BUILDING PERFORMANCE

KIBBIE DOME – WEIGHT ROOM

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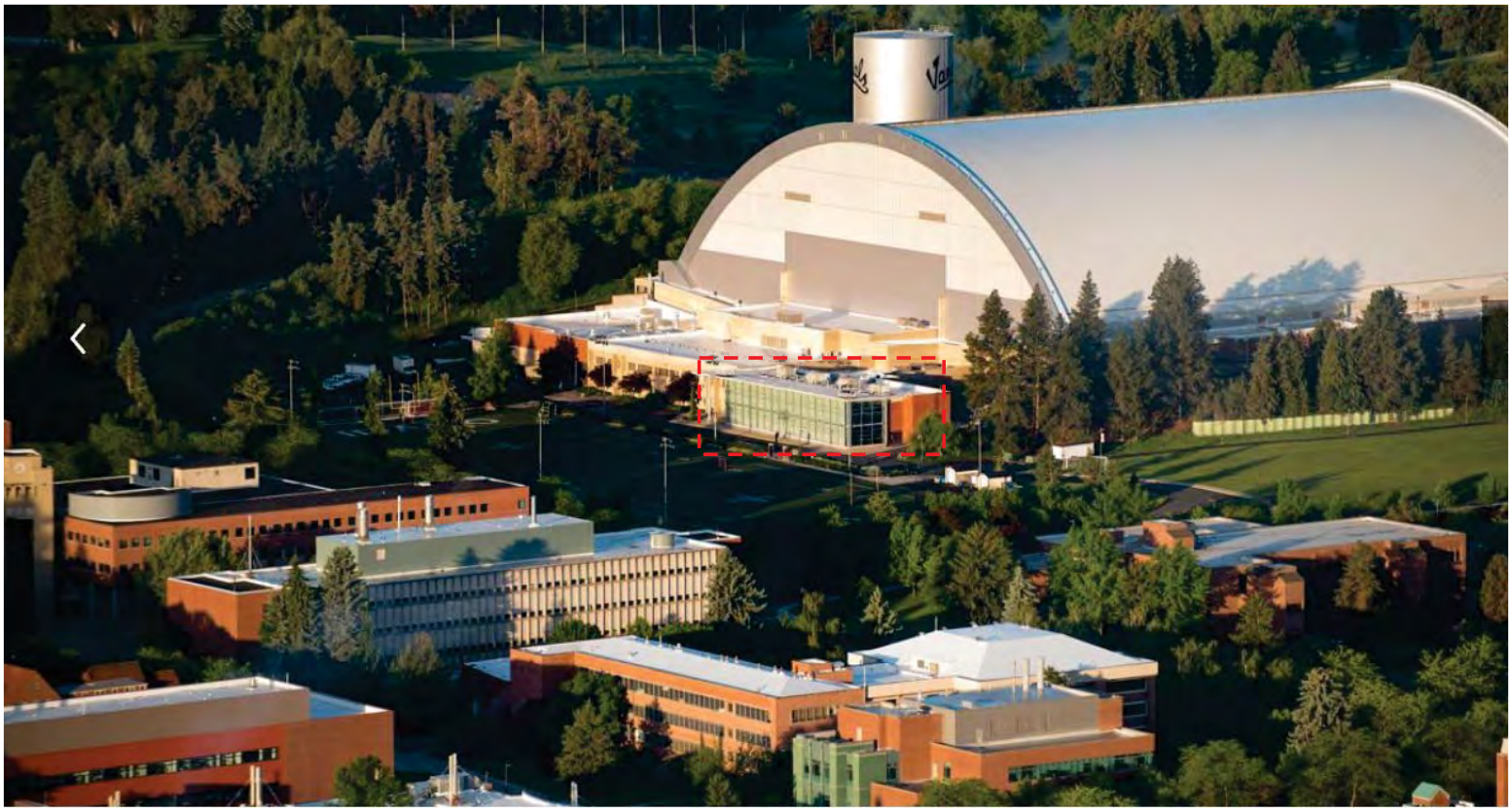


HYPOTHESIS

H1	H2	H3
The air - conditioner is operable in sunny morning in Winter.	The blinds are consistently used in the morning.	Pool causes moister in the air.
Proposed procedure: Use Hobo to find out the temperature drops in the room and see whether they use the air conditioner in the mornings or not. Also to find out the internal and solar heat gain in the room in early mornings.	Proposed procedure: Frequent visiting to the Kibbie dome for observance, HOBO analysis.	Proposed procedure: Use Hobo on the Mezzanine Floor and the First Floor to find out the difference in air water content caused by the pool.

BUILDING AT A GLANCE

Name- Kibbie Dome Addition

Location- Moscow ,ID East side of the Kibbie Dome

Owner- University of Idaho

Principle Use- Recreational area used by athelets of the Univeristy of Idaho to train

Includes- Locker rooms, offices, weight room, athletic training facility, equipment room and hydrotherapy pool

Employee/Occupants - 92 max

Occupied when- Its in use mainly in the morning slows down during the day since it closes aroundd 5 pm

Gross Square Footage- 9,552

Total Cost- 3.9 Million

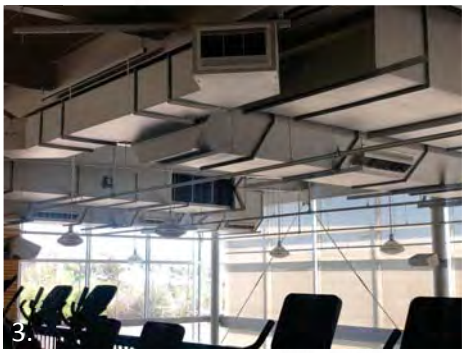
Completion- Fall 1982
worked on again April 2004

EXISTING FEATURES

1. Roof system that goes around the whole building that tries to act as a shading device.
2. Hydrotherapy pool that is located on the mezzanine floor.
3. HVAC System that can be seen on the ceiling of the weight room.
4. Curtain wall system that provides shade on east, north and south sides.
5. Two floor system: First Floor and Mezzanine floor.
6. Clearstory windows on west side of Mezzanine floor.
7. Black rubber flooring.


1.


2.


3.

7.


6.

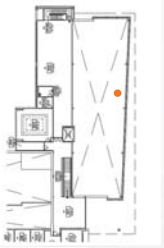

5.

HYPOTHESIS 1 The air - conditioner is operable in sunny morning in Winter.

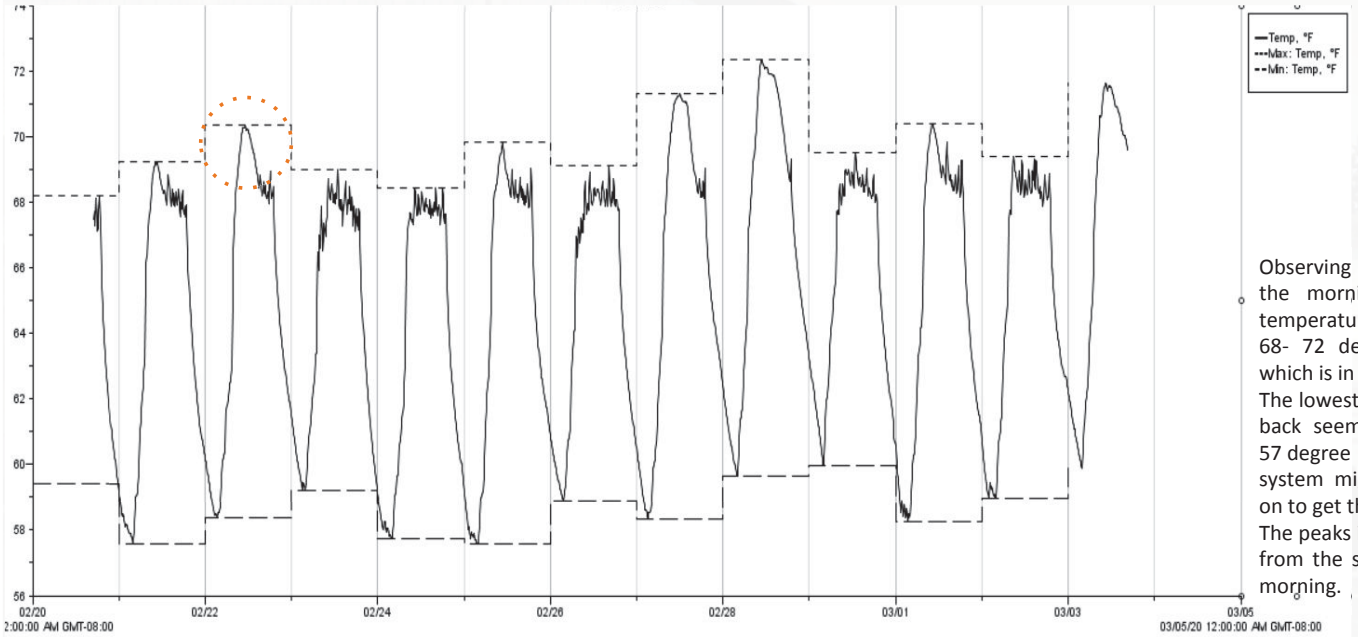
METHODOLOGY

1) ANALYSIS OF HOBO ON FIRST FLOOR AND MEZZANINE FLOOR.
2) SBEED ANALYSIS

HYPOTHESIS 1# The air - conditioner is operable in sunny morning in Winter.



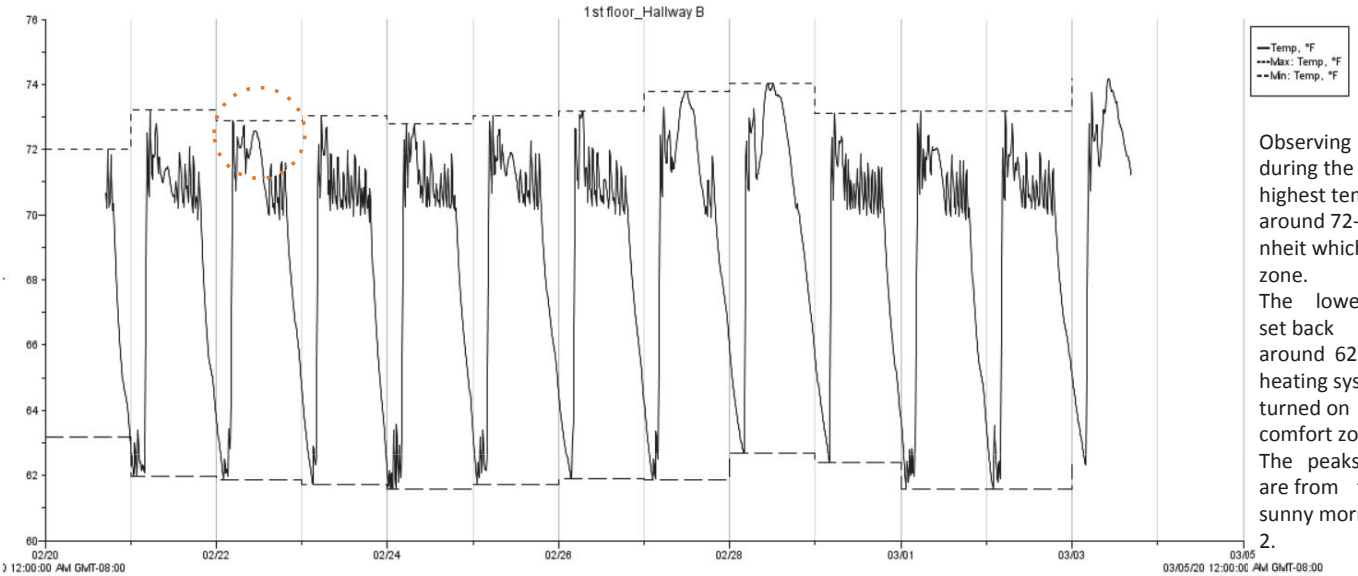
HOBO 2 INSTALLED ON FLOOR OF WEIGHT ROOM



Observing the chart, during the morning the highest temperature reach around 68- 72 degree Fahrenheit which is in comfort zone.
The lowest temperature set back seems to be around 57 degree and the heating system might have turned on to get the comfort zone.
The peaks in the picture are from the sun during sunny morning.

HYPOTHESIS 1# The air - conditioner is operable in sunny morning in Winter.

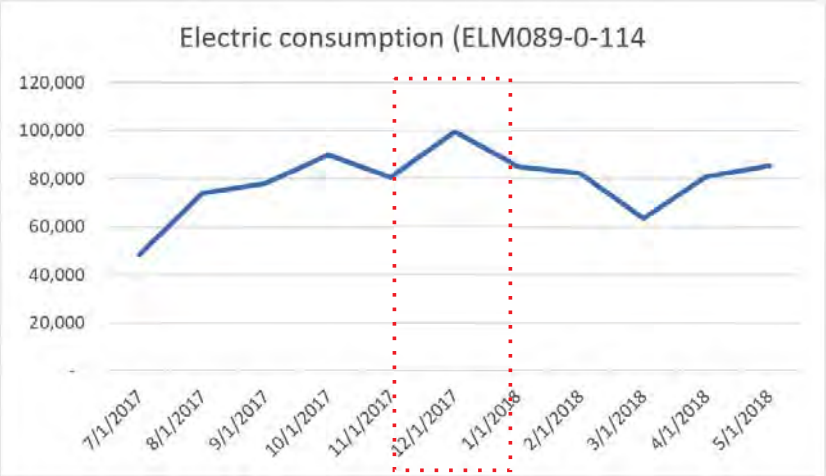
HOBO 4 INSTALLED ON MEZZANINE FLOOR OF WEIGHT ROOM



Observing the chart, during the morning the highest temperature reach around 72- 74 degree Fahrenheit which is in comfort zone.
The lowest temperature set back seems to be around 62 degree and the heating system might have turned on to get the comfort zone.
The peaks in the picture are from the sun during sunny morning as in HOBO 2.

HYPOTHESIS 1# The air - conditioner is operable in sunny morning in Winter.

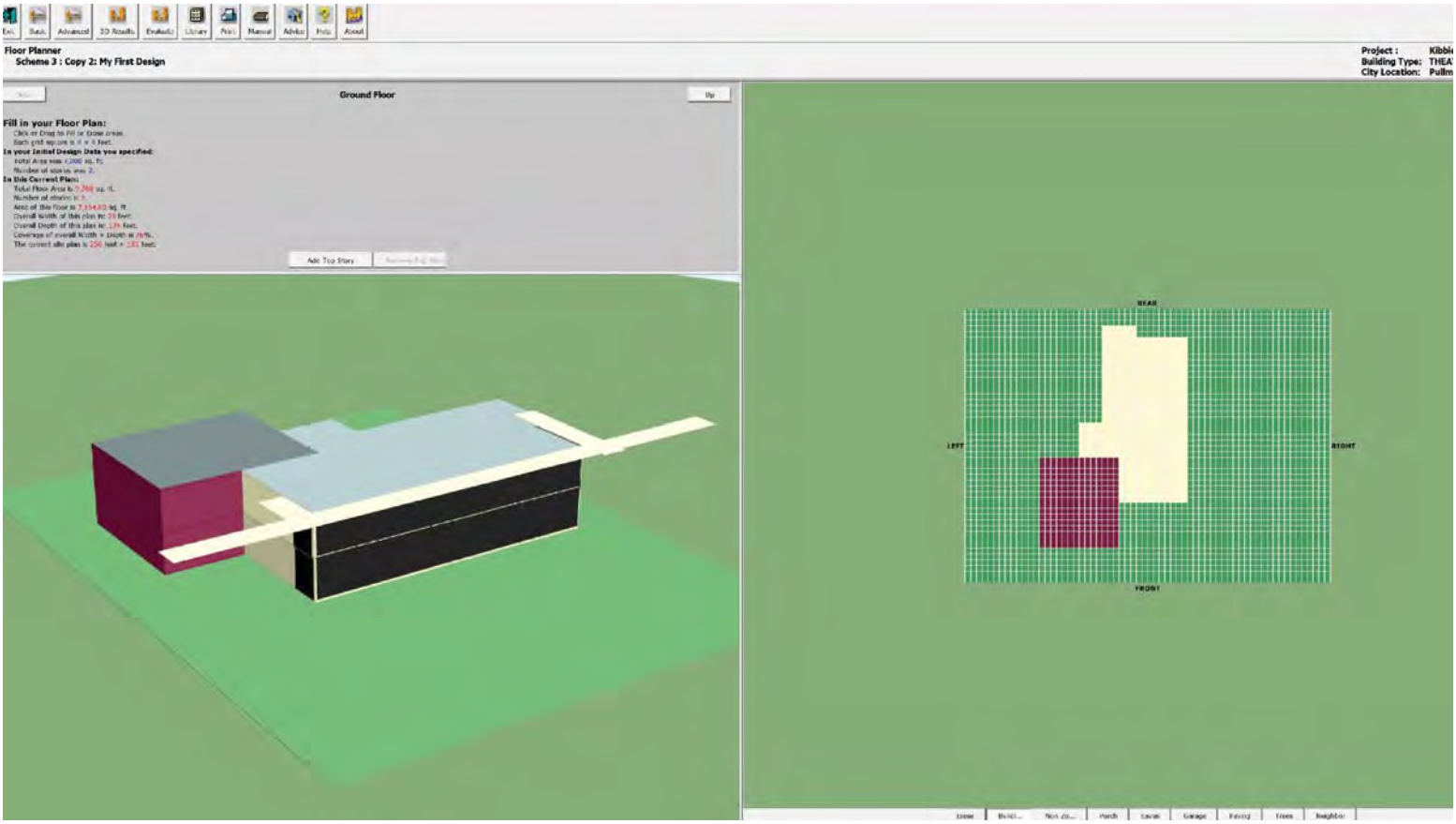
ELECTRIC CONSUMPTION IN DIFFERENT TIMES OF THE YEAR



The chart shows that the electric consumption is highest during the coldest month of the year I.e. December and January. It can be due to the HVAC systems running during this time of year .

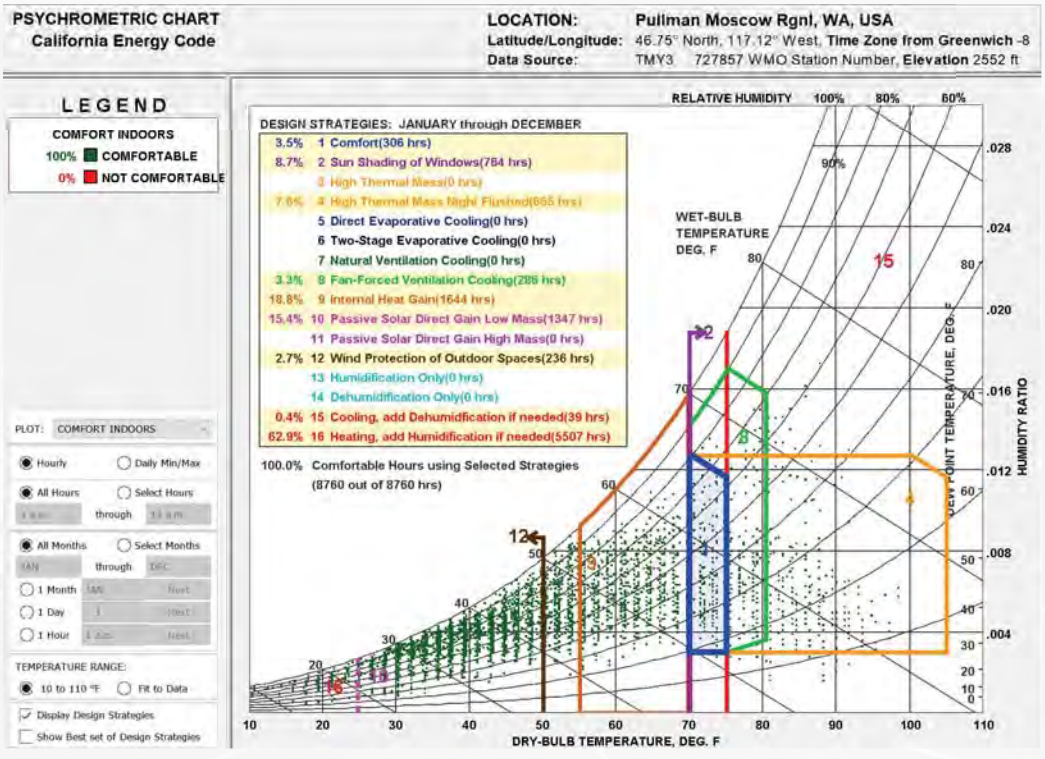
SBEED ANALYSIS

SBEED (Small Building Energy Efficient Design)



CLIMATE NEEDS

- Most of the passive design strategies for the Pullman/Moscow climate involve Heating
  - Internal Heat Gain (18.9%)
  - Passive Solar Direct Gain (15.4%)
  - Heating, add Humidification if needed (62.9%)
- Higher than average internal gains?
  - Users sweating and working out.
  - Temperature controlled pool.



RECOMMENDED STRATEGIES

- After modeling the Weight Room in SBEED, we can analyze each of the recommended design strategies to see how efficient the original designers planned the building.
- Top Design Guidelines:
  - Passive buildings have snug floorplan w/ central heat source, south facing windows, and roof pitched for protection.
  - Low mass lightly sealed, well insulated construction to provide rapid heat buildup in morning.
  - Winter sun penetrates daytime use spaces w/ specific functions that coincide with solar orientation.

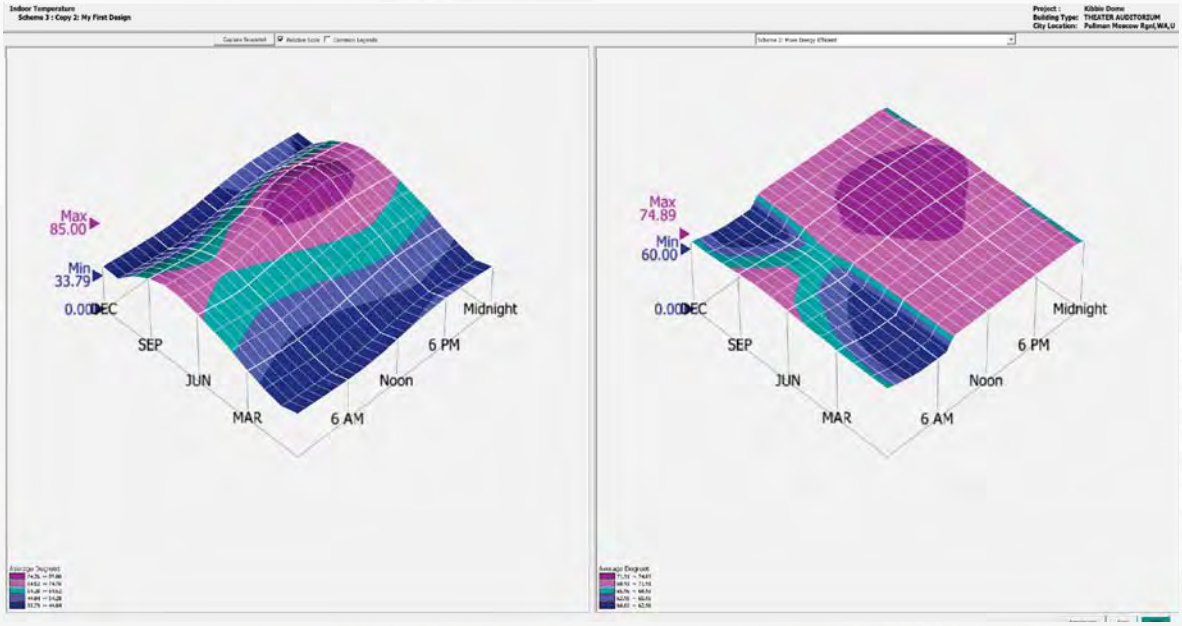
DESIGN GUIDELINES (for the Full Year)
California Energy Code
User Modified Design Strategies, Default Criteria

LOCATION: **Pullman Moscow Rgnl, WA, USA**
Latitude/Longitude: 46.75° North, 117.12° West. **Time Zone from Greenwich** -8
Data Source: TMY3 727857 WMO Station Number. **Elevation** 2552 ft

Assuming only the Design Strategies that were selected on the Psychrometric Chart, 100.0% of the hours will be Comfortable.
This list of Residential Design guidelines applies specifically to this particular climate, starting with the most important first.
Click on a Guideline to see a sketch of how this Design Guideline shapes building design (see Help).

19	For passive solar heating face most of the glass area south to maximize winter sun exposure, but design overhangs to fully shade in summer
20	Provide double pane high performance glazing (Low-E) on west, north, and east, but clear on south for maximum passive solar gain
3	Lower the indoor comfort temperature at night to reduce heating energy consumption (lower thermostat heating setback) (see comfort low criteria)
1	Tiles or slate (even on wood floors) or a stone-faced fireplace provides enough surface mass to store winter daytime solar gain and summer nighttime 'coolth'
18	Keep the building small (right-sized) because excessive floor area wastes heating and cooling energy
15	High Efficiency furnace (at least Energy Star) should prove cost effective
4	Extra insulation (super insulation) might prove cost effective, and will increase occupant comfort by keeping indoor temperatures more uniform
11	Heat gain from lights, people, and equipment greatly reduces heating needs so keep home tight, well insulated (to lower Balance Point temperature)
13	Steep pitched roof, with a vented attic over a well insulated ceiling, works well in cold climates (sheds rain and snow, and helps prevent ice dams)
8	Sunny wind-protected outdoor spaces can extend living areas in cool weather (seasonal sun rooms, enclosed patios, courtyards, or verandahs)
67	Traditional passive homes in cold clear climates had snug floorplan with central heat source, south facing windows, and roof pitched for wind protection
2	If a basement is used it must be at least 18 inches below frost line and insulated on the exterior (foam) or on the interior (fiberglass in furred wall)
16	Trees (neither conifer or deciduous) should not be planted in front of passive solar windows, but are OK beyond 45 degrees from each corner
14	Locate garages or storage areas on the side of the building facing the coldest wind to help insulate
63	Traditional passive homes in cool overcast climates used low mass lightly sealed, well insulated construction to provide rapid heat buildup in morning
31	Organize floorplan so winter sun penetrates into daytime use spaces with specific functions that coincide with solar orientation
23	Small well-insulated skylights (less than 3% of floor area in clear climates, 5% in overcast) reduce daytime lighting energy and cooling loads
22	Super tight buildings need a fan powered HRV or ERV (Heat or Energy Recovery Ventilator) to ensure indoor air quality while conserving energy
6	Exterior wind shields or dense planting can protect entries from cold winter winds (wing walls, wind breaks, fences, exterior structures, or land forms)
5	Carefully seal building to minimize infiltration and eliminate drafts, especially in windy sites (house wrap, weather stripping, tight windows)

STIMULATING INDOOR TEMPS



Indoor temperatures of building year-round:

Left side: Mechanical Heating and Cooling turned off

Compared with Right side: Mechanical Heating/Cooling turned on.

In comfort zone through much of the year (May – Oct)

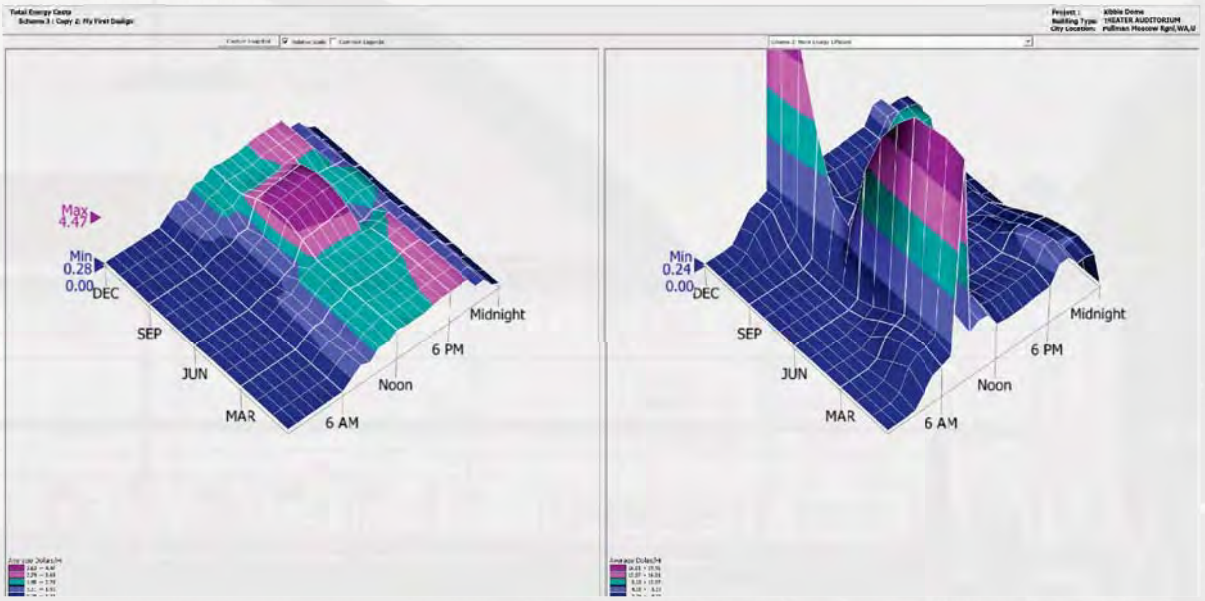
STIMULATING ENERGY COSTS

Energy Costs in Average Dollars per hour.

Left side: Mechanical Heating and Cooling turned off.

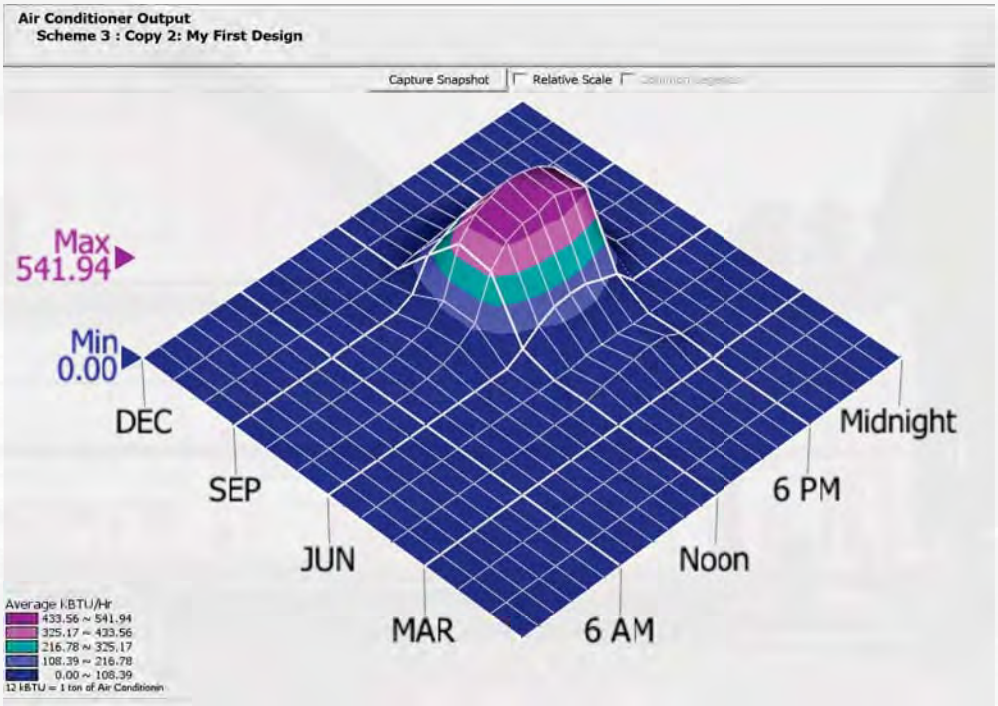
Compared with Right side: Mechanical Heating/Cooling turned on.

3-4 times higher energy costs running year round HVAC.



STIMULATING AIR CONDITIONER OUTPUT

- Isolating the air conditioning unit output for the building. As expected, the air conditioning is running through warmer summer months, with peak running time occurring from July through August with high output in the evenings.



HYPOTHESIS #1 RESULTS

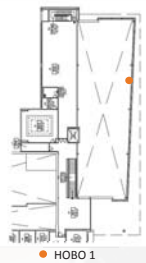
- Using the hobos and SBEED we found out some information we claimed that the air conditioner was being used during the sunny mornings in the winter we found out that early in the morning its actually quite cold so the heating system must be turned on so that it's a comfortable temp for the users we also noted that the electricity's highest use was during the winter which makes sense. Looking at SBEED it also confirmed the fact that the winter mornings are being used for heating.
- So in conclusion we were wrong about our hypothesis

HYPOTHESIS 2. The blinds are consistently used in the morning.

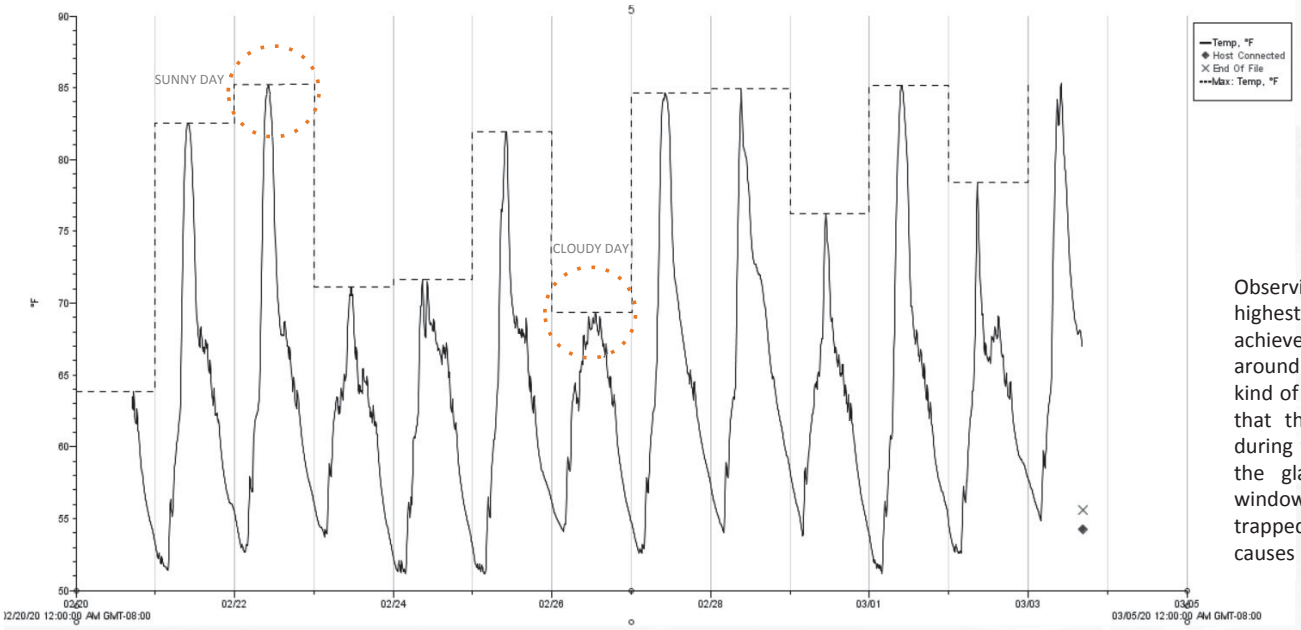
METHODOLOGY

1) ANALYSIS OF HOBO ON EAST AND SOUTH FACING WINDOW.
2) SEFAIRA ANALYSIS
3) GLARE ANALYSIS

HYPOTHESIS 2# The blinds are consistently used in the morning.

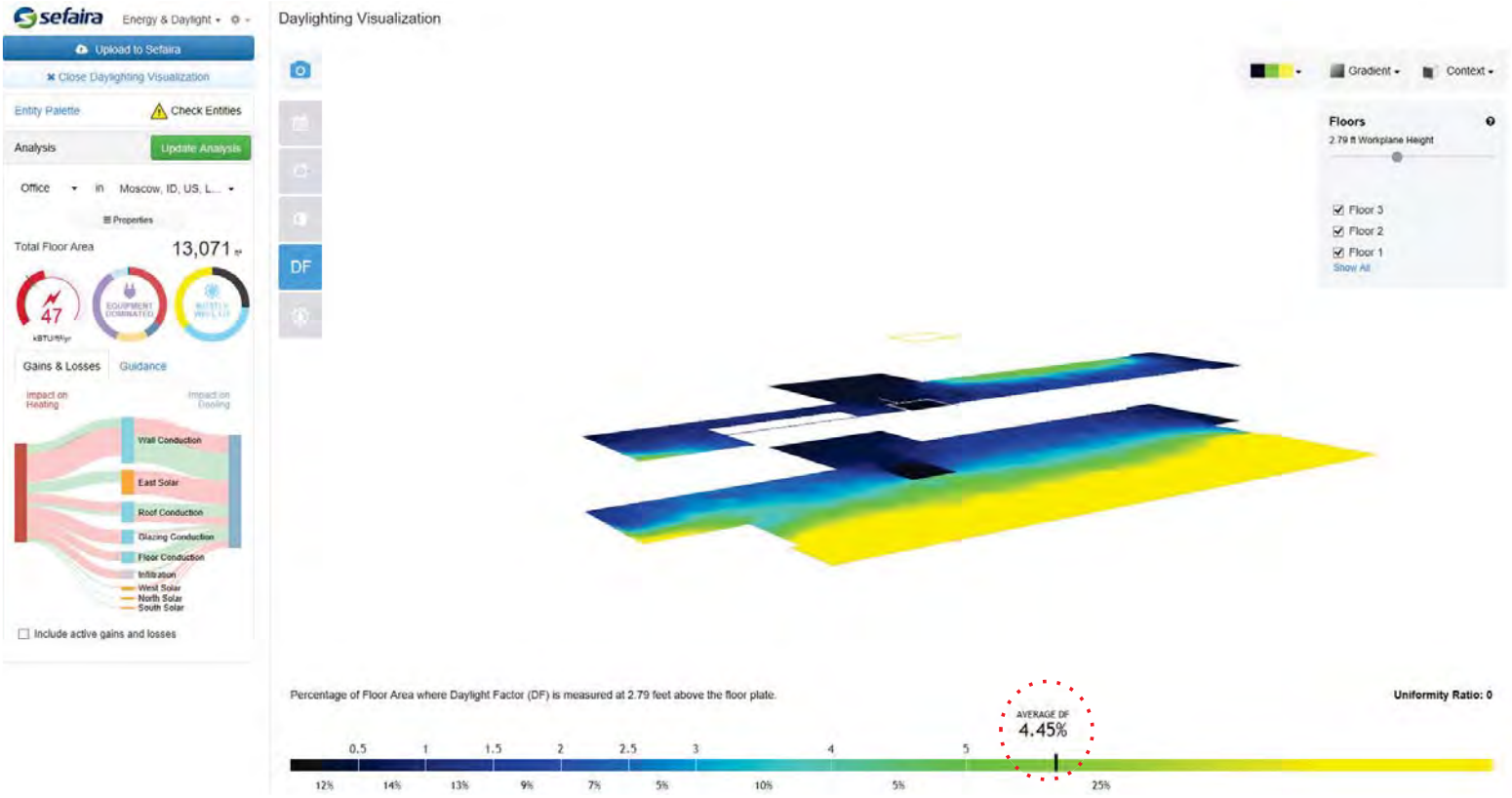


HOBO 1 INSTALLED ON EAST WINDOW



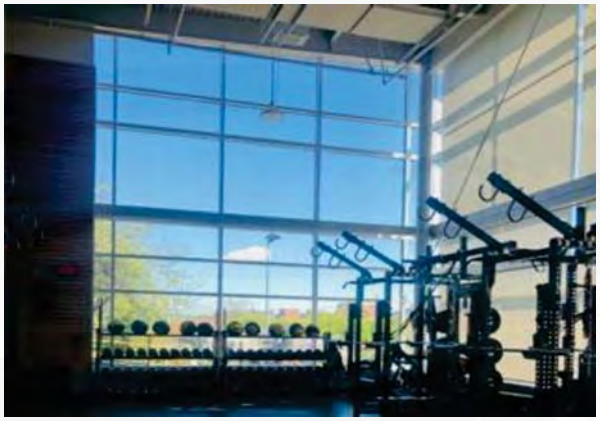
Observing the chart, the highest temperature achieved before noon i.e. around 10 am to noon. This kind of gives a general idea that the blinds are down during this time to prevent the glare from the East windows. And the heat trapped between the blinds causes rise in temperature.

SEFAIRA ANALYSIS

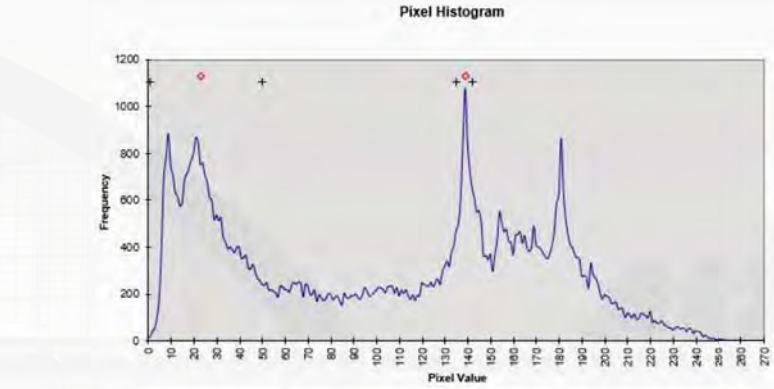


GLARE ANALYSIS

1) VIEW 1 FACING NORTH FACING WINDOW (CLOUDY DAY & SUNNY DAY)
2) VIEW 2 FACING EAST FACING WINDOW (CLOUDY DAY & SUNNY DAY)
3) VIEW 3 FACING SOUTH FACING WINDOW (CLOUDY DAY & SUNNY DAY)

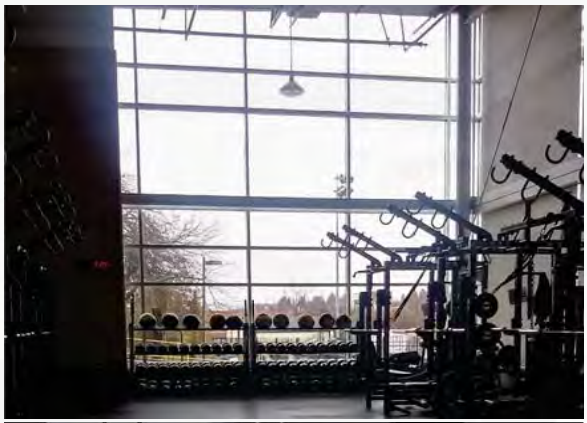


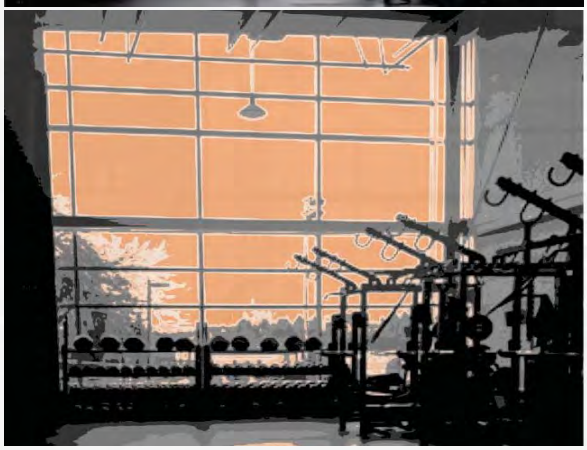
GLARE ANALYSIS #1 Facing North Window (Sunny day 10:00am)



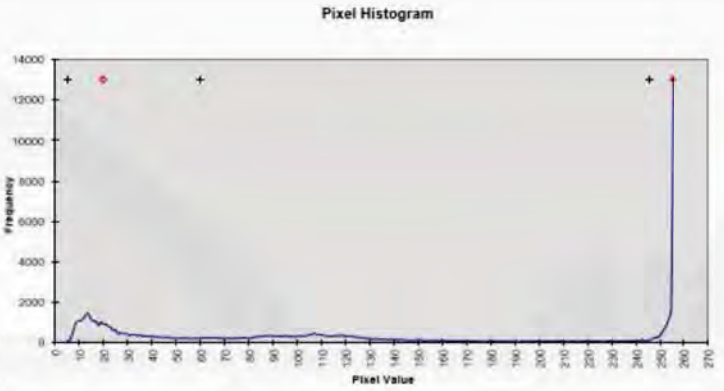
Overall Image		Indiviual Pixel		
Weighted Ave Pixel Intensity	122.24	Individual Pixel Value	130	
Total Number of Pixels	76800	Corresponding Luminance	407.50	footlamberts
Background Bell Curve		**Spike**		
Low End Pixel Value	1	Low End Pixel Value	135	
High End Pixel Value	50	High End Pixel Value	142	
Background Median Value	23	Spike Median Value	139	
Number of Background Pixels	24925	Number of Spike Pixels	5730	
Background Percentage of View	32.45 %	Spike Percentage of View	7.46 %	

Spike to Background Ratio	
Median Spike to Median Background	6.04 TO 1
Schiler Glare ?	YES



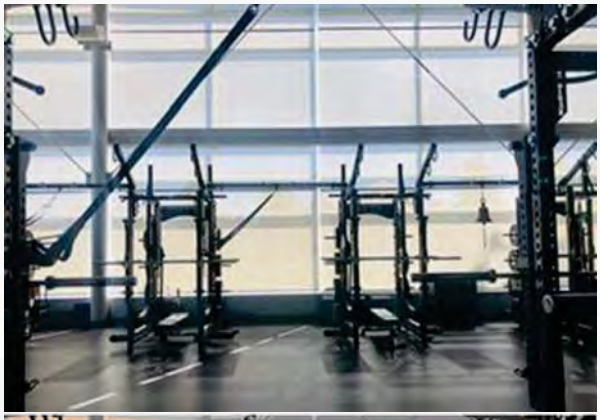


GLARE ANALYSIS #2 Facing North Window (Cloudy day 03:15pm)

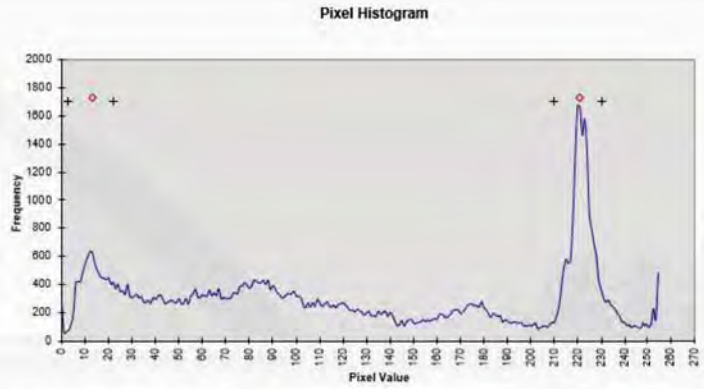


Overall Image		Indiviual Pixel		
Weighted Ave Pixel Intensity	139.13	Individual Pixel Value	130	
Total Number of Pixels	76800	Corresponding Luminance	343.29	footlamberts
Background Bell Curve		**Spike**		
Low End Pixel Value	5	Low End Pixel Value	245	
High End Pixel Value	60	High End Pixel Value	255	
Background Median Value	20	Spike Median Value	255	
Number of Background Pixels	28433	Number of Spike Pixels	18725	
Background Percentage of Vie	37.02 %	Spike Percentage of View	24.38 %	

Spike to Background Ratio	
Median Spike to Median Background	12.75 TO 1
Schiler Glare ?	YES



GLARE ANALYSIS #3 Facing East Window (Sunny day 10:00am)



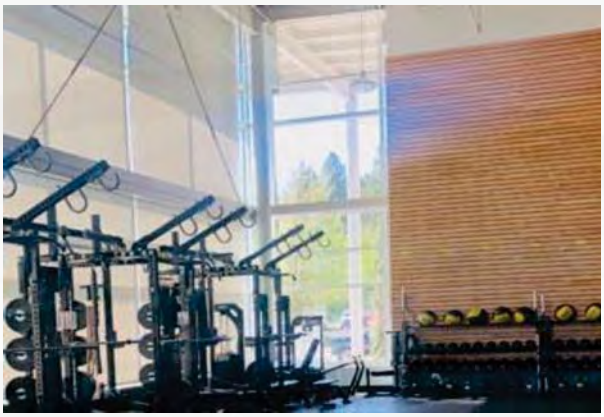
Overall Image		Indiviual Pixel		
Weighted Ave Pixel Intensity	146.16	Individual Pixel Value	130	
Total Number of Pixels	76800	Corresponding Luminance	366.25	footlamberts
Background Bell Curve		**Spike**		
Low End Pixel Value	3	Low End Pixel Value	210	
High End Pixel Value	22	High End Pixel Value	230	
Background Median Value	13	Spike Median Value	221	
Number of Background Pixels	8697	Number of Spike Pixels	16857	
Background Percentage of Vie	11.32 %	Spike Percentage of View	21.95 %	

Spike to Background Ratio	
Median Spike to Median Background	17.00 TO 1
Schiler Glare ?	YES

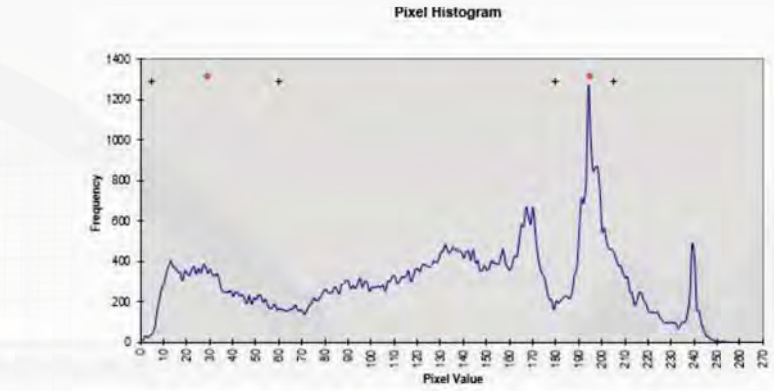
GLARE ANALYSIS #4 Facing East Window (Cloudy day 03:15pm)

Overall Image		Indiviual Pixel		
Weighted Ave Pixel Intensity	102.49	Individual Pixel Value	130	
Total Number of Pixels	76800	Corresponding Luminance	3.55	footlamberts
Background Bell Curve		**Spike**		
Low End Pixel Value	211	Low End Pixel Value	6	
High End Pixel Value	255	High End Pixel Value	13	
Background Median Value	227	Spike Median Value	11	
Number of Background Pixels	11437	Number of Spike Pixels	8535	
Background Percentage of Vie	14.89 %	Spike Percentage of View	11.11 %	

Spike to Background Ratio	
Median Spike to Median Background	0.05 TO 1
Schiler Glare ?	NO

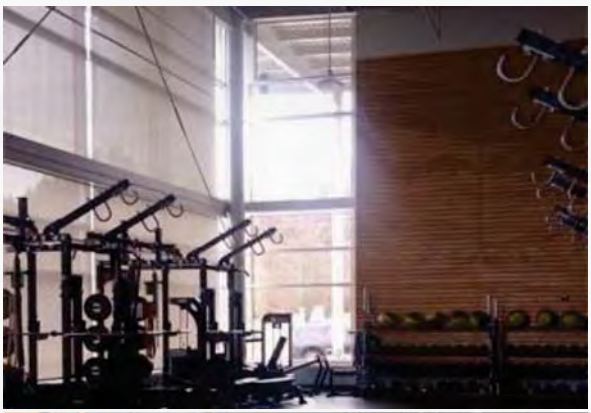


GLARE ANALYSIS #5 Facing South Window (Sunny day 10:00am)

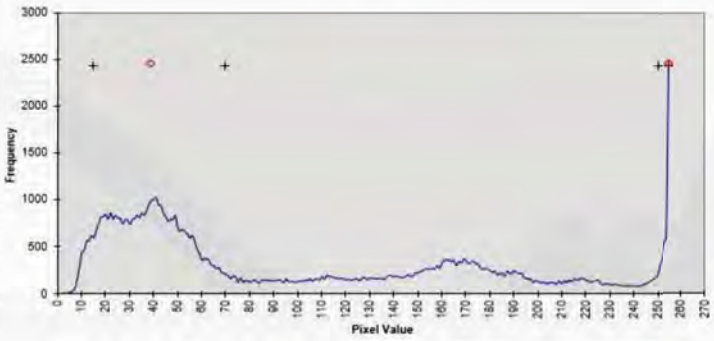


Overall Image		Indivisual Pixel	
Weighted Ave Pixel Intensity	152.71	Individual Pixel Value	130
Total Number of Pixels	76800	Corresponding Luminance	369.13 footlamberts
Background Bell Curve		**Spike**	
Low End Pixel Value	5	Low End Pixel Value	180
High End Pixel Value	60	High End Pixel Value	205
Background Median Value	29	Spike Median Value	195
Number of Background Pixel	15115	Number of Spike Pixels	13770
Background Percentage of V	19.68 %	Spike Percentage of View	17.93 %

Spike to Background Ratio
Median Spike to Median Background 6.72 TO 1
Schiler Glare ? YES



GLARE ANALYSIS #6 Facing South Window (Cloudy day 03:15pm)



Overall Image		Indivisual Pixel	
Weighted Ave Pixel Intensity	115.26	Individual Pixel Value	130
Total Number of Pixels	76800	Corresponding Luminance	3.26 footlamberts
Background Bell Curve		**Spike**	
Low End Pixel Value	15	Low End Pixel Value	250
High End Pixel Value	70	High End Pixel Value	255
Background Median Value	39	Spike Median Value	255
Number of Background Pixels	38092	Number of Spike Pixels	4456
Background Percentage of Vie	49.60 %	Spike Percentage of View	5.80 %

Spike to Background Ratio
Median Spike to Median Background 6.54 TO 1
Schiler Glare ? YES

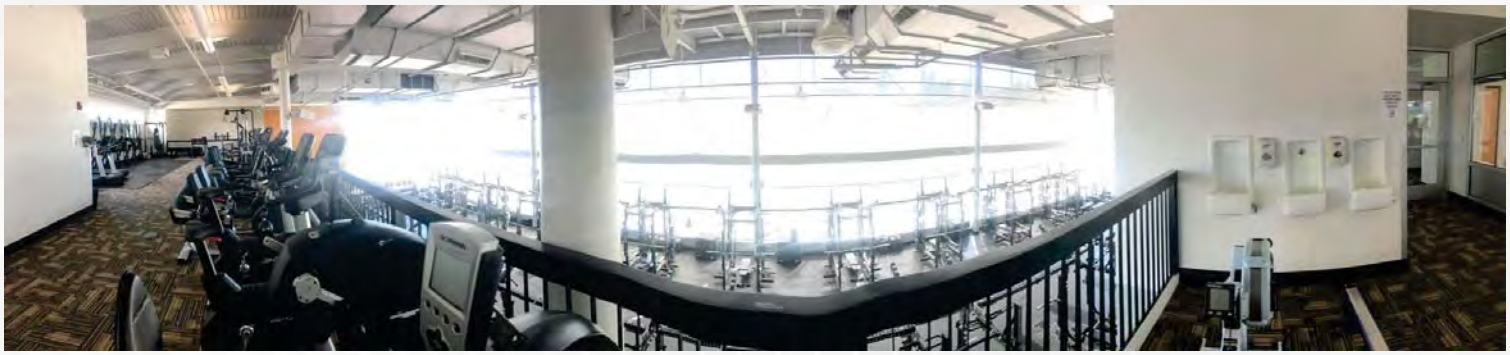
HYPOTHESIS #2 RESULTS

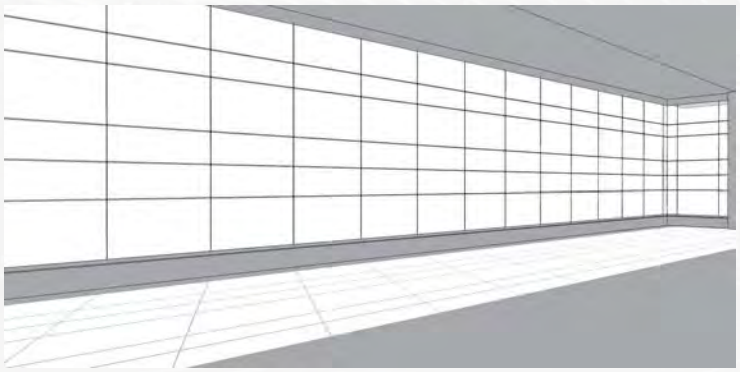
- Using glare analysis, we found out that the East facing windows are creating GLARE in early mornings and the blinds are pulled down to prevent it from the glare (analyzed by the HOBO data as the heat is trapped in the mornings while the blinds are down).
- In conclusion we were RIGHT about our hypothesis

FIXING THE ISSUE (STRATEGIES)

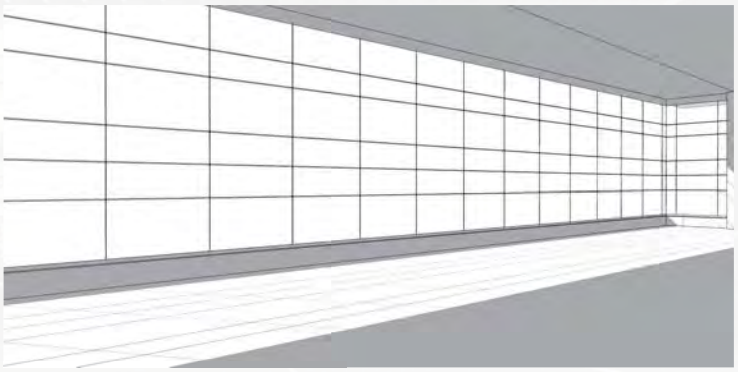
- The Light shelf
- Vertical Shading devices

EXISTING NATURAL LIGHT CONDITIONS



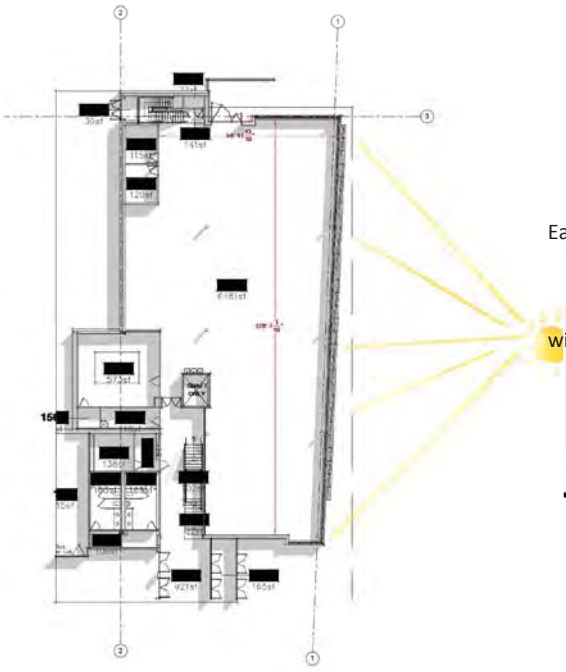


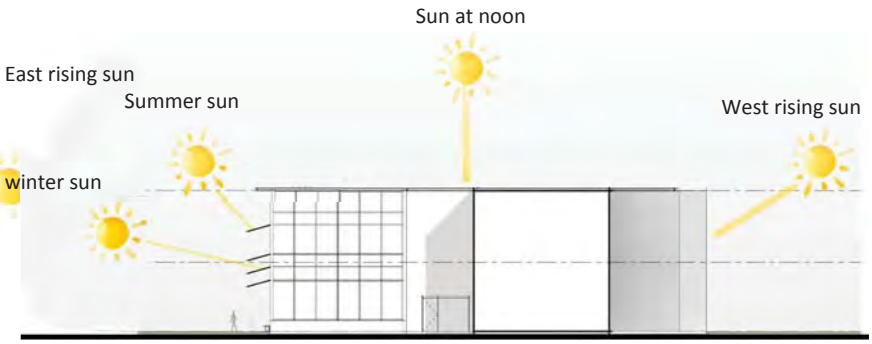
DECEMBER 21 9AM



JUNE 21 9AM

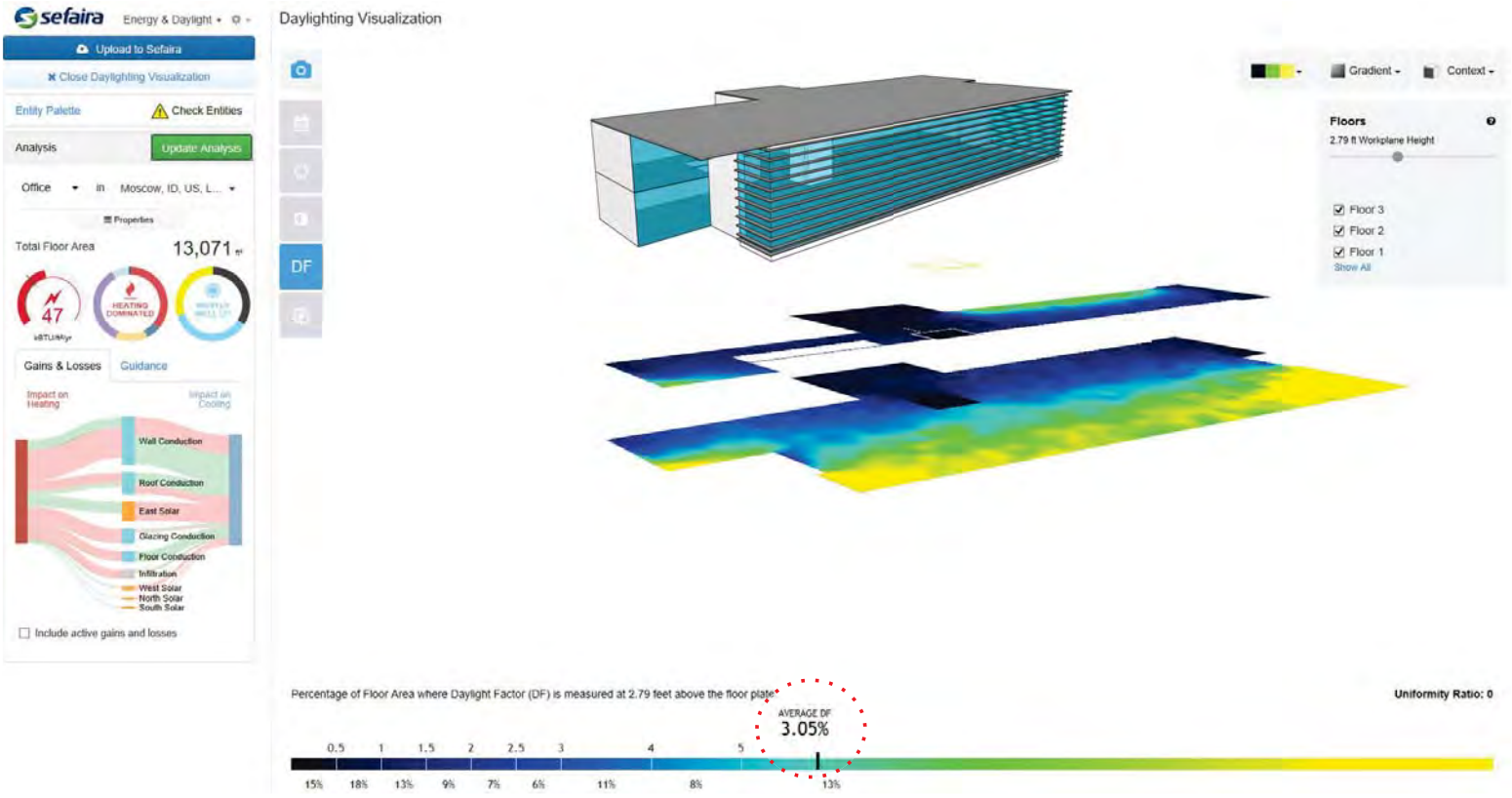
EXPERIMENT WITH HORIZONTAL FINS



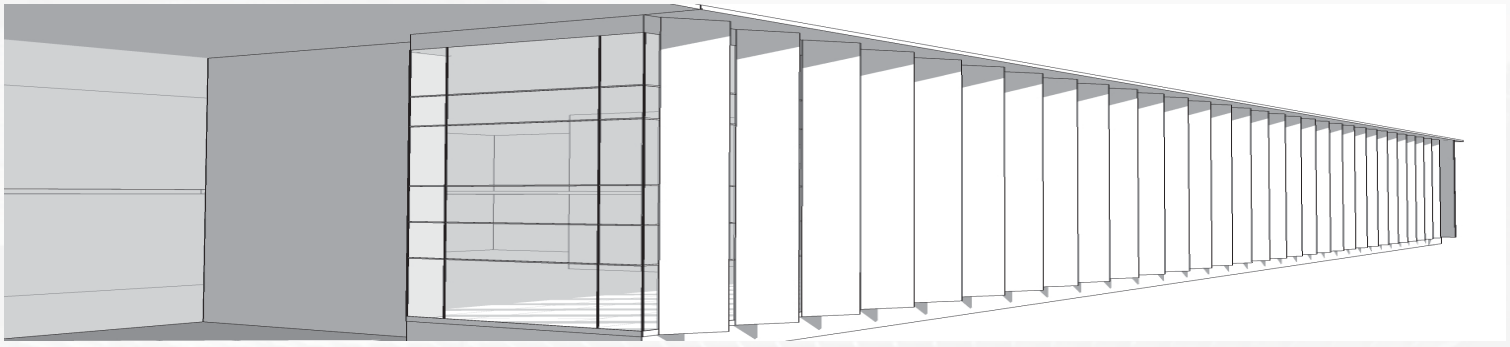


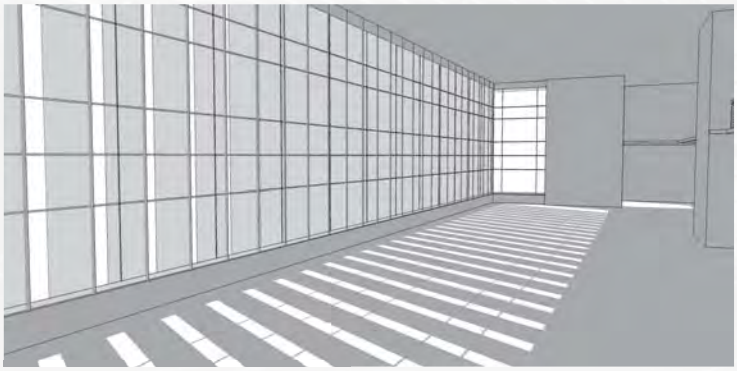
Horizontal Shading device

Horizontal shading devices can be installed on the mullions at the East side the re-radiate the sun rays from entering the building interior.

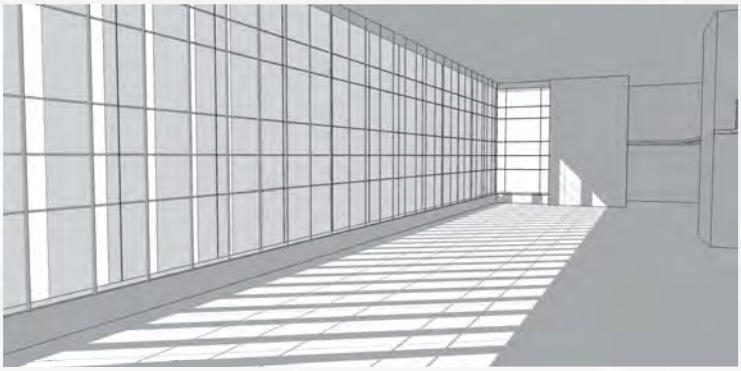


EXPERIMENT WITH VERTICAL FINS



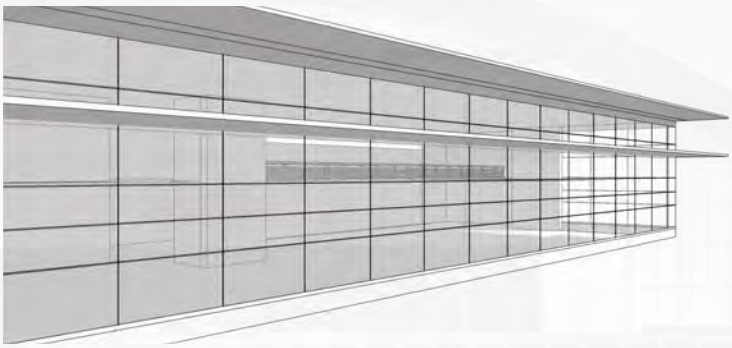


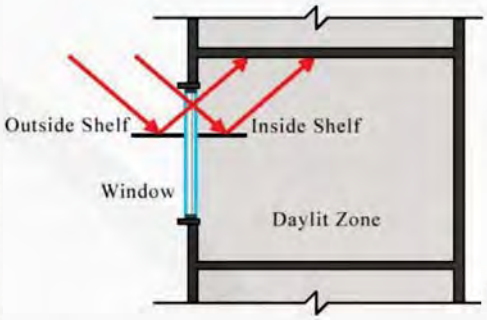
DECEMBER 21 9AM



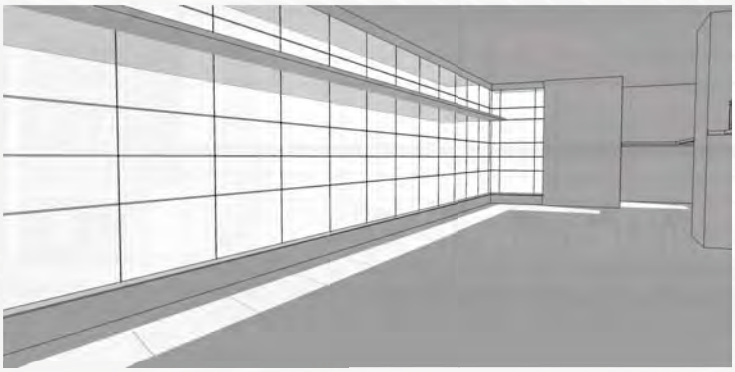
JUNE 21 9AM

EXPERIMENT WITH LIGHT SHELF

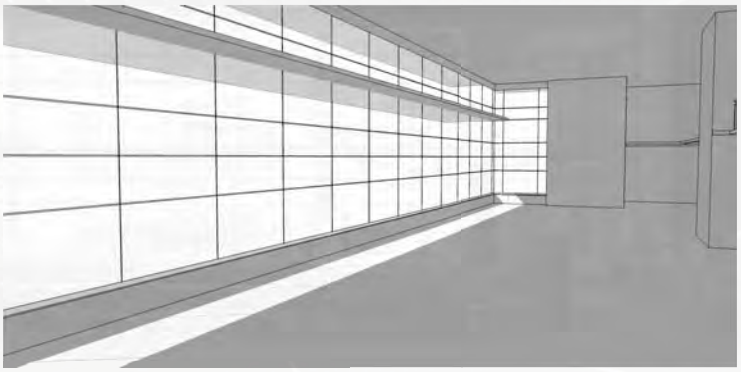




The use of light shelf helps to direct the sunrays towards the ceiling and enable diffusion of natural light along with shading from the direct sunrays.



DECEMBER 21 9AM



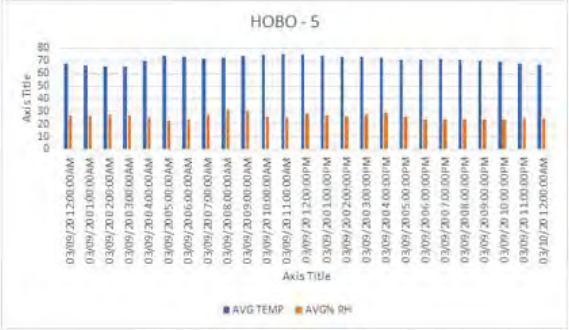
JUNE 21 9AM

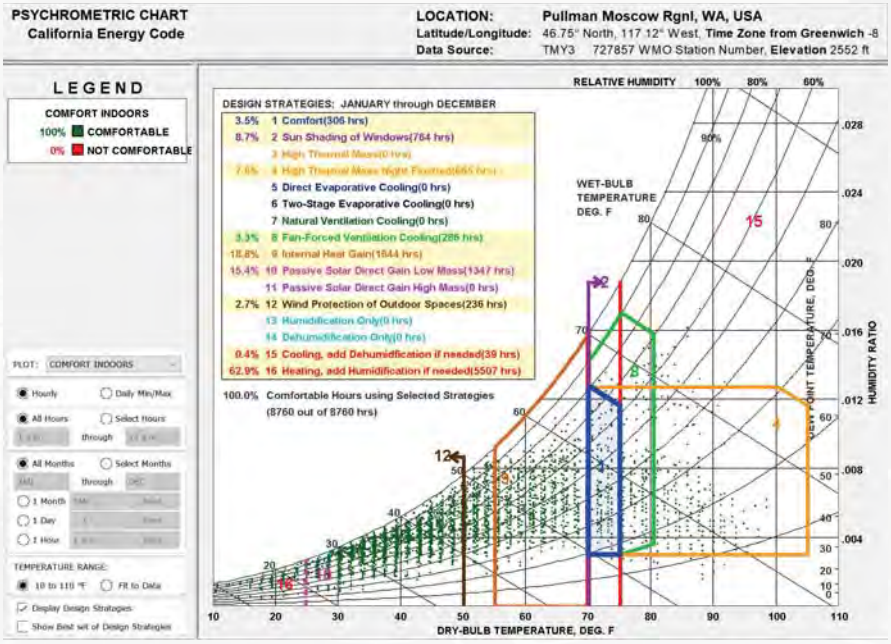
HYPOTHESIS 3 Pool causes humidity in air

METHODOLOGY

1) ANALYSIS OF HOBO ON FIRST FLOOR AND MEZZANINE FLOOR.

MEASURING THE WATER CONTENT IN AIR





- Using our HOBO data (RH and Temp) in conjunction with the Moscow/Pullman Psychrometric chart we can determine amount of water content in the air (in grains of moisture) near the recovery pool and compare to the air on the first floor (below mezzanine).
- This can tell us about air character of the mezzanine floor and how it might affect the comfortability and temperature of the space.

THE PLAN

HOBO 2 data (first floor air) water content

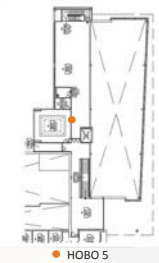
HOBO 5 data (pool air) water content

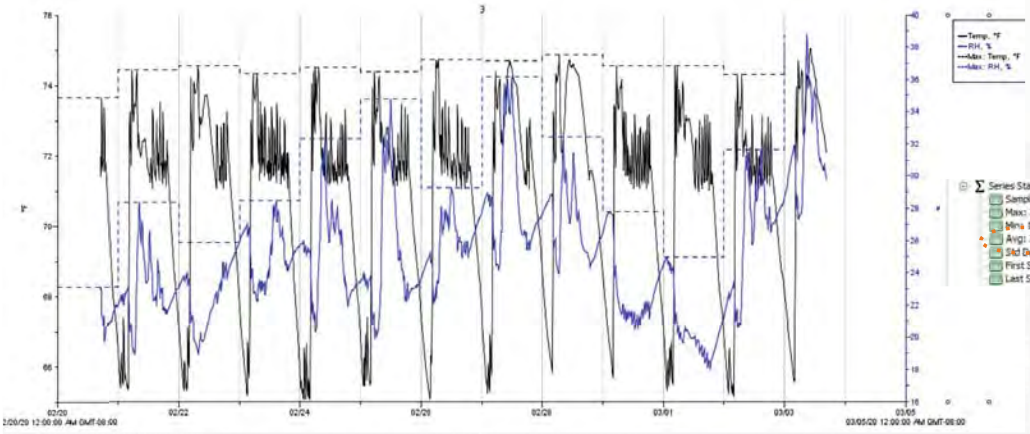
HOBO 4 data (near pool air) water content

Comparing the water content levels in the air

HYPOTHESIS 3# Pool causes humidity

HOBO 5 INSTALLED NEAR THE POOL





-Measurements of the Temp and Relative Humidity of the air near the recovery pool for the period of Feb 20-March 5

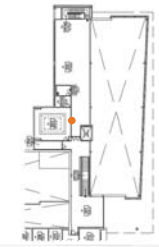
-We can observe an average temp of **70.8** degrees F and an average RH of **25.0 %**

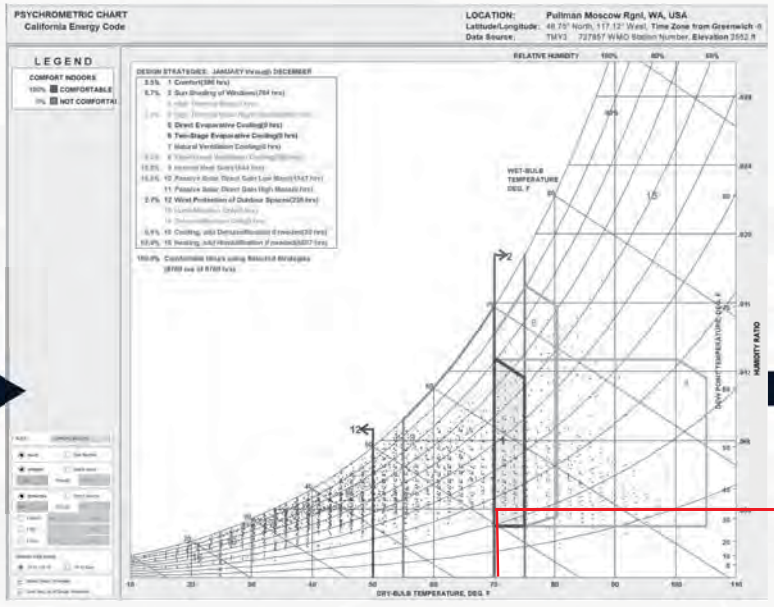
HOBO 5 – Installed near the pool

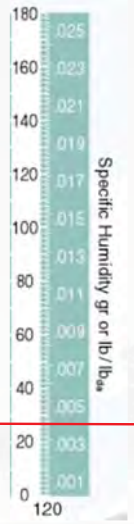
CONVERT TO GRAINS OF MOISTURE

-Measurements of the Temp and Relative Humidity of the air near the recovery pool for the period of Feb 20-March 5

-We can observe an average temp of **70.8** degrees F and an average RH of **20.0 %**



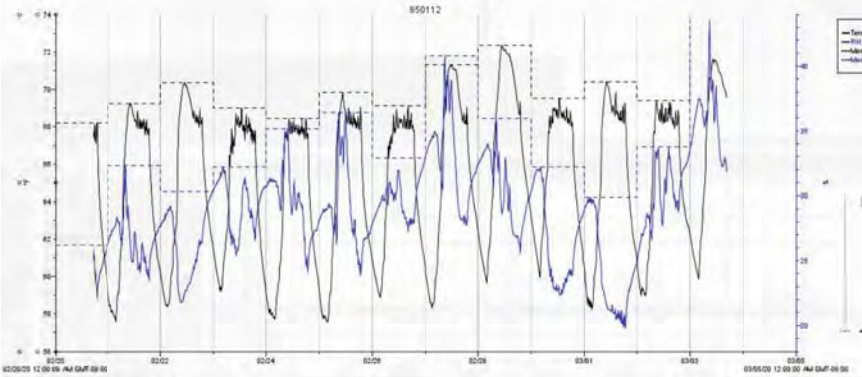


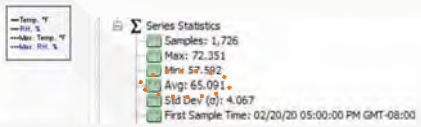


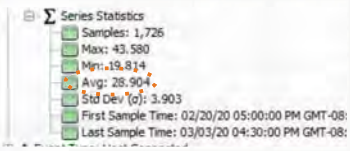
Comes out to be an air water content measurement of ~ **25 gr**

HYPOTHESIS #3 Pool causes humidity

HOBO 2 INSTALLED ON GROUND FLOOR





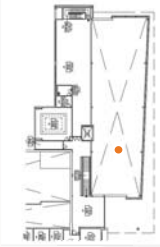


-Measurements of the Temp and Relative Humidity of the air near the recovery pool for the period of Feb 20-March 5

-We can observe an **average temp of 65.1 degrees** and an **average RH of 28.9 %**

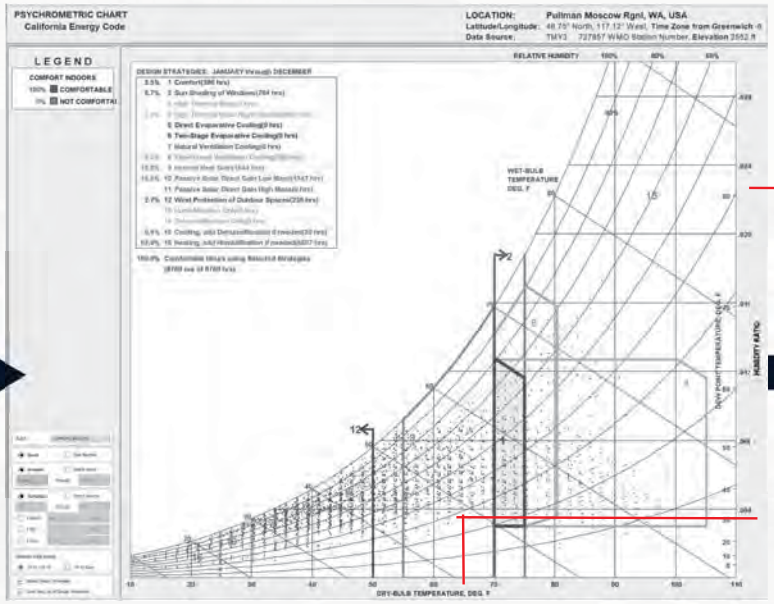
HOBO 2 – Installed on first floor

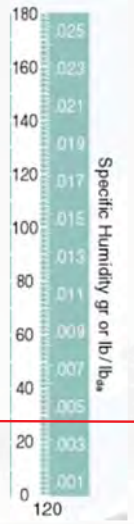
CONVERT TO GRAINS OF MOISTURE



-Measurements of the Temp and Relative Humidity of the air near the recovery pool for the period of Feb 20-March 5

-We can observe an **average temp of 65.1 degrees** and an **average RH of 28.9 %**

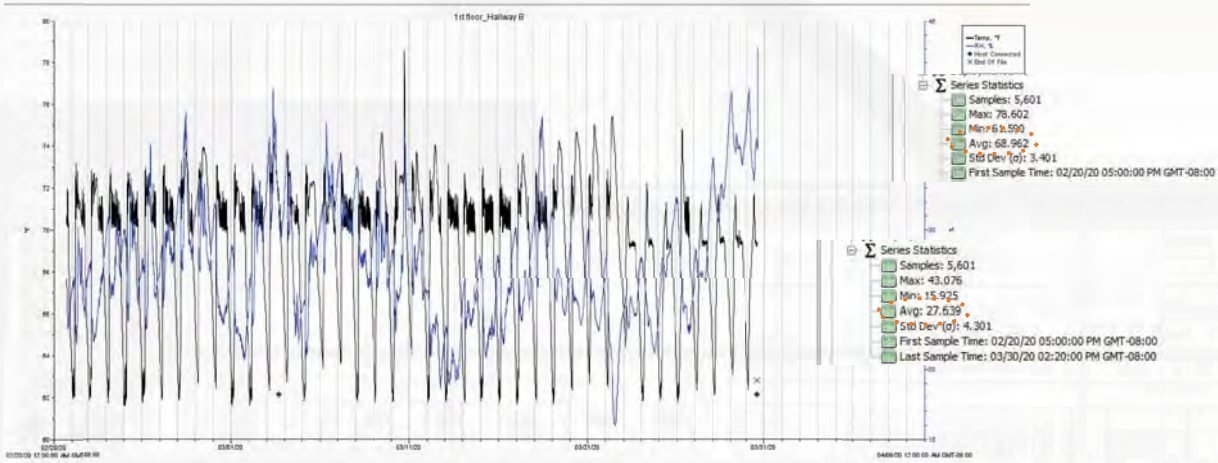




Comes out to be an air water content measurement of **~21 grains** of moisture

HYPOTHESIS 3# Pool causes humidity

HOBO 4 - INSTALLED NEAR HOBO 5



-Measurements of the Temp and Relative Humidity of the air near the recovery pool for the period of Feb 20-March 5

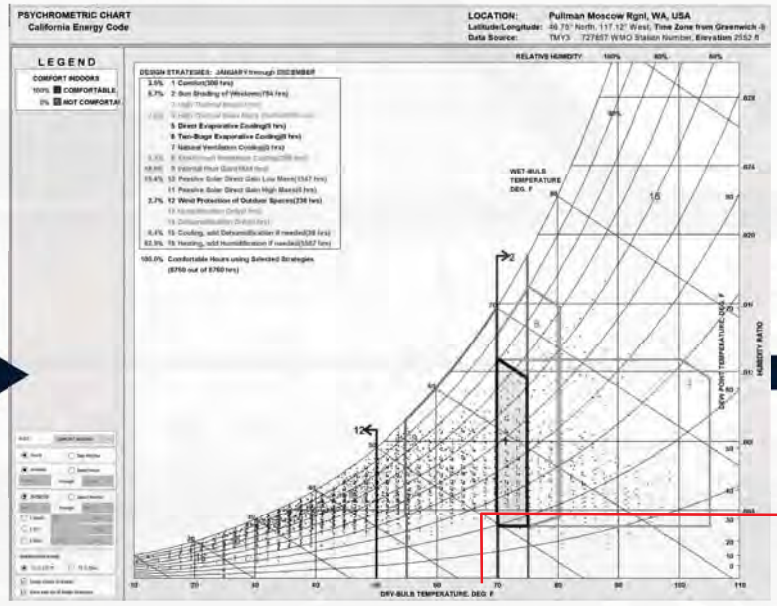
-We can observe an **average temp of 68.9 degrees** and an **average RH of 27.6 %**

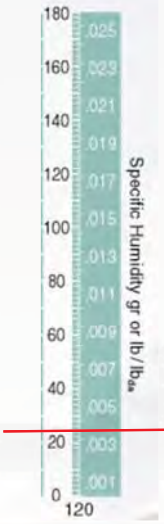
HOBO 4 – Installed near HOBO 5

CONVERT TO GRAINS OF MOISTURE

-Measurements of the Temp and Relative Humidity of the air near the recovery pool for the period of Feb 20-March 5

-We can observe an **average temp of 68.9 degrees** and an **average RH of 27.6 %**

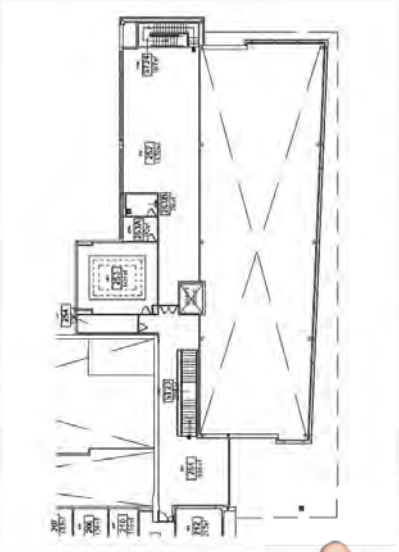




Comes out to be an air water content measurement of **~24 grains** of moisture

HYPOTHESIS #3 RESULTS

HOBO 5 air/water content	HOBO 4 air/water content	HOBO 2 air/water content
~25 gr	~24 gr	~21 gr



As expected, HOBO 5 (the one near the pool) seems to have a higher air moisture measurement at **~25 gr,** HOBO 4 (the one near HOBO 5) has a slightly lower measurement at ~24 gr, which is quite higher than HOBO 2 (the one on the ground floor) at **~21 gr**.

OUTCOMES Results from the 3 Hypotheses.

HYPOTHESIS

1) THE AIR CONDITIONER IS OPERABLE DURING SUNNY WINTER MORNINGS. ✗
2) THE BLINDS ARE CONSISTENTLY USED IN THE MORNING ✓
3) THE POOL CAUSES A HIGHER MOISTER CONTENT IN THE AIR ✓

CONCLUSION & LESSONS LEARNED

Hypothesis #1 – The air conditioner is running in the winter-time.

-Through our data and observations, we determine that the air conditioner is not needed in the winter and is not running during the cold months. Most of the passive strategies should be focused toward efficiently heating the space. If cooling is needed/desired in the winter, some possible options include adding operable windows in strategic locations to cut down on energy consumption.

Hypothesis #2 – The blinds/internal shaders are consistently used during the morning.

-In analyzing the daylight of our building, we can see that the internal blinds are a less ideal way of dealing with natural light of the spaces due to the potential of over lit and glared spaces, while not allowing the full solar gain to heat the space in the morning. Through our simulations, and design experimentations, we suggest that a redesign of a new shading scheme in which light shelves and physical shaders will achieve a more efficient light levels and gains, reducing glare.

Hypothesis #3 – The recovery pool causes more moisture in the air.

-This is correct through our HOBO measurements. The overall water content in the air may contribute to the comfortability of the space, providing a gradient of changing environments the closer the users physically get to the pool.

THANKS FOR A GREAT SEMESTER, BRUCE!