Technical Report One

Yale Sculpture Building

New Haven, CT

Kha N. Dang
Architectural Engineering – Lighting | Electrical Option
http://www.arche.psu.edu/thesis/eportfolio/2007/portfolios/KND107

Lighting Conditions and Design Criteria Report: Technical Report 1

10.05.06

Prepared for: Dr. Richard Mistrick
CC: Ted Dannerth
Date: October 6, 2006

Executive Summary

The following is a technical report regarding the existing lighting conditions and design of The Yale Sculpture Building. This report will contain an analysis of the existing lighting system and major lighting hardware. The wood shop, undergraduate studio space, gallery and the exterior façade were the spaces that were analyzed.

Information about the systems were obtained from the construction documents and specs provided by Kieran Timberlake Associates. The space models were built in AutoCAD 2007 and transferred to AGI32 1.9 for lighting performance analysis. Power density and Light Loss Factors were devised by standard IESNA procedures (refer to IES handbook).

After analyzing the four spaces, the original design fulfills most of the IES requirements but lacks a certain quality about the design. The designs are simple and to the point. The same lamps were used throughout the design as well as very similar fixtures. The lighting design can profit by using tasking lighting instead of increasing the ambient light levels. This project can benefit from a detailed day lighting/ electrical lighting integration study.

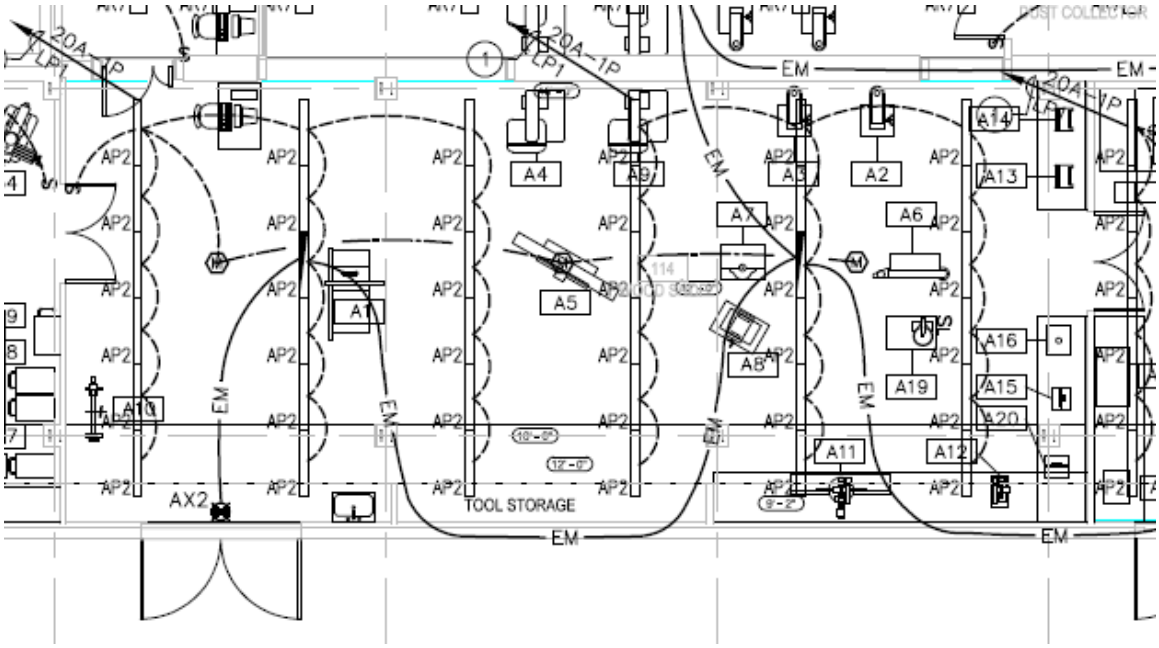
Overall Outline

- Space
  - Plans
  - Materials Reflectance
  - Lighting Hardware
  - Furniture and Equipment
  - Design Criteria
  - Existing Lighting System Analysis
    - Light Loss Factors
    - Power Density
    - AGI 32 1.9 Software Analysis
  - Summary

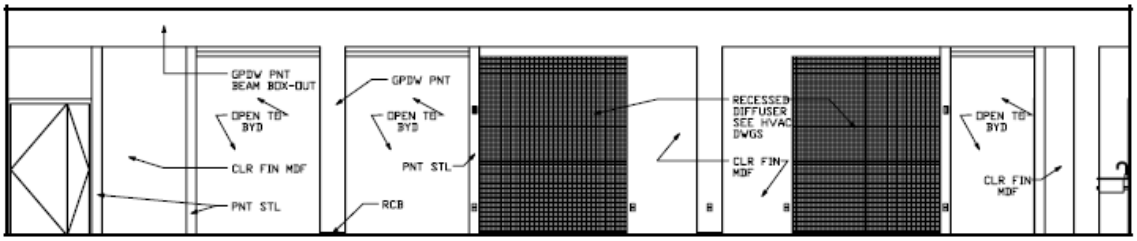
Space 1 - Wood Shop

Plans

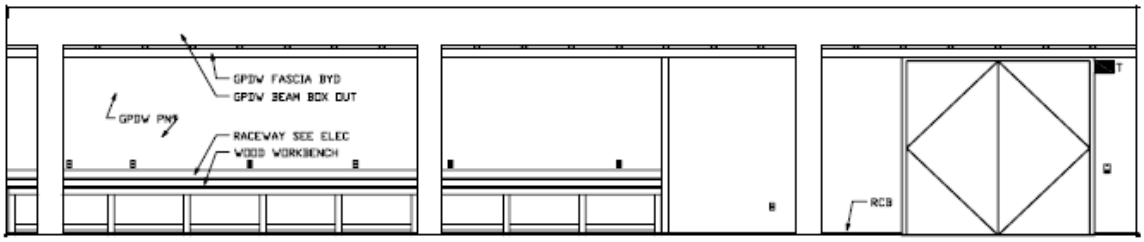
Lighting Plan



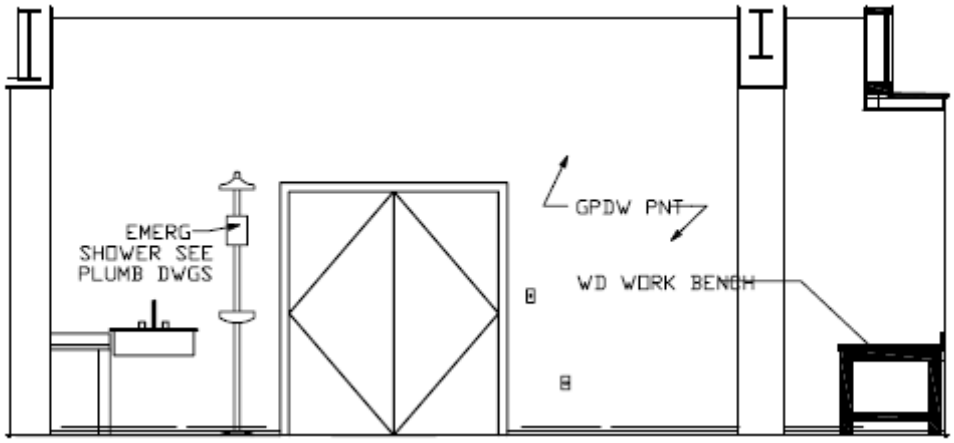
North Interior Elevation



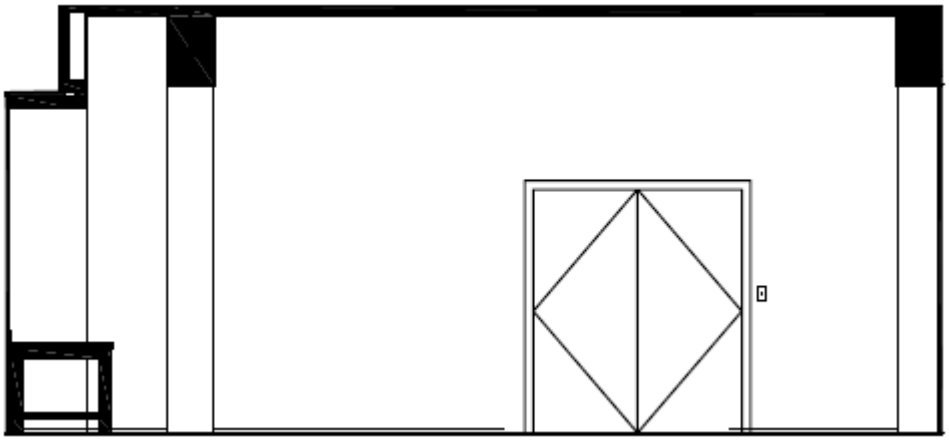
South Interior Elevation



East Interior Elevation



West Interior Elevation



Material Reflectance

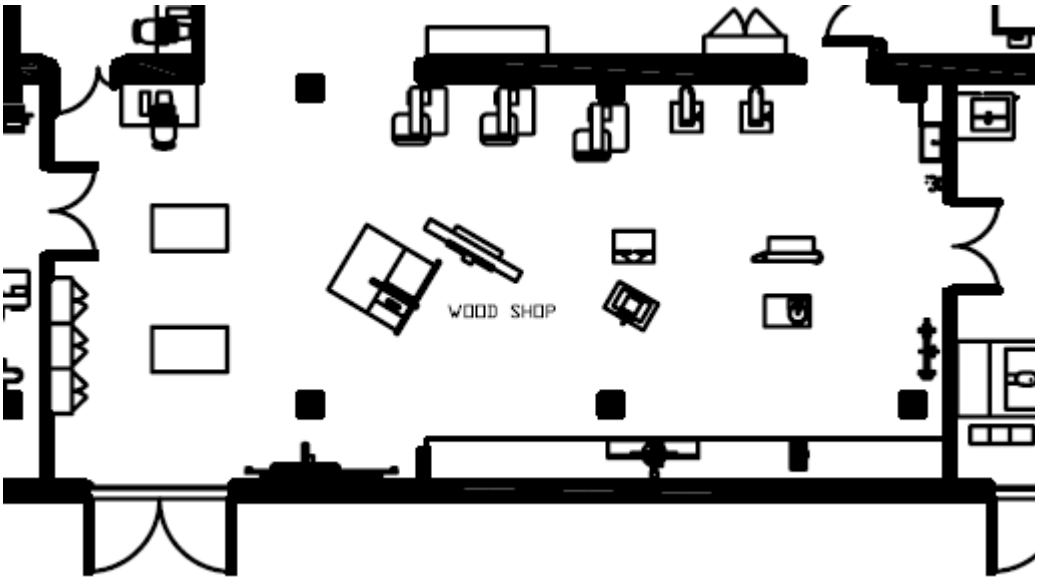
Material	Reflectance
Gypsum Board	0.70
Steel	0.20
Concrete	0.35
CLR FIN (Clearance Finish)	0.80
RCB (Rubber Cove Band)	0.50
Wooden Work Bench	0.40

Lighting Hardware

The only luminaire used in this space is a linear fluorescent pendant fixture. The fixture is manufactured by Linear Lighting and its catalog number is A66-D-2-ET8-Pbw-C—ED. It houses two T8 fluorescent lamps that are operated by a 120V electronic dimming ballast (Advance Mark 10). The louvers are matte aluminum.

This space contains two occupancy sensors with power packs. These sensors are located perpendicular to the side doors.

Furniture/ Equipment



Design Criteria

Color appearance and rendering (Contrast)

Students and professors must be able to distinguish different materials and equipment easily. The will decrease the occurrences of accidents and miscommunication.

Direct/Reflected Glare

Glare can cause accidents when students are using the woodworking equipment. Glare can impair vision and increase tension in students.

Light Distribution (Uniformity)

Illuminances on the work plane and floor should not vary greatly since it can impair vision in darker areas.

Shadows

Shadows can obstruct equipment operator's visual task.

Flicker (Strobe effect)

HID lamps can be a source of flicker. This can be a nuisance to students and create a potential hazard.

Illuminance Recommendation

I am recommending a illuminance valve of at least 50fc to insure proper safety in this hazardous area.

Existing Lighting System Analysis

Light Loss Factors

Luminaire	Cat.	Room	Cl.Int.	BF	LLD	RSDD	LDD	LLF
AP2	III	Clean	12	1.0	0.91	0.97	0.9	0.8

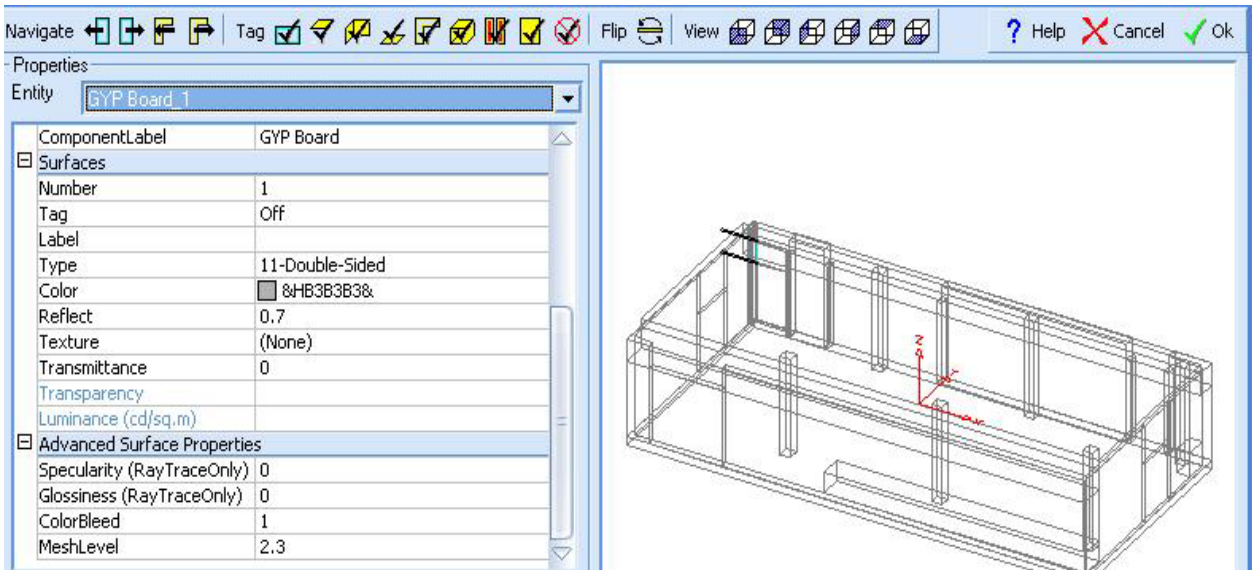
Power Density

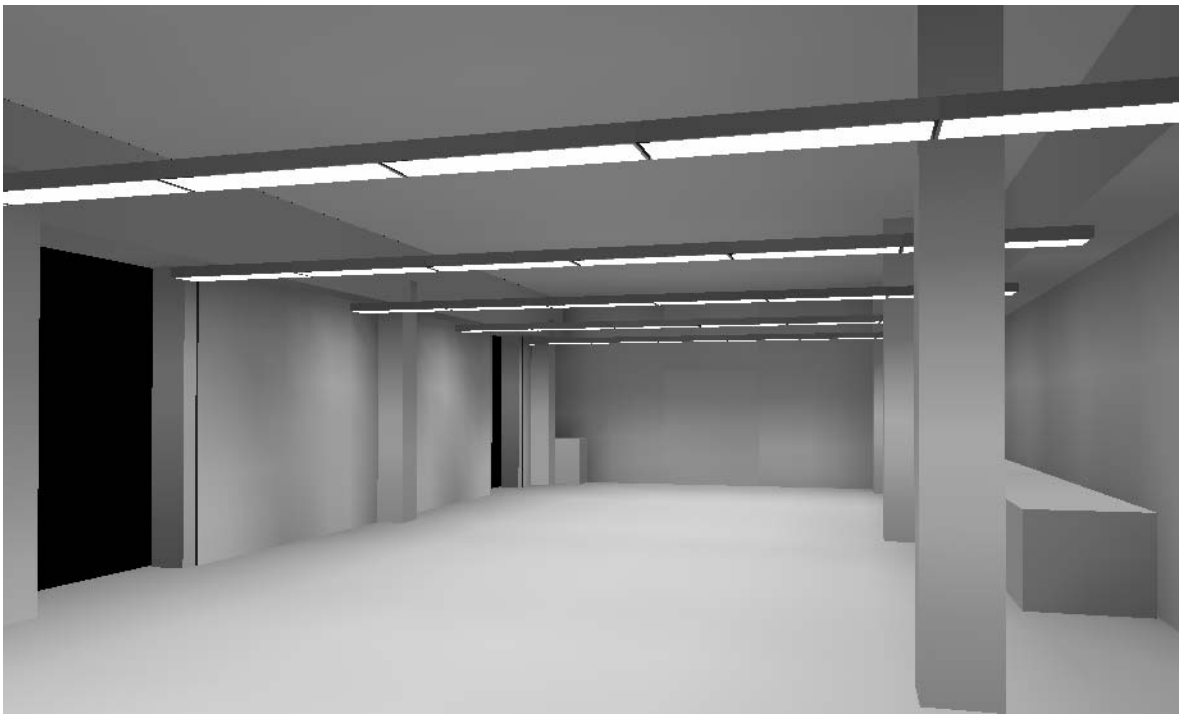
Input Watts (max): 68W/15W
Number of Fixtures: 36 units
Area: 1590 sf
Power Density: 0.33-1.53W/ft^2

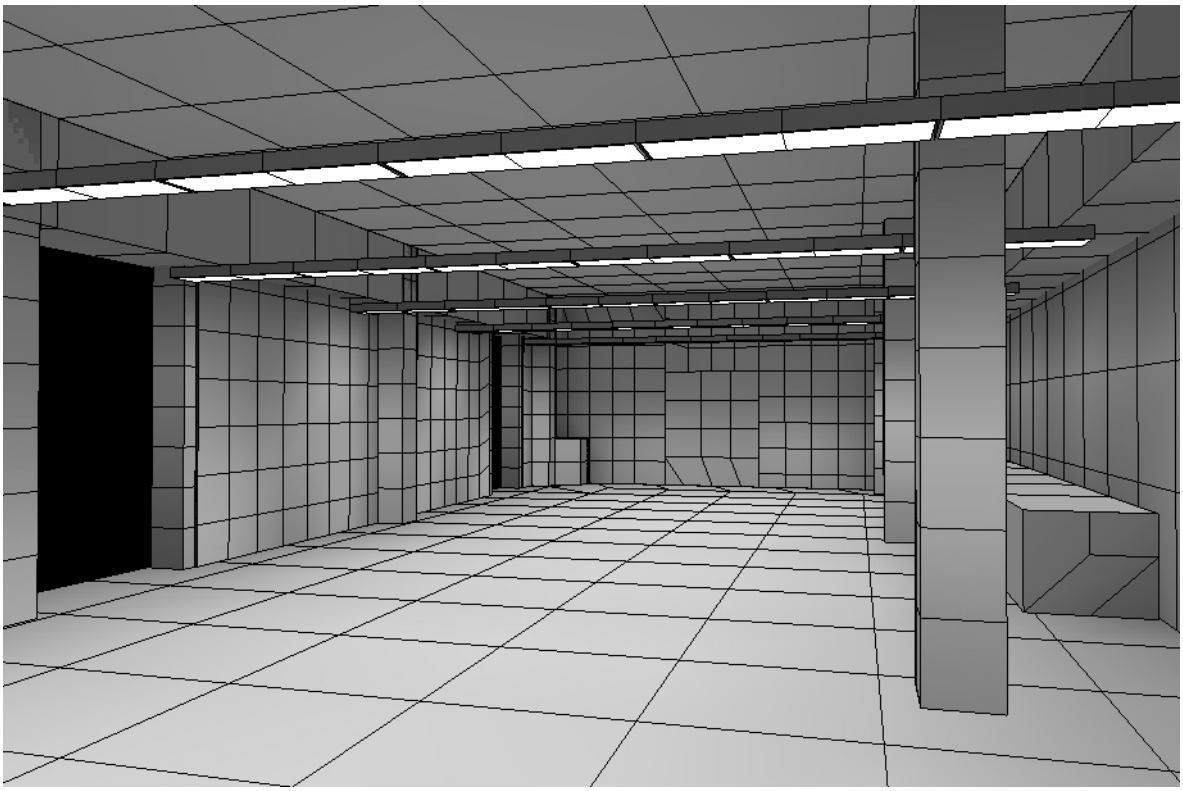
ASHRAE/IESNA Standard 90.1 – Classroom/Meeting/Training – 1.4 W/ft^2

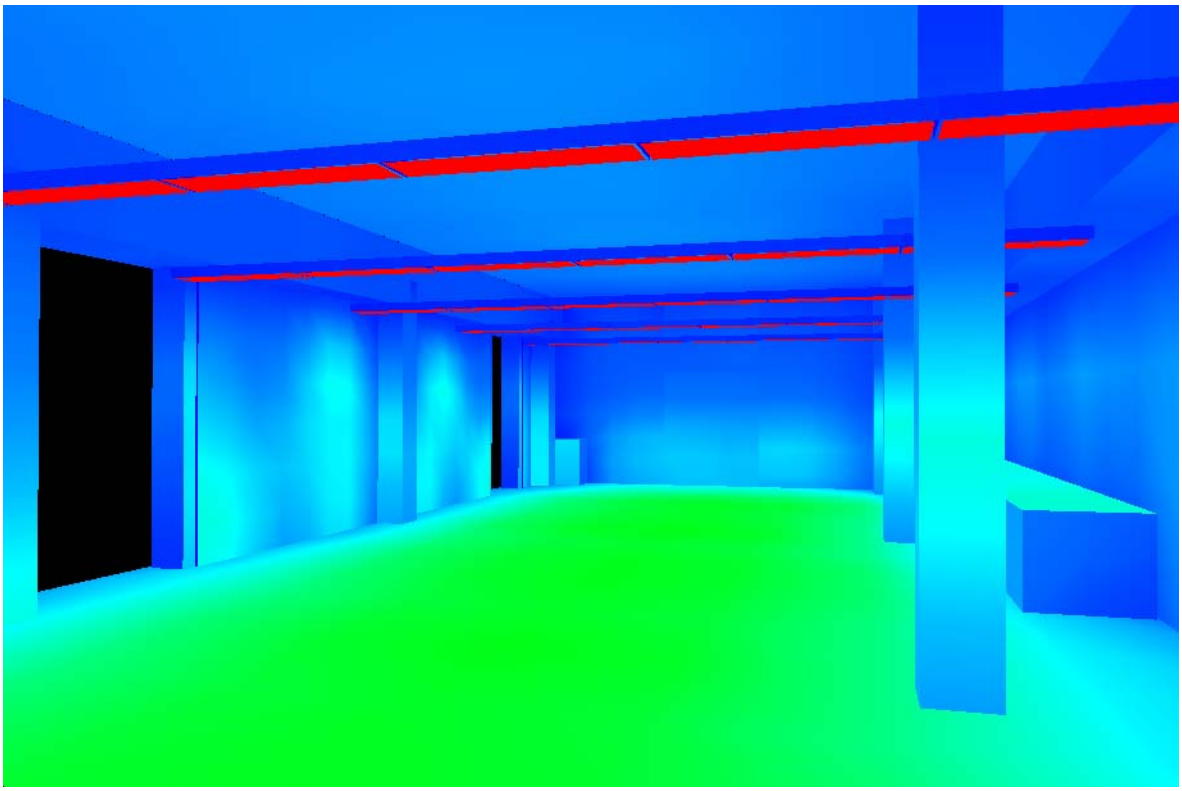
AGI32 Performance Model

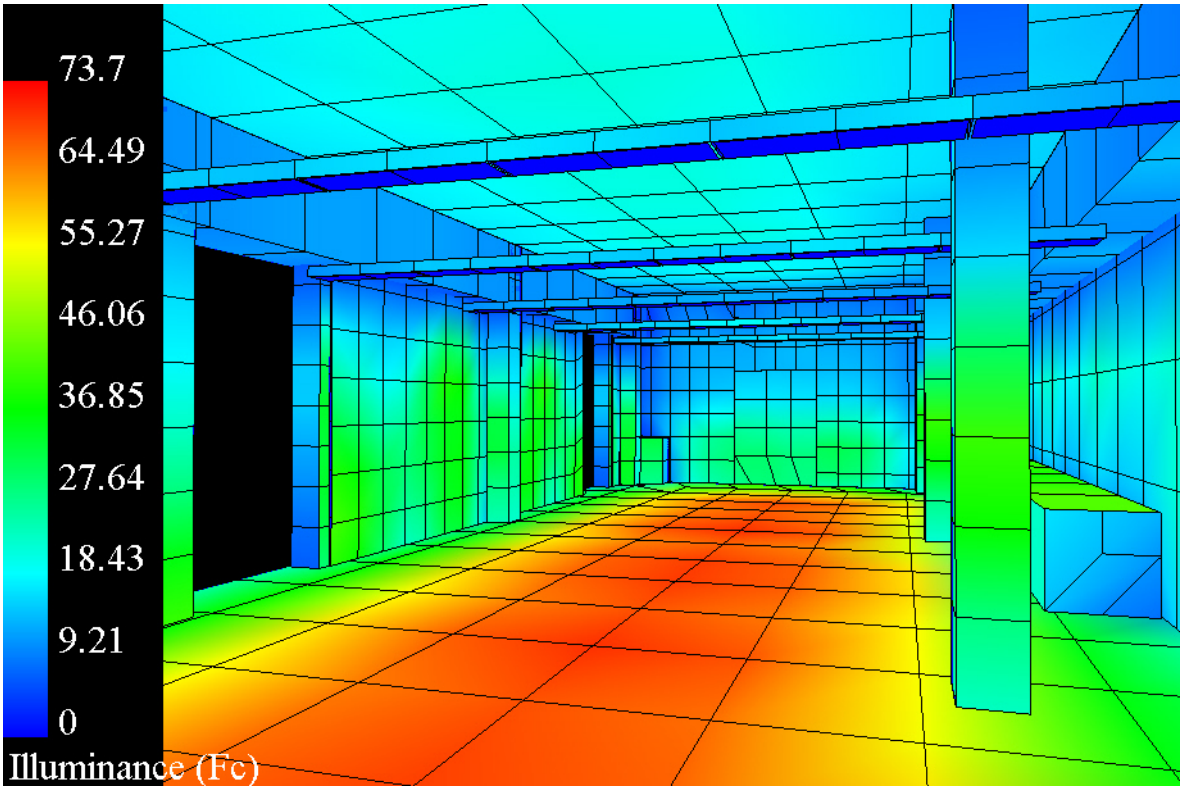
Verification of Mesh level used in model



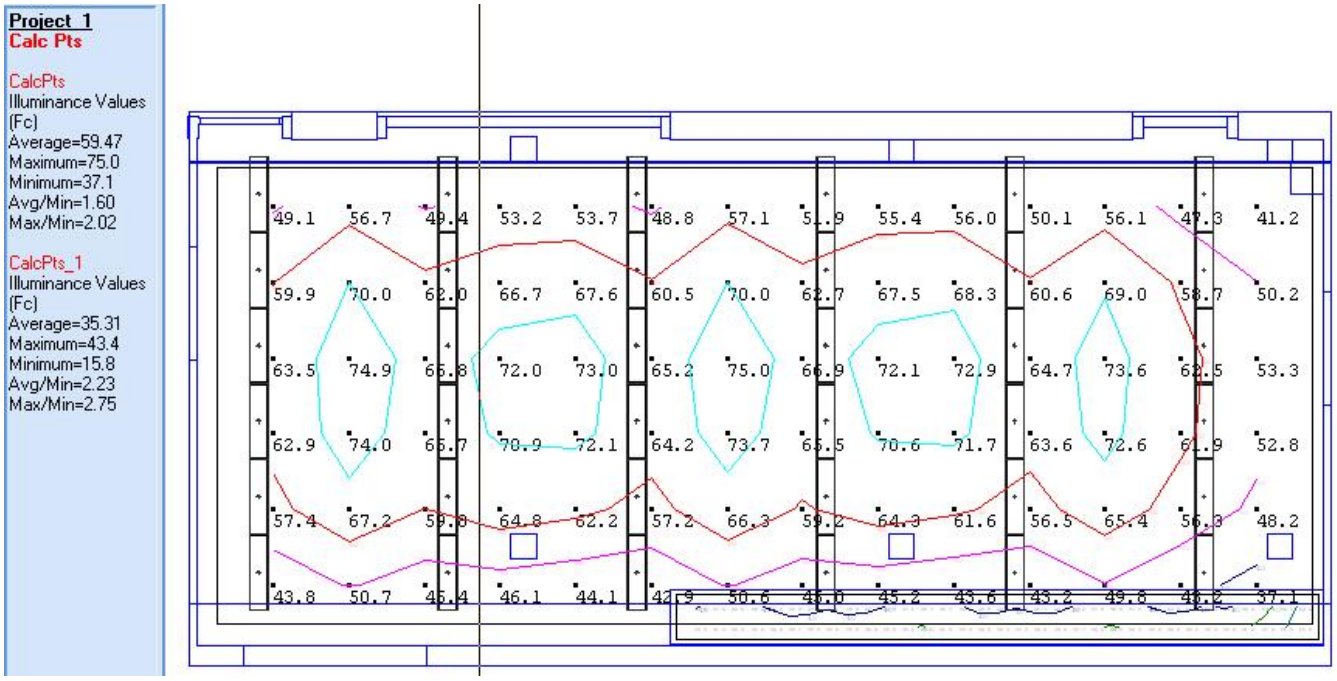




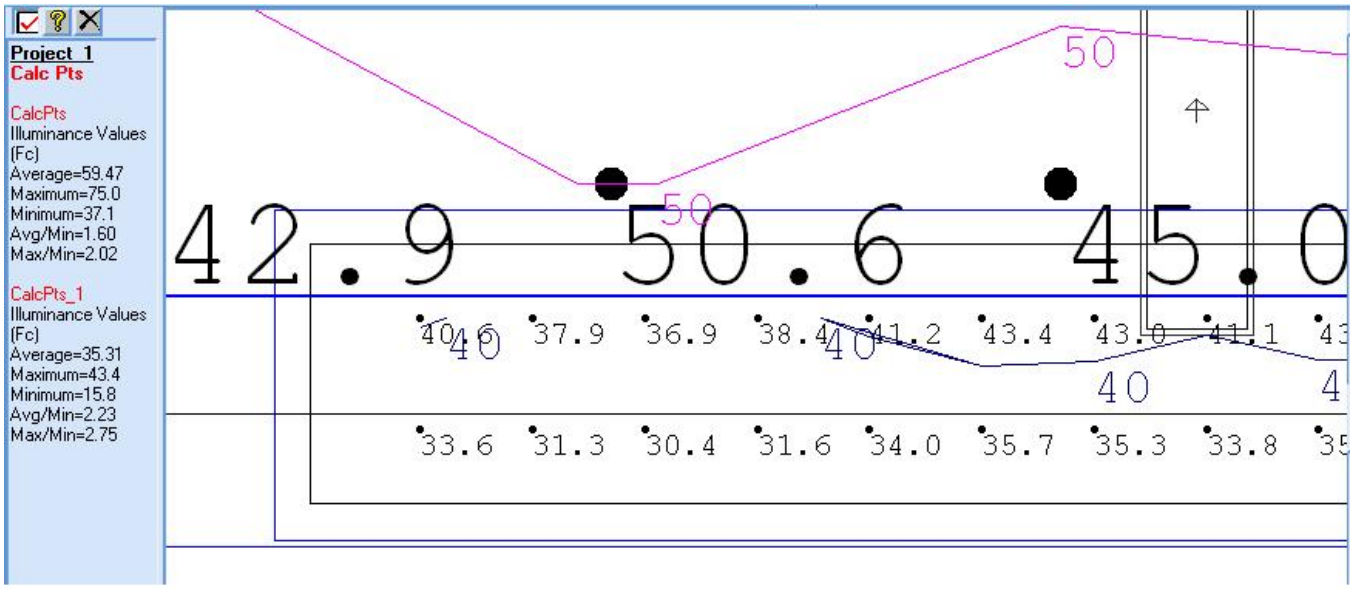



73.7
64.49
55.27
46.06
36.85
27.64
18.43
9.21
0
Illuminance (Fc)

General Illuminances Values for Room



Zoom in View of Calculations points on workbench



Summary

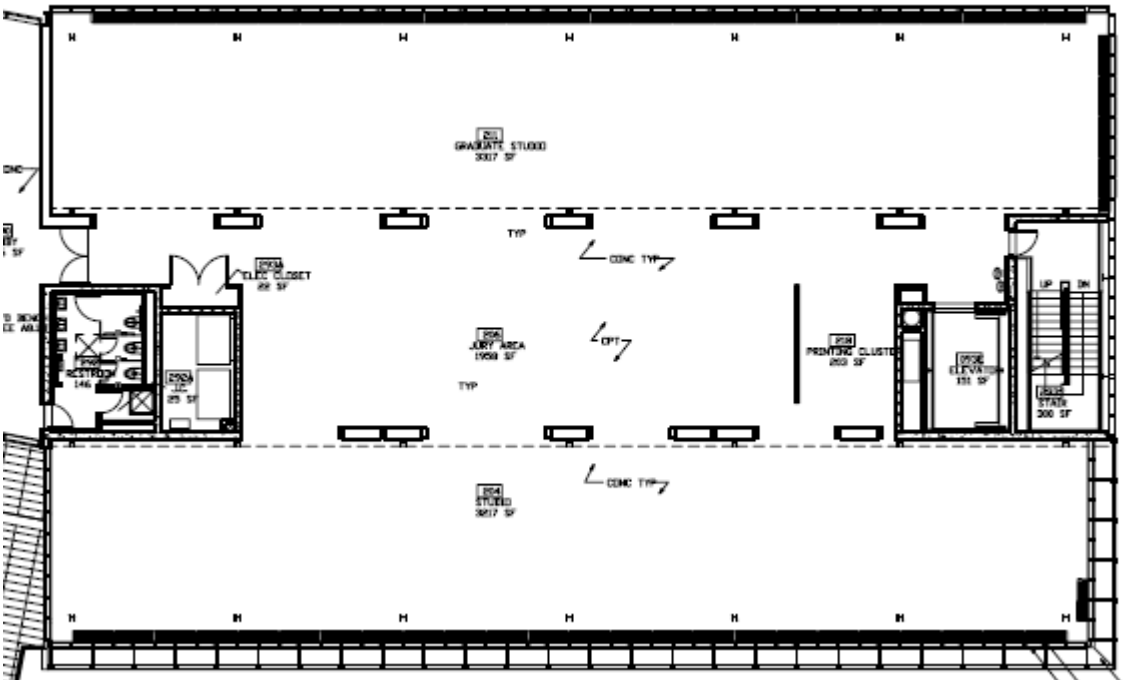
According to the AGI model, the design criteria seem to be met. The average illuminance is well over the recommended level. However, the higher illuminance values contribute to the power density that can be over the ASHRAE 90.1 standard if the lighting is kept on max power. Staying below the 1.4 W/ft^2 power density should not be a problem since there are two occupancy sensors installed in the space. The lighting configuration is well placed with the equipment placement. The system will decrease glare by not having any sources above or slighting ahead of a user. The illuminance has a decent uniformity over the entire space.

Although this design is acceptable according to the criteria, it can be improved. The overuse of light fixtures is consuming extra power that does not develop the overall design. I recommend that task lighting be implemented and decrease the number of pendant fixtures. The existing fixtures are direct lighting that cause the ceiling to look rather dark compared to the illuminance levels on the walls and floor.

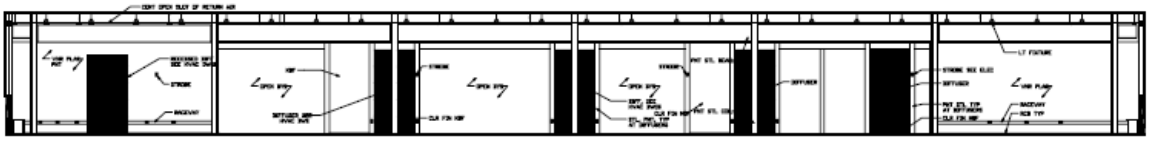
Space 2 – Undergraduate Studio Space

Plans

Lighting Plans

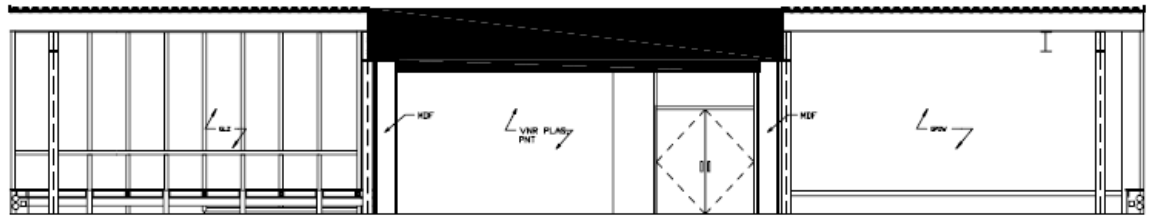


North Interior Elevation

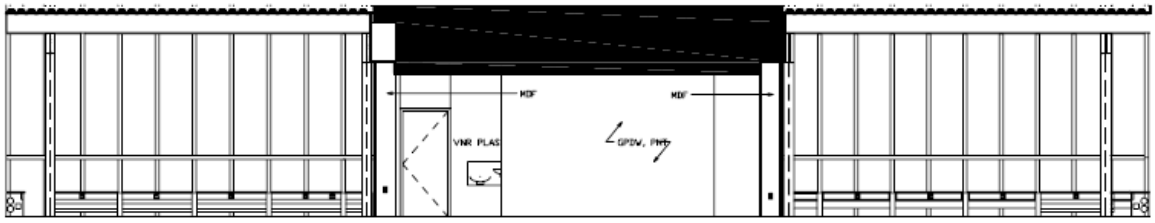


South Interior Elevation

West Interior Elevation



East Interior Elevation



Material Reflectance

Material	Reflectance
Gypsum Board	0.70
Steel (W-Beams)	0.20
Concrete	0.35
CLR FIN (Clearance Finish)	0.80
RCB (Rubber Cove Band)	0.50
Wooden Work Stations	0.40
Mullions (Painted)	0.80
Glazing (double glazed Low-E IGU operable)	0.6

Lighting Hardware

The lighting system consists of a staggered configuration of Linear Lighting's AlphaLite A66. The catalog number for this fixture is A66-D-2-ET8-120-PBW—SMT-ED-SF. This fixture also utilizes the T8 fluorescent lamp on a 120V electronic dimming ballast. The lighting system in the Studios are configured so that partitions can be removed and rearranged to accommodate varies activities. With this idea in mind, the lighting designers constructed a module arrangement of bus ways around the space.

The space utilizes daylight and occupancy sensors. The occupancy sensors are arranged systematically around the space. The daylight sensors are located one-third distance from the glazing system.

Furniture/ Equipment

The studios are arranged as an open space. Desks and work stations are configured depending occupancy.

Design Criteria

Daylight Integration

The studios have both a North and South facing windows. Daylight integration is critical for this space for energy savings. If daylight is not taken in account then there might be serve heating/ cooling problems and student discomfort.

Direct/ Reflected Glare

Glare can cause discomfort to students and professors. This can also lead to presentation discomfort.

Tasks

This area is used by students often during all hours of the day. The lighting system must be able to accommodate for daylight and nighttime situations. This space will be occupied by architect students whom will need quality lighting for modeling and sketching.

Accent Lighting

Accenting lighting can be important to showcase student's works. It can also be used during presentations or lectures.

Illuminance

Horizontal and vertical illuminance should be approximately 30-50 fc for desks.

Existing Lighting System Analysis

Light Loss Factors

Luminaire	Cat.	Room	Cl.Int.	BF	LLD	RSDD	LDD	LLF
ACA	III	Clean	12	1.0	0.91	0.97	0.9	0.8

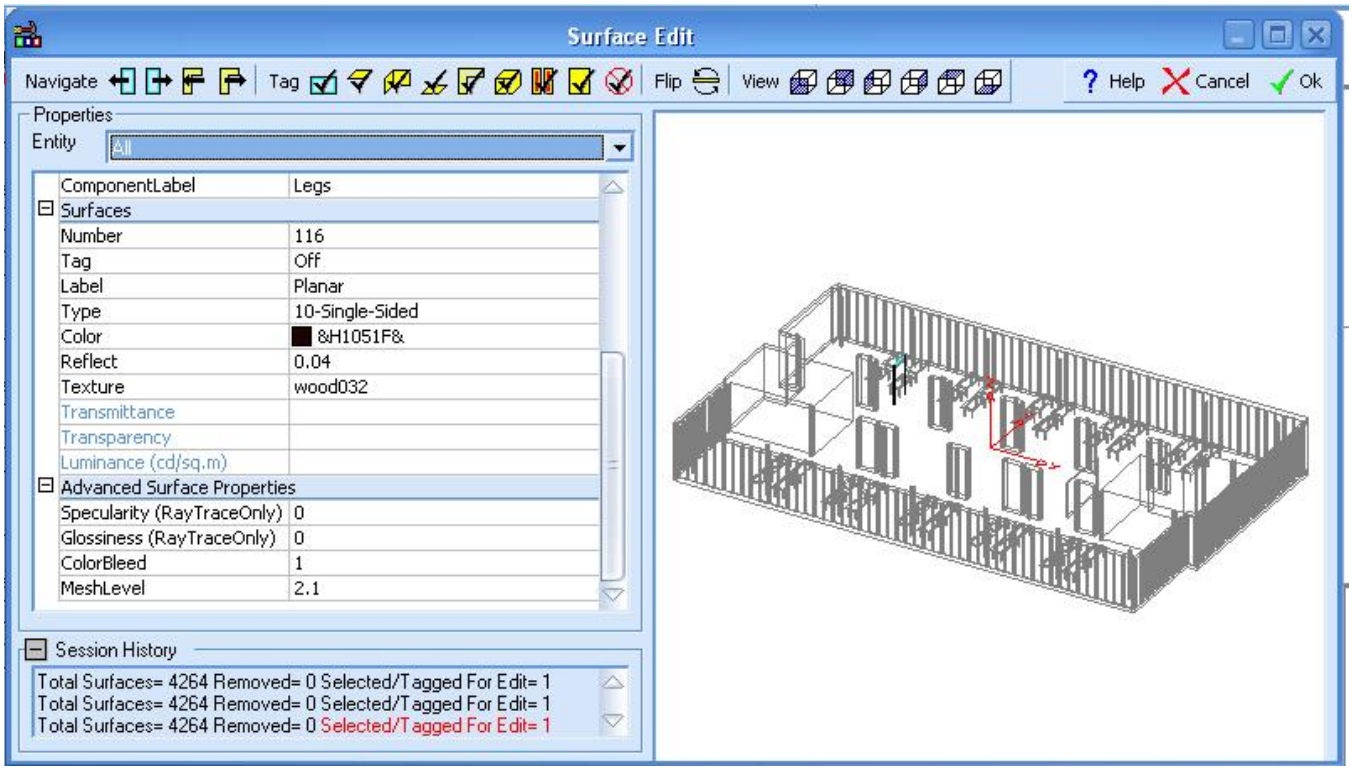
Power Density

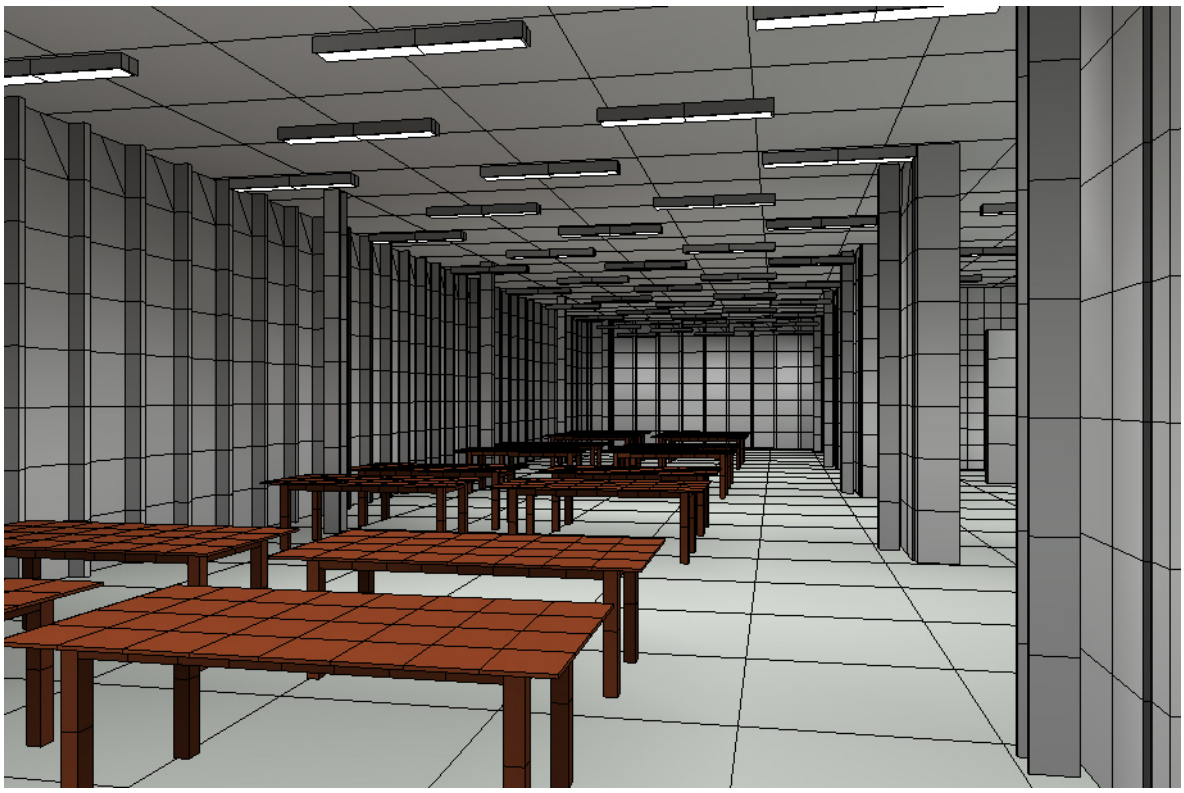
Input Watts (max): 68W/15W
Number of Fixtures: 162 units
Area: 7923 sf
Power Density: 0.3-1.39W/ft^2

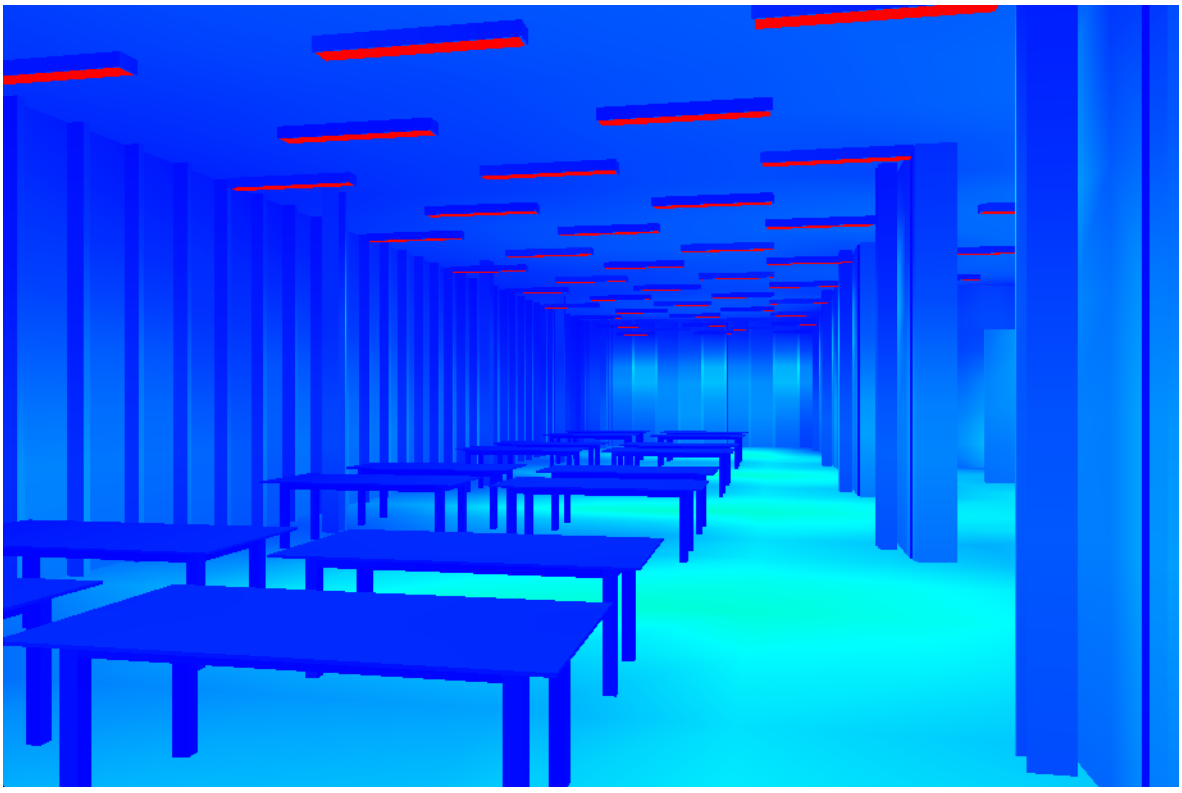
ASHRAE/IESNA Standard 90.1 – Classroom/Meeting/Training – 1.4 W/ft^2

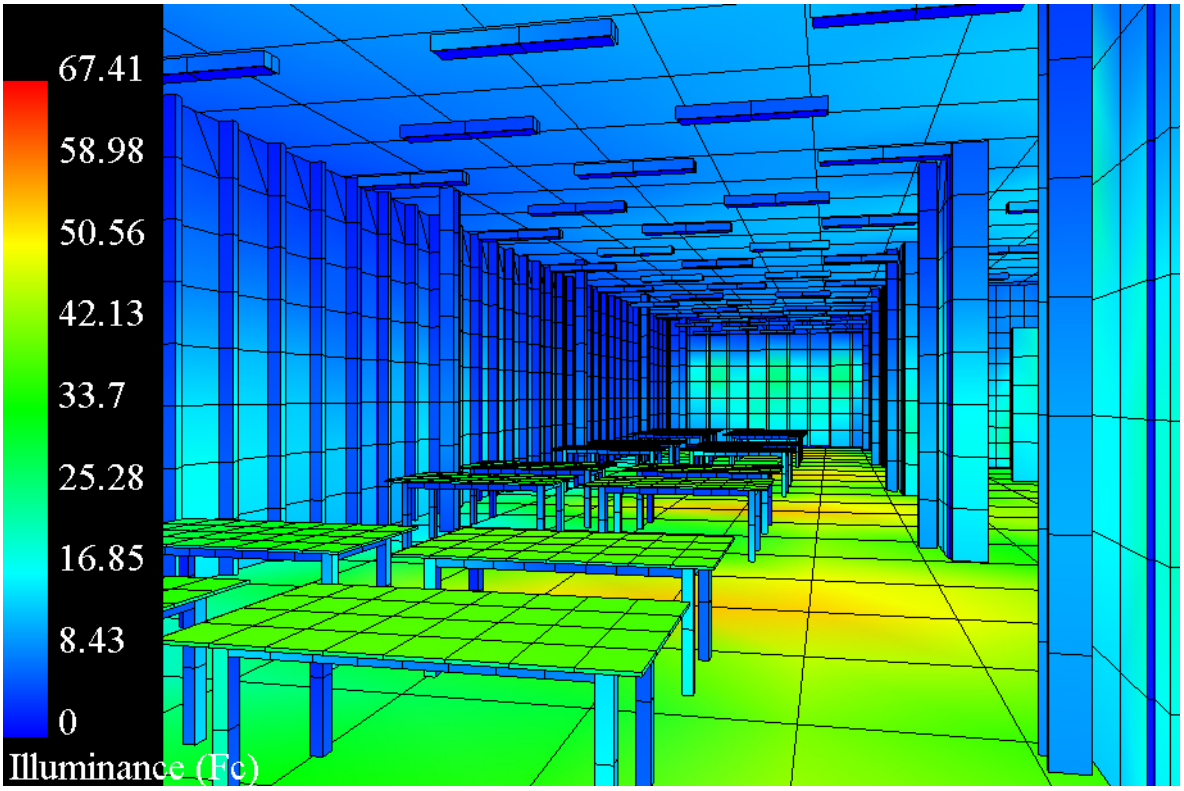
AGI32 Performance Model

Verification of Mesh Level





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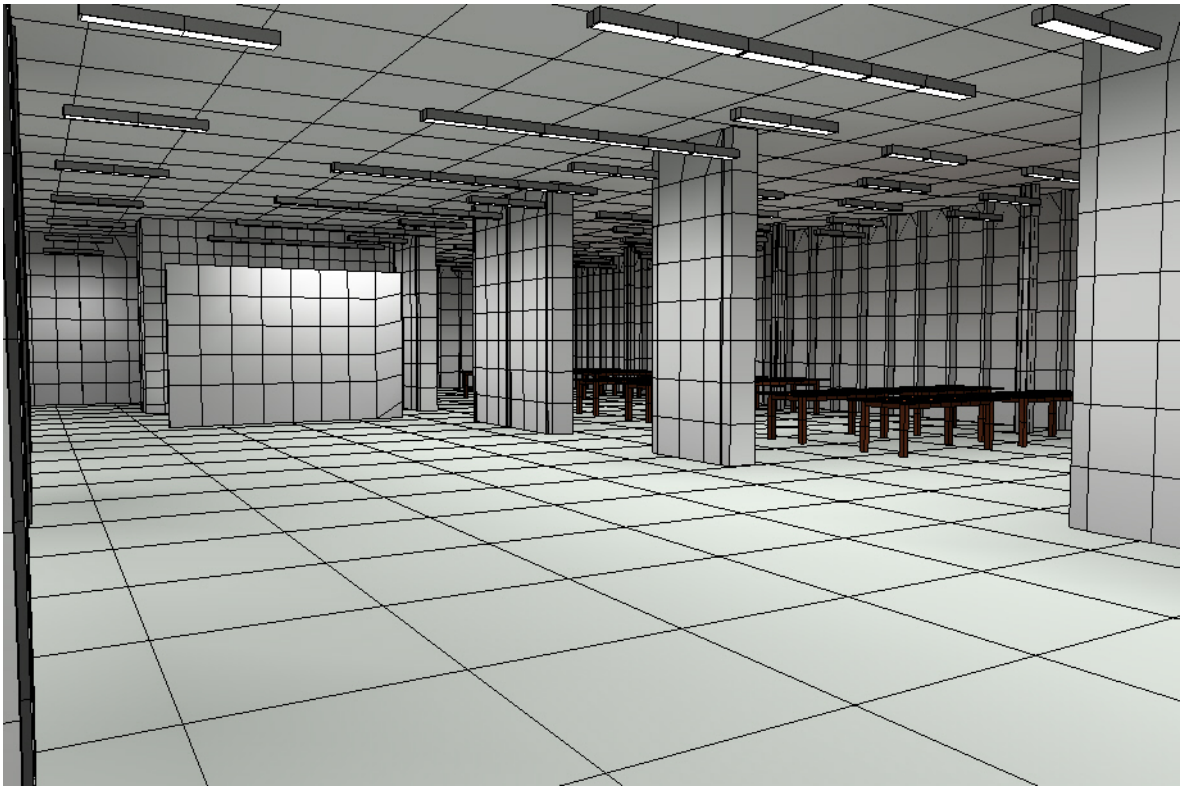
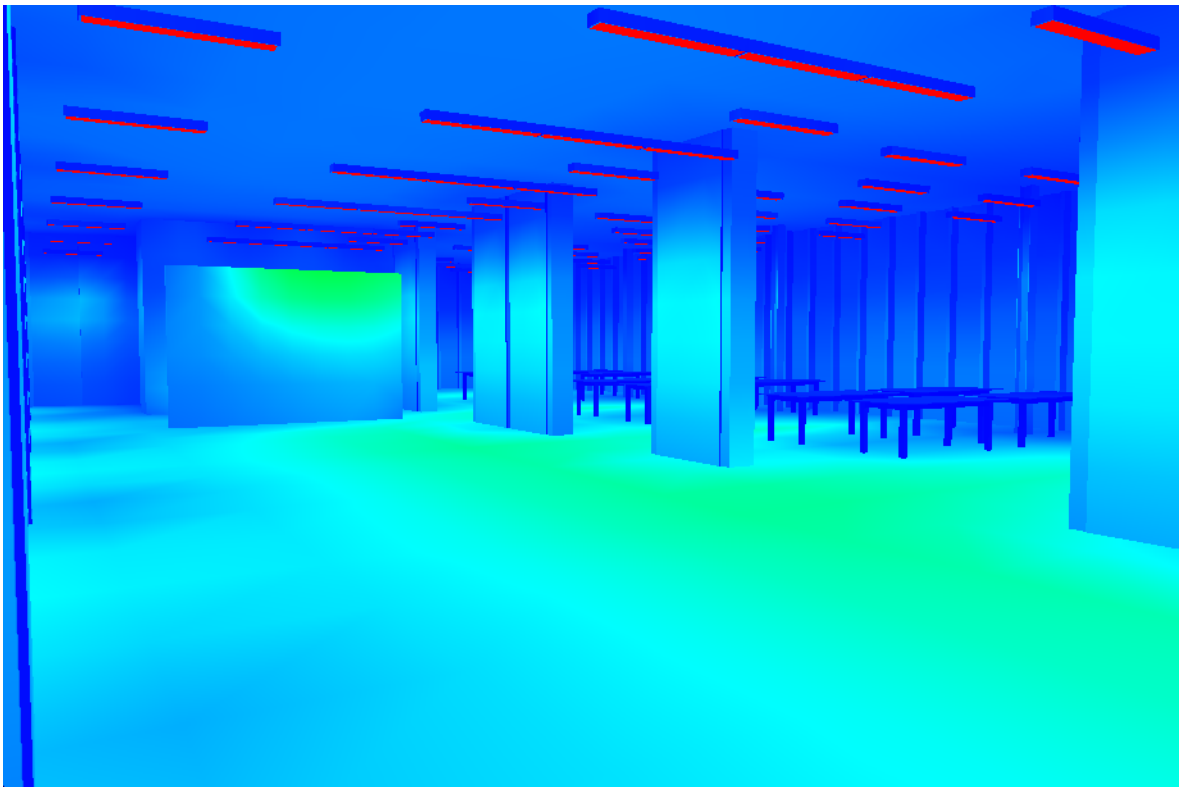
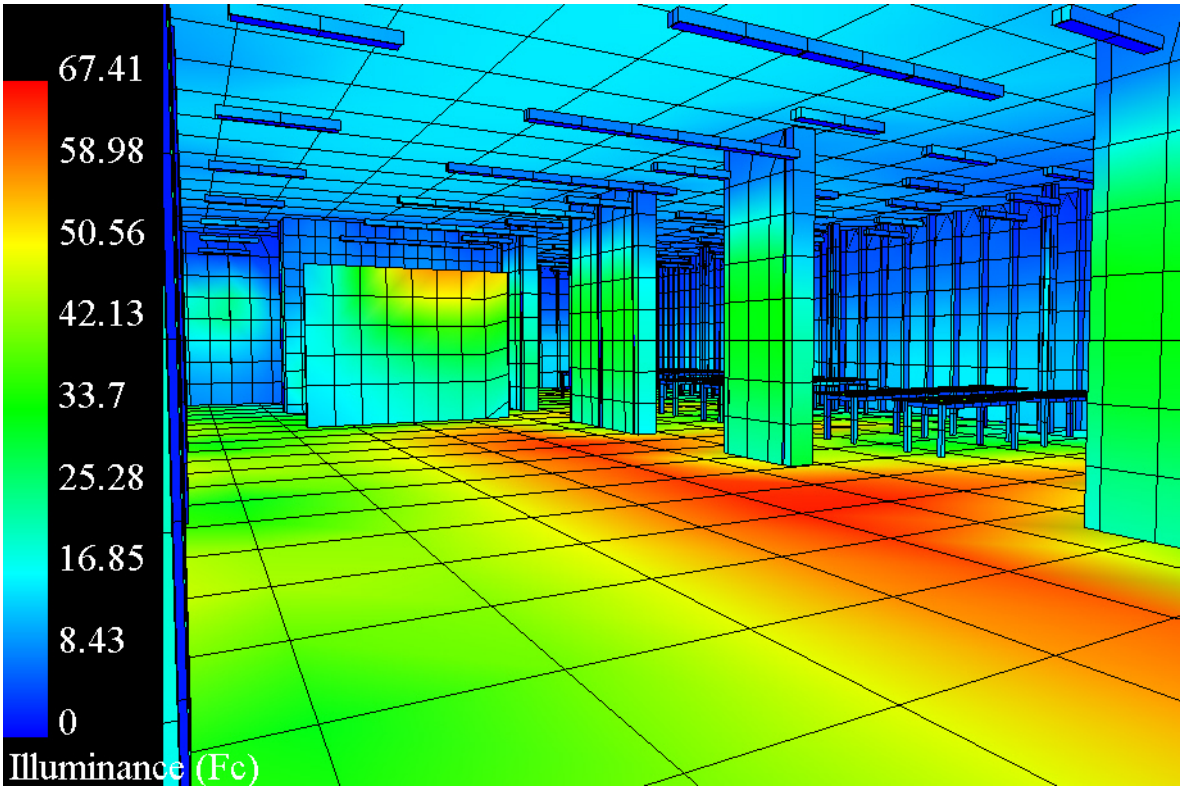
58.98
50.56
42.13
33.7
25.28
16.85
8.43
0
Illuminance (Fc)



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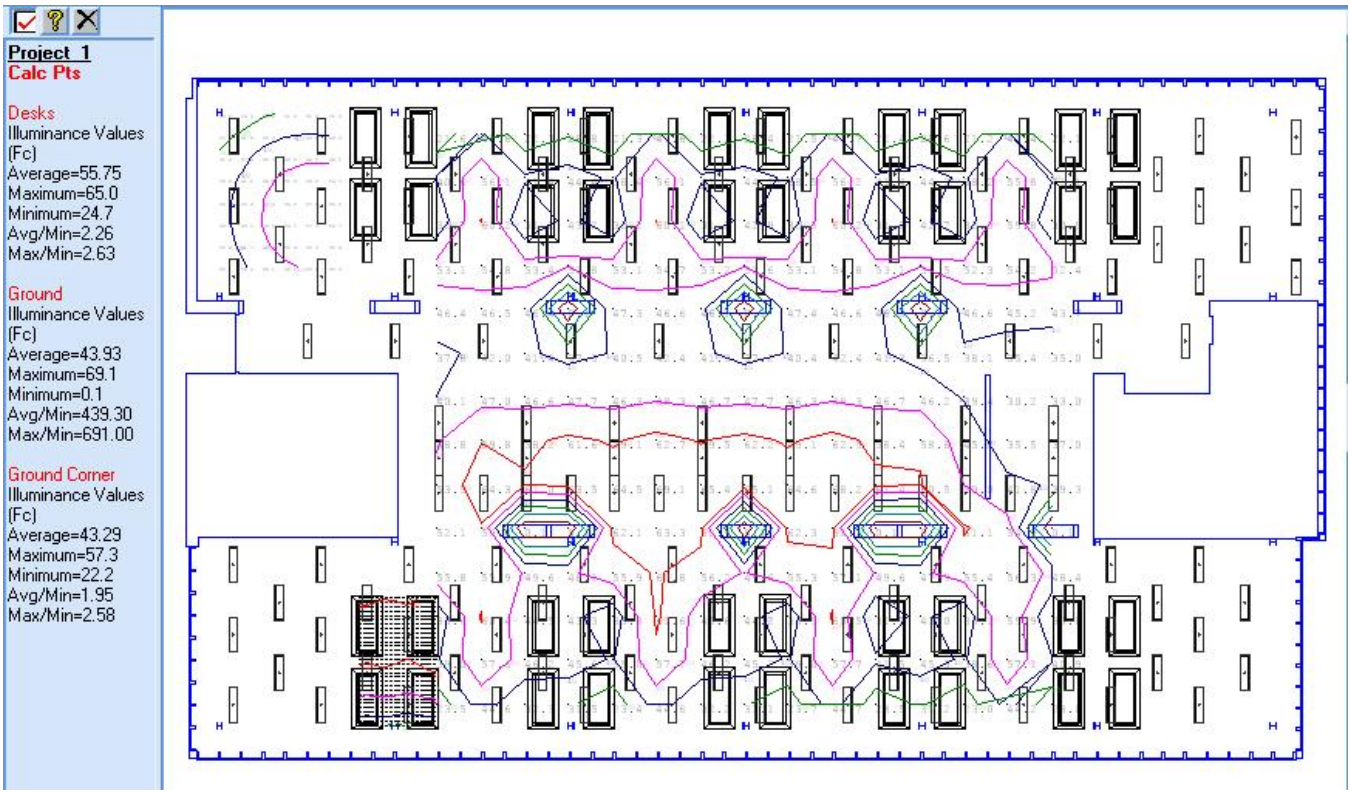
0
Illuminance (Fc)


Project 1
Calc Pts
Desks
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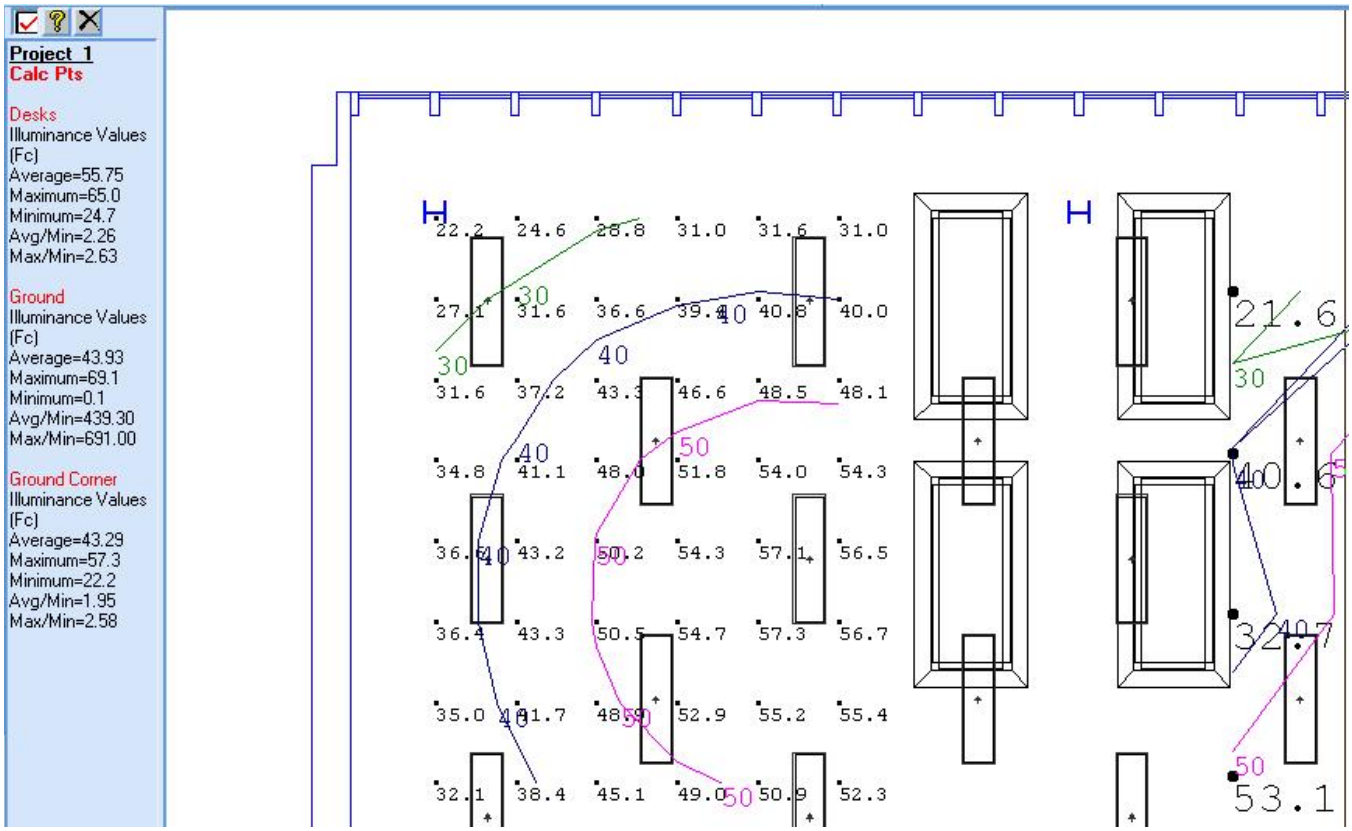
Minimum=24.7
Avg/Min=2.26
Max/Min=2.63
Ground
Illuminance Values (Fc)
Average=43.93
Maximum=69.1
Minimum=0.1
Avg/Min=439.30
Max/Min=691.00
Ground Corner
Illuminance Values (Fc)
Average=43.29
Maximum=57.3
Minimum=22.2
Avg/Min=1.95
Max/Min=2.58


Project 1
Calc Pts
Desks
Illuminance Values (Fc)
Average=55.75
Maximum=65.0
Minimum=24.7
Avg/Min=2.26
Max/Min=2.63
Ground
Illuminance Values (Fc)
Average=43.93
Maximum=69.1
Minimum=0.1
Avg/Min=439.30
Max/Min=691.00
Ground Corner
Illuminance Values (Fc)
Average=43.29
Maximum=57.3
Minimum=22.2
Avg/Min=1.95
Max/Min=2.58
H
22.2 24.6 28.8 31.0 31.6 31.0
27.1 31.6 36.6 39.4 40.8 40.0
31.6 37.2 43.3 46.6 48.5 48.1
34.8 41.1 48.0 51.8 54.0 54.3
36.6 43.2 50.2 54.3 57.1 56.5
36.4 43.3 50.5 54.7 57.3 56.7
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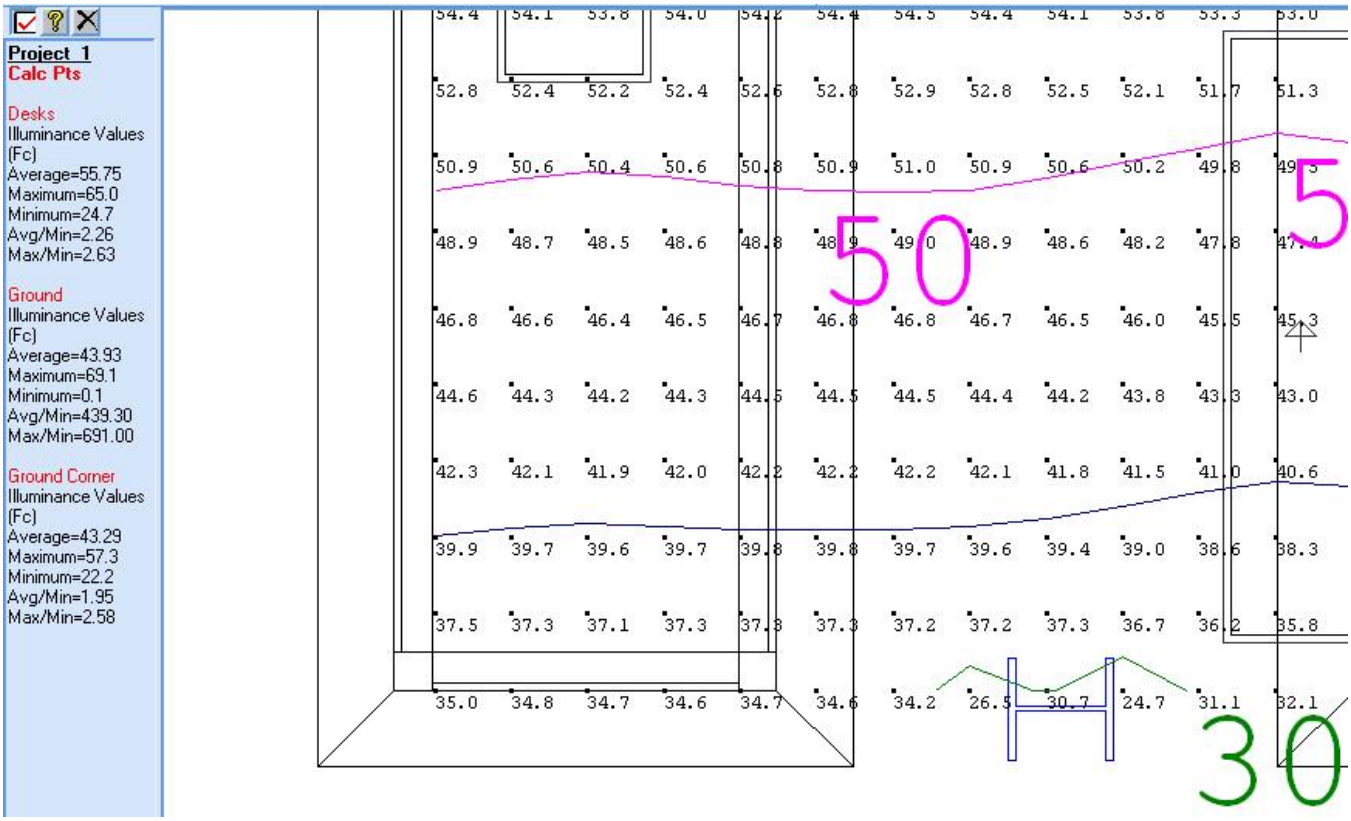
21.6
53.1



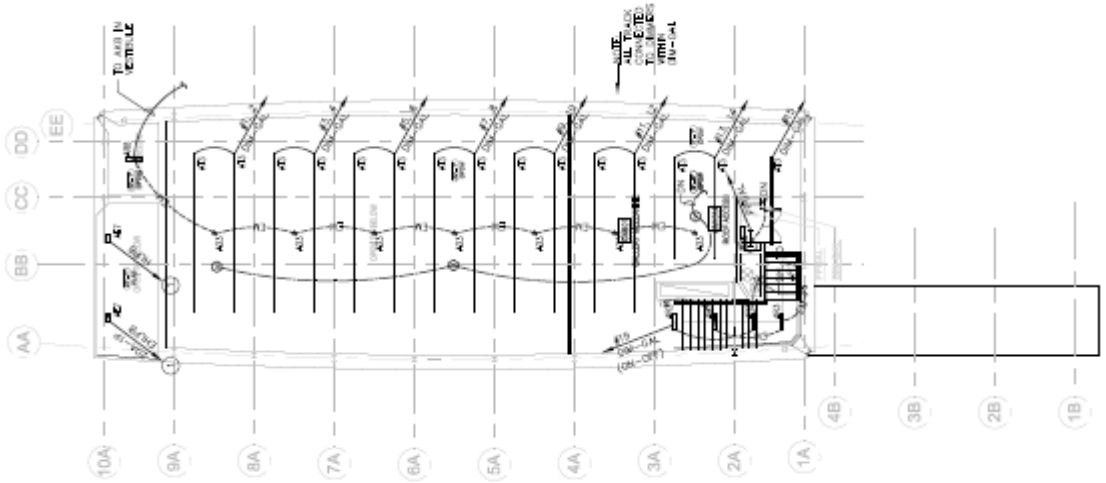
Summary

The design of the studio spaces was adequate for the design criteria. The illuminance levels on the desks reached an average of 46-55 fc. The illuminance on the ground reach a maximum of 69 fc and an average of 44 fc. The overall design had a uniform light distribution. The lighting system reached a maximum of 1.4 W/ft^2 for the power density. The space was modeled without day lighting so I believe that the design can be simpler and more effective.

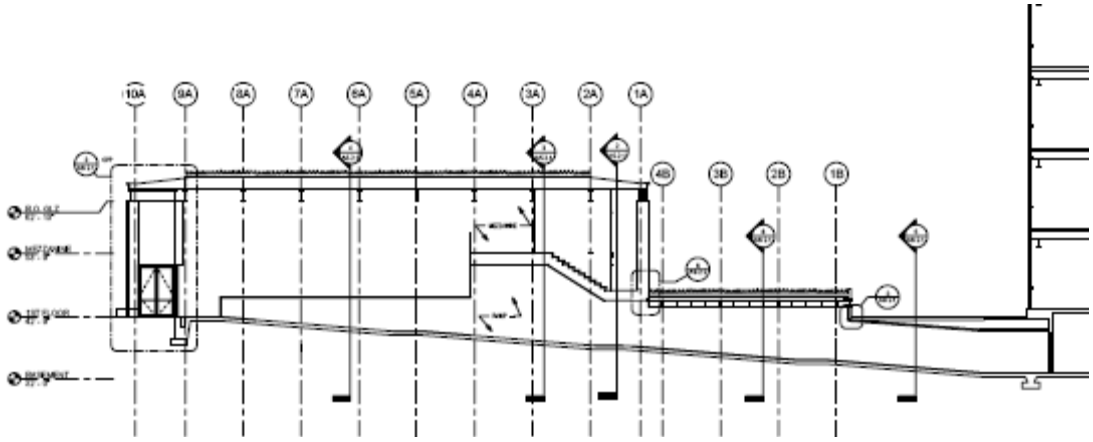
Space 3 – Gallery

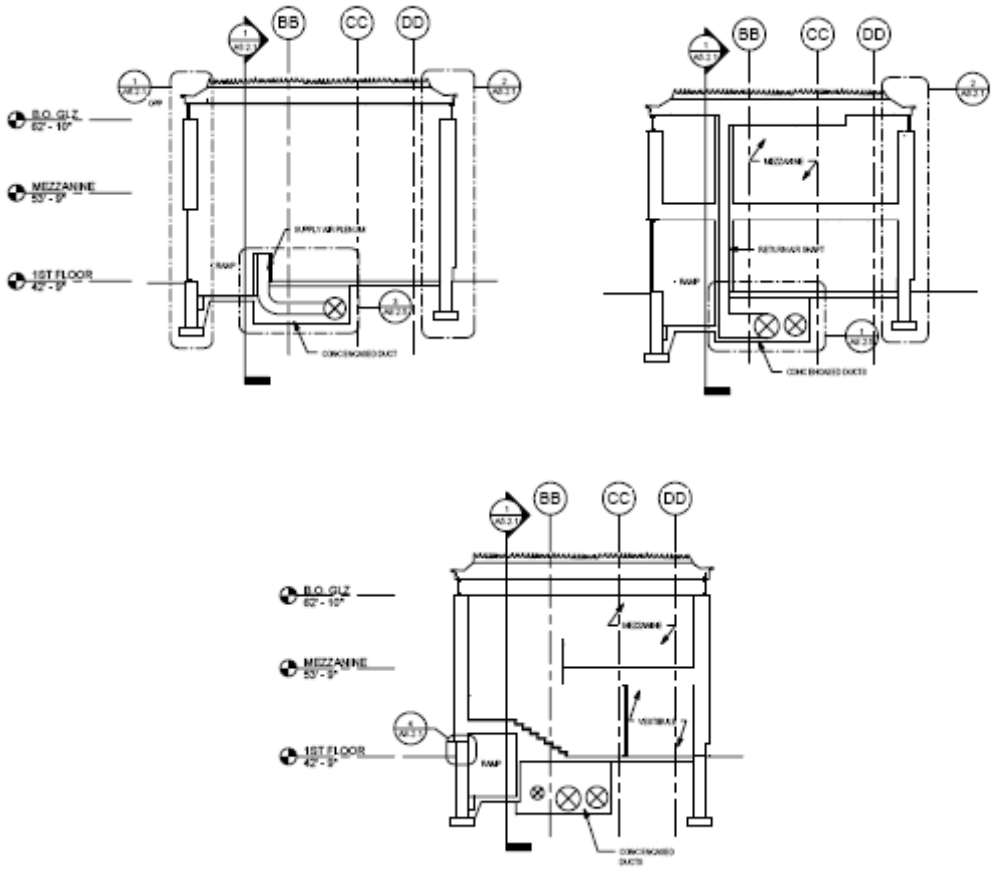
Plans

Lighting Plan



Sections





Material Reflectance

Material	Reflectance
Gypsum Board	0.70
Steel (W-Beams)	0.20
Concrete	0.35
CLR FIN (Clearance Finish)	0.80
RCB (Rubber Cove Band)	0.50
Wooden Work Stations	0.40
Mullions (Painted)	0.80
Glazing (double glazed Low-E IGU operable)	0.6

Lighting Hardware

The lighting system in the gallery is not yet complete. The design thus far incorporates a modular system of track fixtures. The system calls for either a 90W par or 50W par for every 8 feet of track. Nine inch recessed down lights act as cleaning and emergency systems. This design was meant for a customizable feature for sculptures and art works. The student or artist can depict what lighting levels and aiming angles are appropriate for the work.

The gallery space is a double height space that uses three occupancy sensors. Even with the large amount of glazing, this space does not have a day lighting sensor.

Furniture/ Equipment

The gallery is arranged as an open double-height space.

Design Criteria

Daylight Integration

The large amount of glazing in this area requires some sort of daylight control. The space is small in size but it will be used often because of its under-grade connection to the main Sculpture Building. This building has a large glass wall as well as a band of glazing at the top of the double-height space.

Direct/ Reflected Glare

Glare control is important for quality viewing of sculptures and other art works. The large glazing areas presence a problem with glare.

Accent Lighting

The sculptures can look more dynamic with good lighting.

Existing Lighting System Analysis

Light Loss Factors

Luminaire	Cat.	Room	Cl.Int.	BF	LLD	RSDD	LDD	LLF
AD3	IV	Clean	12	1.0	0.88	0.96	0.86	0.72
ATA	V	Clean	12	1.0	0.88	0.96	0.8	0.67
ATB	V	Clean	12	1.0	0.88	0.96	0.8	0.67

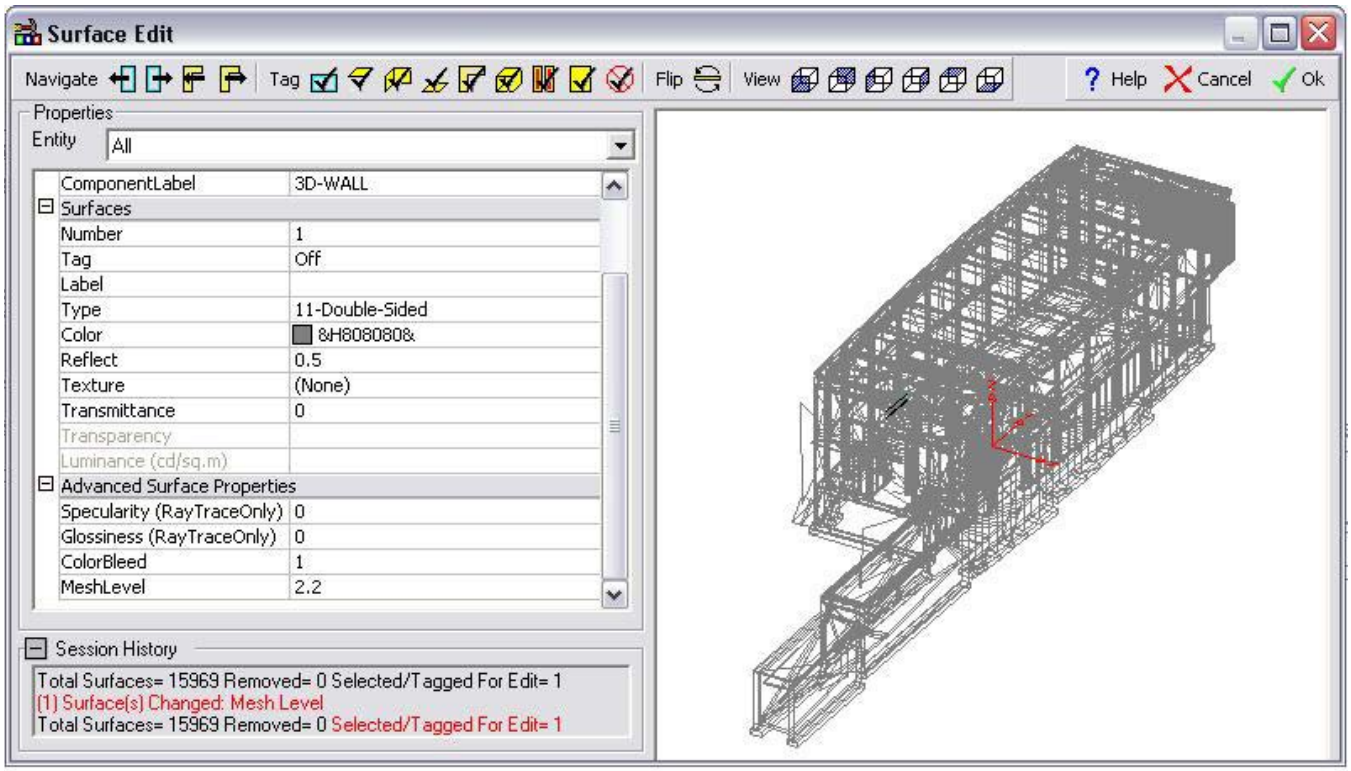
Power Density

Input Watts (max): 1260W + 525W (max) + 700W = 2485W
Number of Fixtures: 35 units
Area: 2484 sf
Power Density: 1.0 W/ft^2

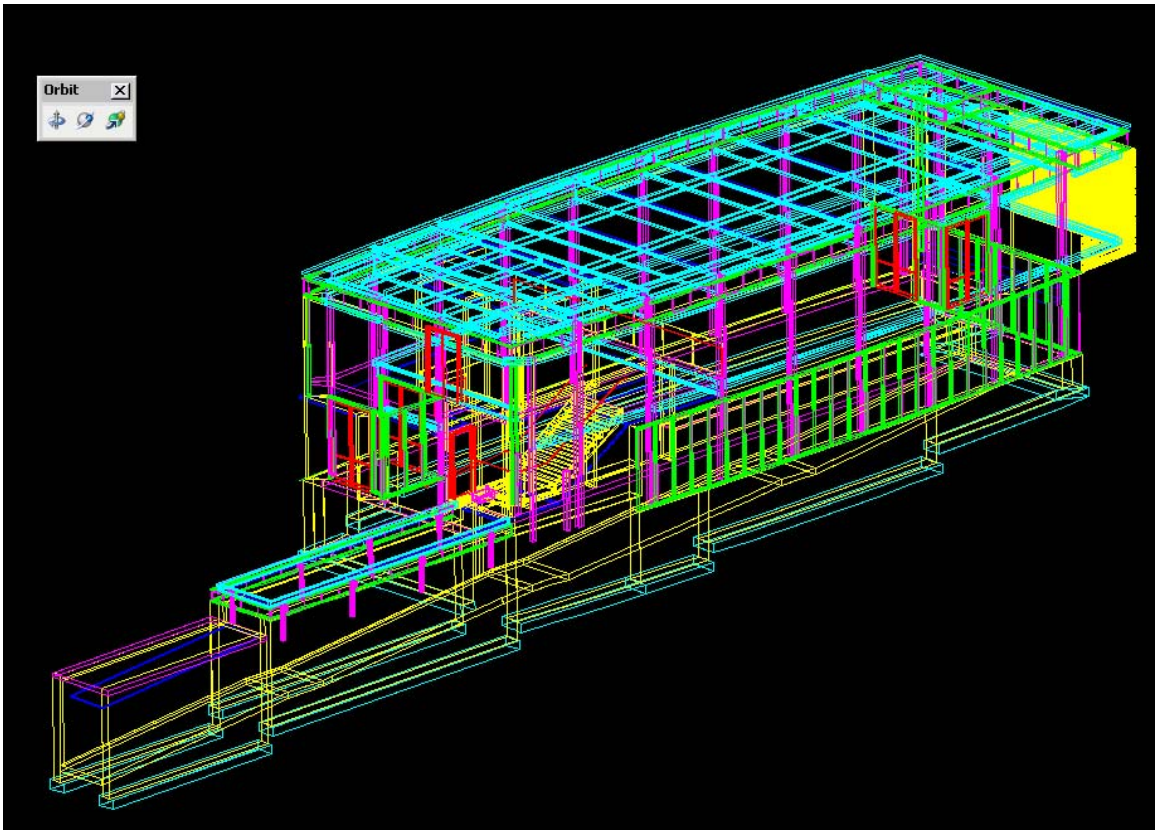
ASHRAE/IESNA Standard 90.1 – Gallery – 1.0 W/ft^2

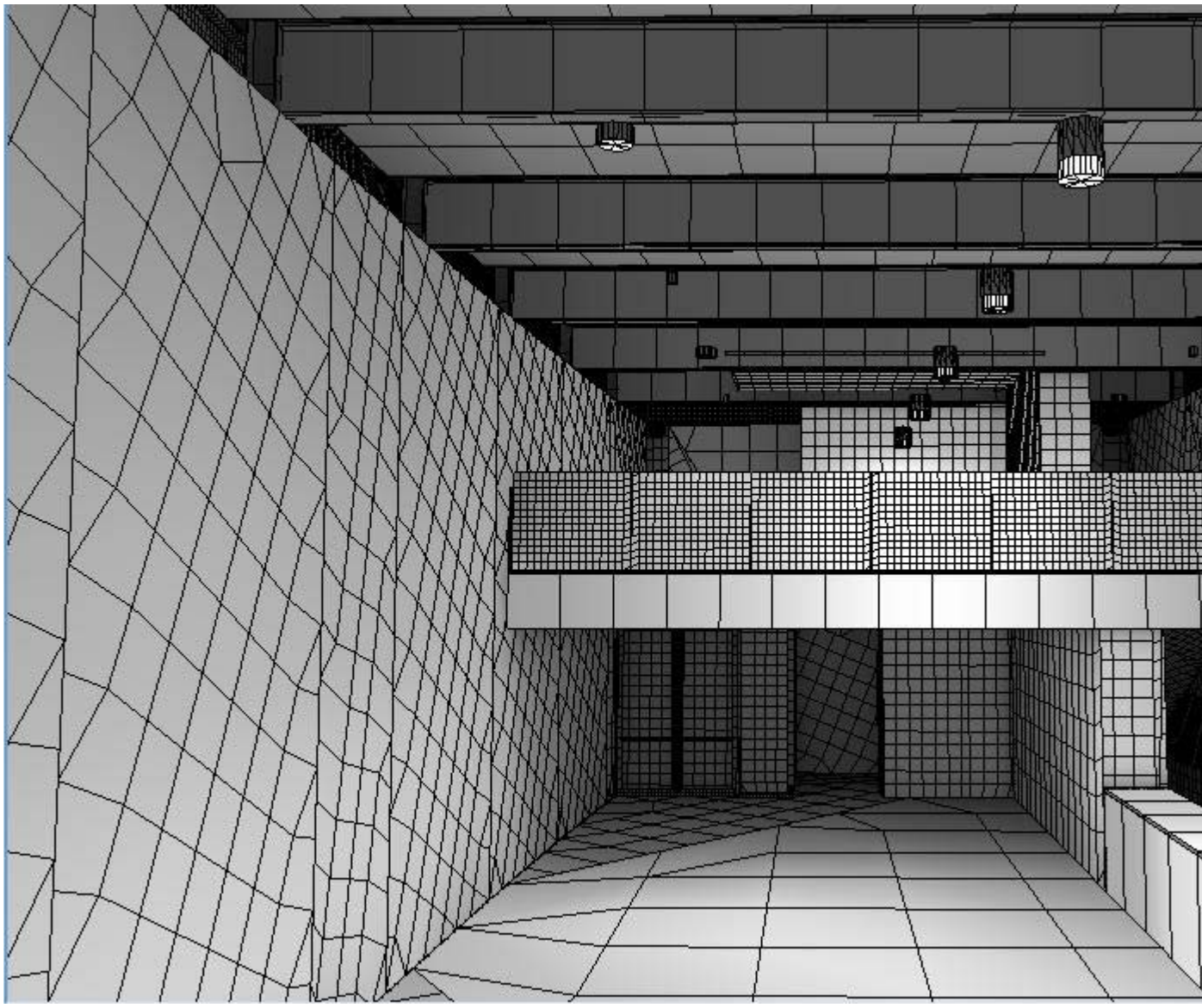
AGI32 Performance Model

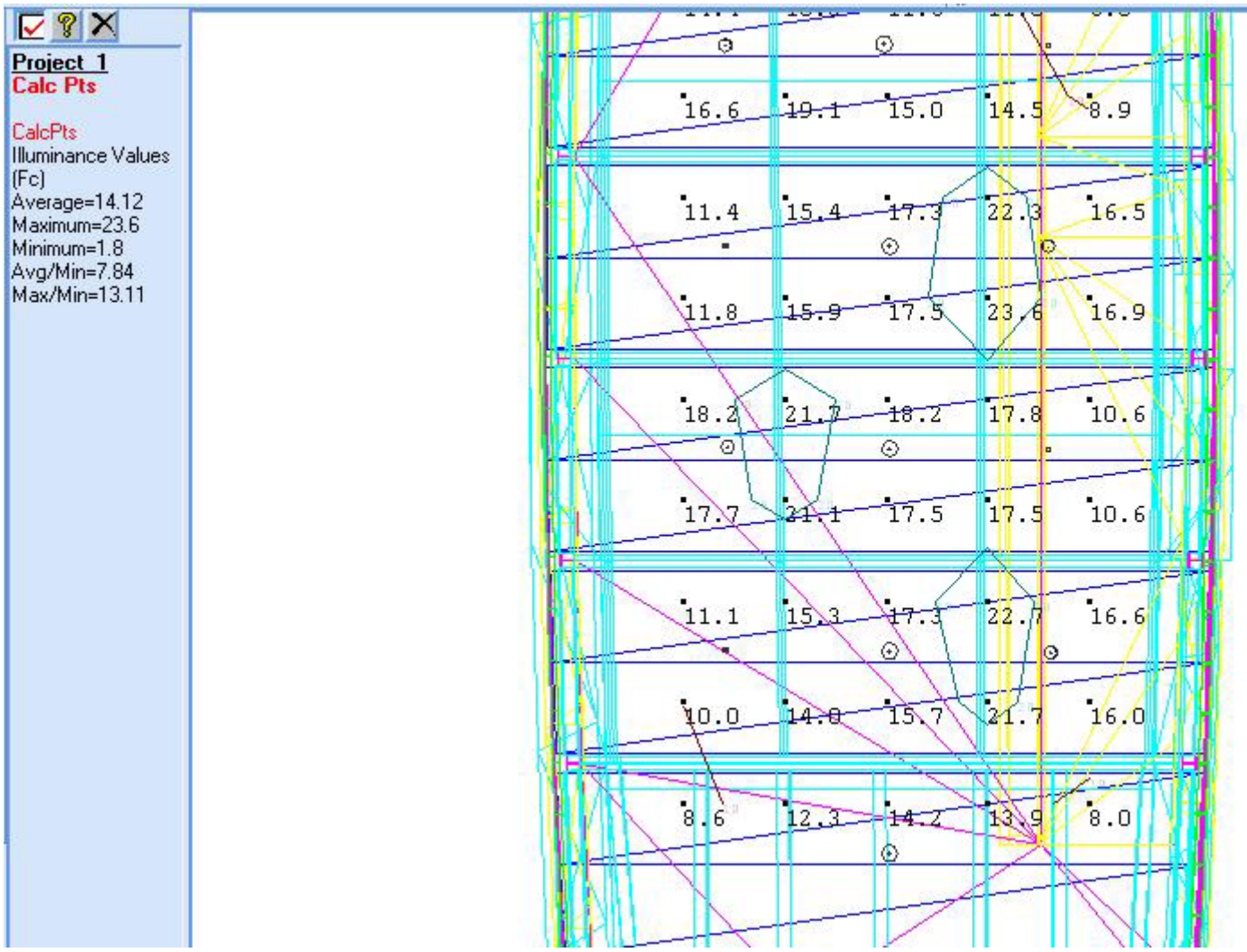
Verification of Mesh Level



AutoCAD Model





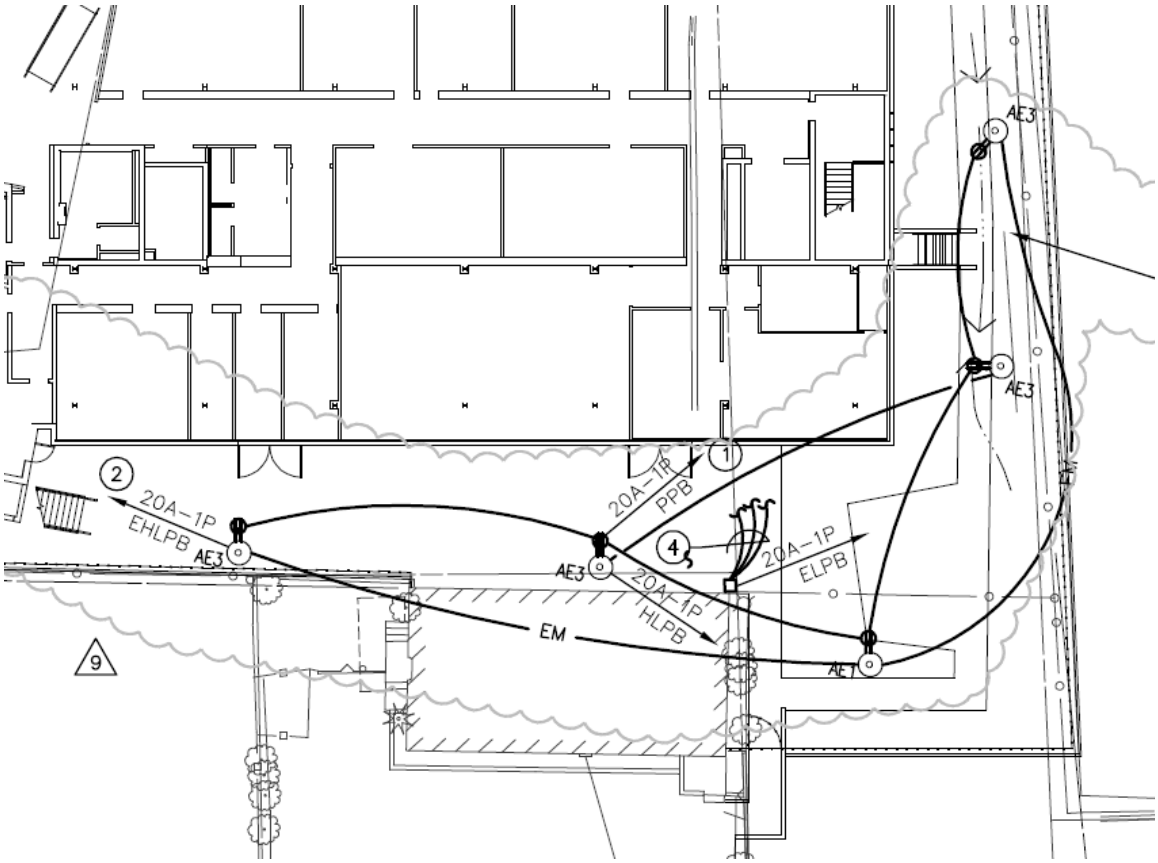


Summary

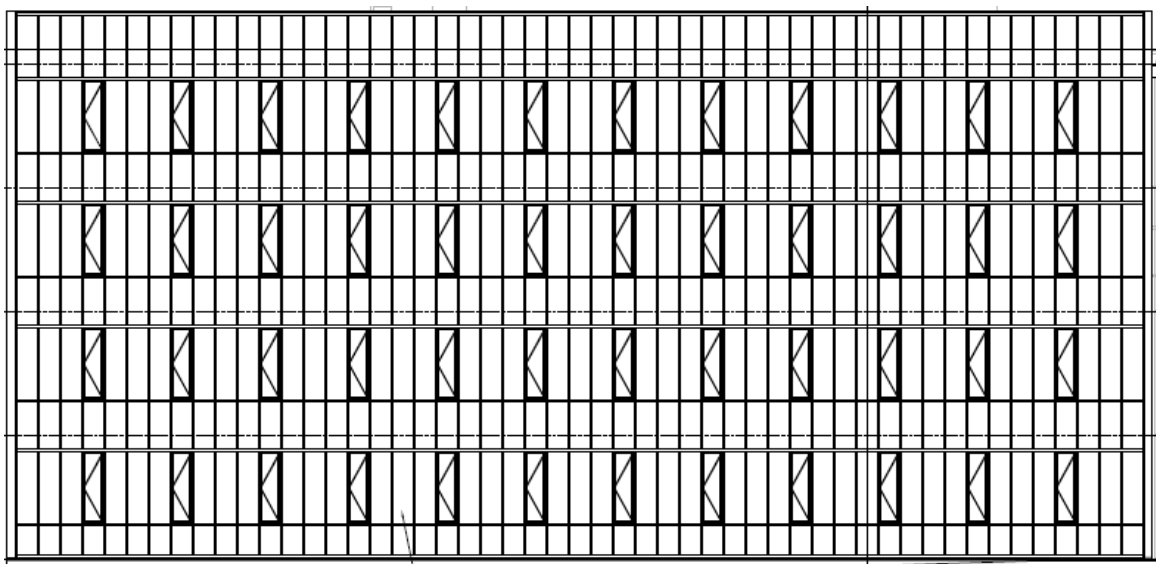
The lighting system in the gallery was designed to make the lighting scenarios flexible. The gallery has varies exhibitions and displays throughout the year. Since the designer did not know exactly what was going to be housed in the gallery, track was used throughout the design to have adjustable spots and flood determining the situation. The AGI32 model was calculated using the maximum one fixture per eight feet of track. This design is adequate for this situation but I think that it can be rearranged to be more adaptable to different situations. I would like to see an arrangement that will utilize a lighting scenario with available key, fill, and back lighting for sculptures and two fixtures at 45 degrees for paintings.

Space 4: Exterior Façade

Plans



Elevation



Material Reflectance

Material	Reflectance
Steel (W-Beams)	0.20
Concrete	0.35
Mullions (Painted)	0.80
Glazing (double glazed Low-E IGU operable)	0.6

Lighting Hardware

The exterior lighting systems consists of Architectural Area Lighting's Langent Fixture. The fixture is mounted on a 12' pole. The lamps spec is 70W metal halide.

Furniture/ Equipment

N/A

Design Criteria

Illuminance (Horizontal and vertical)

Glare can be a problem for vehicular and pedestrian traffic. The building must be clearly visible from the exterior parking lots and areas.

Direct/ Reflected Glare

Glare can be a problem for vehicular and pedestrian traffic. The building must be clearly visible from the exterior parking lots and areas.

Public Safety

Exterior lighting must provide enough illuminance to verify people faces and objects from a distance.

Light Pollution/ Trespass

Avoid using luminaires that direct light above the horizontal plane. Minimize light into nearby windows and adjacent object.

Light distribution (uniformity)

Uniform illuminance in parking lots (4:1)

Existing Lighting System Analysis

Light Loss Factors

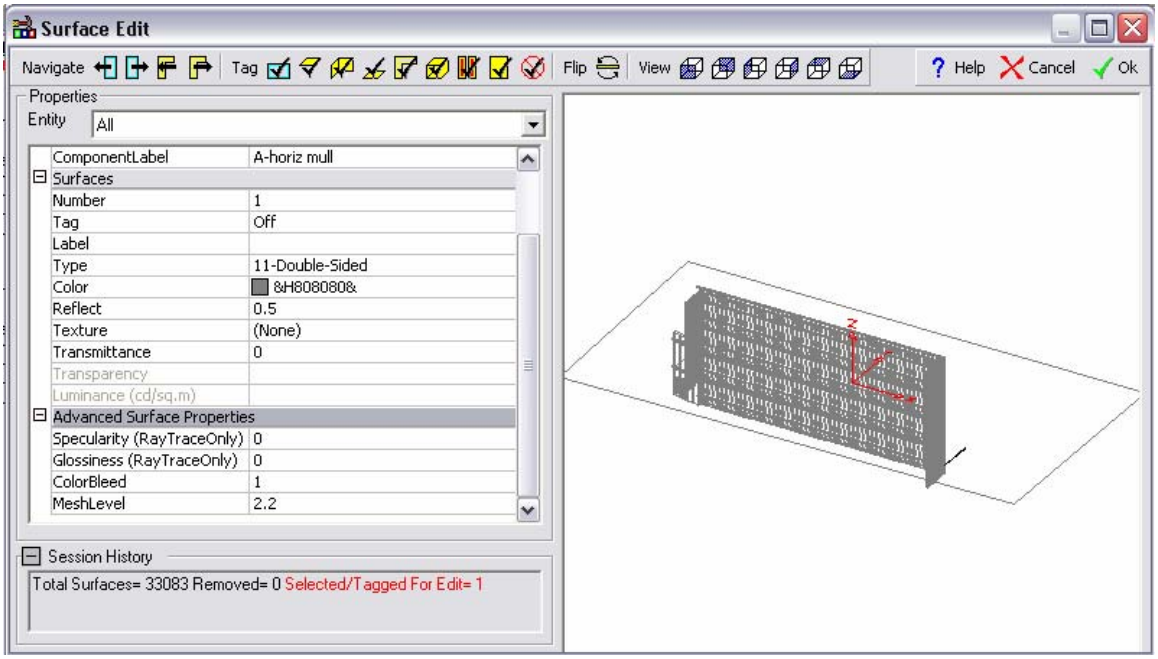
Luminaire	Cat.	Room	Cl.Int.	BF	LLD	RSDD	LDD	LLF
AE3	IV	Medium	12	0.8	0.81	0.95	0.76	0.5

Power Density

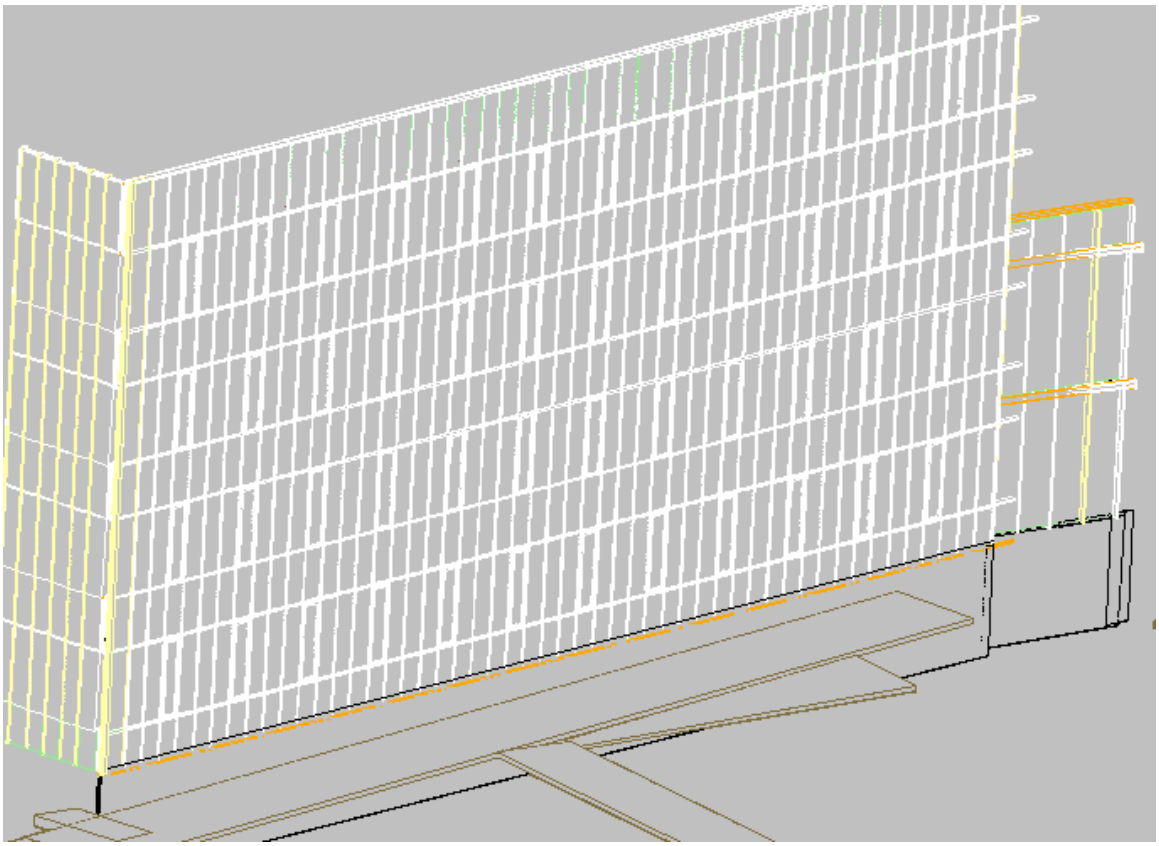
Input Watts (max): 70W
Number of Fixtures: 5 units

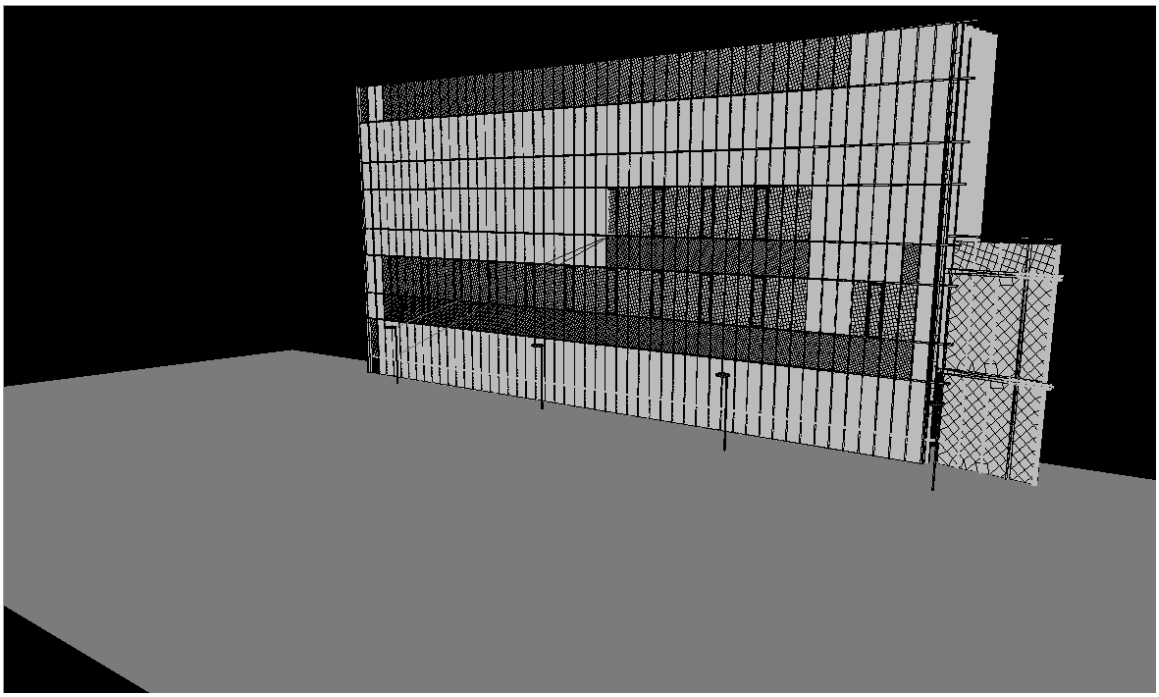
AGI32 Performance Model

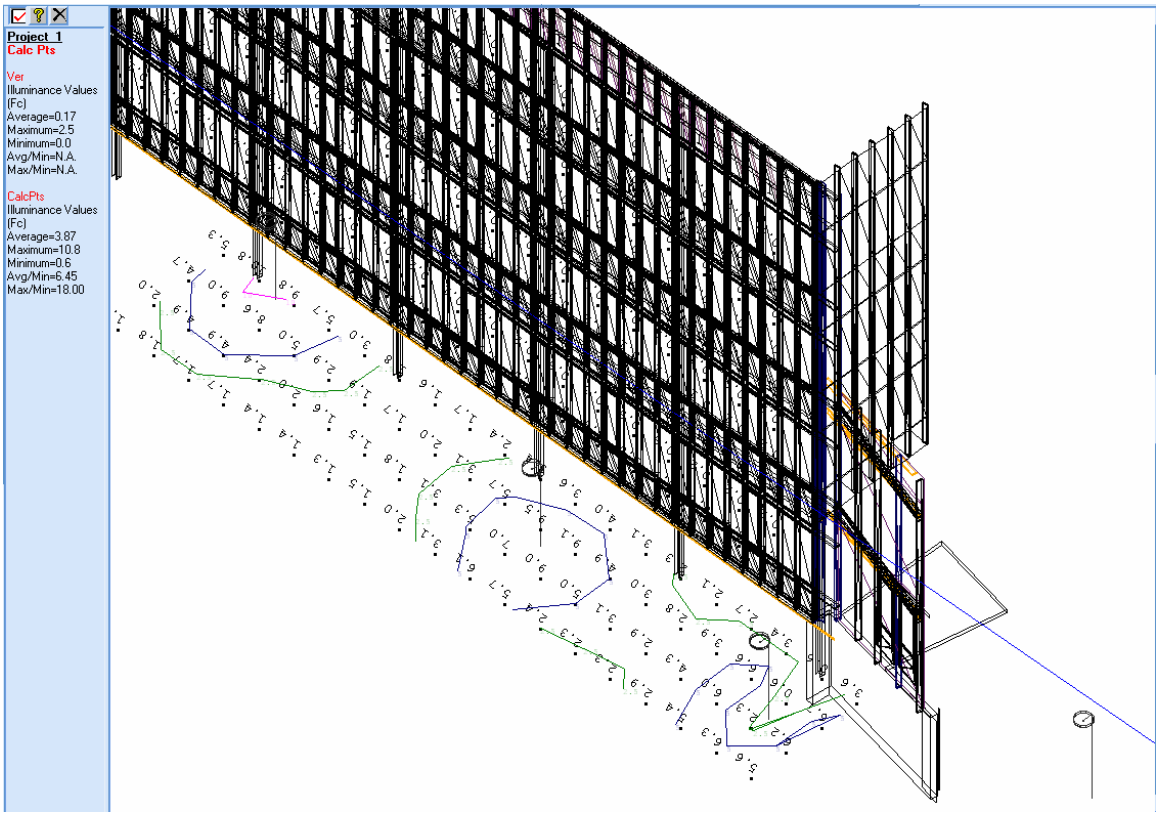
Verification of Mesh Level

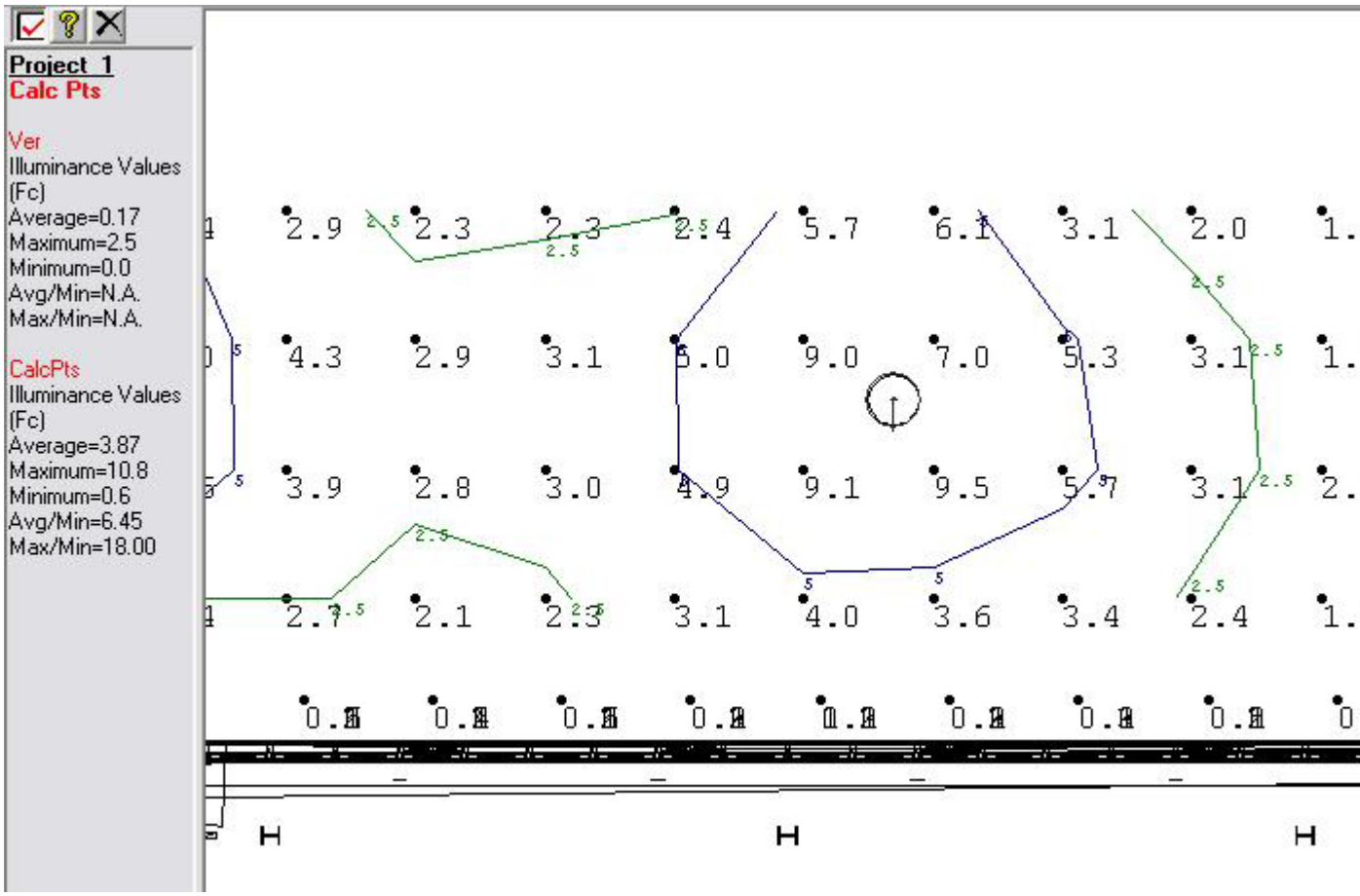


AutoCAD Drawing






Project_1
Calc Pts
Ver
Illuminance Values
(Fc)
Average=0.17
Maximum=2.5
Minimum=0.0
Avg/Min=N.A.
Max/Min=N.A.
CalcPts
Illuminance Values
(Fc)
Average=3.87
Maximum=10.8
Minimum=0.6
Avg/Min=6.45
Max/Min=18.00



Summary

The luminaires that were used in the exterior lighting were full cut off fixtures. The average vertical illuminance was 0.17 fc while the max was 2.5 fc. The horizontal illuminance averaged 4fc and maxed out at 10.8 fc. This lighting is adequate for simple pedestrian and vehicular traffic. Perhaps the design can be changed to increase the overall appearance to the façade of the main sculpture building. The langent fixtures do not have a positive effect on the façade.

END OF SECTION