HORIZON

"A DAYLIGHTED ROOM" CASE STUDY

CHASE MACAW
ANDRES ROJO
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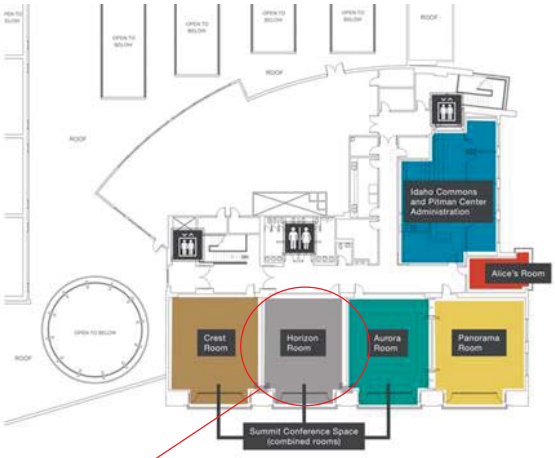
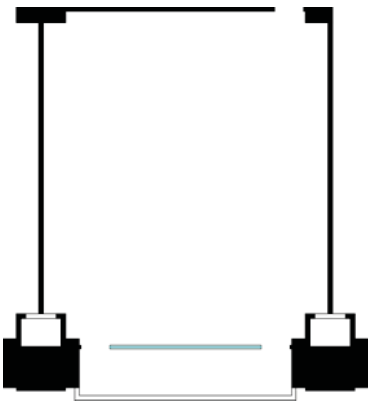
[CASE STUDY]

University of Idaho Commons
4th Floor - Horizon Room





[HORIZON ROOM]

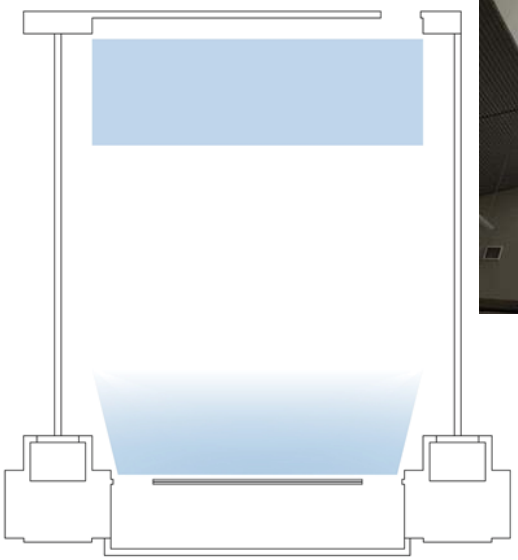
GENERAL BUILDING DESCRIPTION

• The Horizon Room is located in the Idaho Commons on 4th 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]

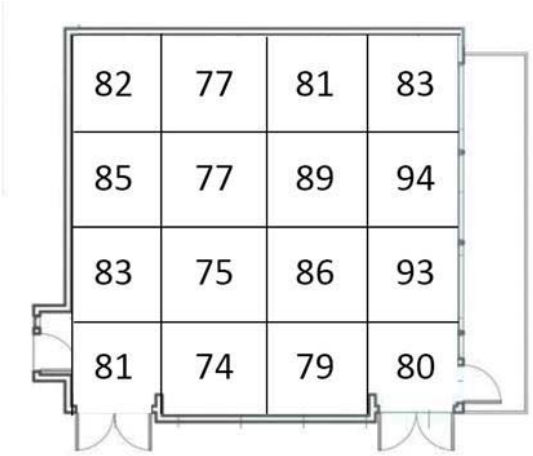
DAYLIGHTING PLAN:

- 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.

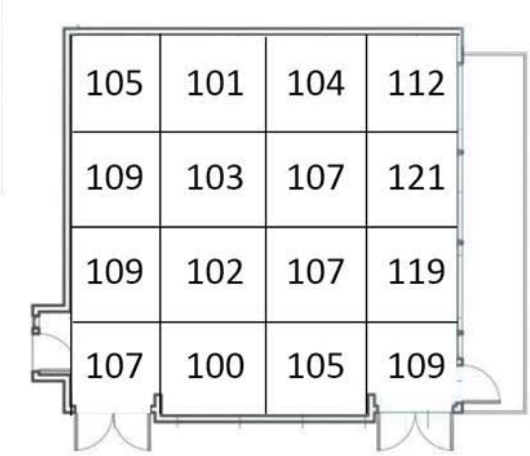


[PERFORMANCE ANALYSIS] A.1

Lighting Sweep of Horizon Room

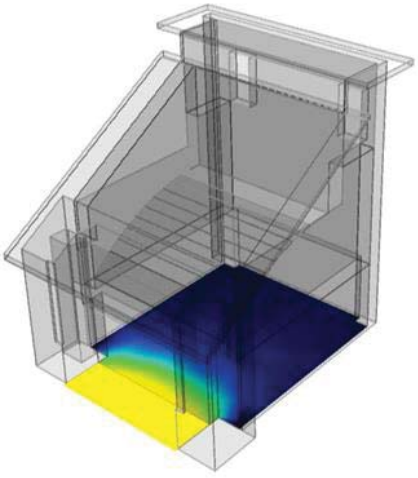


Daytime (Lights Off)



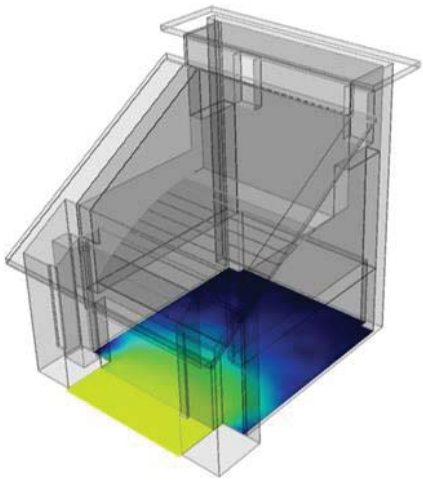
Daytime (Lights On)

[PERFORMANCE ANALYSIS] A.4



DAYLIGHT FACTOR

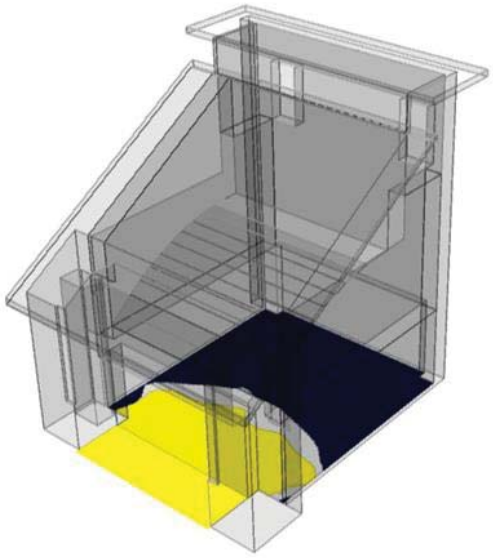
The average indoor illuminance is 5.79% of the average outdoor illuminance under an overcast sky.

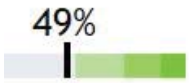


ANNUAL ILLUMINANCE

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

[PERFORMANCE ANALYSIS] A.4



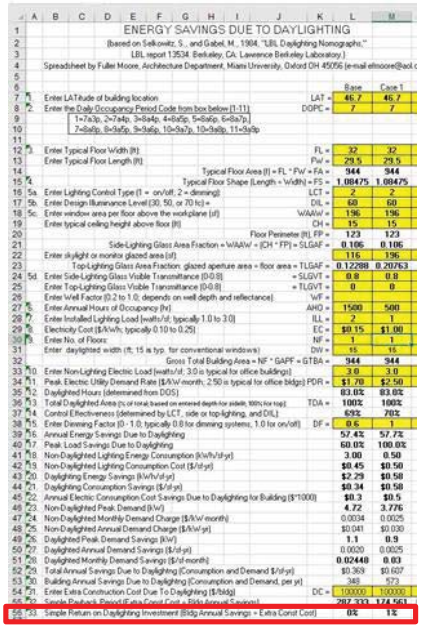


SPATIAL DAYLIGHT AUTONOMY

Percentage of the space that receives sufficient daylighting

ANNUAL SUN EXPOSURE

Percentage of the space that receives too much direct sunlight



ENERGY SAVINGS DUE TO DAYLIGHTING

(based on Selkowitz, S., and Gabel, M., 1904, "LBL Daylighting Nomographs," LBL report 13534. Berkeley, CA: Lawrence Berkeley Laboratory.)

Spreadsheet by Fuller Moore, Architecture Department, Miami University, Oxford OH 45056 (e-mail efmoore@aol.com)

			Base	Case 1
Enter LATitude of building location	LAT =		46.7	46.7
Enter the Daily Occupancy Period Code from box below [1-11]	DOPC =		7	7
1=7a3p, 2=7a4p, 3=8a4p, 4=8a5p, 5=8a6p, 6=8a7p, 7=8a8p, 8=9a5p, 9=9a6p, 10=9a7p, 11=9a8p				
Enter Typical Floor Width (ft)	FL =		32	32
Enter Typical Floor Length (ft)	FW =		29.5	29.5
	Typical Floor Area (f) = FL * FW =	FA =	944	944
	Typical Floor Shape (Length ÷ Width) =	FS =	1.08475	1.08475
Enter Lighting Control Type (1 = on/off, 2 = dimming)		LCT =	2	2
Enter Design Illuminance Level (30, 50, or 70 fc) =		DIL =	60	60
Enter window area per floor above the work plane (sf)		WAAW =	196	196
Enter typical ceiling height above floor (ft)		CH =	15	15
	Floor Perimeter (ft), FP =		123	123
	Side-Lighting Glass Area Fraction = WAAW ÷ (CH * FP) =	SLGAF =	0.106	0.106
Enter skylight or monitor glazed area (sf)			116	196
	Top-Lighting Glass Area Fraction: glazed aperture area ÷ floor area =	TLGAF =	0.12288	0.20763
Enter Side-Lighting Glass Visible Transmittance (0-0.9)		SLGVT =	0.8	0.8
Enter Top-Lighting Glass Visible Transmittance (0-0.9)		TLGVT =	0	0
Enter Well Factor (0.2 to 1.0; depends on well depth and reflectance)		WF =		
Enter Annual Hours of Occupancy (hr)		AHO =	1500	500
Enter Installed Lighting Load (watts/sf; typically 1.0 to 3.0)		ILL =	2	1
Electricity Cost ($/kWh; typically 0.10 to 0.25)		EC =	$0.15	$1.00
Enter No. of Floors		NF =	1	1
Enter daylighted width (ft; 15 is typ. for conventional windows)		DW =	15	15
	Gross Total Building Area = NF * GAPF =	GTBA =	944	944
Enter Non-Lighting Electric Load (watts/sf; 3.0 is typical for office buildings)			3.0	3.0
Peak Electric Utility Demand Rate ($/kW/month; 2.50 is typical for office bldgs)		PDR =	$1.70	$2.50
Daylighted Hours (determined from DOS)			83.0%	83.0%
Total Daylighted Area (% of total; based on entered depth for sidelit, 100% for top)		TDA =	100%	100%
Control Effectiveness (determined by LCT, side or top-lighting, and DIL)			69%	70%
Enter Dimming Factor (0 - 1.0; typically 0.8 for dimming systems, 1.0 for on/off)		DF =	0.6	1
Annual Energy Savings Due to Daylighting			57.4%	57.7%
Peak Load Savings Due to Daylighting			60.0%	100.0%
Non-Daylighted Lighting Energy Consumption (kWh/sf-yr)			3.00	0.50
Non-Daylighted Lighting Consumption Cost ($/sf-yr)			$0.45	$0.50
Daylighting Energy Savings (kWh/sf-yr)			$2.29	$0.50
Daylighting Consumption Savings ($/sf-yr)			$0.34	$0.50
Annual Electric Consumption Cost Savings Due to Daylighting for Building ($*1000)			$0.3	$0.5
Non-Daylighted Peak Demand (kW)			4.72	3.776
Non-Daylighted Monthly Demand Charge ($/kW-month)			0.0034	0.0025
Non-Daylighted Annual Demand Charge ($/kW-yr)			$0.041	$0.030
Daylighted Peak Demand Savings (kW)			1.1	0.9
Daylighted Annual Demand Savings ($/sf-yr)			0.0020	0.0025
Daylighted Monthly Demand Savings ($/sf-month)			0.02440	0.03
Total Annual Savings Due to Daylighting (Consumption and Demand $/sf-yr)			$0.369	$0.607
Building Annual Savings Due to Daylighting (Consumption and Demand, per yr)			348	572
Enter Extra Construction Cost Due To Daylighting ($/bldg)		DC =	100000	100000
Simple Payback Period (Extra Const Cost ÷ Bldg Annual Savings)			287.333	174.563
Simple Return on Daylighting Investment (Bldg Annual Savings ÷ Extra Const Cost)			0%	1%

LBL Nomograph

Simple return on daylight investment:

0% - 1%

[PERFORMANCE ANALYSIS] A.6

Daylight Glare

Nighttime

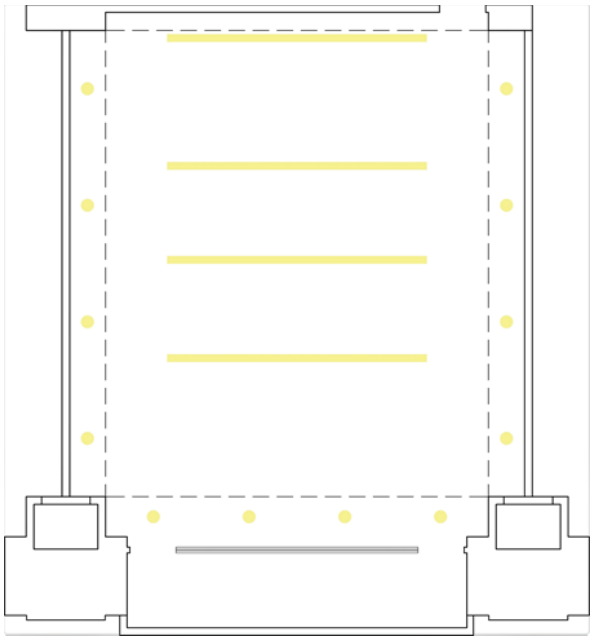
After designing the room with appropriate interior materiality, SPOT shows us that the walls and ceiling have a very high IRC, causing an excessive amount of glare.

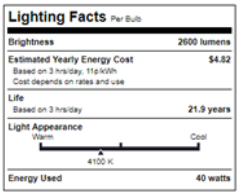
[PERFORMANCE ANALYSIS] B.1

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:

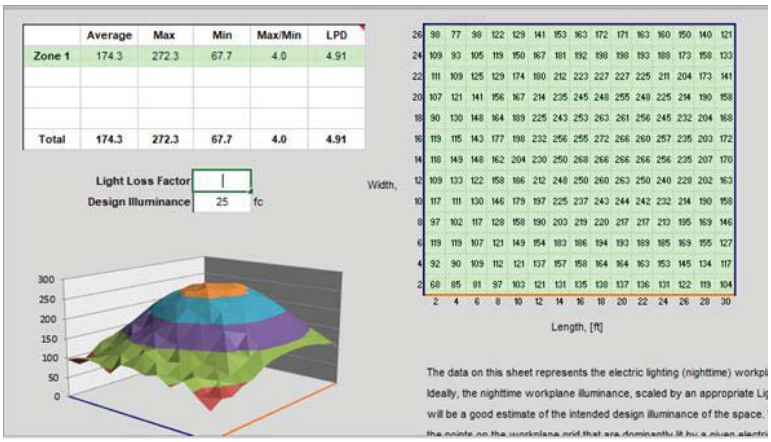
- **560 hours/year**
- **706.2 kWh/year**
- **$7.92 kWh/bulb**
- **11,862.5 hours / bu;b**
- **$63.36 / yearly cost**
  About 50% savings!

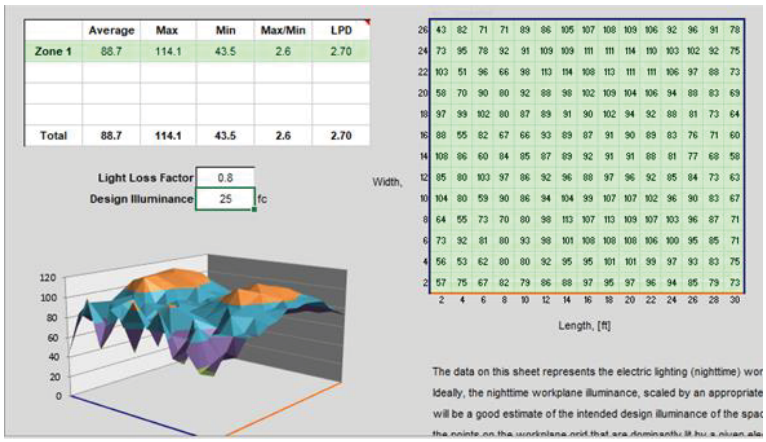
[PERFORMANCE ANALYSIS] B.3

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

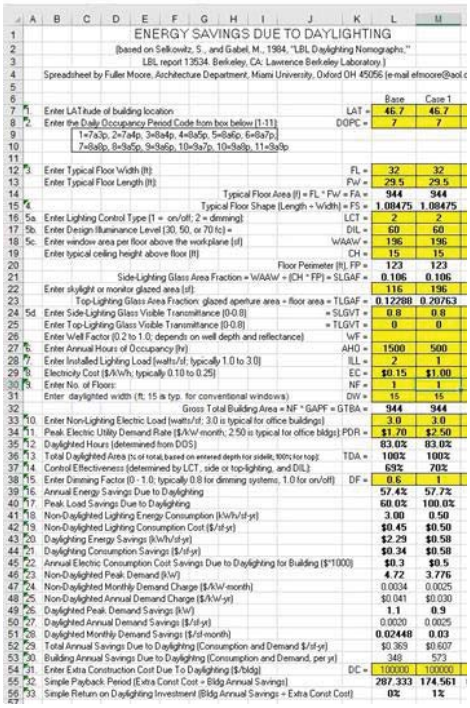




Lights On

Lights off when Adequate Daylight

[PERFORMANCE ANALYSIS] B.4



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3.	Enter Typical Floor Width (ft): FL =	32	32
	Enter Typical Floor Length (ft): FW =	29.5	29.5
	Typical Floor Area (ft) = FL * FW = FA =	944	944
	Typical Floor Shape (Length ÷ Width) = FS =	1.08475	1.08475
5a.	Enter Lighting Control Type (1 = on/off; 2 = dimming): LCT =	2	2
5b.	Enter Design Illuminance Level (30, 50, or 70 fc) = DIL =	60	60
5c.	Enter window area per floor above the workplane (sf): WAAW =	196	196
	Enter typical ceiling height above floor (ft): CH =	15	15
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	Enter Well Factor (0.2 to 1.0; depends on well depth and reflectance): WF =		
6.	Enter Annual Hours of Occupancy (hr): AHO =	1500	500
7.	Enter Installed Lighting Load (watts/sf; typically 1.0 to 3.0): ILL =	2	1
8.	Electricity Cost ($/kWh; typically 0.10 to 0.25): EC =	$0.15	$1.00
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11.	Peak Electric Utility Demand Rate ($/kW-month; 2.50 is typical for office bldgs): PDR =	$1.70	$2.50
12.	Daylighted Hours (determined from DOS):	83.0%	83.0%
13.	Total Daylighted Area (% of total, based on entered depth for sidelit, 100% for top): TDA =	100%	100%
14.	Control Effectiveness (determined by LCT, side or top-lighting, and DIL):	69%	70%
15.	Enter Dimming Factor (0 - 1.0; typically 0.8 for dimming systems, 1.0 for on/off): DF =	0.6	1
16.	Annual Energy Savings Due to Daylighting:	57.4%	57.7%
17.	Peak Load Savings Due to Daylighting:	60.0%	100.0%
18.	Non-Daylighted Lighting Energy Consumption (kWh/sf-yr):	3.00	0.50
19.	Non-Daylighted Lighting Consumption Cost ($/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	$0.5
23.	Non-Daylighted Peak Demand (kW):	4.72	3.776
24.	Non-Daylighted Monthly Demand Charge ($/kW-month):	0.0034	0.0025
25.	Non-Daylighted Annual Demand Charge ($/kW-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 Daylightng (Consumption and Demand $/sf-yr):	$0.369	$0.607
30.	Building Annual Savings Due to Daylightng (Consumption and Demand, per yr):	348	573
31.	Enter Extra Construction Cost Due To Daylighting ($/bldg): DC =	100000	100000
32.	Simple Payback Period (Extra Const Cost ÷ Bldg Annual Savings):	287.333	174.561
33.	Simple Return on Daylighting Investment (Bldg Annual Savings ÷ Extra Const Cost):	0%	1%

16.	Annual Energy Savings Due to Daylighting	57.4%	57.7%
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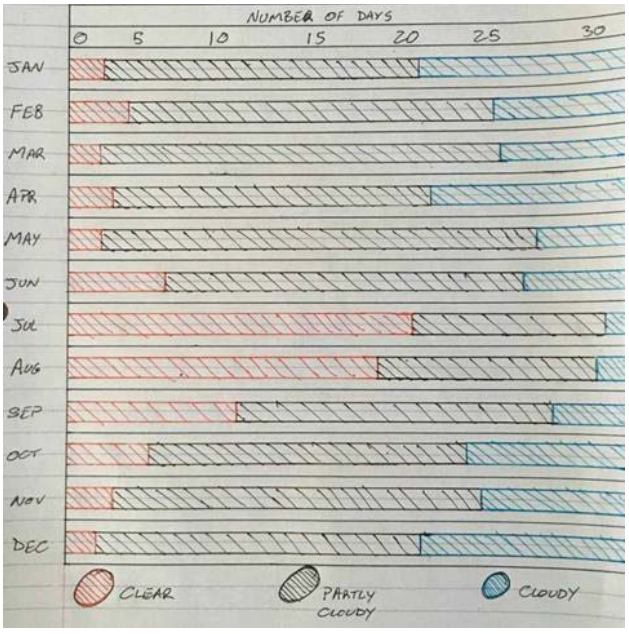
29.	Total Annual Savings Due to Daylightng (Consumption and Demand $/sf-yr)	$0.369	$0.607
30.	Building Annual Savings Due to Daylightng (Consumption and Demand, per yr)	348	573

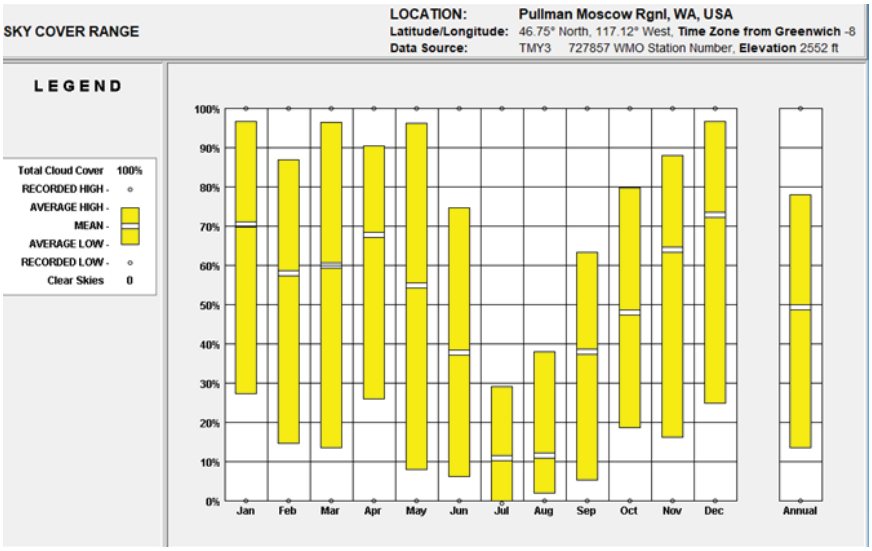
LBL Nomograph Savings:

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

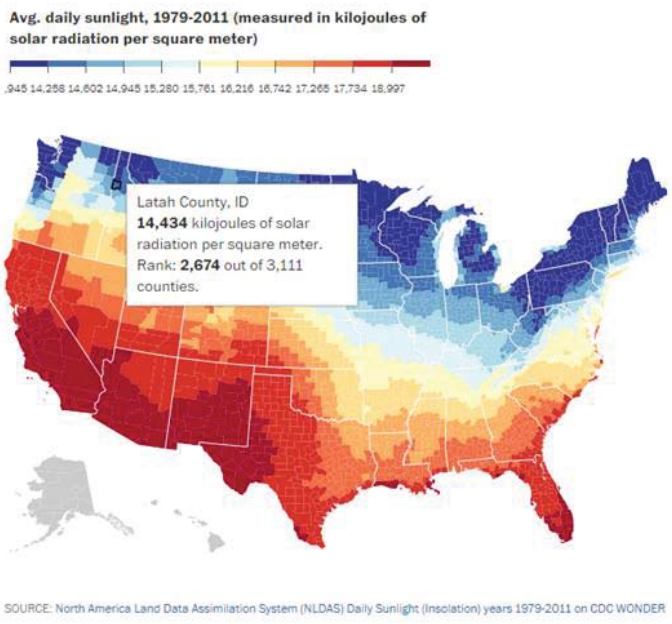


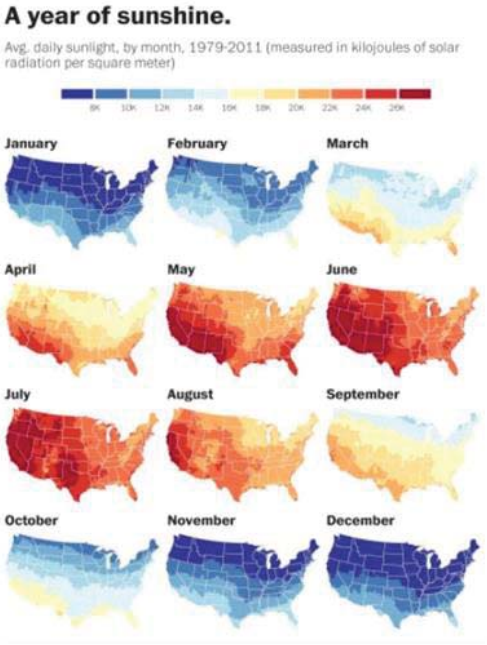
Climate Consultant's Sky Cover Range Chart



Average about 50% Cloud Coverage - Annually

[CLIMATE ANALYSIS]





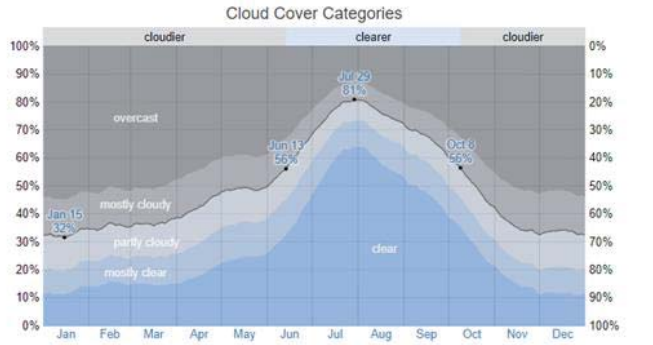
The average US daily sunlight

[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.

Moscow, ID Chance of Sunshine				
Month	% 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



The percentage of time spent in each cloud cover band, categorized by the percentage of the sky covered by clouds: clear < 20% < mostly clear < 40% < partly cloudy < 60% < mostly cloudy < 80% < overcast.

The number of hours during which the Sun is visible (black line). From bottom (most yellow) to top (most gray), the color bands indicate: full daylight, twilight (civil, nautical, and astronomical), and full night.

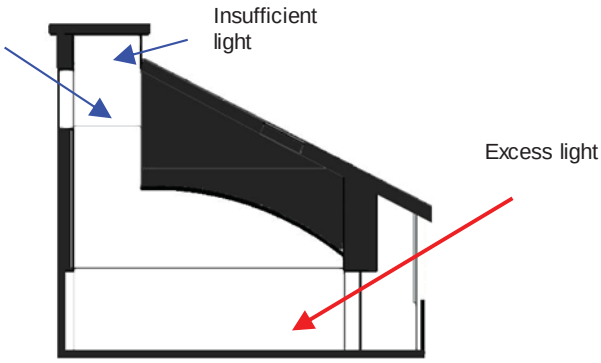
[REDESIGN] C.2

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 useds 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.

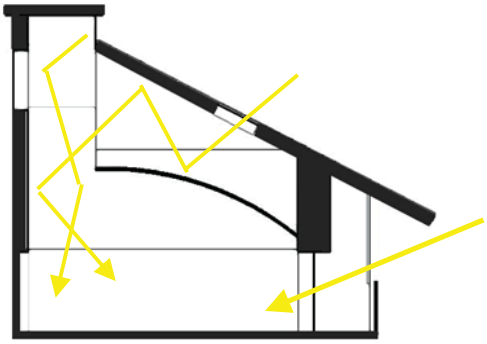
Task Area	Floor Area	Target DF	Glazing Strategy	Glazing Area Required	Glazing Area Provided	Resultamt DF
Office	1013 sqft	2%-4$	East Facing	96 sqft	120 sqft	3.74%

[REDESIGN] C.3



ORIGINAL DESIGN

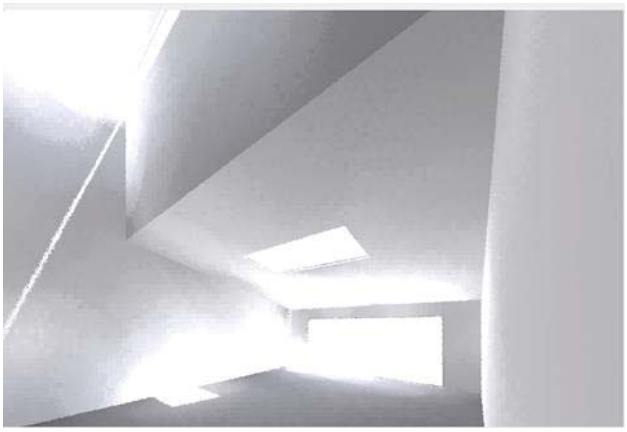
The existing form of the Horizon room allows too much direct sunlight through the East balcony window, while the elevated monitor does not direct light well enough to the back of the room.

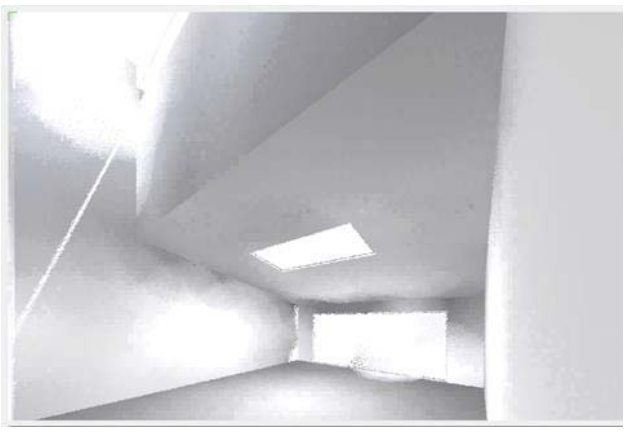


REDESIGN

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

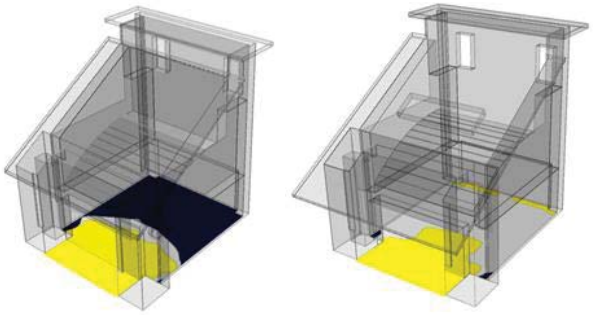
-

-

[REDESIGN] C.3

BEFORE

AFTER

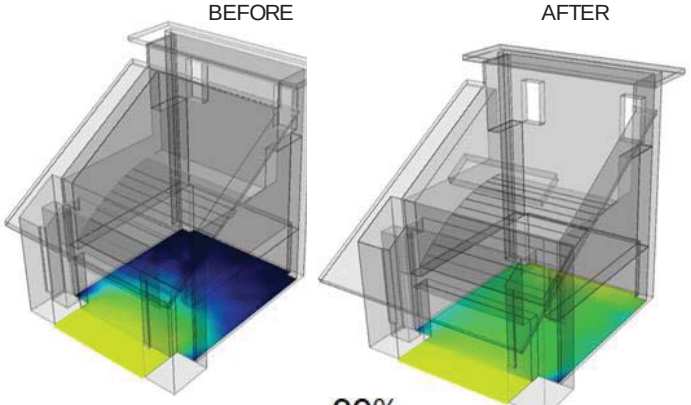


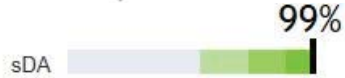
(Yellow) - OVERLIT

(Blue) - UNDERLIT

BEFORE

AFTER





SPATIAL DAYLIGHT AUTONOMY

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.