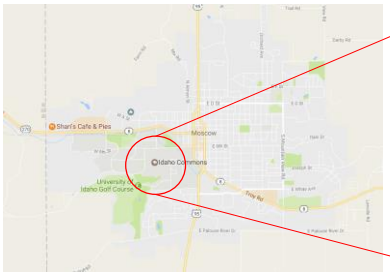
Case Study #1: A Daylighted Room

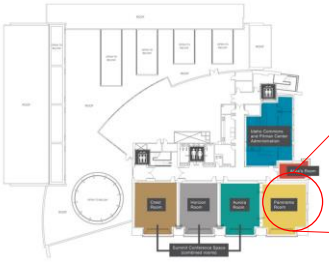
Johnson Chou Thomas Corr Zhimin Zhu

Case Study

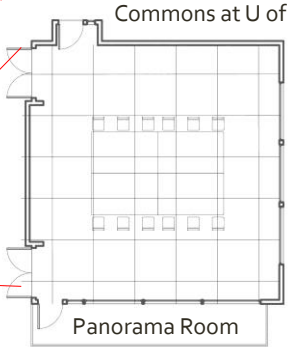


Moscow, ID

Commons at U of I



4th Floor of the Commons

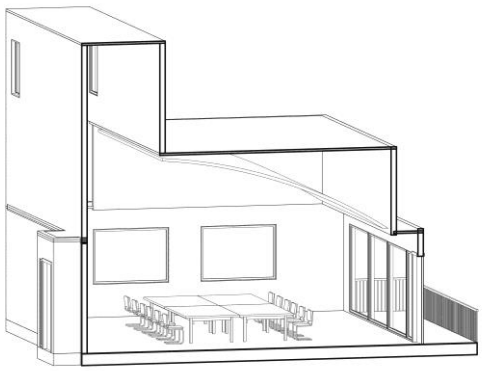


Panorama Room

Case Study

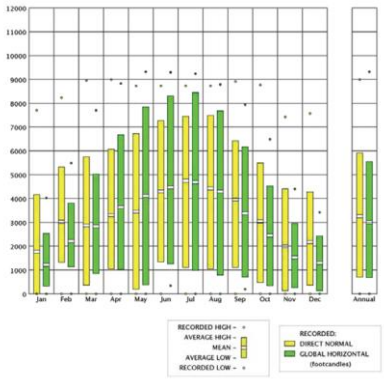
- Adequately lighting
- Well design daylighting for potential saving energy
- Daylight can be improved with change to top lighting

Case Study

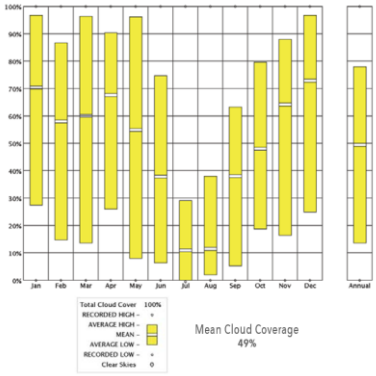


- Room Description
  - Located at Center of University of Idaho
  - In Commons
  - 4th Floor
  - Facing East
  - Wall
    - 10 ft. towards east
    - 29 ft. towards the west
  - 2 Exterior wall
    - North
      - 2 Large window
    - East
      - Large window wall
      - Have a exterior balcony
  - Large Ceiling
    - Incoming skylight
    - Daylight monitor

Climate Data



Ave. 3200 FC / yr

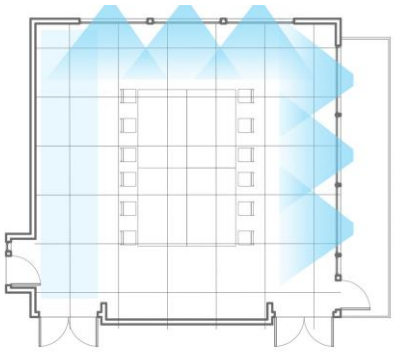


Avg. 50% Cloud coverage / yr

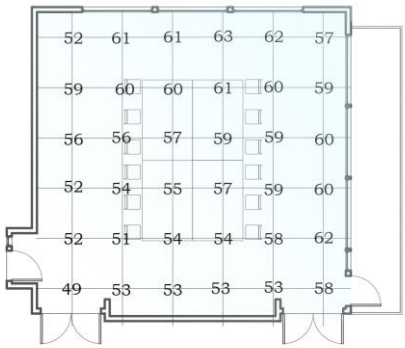
Performance Analysis

- The room receives adequate daylighting but has the potential to be improved though the building's top ceiling fixture and daylight monitors. There is a 29 foot wall including the daylight monitor that is design at the wrong height and angle. This creates an issue of daylight does not enter the lower half of the room.

Performance Analysis



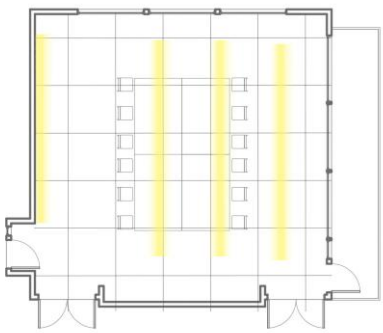
Daylighting Plan



Illumination Footprint

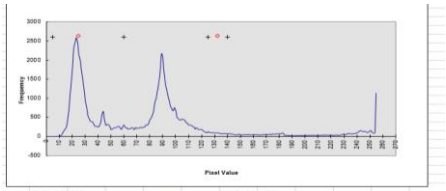
Performance Analysis

- Electrical Lighting Scheme
- Fluorescent lighting
  - 8 bulb/fixture
  - 40 watts/bulb
  - 1080 hour/yr.
  - 1,382.4 kw/yr.
  - $8.97 / blub
  - 22,075 hours / bulb
  - $154.24 / yr for electric lighting

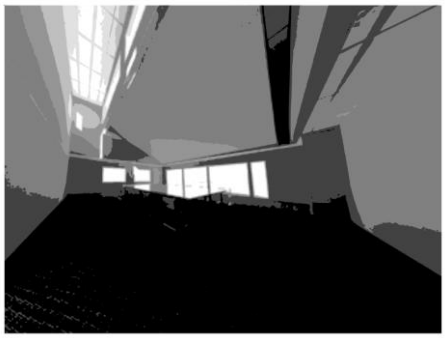


Light Fixtures Plan

Glare Analysis



Overall Image		Individual Pixel	
Weighted Ave Pixel Intensity	87.66	Individual Pixel Value	130
Total Number of Pixels	76800	Corresponding Luminance	291.89 footlamberts
Background Bell Curve		**Spike**	
Low End Pixel Value	5	Low End Pixel Value	125
High End Pixel Value	60	High End Pixel Value	140
Background Median Value	25	Spike Median Value	132



Panorama Room Before Redesign

Redesign Room

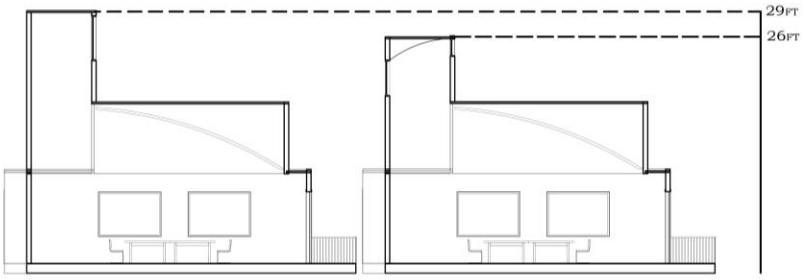
The Ultimate Goal:

To improve daylight distribution throughout the room during properly work hours.

Original Panorama Room

Redesigned Panorama Room

Redesign Room



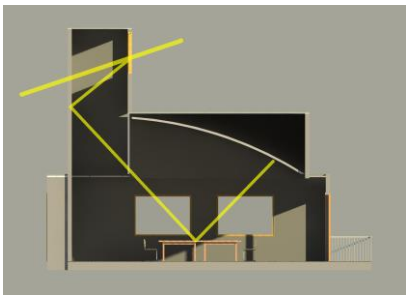
Original Panorama Room

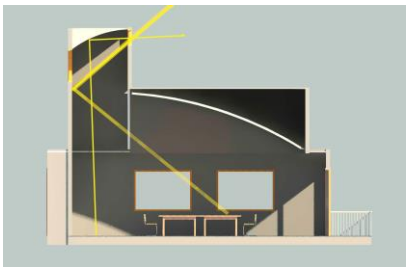
Redesigned Panorama Room

By changing the height of the daylight monitor, we increase the rate of daylight staying inside the room.

Redesign Room

- By change the angles and location of the clerestory window we redirect the daylight into the room creating a much brighter shape.





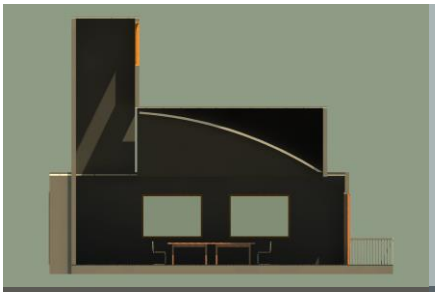
- To ensure that no direct dawn sun light goes straight into the room, we change the west side window to be controllable to be dimmed.

Redesign Performance Analysis

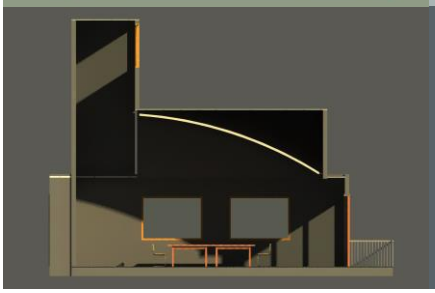
Original Panorama

Redesign Panorama

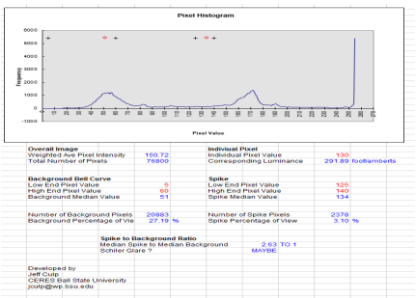
Summer

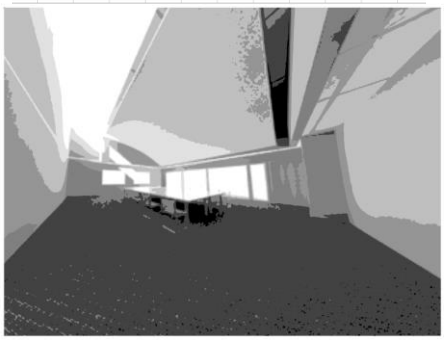


Winter



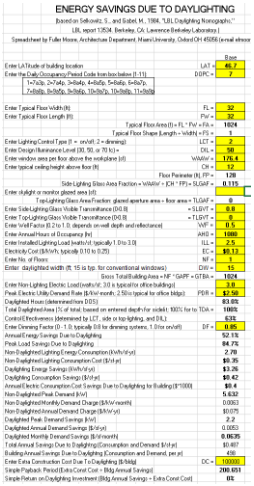
Post-Glare Analysis





Panorama Room After Redesign

Energy

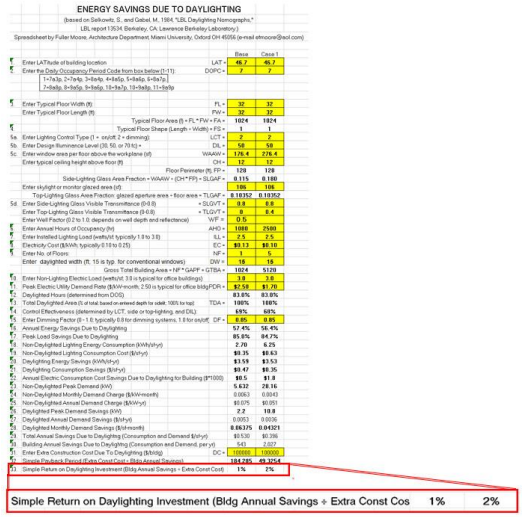


ENERGY SAVINGS DUE TO DAYLIGHTING

(based on Selkowitz, S., and Seibel, M., 1984, "LBL Daylighting Nomographs," LBL report 13534, Berkeley, CA: Lawrence Berkeley Laboratory.)

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

		Base
Enter LAT/route of building location	LAT =	46.7
Enter the Daily Occupancy Period Code from box below (1-11):	DOPC =	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
Enter Typical Floor Length (ft)	FW =	32
Typical Floor Area (f) = FL * FW = FA =		1024
Typical Floor Shape (Length ÷ Width) = FS =		1
Enter Lighting Control Type (1 = on/off, 2 = dimming)	LCT =	2
Enter Design Illuminance Level (30, 50, or 70 fc) =	DIL =	50
Enter window area per floor above the workplane (sf)	WAWW =	176.4
Enter typical ceiling height above floor (ft)	CH =	12
Floor Perimeter (ft), FP =		128
Side-Lighting Glass Area Fraction = WAWW ÷ (CH * FP) = SLGAF =		0.115
Enter skylight or monitor glazed area (sf)		
Top-Lighting Glass Area Fraction: glazed aperture area ÷ floor area = TLGAF =		0
Enter Side-Lighting Glass Visible Transmittance (0-0.9)	+ SLGVT =	0.8
Enter Top-Lighting Glass Visible Transmittance (0-0.9)	+ TLGVT =	0
Enter Well Factor (0.2 to 1.0; depends on well depth and reflectance)	WF =	0.5
Enter Annual Hours of Occupancy (hr)	AHO =	1080
Enter Installed Lighting Load (watts/sf; typically 1.0 to 3.0)	ILL =	2.5
Electricity Cost ($/kWh; typically 0.10 to 0.25)	EC =	$0.13
Enter No. of Floors	NF =	1
Enter daylighted width (ft, 15 is typ. for conventional windows)	DW =	15
Gross Total Building Area = NF * GAFF = GTBA =		1024
Enter Non-Lighting Electric Load (watts/sf; 3.8 is typical for office buildings)		3.8
Peak Electric Utility Demand Rate ($/kW-month; 2.50 is typical for office bldgs)	PDR =	$2.50
Daylighted Hours (determined from DOS)		83.8%
Total Daylighted Area (% of total; based on entered depth for sidelit; 100% for toplighted)	TDA =	100%
Control Effectiveness (determined by LCT, side or top-lighting, and DIL)		63%
Enter Dimming Factor (0 - 1.0; typically 0.8 for dimming systems, 1.0 for on/off)	DF =	0.85
Annual Energy Savings Due to Daylighting		52.1%
Peak Load Savings Due to Daylighting		84.7%
Non-Daylighted Lighting Energy Consumption (kWh/sf-yr)		2.78
Non-Daylighted Lighting Consumption Cost ($/sf-yr)		$0.35
Daylighting Energy Savings (kWh/sf-yr)		$3.26
Daylighting Consumption Savings ($/sf-yr)		$0.42
Annual Electric Consumption Cost Savings Due to Daylighting for Building ($*1000)		$0.4
Non-Daylighted Peak Demand (kW)		5.632
Non-Daylighted Monthly Demand Charge ($/kW-month)		0.0063
Non-Daylighted Annual Demand Charge ($/kW-yr)		$0.075
Daylighted Peak Demand Savings (kW)		2.2
Daylighted Annual Demand Savings ($/sf-yr)		0.0053
Daylighted Monthly Demand Savings ($/sf-month)		0.0635
Total Annual Savings Due to Daylighting (Consumption and Demand $/sf-yr)		$0.467
Building Annual Savings Due to Daylighting (Consumption and Demand, per yr)		478
Enter Extra Construction Cost Due To Daylighting ($/bldg)	DC =	100000
Simple Payback Period (Extra Const Cost ÷ Bldg Annual Savings)		209.051
Simple Return on Daylighting Investment (Bldg Annual Savings ÷ Extra Const Cost)		0%



ENERGY SAVINGS DUE TO DAYLIGHTING

(based on Selkowitz, S., and Seibel, M., 1984, "LBL Daylighting Nomographs," LBL report 13534, Berkeley, CA: Lawrence Berkeley Laboratory.)

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

		Base	Case 1
Enter LAT/route 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 =	32	32
Typical Floor Area (f) = FL * FW = FA =		1024	1024
Typical Floor Shape (Length ÷ Width) = FS =		1	1
5a. Enter Lighting Control Type (1 = on/off, 2 = dimming)	LCT =	2	2
5b. Enter Design Illuminance Level (30, 50, or 70 fc) =	DIL =	50	50
5c. Enter window area per floor above the workplane (sf)	WAWW =	176.4	276.4
Enter typical ceiling height above floor (ft)	CH =	12	12
Floor Perimeter (ft), FP =		128	128
Side-Lighting Glass Area Fraction = WAWW ÷ (CH * FP) = SLGAF =		0.115	0.180
Enter skylight or monitor glazed area (sf)		186	186
Top-Lighting Glass Area Fraction: glazed aperture area ÷ floor area = TLGAF =		0.18352	0.18352
5d. 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	0.4
Enter Well Factor (0.2 to 1.0; depends on well depth and reflectance)	WF =	0.5	
Enter Annual Hours of Occupancy (hr)	AHO =	1080	2580
Enter Installed Lighting Load (watts/sf; typically 1.0 to 3.0)	ILL =	2.5	2.5
Electricity Cost ($/kWh; typically 0.10 to 0.25)	EC =	$0.13	$0.10
Enter No. of Floors	NF =	1	1
Enter daylighted width (ft, 15 is typ. for conventional windows)	DW =	15	15
Gross Total Building Area = NF * GAFF = GTBA =		1024	5120
Enter Non-Lighting Electric Load (watts/sf; 3.8 is typical for office buildings)		3.8	3.8
Peak Electric Utility Demand Rate ($/kW-month; 2.50 is typical for office bldgs)	PDR =	$2.50	$1.70
Daylighted Hours (determined from DOS)		83.8%	83.8%
Total Daylighted Area (% of total; based on entered depth for sidelit; 100% for toplighted)	TDA =	100%	100%
Control Effectiveness (determined by LCT, side or top-lighting, and DIL)		63%	63%
Enter Dimming Factor (0 - 1.0; typically 0.8 for dimming systems, 1.0 for on/off)	DF =	0.85	0.85
Annual Energy Savings Due to Daylighting		52.1%	56.4%
Peak Load Savings Due to Daylighting		84.7%	84.7%
Non-Daylighted Lighting Energy Consumption (kWh/sf-yr)		2.78	6.25
Non-Daylighted Lighting Consumption Cost ($/sf-yr)		$0.35	$0.63
Daylighting Energy Savings (kWh/sf-yr)		$3.59	$3.53
Daylighting Consumption Savings ($/sf-yr)		$0.47	$0.35
Annual Electric Consumption Cost Savings Due to Daylighting for Building ($*1000)		$0.5	$1.8
Non-Daylighted Peak Demand (kW)		5.632	28.16
Non-Daylighted Monthly Demand Charge ($/kW-month)		0.0063	0.0043
Non-Daylighted Annual Demand Charge ($/kW-yr)		$0.075	$0.051
Daylighted Peak Demand Savings (kW)		2.2	10.8
Daylighted Annual Demand Savings ($/sf-yr)		0.0053	0.0036
Daylighted Monthly Demand Savings ($/sf-month)		0.06375	0.04321
Total Annual Savings Due to Daylighting (Consumption and Demand $/sf-yr)		$0.530	$0.396
Building Annual Savings Due to Daylighting (Consumption and Demand, per yr)		543	2,027
Enter Extra Construction Cost Due To Daylighting ($/bldg)	DC =	100000	100000
Simple Payback Period (Extra Const Cost ÷ Bldg Annual Savings)		184.285	49.3754
Simple Return on Daylighting Investment (Bldg Annual Savings ÷ Extra Const Cost)		1%	2%

Simple Return on Daylighting Investment (Bldg Annual Savings ÷ Extra Const Cos 1% 2%

Case w/ no daylight

Original and Redesigned Room

Conclusion

- Overall, the Panorama room was already very well lit
- We made little tweaks to the room that improved the overall energy use and ability of daylight to get into the room
  - Lower clerestory window height
  - Change the angle in which daylight comes into the room

The End

- Thank you for Listening