

# HORIZON

“A DAYLIGHTED ROOM” CASE STUDY

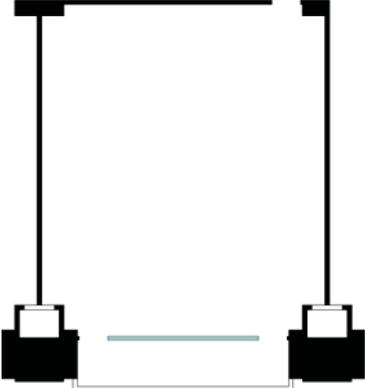
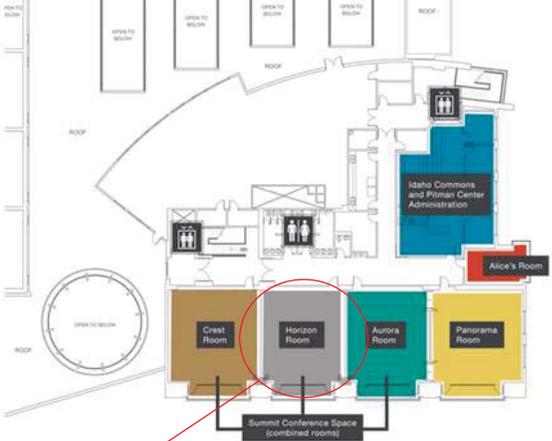
CHASE MACAW  
ANDRES ROJO  
ADAM HARFMANN



## [ CASE STUDY ]



University of Idaho Commons  
4th Floor - Horizon Room



# [ HORIZON ROOM ]

## GENERAL BUILDING DESCRIPTION

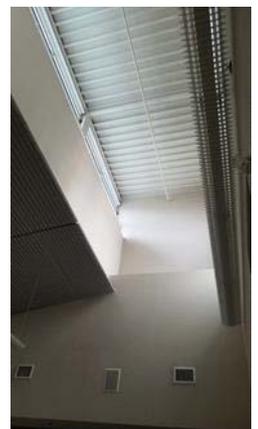
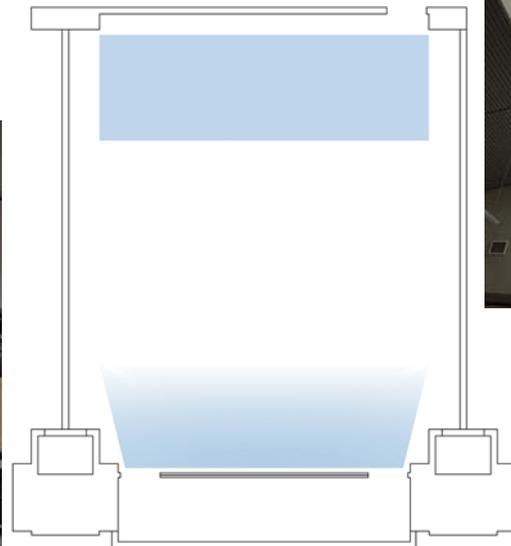
- The Horizon Room is located in the Idaho Commons on 4<sup>th</sup> floor.
- With 1013 square/feet this room is used for meeting/conference and has a room capacity of 60 people with the option of expanding the room size.
- The room has light monitor windows on the East and West side.
- Its equip with mechanical shading devices.
- Has adjustable lighting.



# [ PERFORMANCE ANALYSIS ]

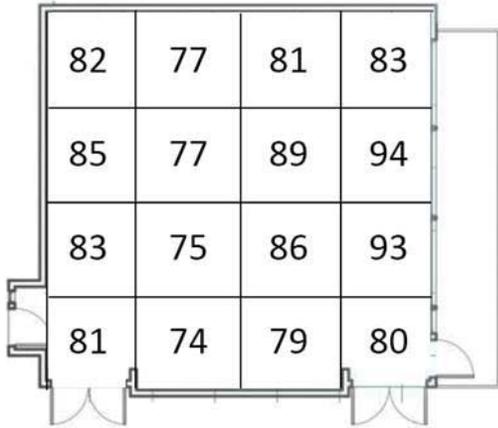
## DAYLIGHTING PLAN:

- Has light monitor windows that allows light to enter from the east and west direction.
- Curtain wall allows light from the east direction to enter.
- Mechanical shading device
- Curvilinear ceiling that arrays the light to reflect off.

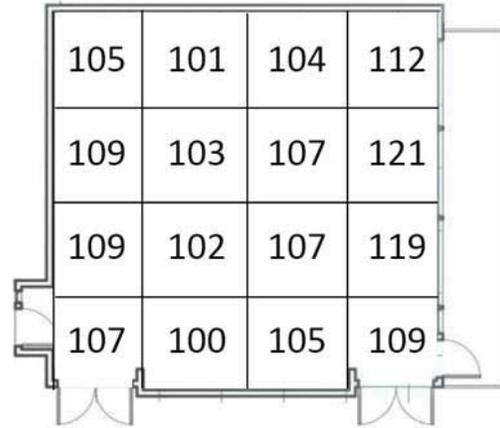


# [ PERFORMANCE ANALYSIS ] A.1

## Lighting Sweep of Horizon Room

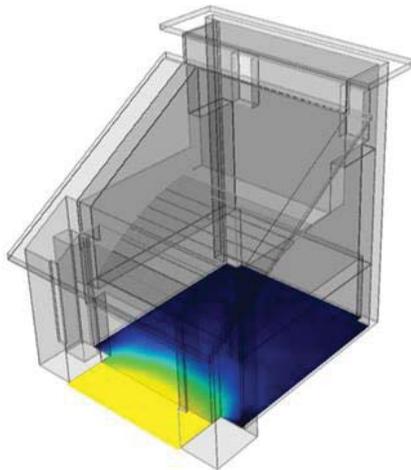


Daytime (Lights Off)  
On)



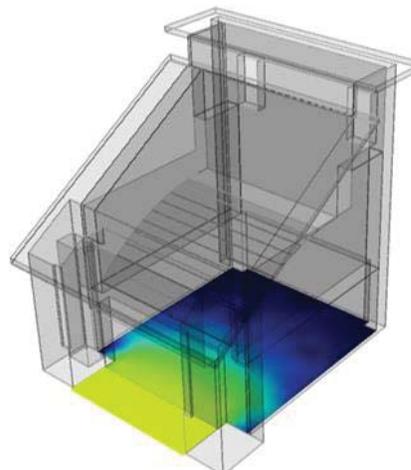
Daytime (Lights On)

# [ PERFORMANCE ANALYSIS ] A.4



### DAYLIGHT FACTOR

The average indoor illuminance is 5.79% of the average outdoor illuminance under an overcast sky.

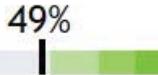
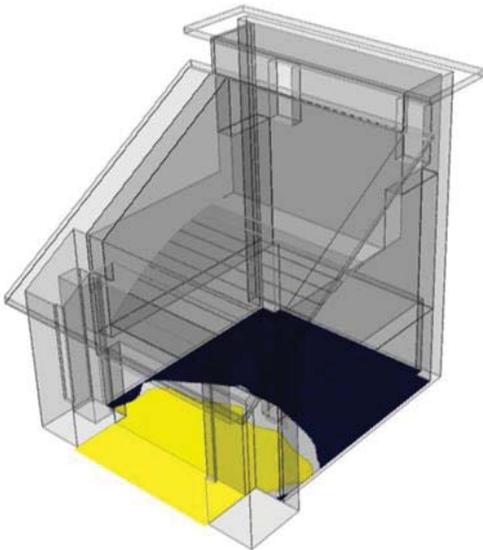


### ANNUAL ILLUMINANCE

Representation of the occupied hours where illuminance is at least 37 footcandles - the minimum illuminance for a school/office setting.



# [ PERFORMANCE ANALYSIS ] A.4



SPATIAL DAYLIGHT AUTONOMY

Percentage of the space that receives sufficient daylighting



ANNUAL SUN EXPOSURE

Percentage of the space that receives too much direct sunlight

A	B	C	D	E	F	G	H	I	J	K	L	M
ENERGY SAVINGS DUE TO DAYLIGHTING												
(Based on Selkowitz, S. and Gabel, M., 1984, "LBL Daylighting Nomographs," LBL report 12534, Berkeley, CA, Lawrence Berkeley Laboratory.)												
Spreadsheet by Fuller Moore, Architecture Department, Maine University, Oxford OH 45056 (jmoore@maine.edu)												
1	2	3	4	5	6	7	8	9	10	11	12	13
14	15	16	17	18	19	20	21	22	23	24	25	26
27	28	29	30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49	50	51	52
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# [ PERFORMANCE ANALYSIS ] B.1

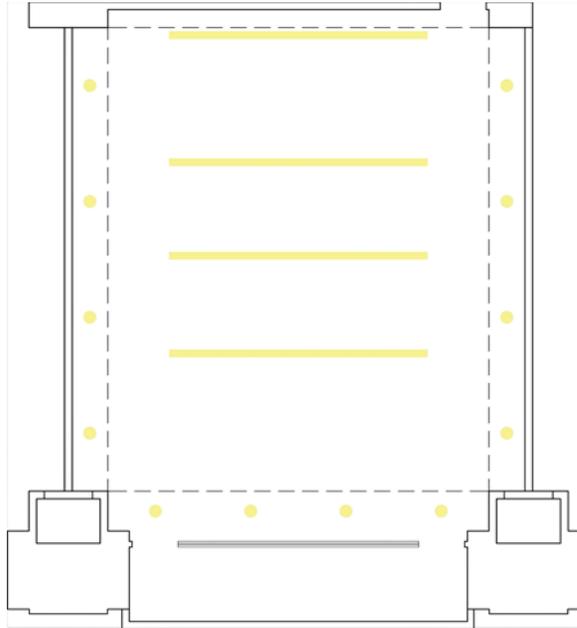
## ELECTRICAL LIGHTING SCHEME

### Fluorescent Lighting

- 12 Bulbs and 13 Tubes
- 40 watts/bulbs
- \$ 5 Bulb/ \$ 3 a Tube
- 1120 hours/year
- 1,412.4 kWh/year
- \$ 7.92 kWh/bulb
- 23,725 hours / bulb
- \$126.72 / yearly cost

### Lights Turned Off With Adequate Daylight:

- 560 hours/year
- 706.2 kWh/year
- \$7.92 kWh/bulb
- 11,862.5 hours / bulb
- \$63.36 / yearly cost
- About 50% savings!



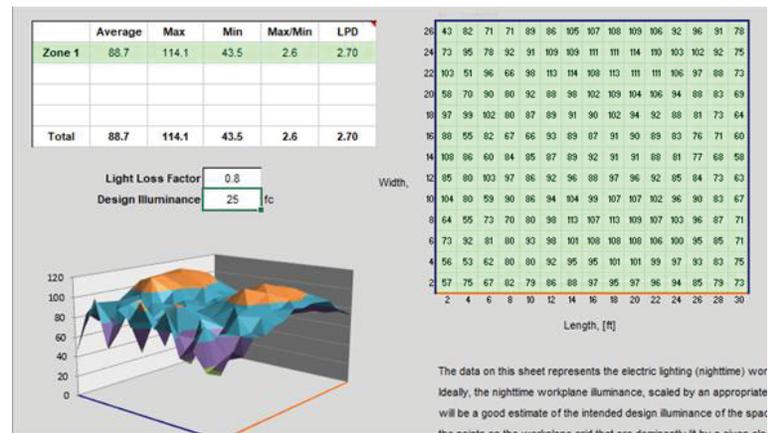
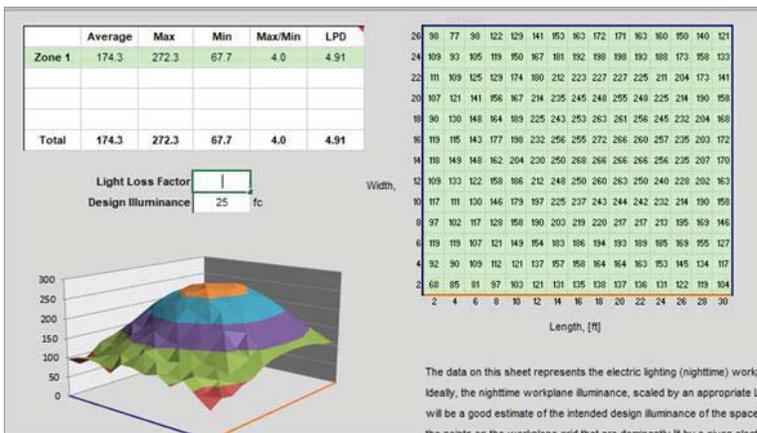
Lighting Facts Per Bulb	
Brightness	2600 lumens
Estimated Yearly Energy Cost	\$4.82
Based on 3 hrs/day, 116 kWh	
Cost depends on rates and use	
Life	21.9 years
Based on 3 hrs/day	
Light Appearance	4100 K
Energy Used	40 watts

# [ PERFORMANCE ANALYSIS ] B.3

SPOT: Zone 1 LPD = 4.91

SPOT: Zone 2 LPD = 2.7

A 2.21 LPD difference when lights are off when room is adequately daylighted



Lights On

Lights off when Adequate Daylight

# [ PERFORMANCE ANALYSIS ] B.4

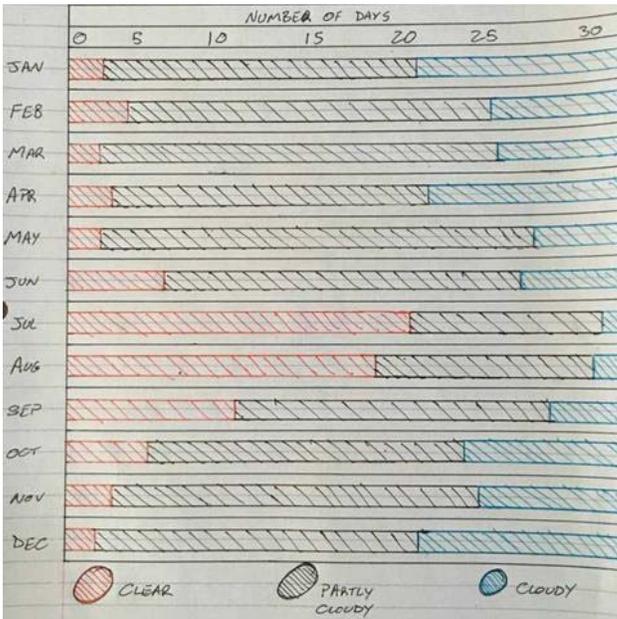
ENERGY SAVINGS DUE TO DAYLIGHTING										
Based on Selkowitz, S., and Gabel, M., 1994, "LBL Daylighting Nomograph," LBL report 13534, Berkeley, CA: Lawrence Berkeley Laboratory										
Spreadsheet by Fuller Moore, Architecture Department, Miami University, Oxford OH 45056 (email:fmoores@aol.com)										
Base Case 1										
7	Enter LATitude of building location	LAT =	46.7	46.7						
8	Enter the Daily Occupancy Period Code from box below (1-13)	DOPC =	7	7						
9	1=7a-9p, 2=7a-9p, 3=8a-5p, 4=8a-5p, 5=8a-5p, 6=8a-7p, 7=8a-5p, 8=8a-5p, 9=8a-5p, 10=8a-7p, 11=8a-5p									
11	Enter Typical Floor Width (ft)	FL =	32	32						
12	Enter Typical Floor Length (ft)	FL =	29.5	29.5						
13	Typical Floor Area (A) = FL * FL = FA =	944	944							
14	Typical Floor Shape (Length * Width) = FS =	1.08475	1.08475							
15	Enter Lighting Control Type (1 = on/off; 2 = dimming)	LCT =	2	2						
16	Enter Design Illuminance Level (30, 50, or 70 fc)	DIL =	60	60						
17	Enter window area per floor above the workspace (sf)	WAAW =	196	196						
18	Enter typical ceiling height above floor (ft)	CH =	15	15						
19	Enter typical ceiling height above floor (ft)	CH =	123	123						
20	Side-Lighting Glass Area Fraction = WAAW / (CH * FL) = SLGAF =	0.106	0.106							
21	Enter skylight or monitor glazed area (sf)	116	196							
22	Top-Lighting Glass Area Fraction: glazed aperture area - floor area = TLGAF =	0.12260	0.20763							
23	Enter Top-Lighting Glass Visible Transmittance (0-0.8)	TLGVT =	0.8	0.8						
24	Enter Top-Lighting Glass Visible Transmittance (0-0.8)	TLGVT =	0	0						
25	Enter Wall Factor (0.2 to 1.0; depends on wall depth and reflectance)	WLF =	1500	500						
26	Enter Annual Hours of Occupancy (hr)	AHO =	2	1						
27	Enter Installed Lighting Load (watts/sf, typically 1.0 to 3.0)	ILL =	2	1						
28	Electricity Cost (\$/kWh, typically 0.10 to 0.25)	EC =	\$0.15	\$1.00						
29	Enter No. of Floors	NF =	1	1						
30	Enter daylighted width (ft, 15 is typ. for conventional windows)	DW =	15	15						
31	Gross Total Building Area = NF * GAFP = GTBA =	944	944							
32	Enter Non-lighting Electric Load (watts/sf, 3.0 is typical for office buildings)	3.0	3.0							
33	Peak Electric Utility Demand Rate (\$/kWh month, 2.50 is typical for office bldgs)	PDH =	\$1.70	\$2.50						
34	Daylighted Hours (determined from DOPC)	83.0%	83.0%							
35	Total Daylighted Area (not based on entered depth for side, 100% for top)	TDA =	100%	100%						
36	Control Effectiveness (determined by LCT, side or top-lighting, and DIL)	69%	70%							
37	Enter Dimming Factor (0 - 1.0; typically 0.8 for dimming systems, 1.0 for on/off)	DF =	0.6	1						
38	Annual Energy Savings Due to Daylighting	57.4%	57.7%							
39	Peak Load Savings Due to Daylighting	60.0%	100.0%							
40	Non-Daylighted Lighting Energy Consumption (kWh/sf-yr)	3.00	0.50							
41	Non-Daylighted Lighting Consumption Cost (\$/sf-yr)	\$0.45	\$0.50							
42	Daylighting Energy Savings (kWh/sf-yr)	\$2.29	\$0.58							
43	Daylighting Consumption Savings (\$/sf-yr)	\$0.34	\$0.58							
44	Annual Electric Consumption Cost Savings Due to Daylighting for Building (\$*1000)	\$0.3	\$0.5							
45	Non-Daylighted Peak Demand (kW)	4.72	3.776							
46	Non-Daylighted Monthly Demand Charge (\$/kWh-month)	0.0034	0.0025							
47	Non-Daylighted Annual Demand Charge (\$/kWh-yr)	\$0.041	\$0.030							
48	Daylighted Peak Demand Savings (kW)	1.1	0.9							
49	Daylighted Annual Demand Savings (\$/sf-yr)	0.0020	0.0025							
50	Daylighted Monthly Demand Savings (\$/sf-month)	0.02448	0.03							
51	Total Annual Savings Due to Daylighting (Consumption and Demand \$/sf-yr)	\$0.369	\$0.607							
52	Building Annual Savings Due to Daylighting (Consumption and Demand, per yr)	348	573							
53	Enter Extra Construction Cost Due To Daylighting (\$/bldg)	16000	10000							
54	Simple Payback Period (Extra Const Cost - Bldg Annual Savings)	287.333	174.561							
55	Simple Return on Daylighting Investment (Bldg Annual Savings - Extra Const Cost)	0%	1%							

16. Annual Energy Savings Due to Daylighting	57.4%	57.7%
17. Peak Load Savings Due to Daylighting	60.0%	100.0%
18. Non-Daylighted Lighting Energy Consumption (kWh/sf-yr)	3.00	0.50
19. Non-Daylighted Lighting Consumption Cost (\$/sf-yr)	\$0.45	\$0.50
20. Daylighting Energy Savings (kWh/sf-yr)	\$2.29	\$0.58
21. Daylighting Consumption Savings (\$/sf-yr)	\$0.34	\$0.58
22. Annual Electric Consumption Cost Savings Due to Daylighting for Building (\$*1000)	\$0.3	\$0.5
23. Non-Daylighted Peak Demand (kW)	4.72	3.776
24. Non-Daylighted Monthly Demand Charge (\$/kWh-month)	0.0034	0.0025
25. Non-Daylighted Annual Demand Charge (\$/kWh-yr)	\$0.041	\$0.030
26. Daylighted Peak Demand Savings (kW)	1.1	0.9
27. Daylighted Annual Demand Savings (\$/sf-yr)	0.0020	0.0025
28. Daylighted Monthly Demand Savings (\$/sf-month)	0.02448	0.03
29. Total Annual Savings Due to Daylighting (Consumption and Demand \$/sf-yr)	\$0.369	\$0.607
30. Building Annual Savings Due to Daylighting (Consumption and Demand, per yr)	348	573

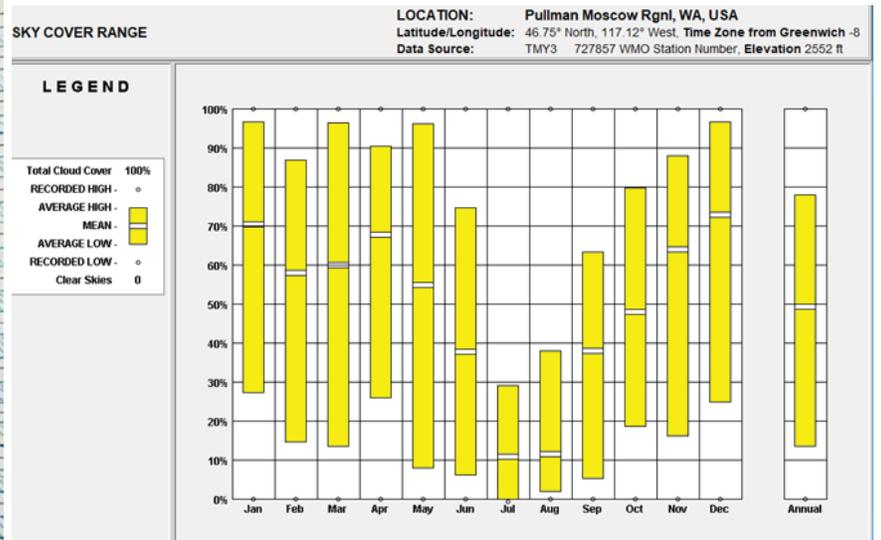
LBL Nomograph Savings:

- 17) Peak Load Savings Due to Daylighting = 40% More
- 21) Daylight Consumption Savings (\$/sf-yr) = \$0.24 More
- 27) Daylighted Annual Demand Savings (\$/sf-yr) = 0.0005 More
- 30) Building Annual Savings Due to Daylighting = 225 More

# [ CLIMATE ANALYSIS ] C.1



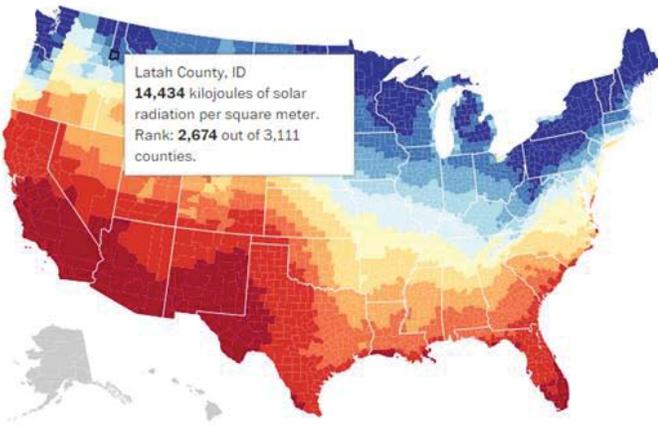
Climate Consultant's Sky Cover Range Chart



Average about 50% Cloud Coverage - Annually

# [ CLIMATE ANALYSIS ]

Avg. daily sunlight, 1979-2011 (measured in kilojoules of solar radiation per square meter)

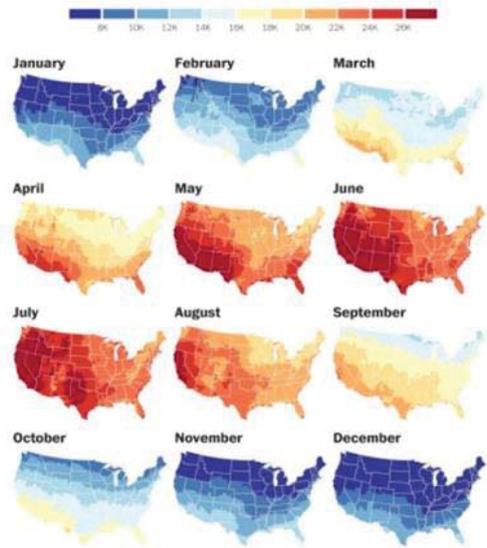


SOURCE: North America Land Data Assimilation System (NLDAS) Daily Sunlight (Insolation) years 1979-2011 on CDC WONDER

The average US daily sunlight

## A year of sunshine.

Avg. daily sunlight, by month, 1979-2011 (measured in kilojoules of solar radiation per square meter)

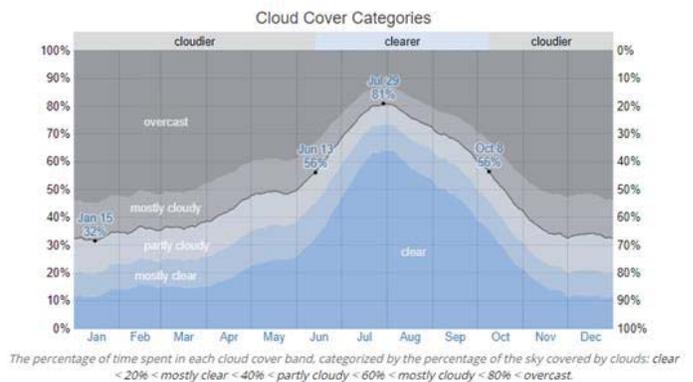


# [ CLIMATE ANALYSIS ]

## DATA:

- The clearer part of the year in Moscow lasts for about 4 months. The sky is clear, mostly clear, or partly cloudy 81% of the time, and overcast or mostly cloudy 19% of the time.
- The cloudier part of the year last about 8 months. The cloudiest day of the year, the sky is overcast or mostly cloudy 68% of the time, and clear, mostly clear, or partly cloudy 32% of the time.

Months	% Sunny	Clear Days	Partly Cloudy Days	Cloudy Days
January	22.58%	3	4	24
February	27.59%	3	5	21
March	32.26%	4	6	21
April	36.67%	5	6	19
May	48.39%	6	9	16
June	56.67%	8	9	13
July	80.65%	18	7	6
August	77.42%	16	8	7
September	68.97%	13	7	9
October	51.61%	9	7	15
November	29.03%	3	6	22
December	22.58%	3	4	24



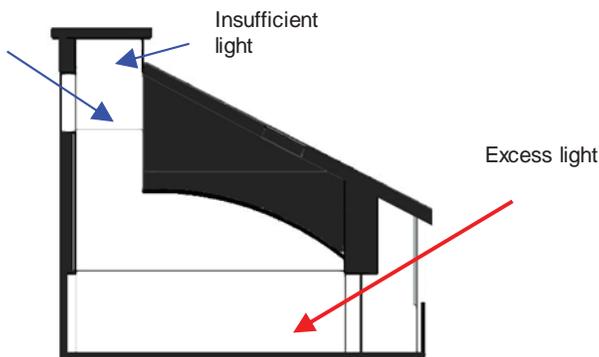
# [ REDESIGN ] C.2

The InsideOut Rule-of Thumb graph explains that our space recommends a 2.0 - 4.0 Daylighting Factor. We chose is as an office space because it's an open space but could also require task lighting depending on how the space is being used at the time.

Offices	General	2.0	Provide task lights or lower DF with photocontrolled electric lighting.
	Typing	4.0	May require task lighting; be careful of reflected glare on video displays.
	Drafting	5.0	May be difficult to provide uniformly high level with only sidelighting.

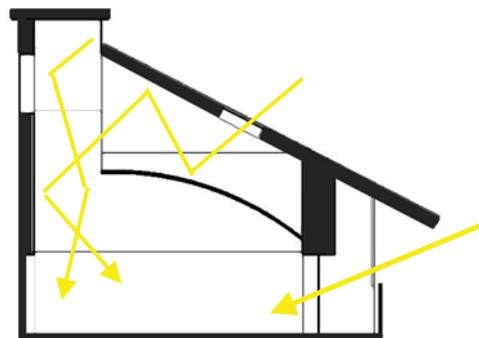
Task Area	Floor Area	Target DF	Glazing Strategy	Glazing Area Required	Glazing Area Provided	Resultant DF
Office	1013 sqft	2%-4%	East Facing	96 sqft	120 sqft	3.74%

# [ REDESIGN ] C.3



ORIGINAL DESIGN

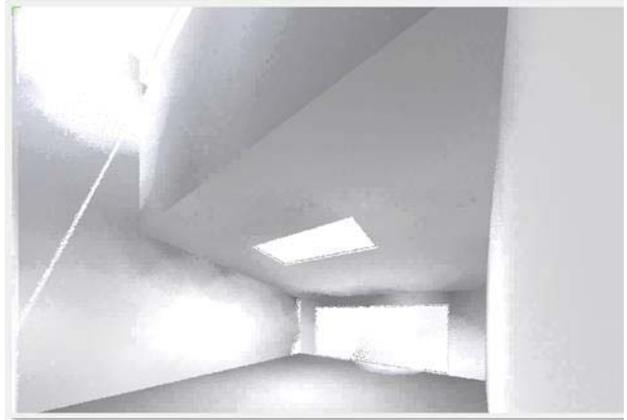
The existing form of the Horizon room allows too much direct sunlight through the East balcony window, while the elevated monitor does not direct light well enough to the back of the room.



REDESIGN

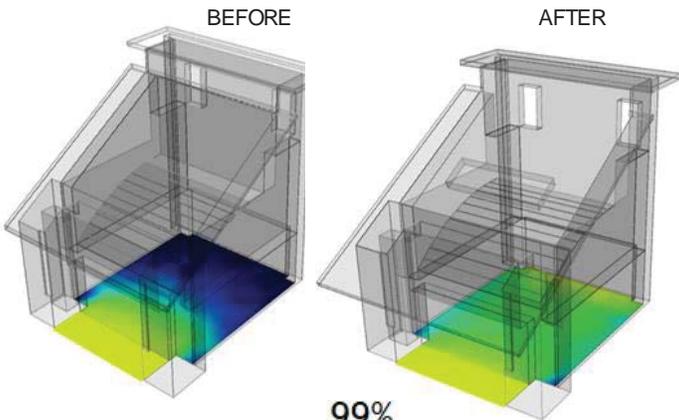
With an extended roof overhang and an additional skylight, less direct light enters the room while more, reflected, indirect light is able to more evenly spread throughout the space. The gap between the existing roof and lowered ceiling panel helps to diffuse direct light and divide it more deeply across the room. The opposing light source from the back and front of the room also aid in canceling unwanted glare from one another.

# [ REDESIGN ] C.3

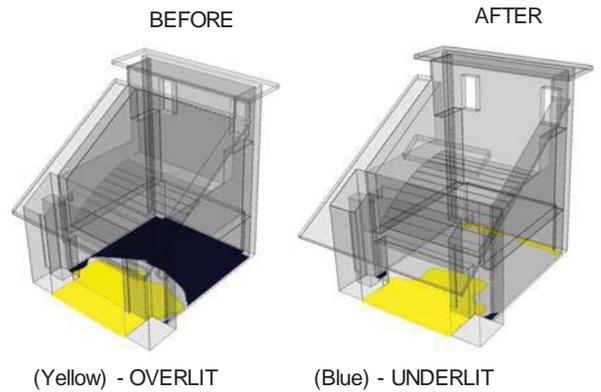


- Skylight Added  
 Extended Exterior Overhang Added
- Better Lighting
  - Reduces Glare
  - Still some glare

# [ REDESIGN ] C.3



After redesign, almost the entire room is sufficiently daylit.



New DF: 3.74% - Previous DF: 5.79%



# [ CONCLUSION ] C.2

## PROGRAM AND PERFORMANCE ANALYSIS CONCLUSION

Given that the Horizon room is a school administrative conference space, according to the **Insideout Exercise D2.4**, the program calls for a required **daylight factor** somewhere in the range of **two to four percent**. After the redesign of the room, Sefaira simulated our daylight factor to be 3.74% - an optimal level for the respective space. The addition of a skylight that brings light to the suspended ceiling reflector diffuses direct light creating a pleasant, ambient illuminance and simultaneously combats the glare from the balcony curtain wall. With the new design, the current LED lights will not need to be turned on during the day as a result of sufficient work propagating skylighting. This, in turn, will greatly reduce the energy use in the space by 32.3%. Overall, it was the implemented skylight and the suspended ceiling light diffuser that were most effective in distributing light throughout the room.