Building Performance Study for Education building

Arch 571/Building Performance Evaluation/ Spring 2018

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Introduction

College of Education, Heath and Human Science reopened in Fall 2016 after a 2years of extensive renovation period.

The building was originally built in 1969, design by Hummell, Hummell, Jones and Shawver (Boise) costing about $17000000.

In 2014, the building was demolished for a grand renovation for $19 million, by architects Miller Hull Partnership.

Education Building in 1967 (Before renovation)
Source : University of Idaho Library's Campus Photograph Collection

Introduction

The **Ed building** is L –shaped in planning, having 90% of glazed curtain wall in its external façade in the north, west and the south.

The building after the renovation has a high-tech learning laboratory and classroom, called the Doceo Center for Innovation and learning. A roof top garden patio on the 5th floor Western side, team rooms and offices for group activities. The building inspires creativity, confidence and collaboration as quoted by Cori Mantle-Bromley, Dean of College of Education

Education Building in 2016 (After renovation)
Source :https://www.uidaho.edu/ed

Hypothesis

The Western Lobby is used more in the morning time of the day.

Study Area
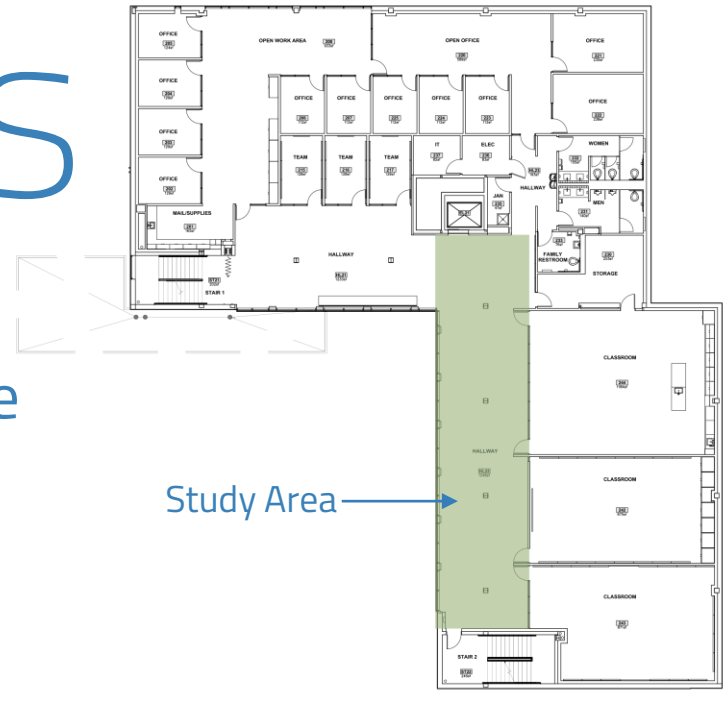
METHODOLOGY

Observation

Physical study

Quantitive analysis and comparison

- Take pictures during different type of the day
- Digital Model

- find out occupancy / number of classes running
- Daylighting performance analysis using Sefaira
- SPOT
- Survey
- conduct Hobo experiments, 24 hr study

- find the temperature in different time of the day: morning , afternoon and evening
- Glare analysis, Daylight factor

Observation Study

Functional Floor Division
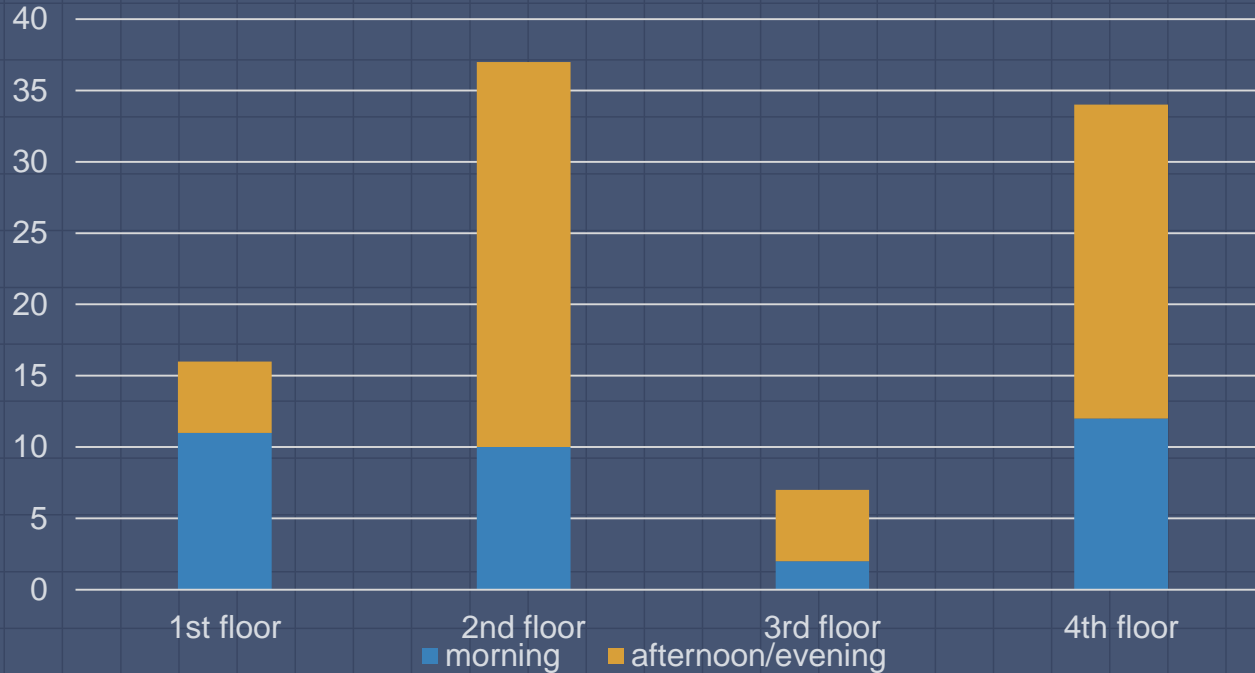

5th floor Roof Terrace Garden

4th Floor Class room spaces

3rd Floor Class room spaces

2nd Floor Class room spaces

1st Floor Class room spaces

Class room busy hrs.

Having more classes
In 2nd floor in the
afternoon

The fourth floor and
second floor is used the
most

Cloudy

2nd Floor

4th Floor

21st March 2018, 8:53 am
Cloudy Day

Daylight not enough
The ceiling light illuminated to 60%.

The shiny finish materials creates more reflectance

29th March 2018, 4:11 am
Partial Cloudy

Daylight enough but not evenly spread, some light fixtures off
The ceiling light illuminated to 30%.
Glare through shiny materials, white table and reflected columns
West wall requires added shading to mitigate uneven lighting and glare issues

Partly Cloudy
2nd Floor

19th April 2018, 4:02 pm
Sunny

19th April 2018, 4:51 pm

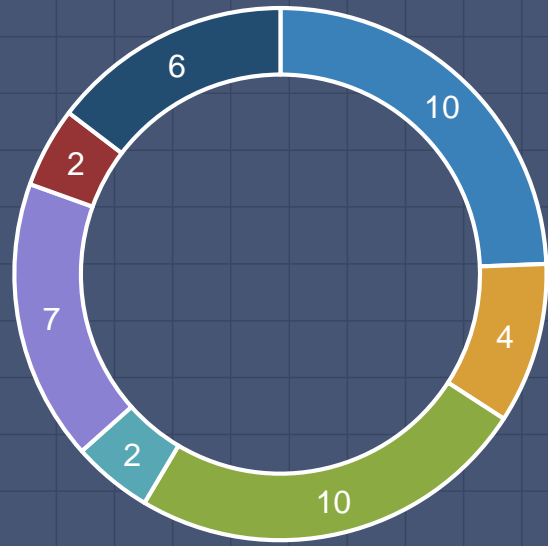Sunny Day
4th Floor

Daylight enough, some light fixtures off(sensor working well)
The ceiling light illuminated to 20%.
Glare through shiny materials, white table and reflected columns
West wall requires added shading to mitigate uneven lighting and glare issues

Building Comfort

- ☐ Comfortable environment
- ☐ Comfortable furniture
- ☐ Comfortable lighting
- ☐ Morning
- ☐ Afternoon
- ☐ Morning and Afternoon
- ☐ Some furniture not comfortable

# ED Building USER Survey

Physical Study

Surface Temperatures

| 10th April 2018,Partly cloudy	Morning 8:30 am	Afternoon 2pm	29th March 2018 Partly cloudy
Pine wood table	71° F	72° F	81° F
White Table	69° F	72° F	73° F
Lounge Chair(dark green)	70° F	72° F	86° F
Concrete Flooring	69° F	70° F	77° F
Wall	69° F	69° F	74° F
Aluminum Window glass	69° F	70° F	75° F
Aluminum Window Frame	67° F	69° F	70° F

Raytek Infrared Thermometer
Partly cloudy day
Outside temperature :53° F
Airconditioning turned on

The darker color and the fabric of the lounge chair absorbs more heat and makes it uncomfortable for people to sit.

HOBO placement
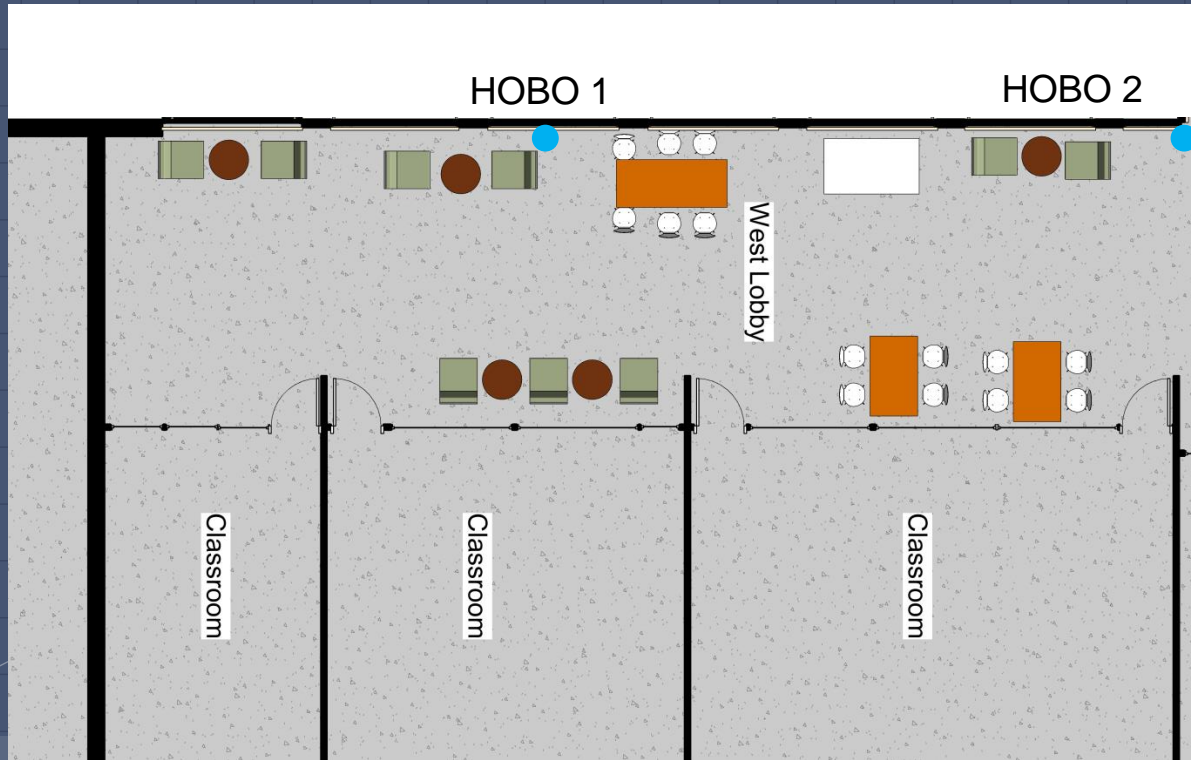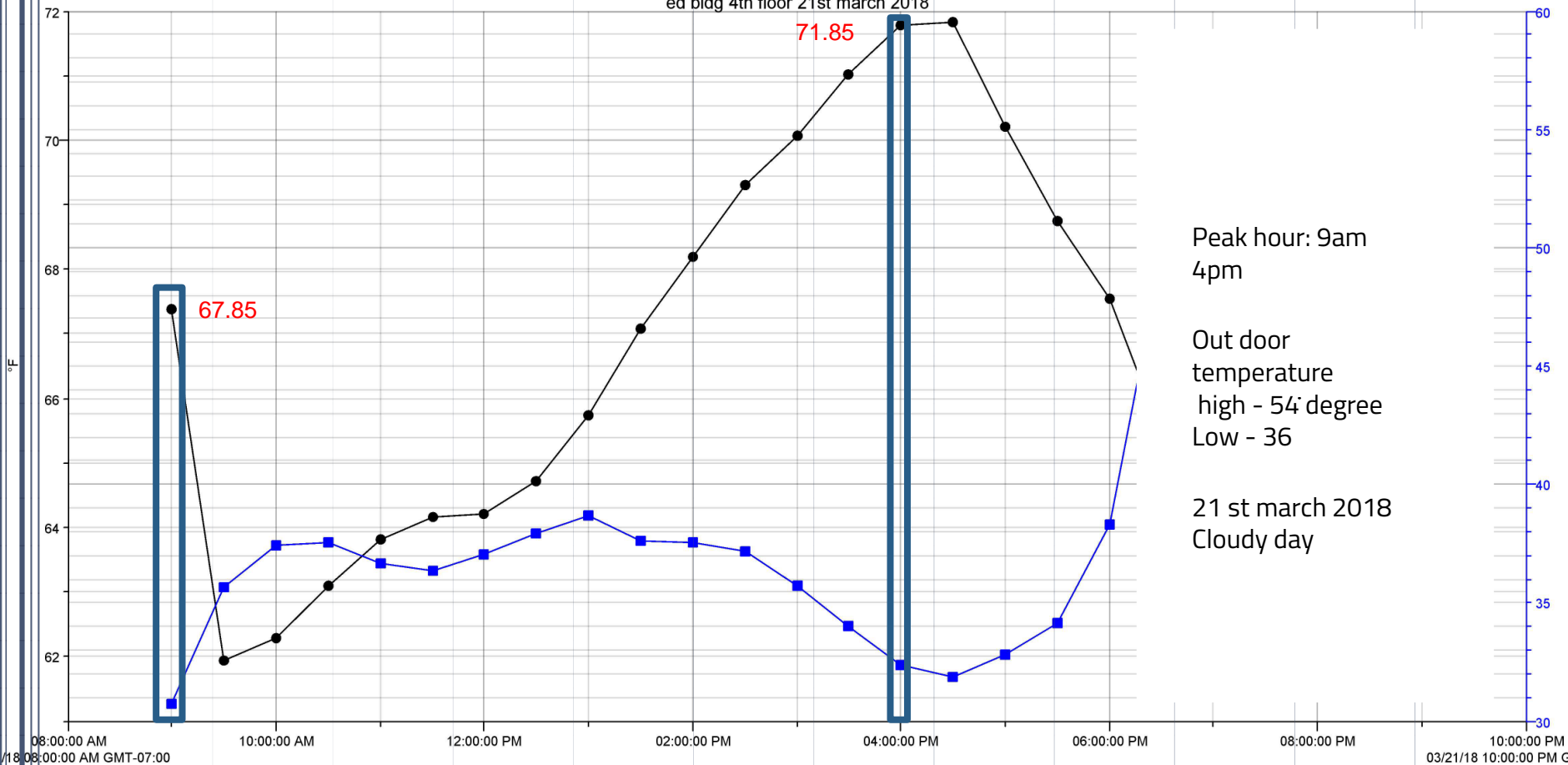
ed bldg 2nd floor 21 march 2018
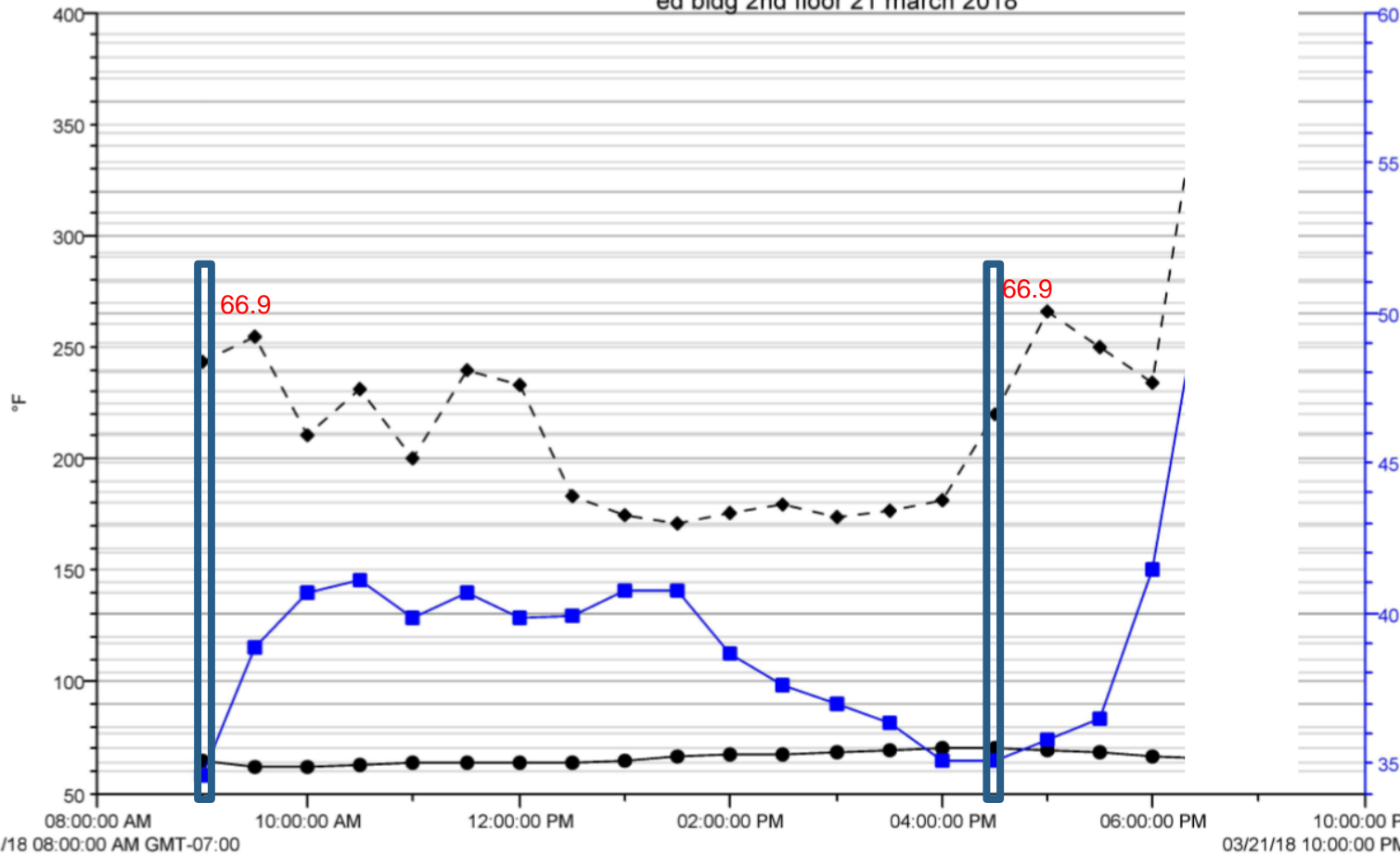
Legend:
- ● Temp, °F (temp)
- ■ RH, % (relative humidity)
- ◆ Temp, °F
- ◆ Host Connected
- ○ Stopped
- ✕ End Of File

66.9

66.9

Peak hours:
9am to 10 am

5pm

Out door
temperature
high – 54 degree
Low – 36
21 st march 2018
Cloudy day

°F

%

400
350
300
250
200
150
100
50

60
55
50
45
40
35

08:00:00 AM   10:00:00 AM   12:00:00 PM   02:00:00 PM   04:00:00 PM   06:00:00 PM   10:00:00 PM

/21/18 08:00:00 AM GMT-07:00

03/21/18 10:00:00 PM GMT-07:00

ed bldg 4th floor 21st march 2018

71.85

67.85

Peak hour: 9am
4pm

Out door
temperature
 high - 54 degree
Low - 36

21 st march 2018
Cloudy day

°F

08:00:00 AM
03/21/18 08:00:00 AM GMT-07:00

10:00:00 AM

12:00:00 PM

02:00:00 PM

04:00:00 PM

06:00:00 PM

08:00:00 PM

10:00:00 PM
03/21/18 10:00:00 PM G

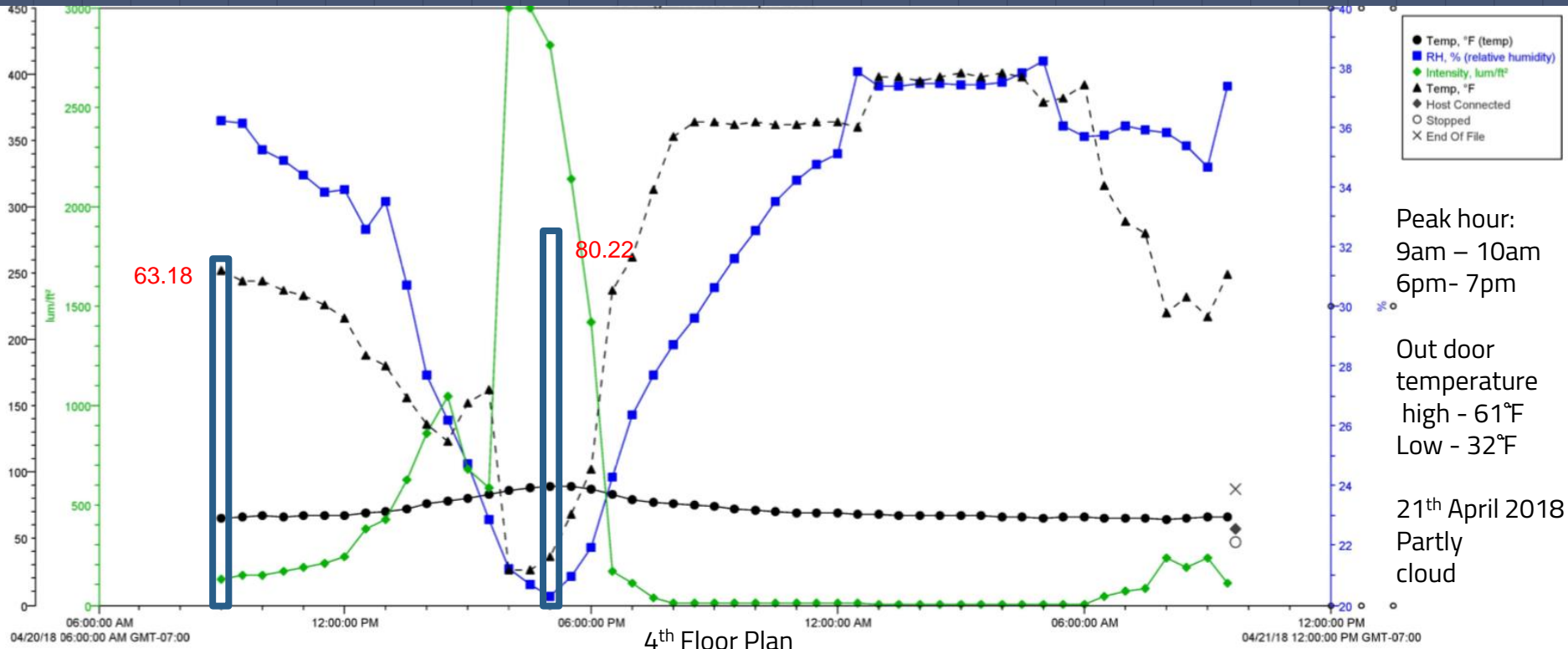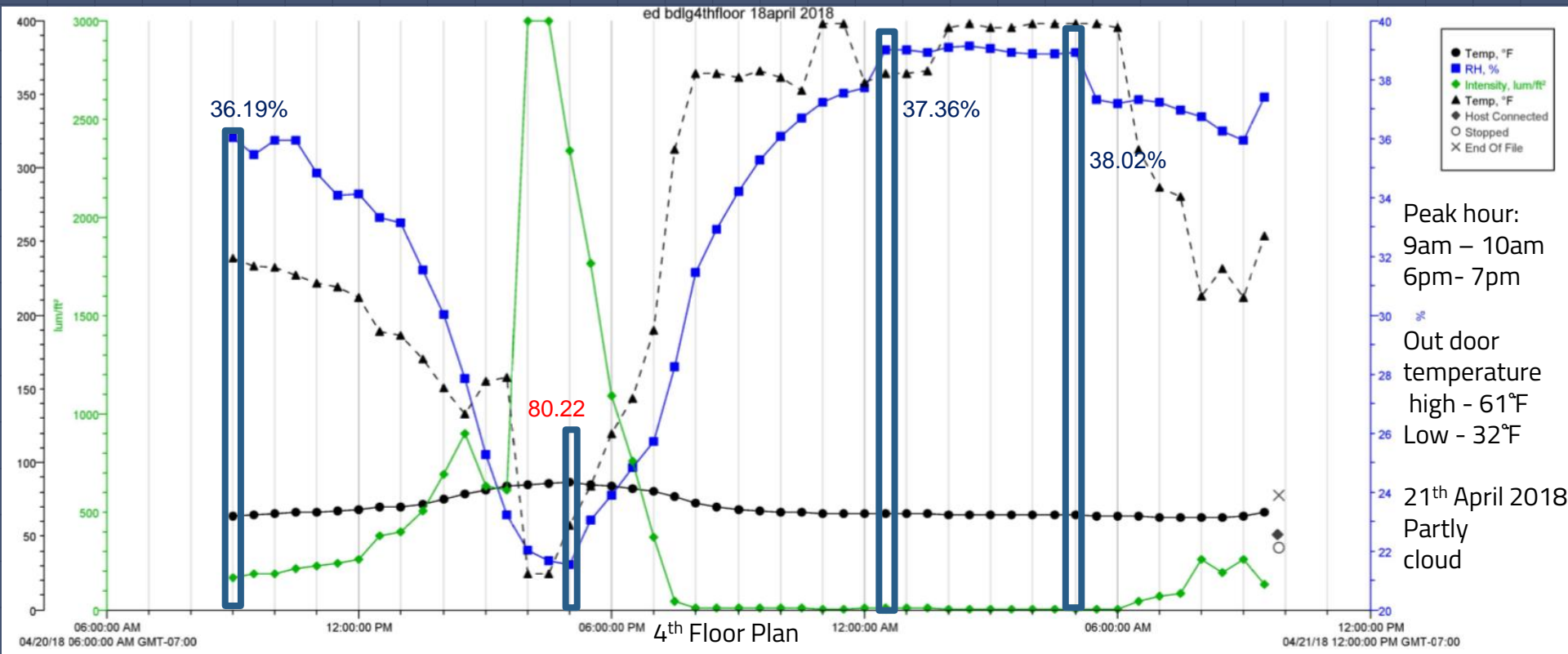ed bldg 2nd floor 11 april 2018
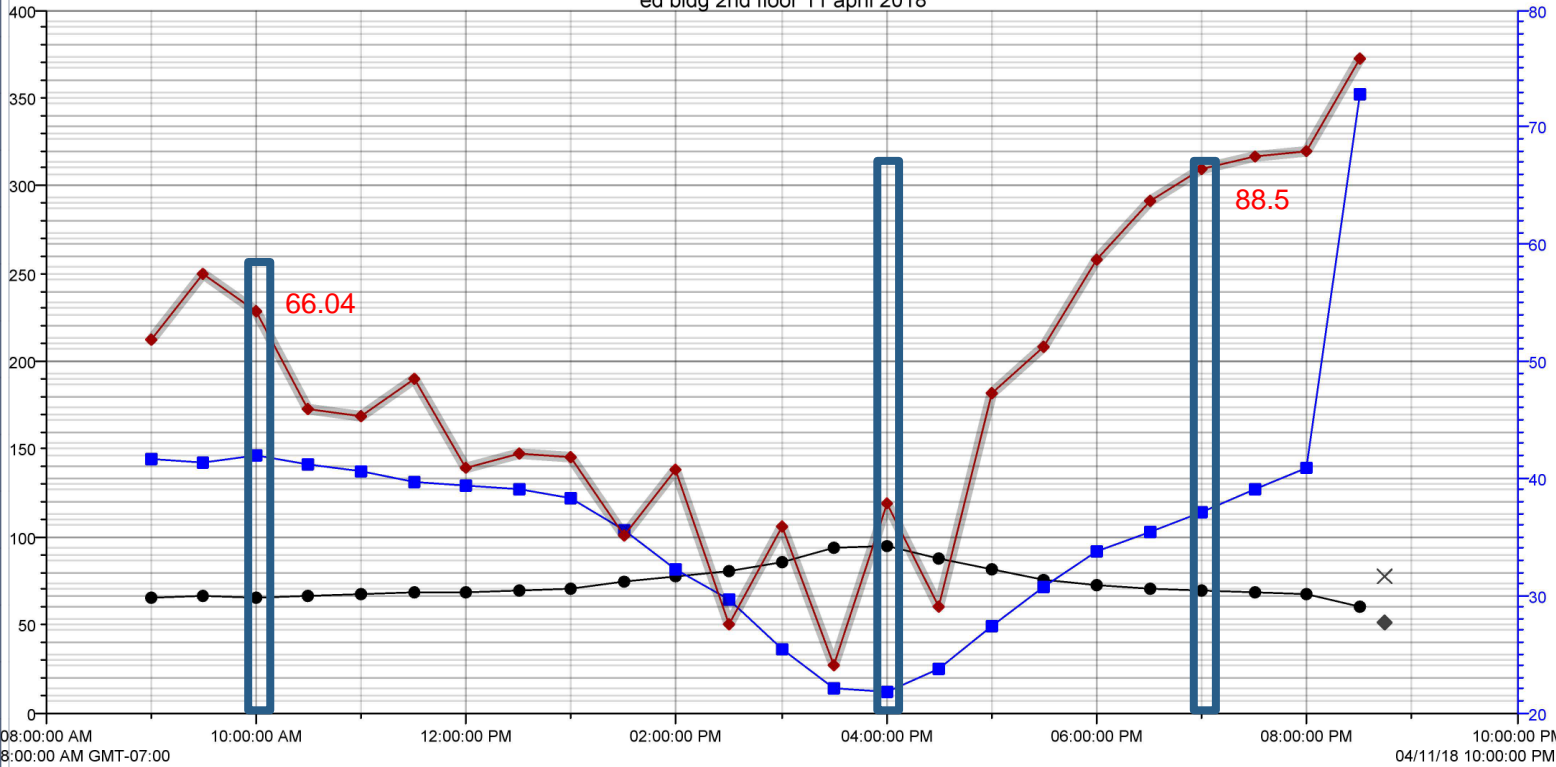
Legend:
- Temp, °F (temp)
- RH, % (relative humidity)
- Temp, °F
- Host Connected
- End Of File

66.04

88.5

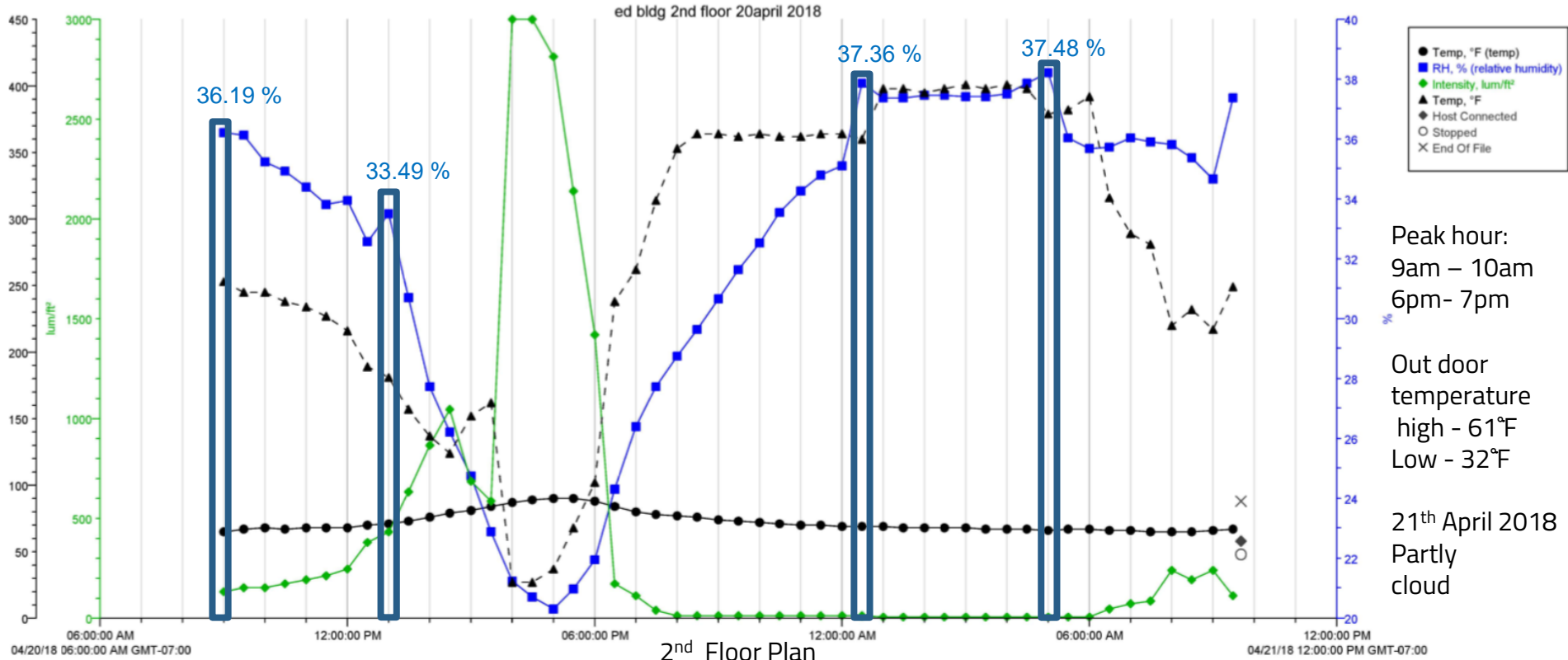Peak hour:
9am – 10 am
4 pm ,7pm

Out door
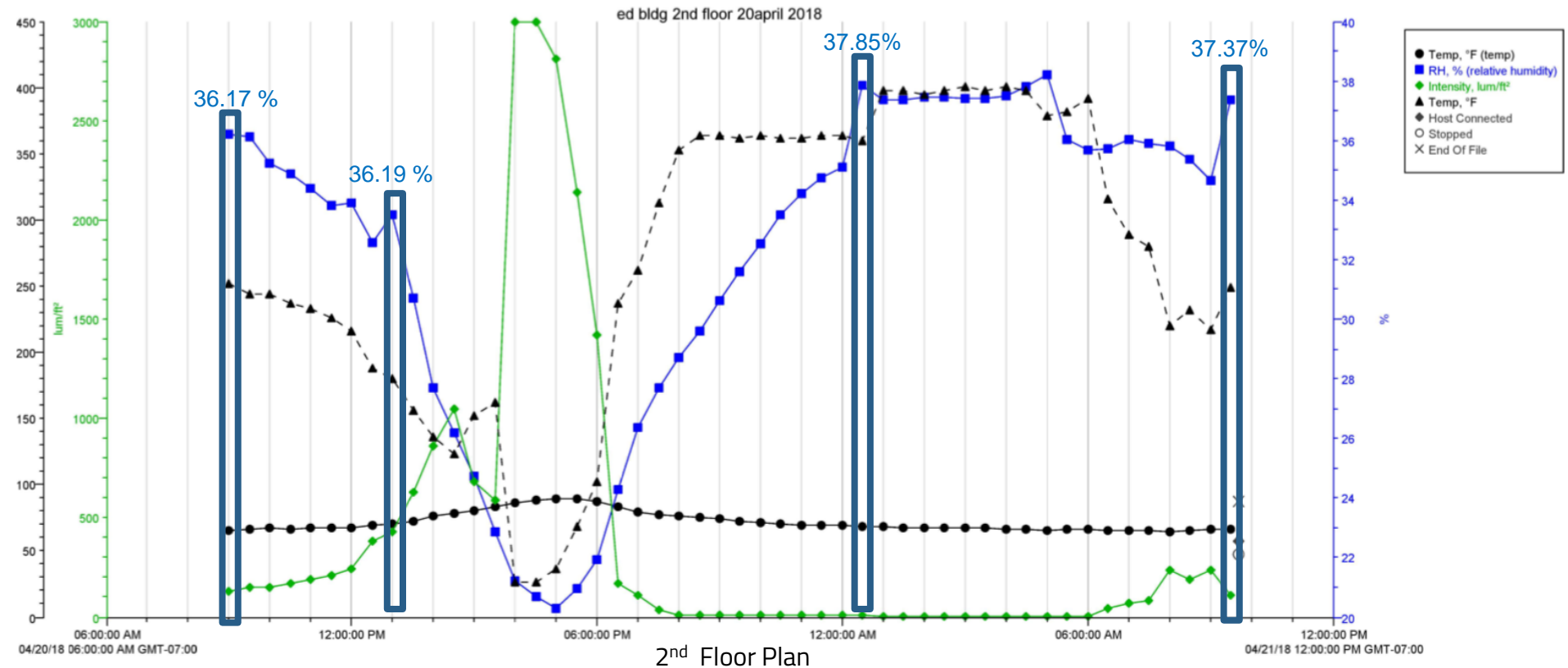temperature
 high – 58
degree
Low - 39

11th April 2018
Rainy day

04/11/18 08:00:00 AM GMT-07:00

04/11/18 10:00:00 PM GMT-07:00

Peak hour:
9am – 10am
6pm- 7pm

Out door
temperature
high - 61°F
Low - 32°F

21th April 2018
Partly
cloud

4th Floor Plan

ed bdlg4thfloor 18april 2018

36.19%

80.22

37.36%

38.02%

Peak hour:
9am – 10am
6pm- 7pm

Out door
temperature
 high - 61℉
Low - 32℉

21th April 2018
Partly
cloud

4th Floor Plan

Legend:
- Temp, °F
- RH, %
- Intensity, lum/ft²
- Temp, °F
- Host Connected
- Stopped
- End Of File

ed bldg 2nd floor 20april 2018

ed bldg 2nd floor 20april 2018

2nd Floor Plan

Hobo Analysis 2nd floor

Floor	Date	Day	Time	Temperature	Humidity
2nd floor	21st March 2018		9am	64.84	43.599
			5pm	69.42	35.79
	21st April 2018		9am	64.88	36.19
			1pm	70.20	33.49
			1am	67.84	37.34
			5am	66.087	38.035
			5:30 am	87.43	20.96
2nd hobo	21st April 2018		9am	64.88	36.178
			5pm	88.167	20.703
			12am	68.52	37.85
			5am	68.82	39.205
			9am	66.64	37.37

People use the lobby more at between 9am – 10 am, 12pm to 1pm and 4pm to 5;30 pm

Hobo Analysis 4th floor

Floor	Date	Day	Time	Temperature	Humidity
4th floor	21st March 2018		9am	67.37	30.72
			4pm	71.79	32.33
			2pm	68.18	37.56
	11st April 2018		10am	71.53	30.14
			5pm	75.02	33.142
			1am	67.84	37.34
	21st April 2018		9am	63.17	36.004
			1pm	69.98	33.142
			3pm	81.50	25.26
			5pm	86.53	21.53

People use the lobby more at between 9am – 10 am, 12pm to 1pm and 4pm to 5;30 pm

Daylight Factor

DF		
Less than 2%	gloomy	Requires electric lightings
2% to 5%	Well daylit	Supplementary electric lighting required depending on Task performed
5% or more	Vigorously daylit	Electric lights not necessary depending on task in hand

LEED recommendation for Daylight factor criteria : a minimum DF of 2% for 75% of normally occupied area
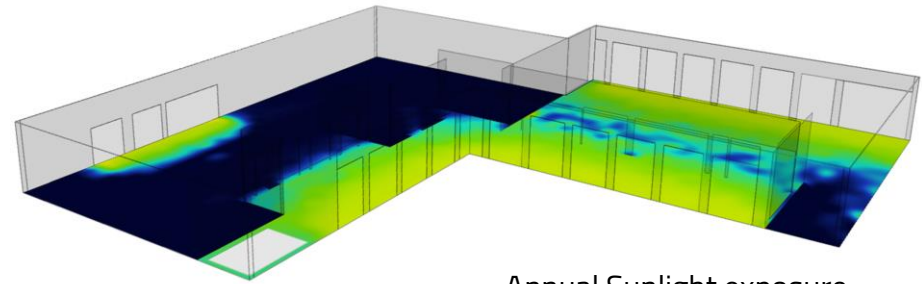
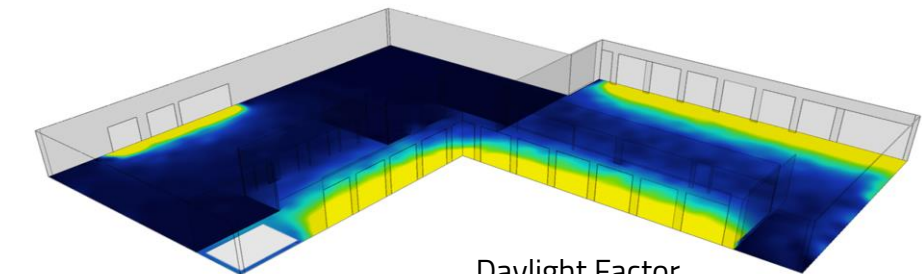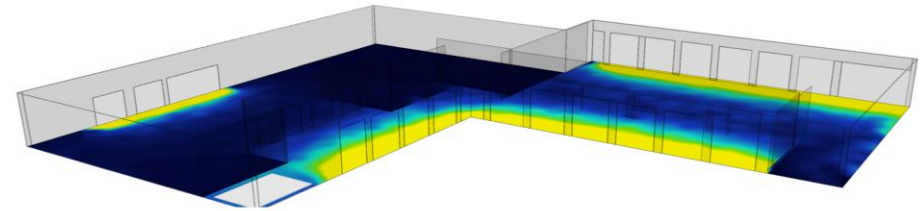Source : Lighting;The Green Studio Hand book; Page 84-85

Sefaira Model

Illuminance Level : 37 footcandles

Overlit
93 footcandles of direct light for more than
250 occupied hours per year- 44%

Underlit
Less than 28 footcandles for more than
50% of occupied hours – 19%

Daylight Factor :2.35%

Annual Sunlight exposure

Overlit & Underlit

Daylight Factor

Internal Reflectance

□ Color determines the quantity of light reflected from a surface.

Darker color – absorbs lights and heat – darker chairs - warmer

Lighter color - reflects lights - white table – bright

□ Texture determines the quality of light leaving surface

Rough texture surface: diffusely reflect light

Smooth or glossy surface: specularly reflect lights- white pillars with white covering

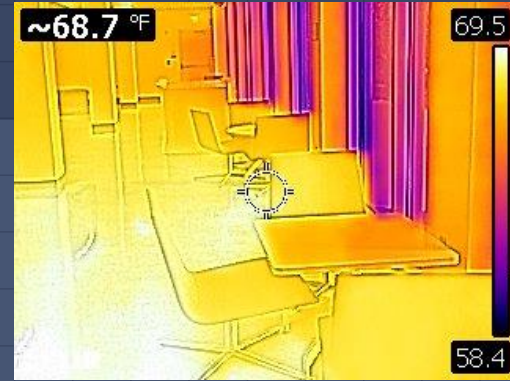| Surface	Reflectance (office)	Reflectance (Classrooms)
Ceilings	80%	70% - 90%
Walls	50 % - 70 %	40% - 50%
Floors	20 % - 40%	30% -50%
Furnishings	25% -45%	30% - 50%

Recommended reflectancefor interior surfaces in different spaces, THE IESNA Lighting handbook,9th Ed.

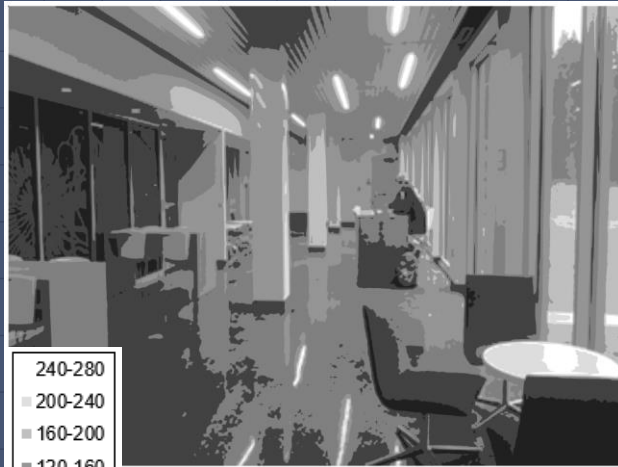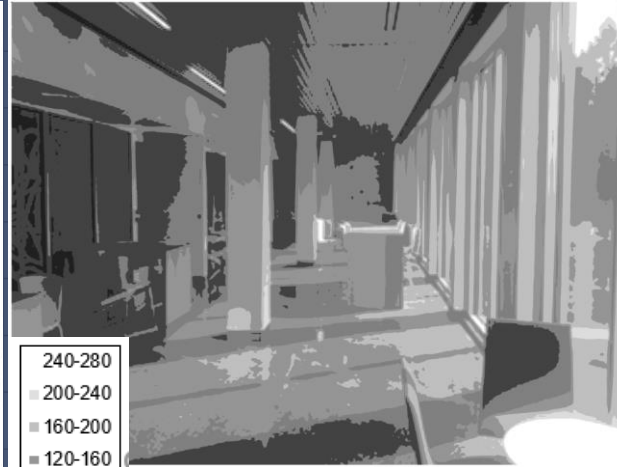# Glare Analysis

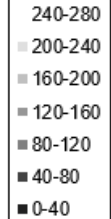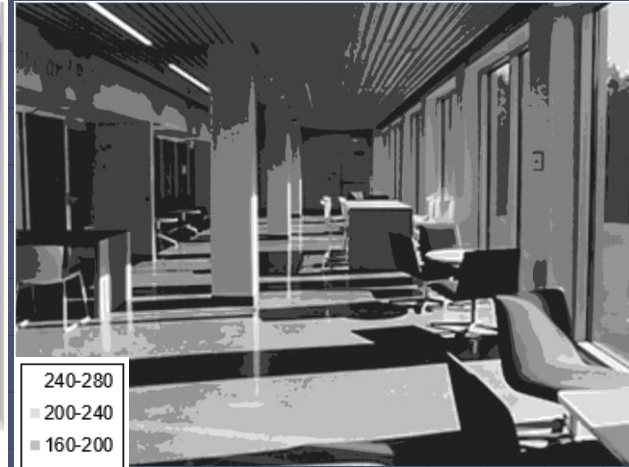Morning

Max.Temp : 68.7 ˚F
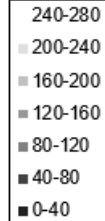

Afternoon

Max.Temp : 84.4 ˚F
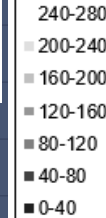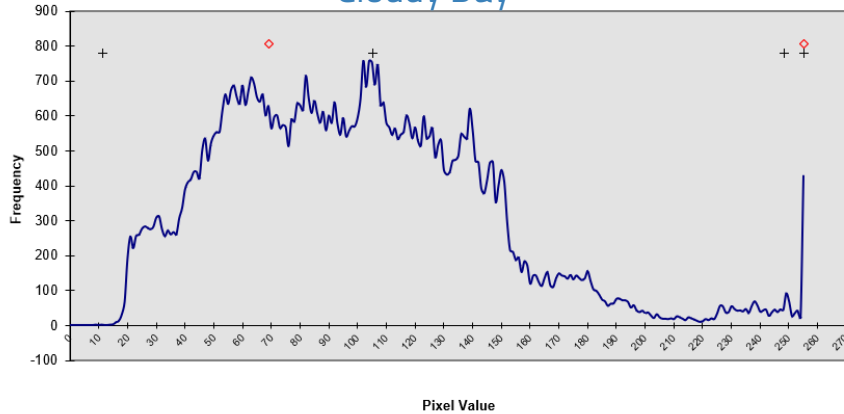
Glare Analysis

Cloudy Day

Partly Cloudy

Sunny day

The windows requires shadings as it penetrate lot of unwanted light producing glare during
A bright day. The LED ceiling lights reflects from shiny, glossy finishes in a cloudy day.

Pixel Histogram — Cloudy Day

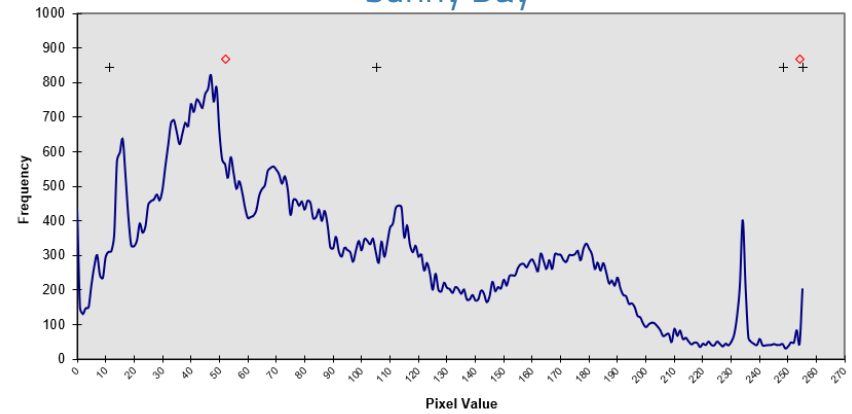| Overall Image		Indiviual Pixel		
Weighted Ave Pixel Intensity	116.10	Individual Pixel Value	40	
Total Number of Pixels	76800	Corresponding Luminance	108.00	footlamberts
Background Bell Curve		**Spike**		
Low End Pixel Value	11	Low End Pixel Value	248	
High End Pixel Value	105	High End Pixel Value	255	
Background Median Value	69	Spike Median Value	255	
Number of Background Pixels	44894	Number of Spike Pixels	752	
Background Percentage of View	58.46 %	Spike Percentage of View	0.98 %	
Spike to Background Ratio				
Median Spike to Median Background		3.70 TO 1		
Schiler Glare ?		YES		

Pixel Histogram — Sunny Day

| Overall Image		Indiviual Pixel		
Weighted Ave Pixel Intensity	107.24	Individual Pixel Value	40	
Total Number of Pixels	76800	Corresponding Luminance	86.83	footlamberts
Background Bell Curve		**Spike**		
Low End Pixel Value	11	Low End Pixel Value	248	
High End Pixel Value	105	High End Pixel Value	255	
Background Median Value	52	Spike Median Value	254	
Number of Background Pixels	46369	Number of Spike Pixels	533	
Background Percentage of View	60.38 %	Spike Percentage of View	0.69 %	
Spike to Background Ratio				
Median Spike to Median Background		4.88 TO 1		
Schiler Glare ?		YES		

SPOT ANALYSIS
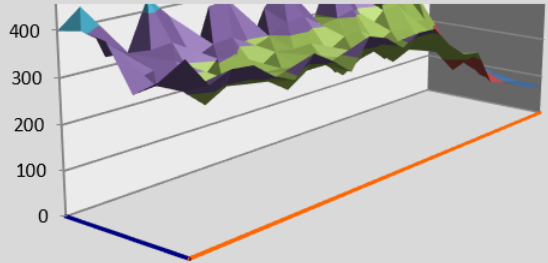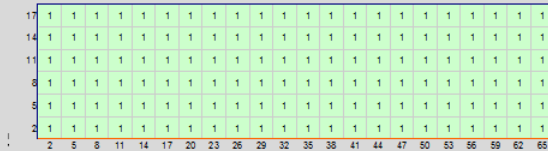
Work plane illuminance

Maximum glare coming from the West window

Maximum DF : 20.83
Minimum DF: 2.35

| Design Condition		Zone 1			
		Avg	Max	Min	Shades?
Clear Sky					
Winter	#####	268	439	74	
	#####	248	1668	72	
	#####	93	162	52	
	#####	71	128	37	
Equinox	#####	1987	3040	161	
	#####	293	964	133	
	#####	147	217	90	
	#####	65	116	36	
Summer	#####	2027	5232	195	
	#####	311	539	147	
	#####	182	245	109	
	#####	80	132	47	
Overcast Sky					
Winter	#####	43	115	12	
	#####	163	435	47	
	#####	109	291	31	
	#####	54	145	16	
Equinox	#####	141	378	41	
	#####	311	831	89	
	#####	277	740	80	
	#####	58	155	17	
Summer	#####	313	836	90	
	#####	352	940	101	
	#####	343	918	99	
	#####	141	376	40	
Annual Average	300				
Annual Maximum		4547			
Dylt Saturation [DS]	0.82	0.84	0.80		
Dylt Excess [DE]	0.30	0.68	0.00		
Dylt Autonomy [DA]	0.80	0.82	0.75		
UDI Combined [UDI]	0.56	0.82	0.19		
UDI exceeded [UDle]	0.26	0.65	0.00		
Daylight Factor [DF]	8.16	21.83	2.35		
Spatial DA [sDA]	0.91	0.94	0.00		
nual Sun. Exp. [ASE]					

BIG CONCEPT

Redesign Proposal

Light Shelves

○ To provide more even distribution of light

○ Increase diffusion of light

○ Redirects incoming daylight

○ Adds physical as well as visual comfort to a space

○ Reduce the use of electric lighting by increasing daylight factor away from apertures

○ To get rid of unwanted glare lights

○ Reduces contrast caused by daylighting of a space

○ External light shelves serves as shading devices reduces cooling loads by reducing solar gains

Conceptual sketch
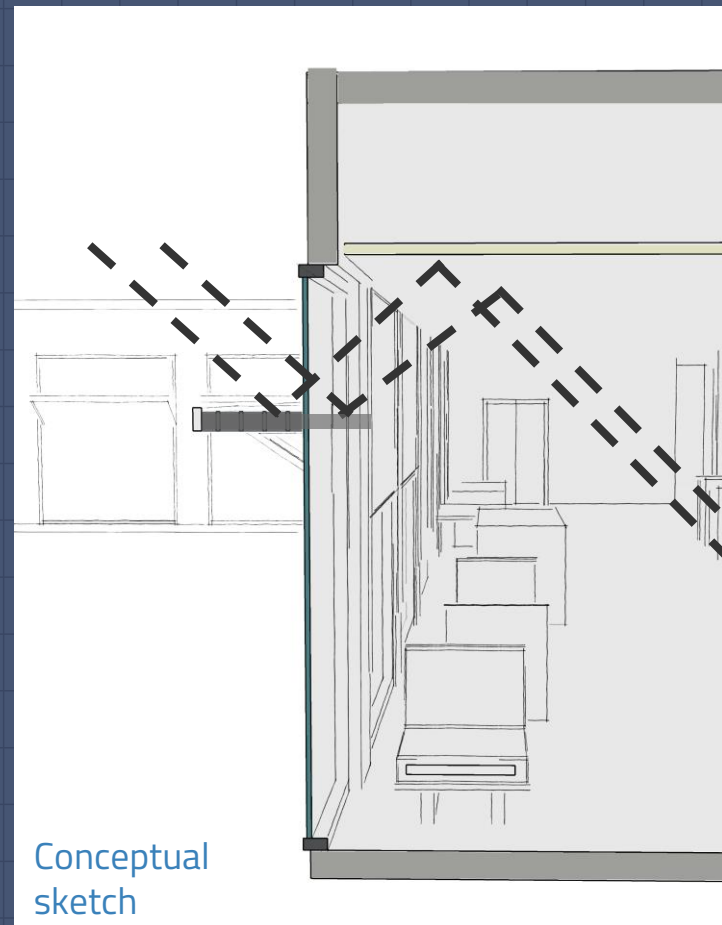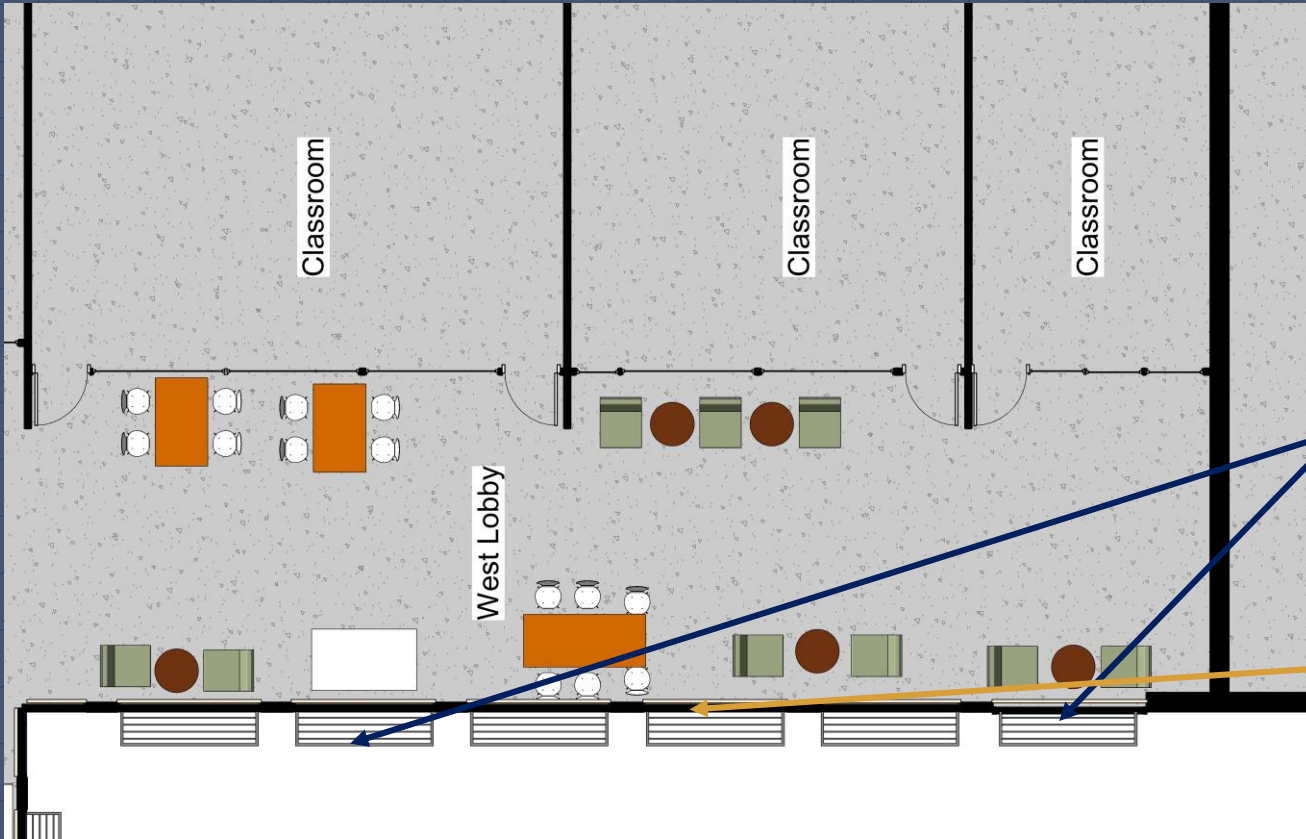
Redesign Proposal

Proposed
Aluminum
Light shelves

Interior
Screens

90%
transmittance

Classroom

Classroom

Classroom

West Lobby
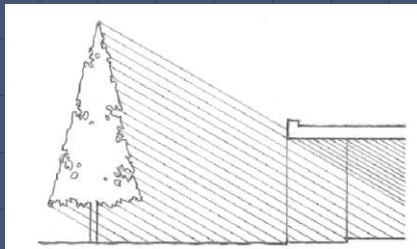
Trees

Trees can be a natural and effective shading device
Planting trees on the Western Façade of the building helps
to shade 1st and 2nd floors.

The advantage of trees as screens

o   Effective shading means on the south west during late
    afternoon when the sun has low altitudes and casts
    long shadows

o   Deciduous trees provide shade and glare protection
    allowing solar radiation to penetrate their branch
    structure during winter

o   Screens unwanted views and light penetrations

Deciduous trees to
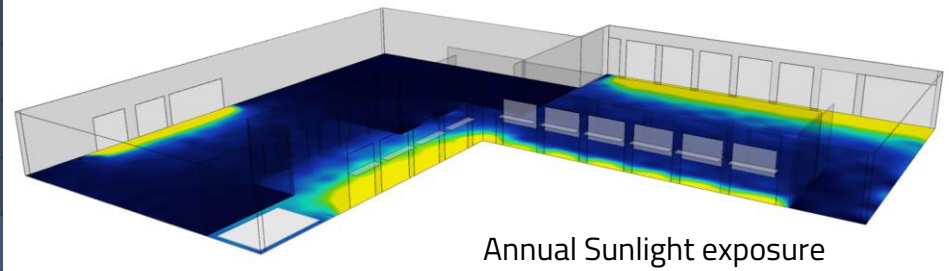prevent glare in 1st and
2nd floors

Sefaira Model

Illuminance Level : 37 footcandles

Overlit
93 footcandles of direct lightfor more than
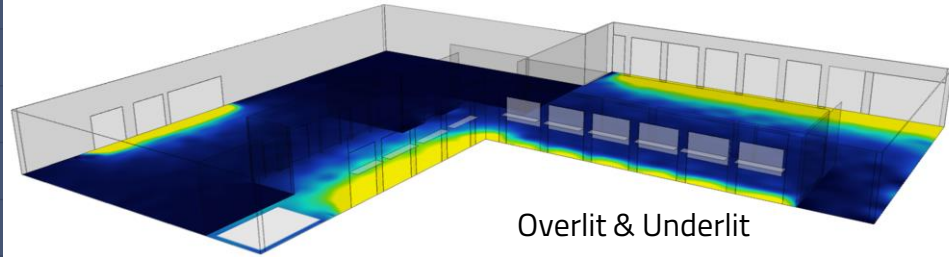250 occupied hours per year- 12%

Well lit: 28%

Underlit
Less than 28 footcandles for more than
50% of occupied hours- 72%

Daylight Factor :1.73% ~ 2 %

Annual Sunlight exposure

Overlit & Underlit
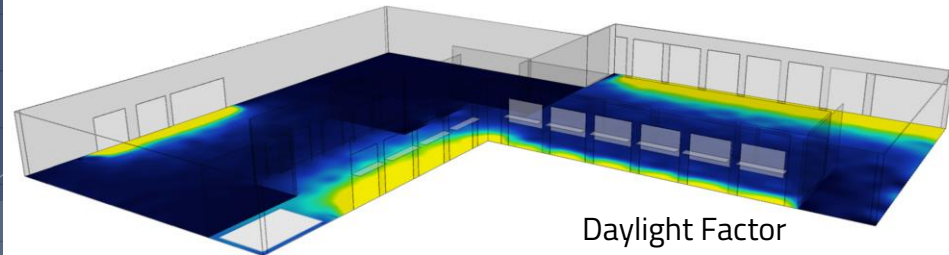
Daylight Factor
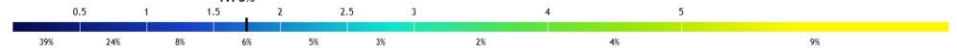
SPOT ANALYSIS

Workplane Illuminance, [fc]

Work plane illuminance with proposed shading device

Maximum DF : 1.71
Minimum DF: 0.41

It reduces the amount of daylighting and glare

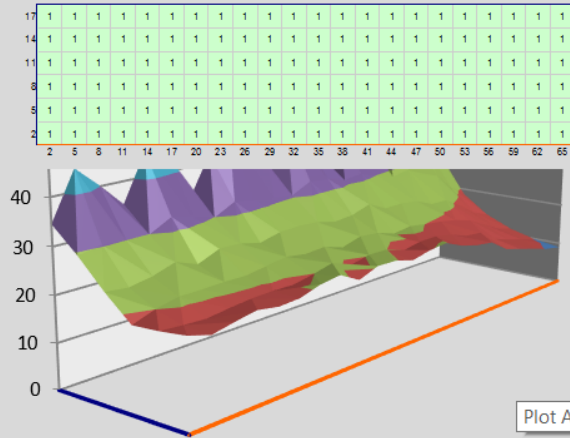| Design Condition		Avg	Max	Min	Shades?
Zone 1					
Clear Sky					
Winter	#####	24	46	9	Z1
	#####	21	105	8	Z1
	#####	8	16	3	Z1
	#####	6	13	3	Z1
Equinox	#####	145	264	46	Z1
	#####	31	67	13	Z1
	#####	12	24	5	Z1
	#####	6	11	3	Z1
Summer	#####	143	310	44	Z1
	#####	27	59	12	Z1
	#####	13	27	6	Z1
	#####	7	14	3	Z1
Overcast Sky					
Winter	#####	4	9	2	Z1
	#####	17	34	8	Z1
	#####	11	23	5	Z1
	#####	6	11	3	Z1
Equinox	#####	15	30	7	Z1
	#####	32	65	16	Z1
	#####	28	58	14	Z1
	#####	6	12	3	Z1
Summer	#####	32	65	16	Z1
	#####	36	74	18	Z1
	#####	35	72	17	Z1
	#####	14	29	7	Z1
Annual Average		25			
Annual Maximum			289		
Dylt Saturation [DS]		0.58	0.76	0.38	
Dylt Excess [DE]		0.00	0.02	0.00	
Dylt Autonomy [DA]		0.30	0.66	0.10	
UDI Combined [UDI]		0.68	0.78	0.43	
UDI exceeded [UDIe]		0.00	0.00	0.00	
Daylight Factor [DF]		0.84	1.71	0.41	
Spatial DA [sDA]		0.31	0.71	0.00	
nual Sun. Exp. [ASE]					

CONCLUSION

- Due to the heavy class schedules in <u>the afternoon the western lobbies are used more</u> by student and faculties before or after each classes, <u>which makes our hypothesis unsuccessful</u>. Further research shows that even though the lobbies are used more in the afternoon , the place seems <u>uncomfortable</u> (glare, very warm furniture).

- To make the lobbies more comfortable, we propose the use of light shelves and internal screens to mitigate glare and also reduce the intensity of solar heat gain on the furniture and space. The Low e glass helps to controls SHG but it is <u>not enough for human comfort</u>.

- We were able to reduce the glare and bring in daylight but the space is not as daylighted as existing designs.