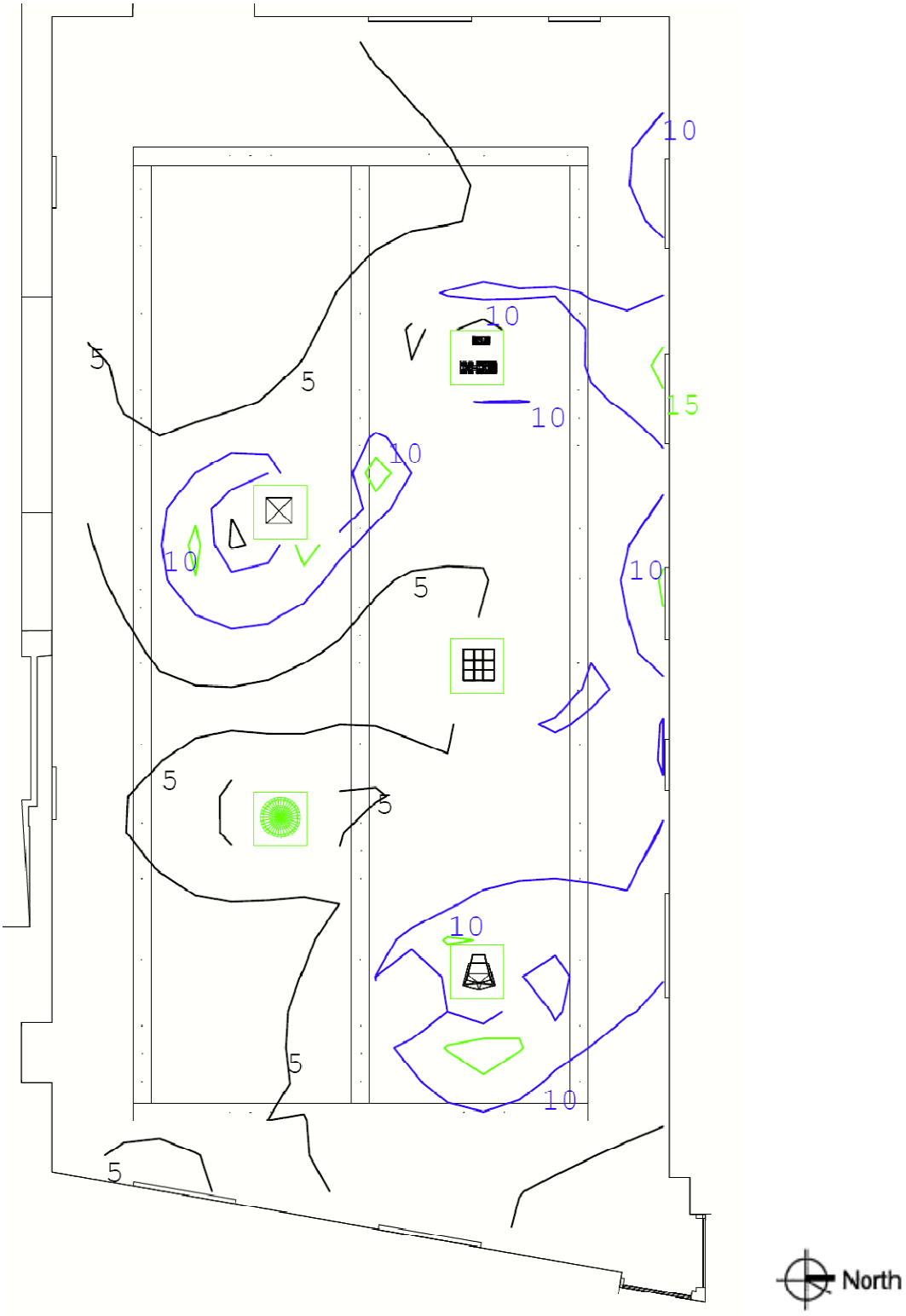


Illuminance Data (All On Condidtion)



AGI Analysis (Accent Fixtures Only)

Illuminance Data (Accent Fixtures only)



Evaluation

The goals of the lighting redesign this space were to provide a flexible lighting system for any configuration of art exhibits and to have a low profile design while meeting ASHRAE standards. Through the use of the recessed channels to house the 1x4 video conference fixtures and the track lighting, the lighting design was able to create a minimal profile within the space. However, I was unable to accurately render how the 1x4 black louvered fixtures would appear within the space. They would be much less apparent than they seem in the all on condition rendered above. With the use of the existing dimmer panel, ambient levels can vary from any full output (all on condition) to where they are off (accent fixtures only). Additionally the accent lighting also has the flexibility to dim from full output (shown) to any other level desired.