

Case Study #1: A Daylighted Room

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LARCH Classroom

- The LARCH classroom is located on the 3rd floor of the Northeast corner of the Art & Architecture building. The space is primarily used for lectures and as a meeting room for landscape architecture students and professors.

DAYLIGHTING SCHEME

- The daylighting system used in the room consists of 8 windows of varying sizes on the North and East exterior walls. Some electrical lighting is also used throughout the space.

Quantity	Dimension	Location
1	H 44 x W 36	N
1	H 44 x W 56	N
2	H 67 x W 41	E
4	H 67 x W 30	E



A.1: Existing Performance Analysis

Light Source Diagram


-  Daylighting
-  Troffer Lighting

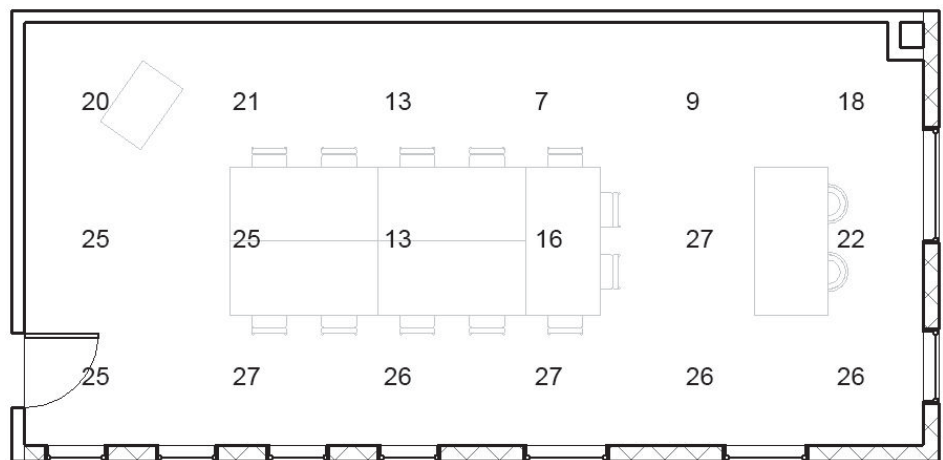
Image displays 8 troffer lights on ceiling and windows allowing natural daylighting into the space.



A.1: Existing Performance Analysis

Illuminance Footprint

As expected the center back of the room has the least amount of footcandles and the areas with the most amount of footcandles are closer to the North and Eastern facade where windows are located.



Illuminance footprint in FC
LARCH 307: 1/30/18 at 12:30pm
Daylight only

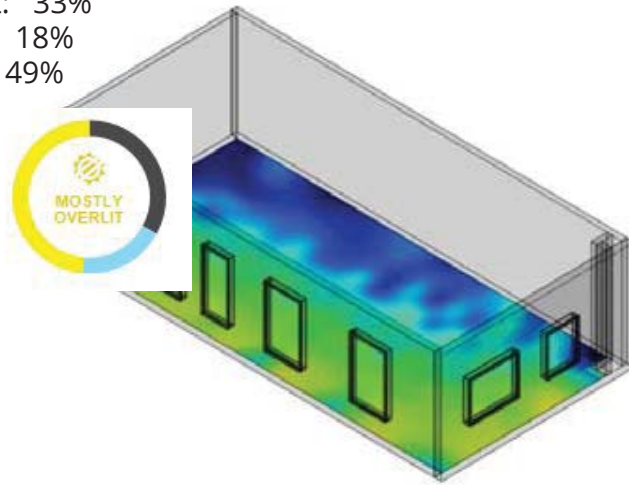


A.1: Existing Performance Analysis

Seferia Analysis

After plugging Revit model into Seferia, it showed that the room was severely overlit, especially in the spaces next to the windows, which is where a lot of glare stemmed from. The light coming from windows is not dispersed into the back of the space which is where the underlit spaces are.

Underlit: 33%
Well-Lit: 18%
Overlit: 49%



Percentage of occupied hours where illuminance is at least 28 footcandles, measured at 2.79 feet above the floor plate.

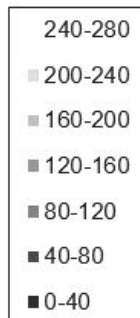


A.6: Glare

The Eastern facing windows bring in the most sunlight, producing much of the glare reflected into the space.

The Southwest corner of the room has the least amount of glare as it is furthest from the direct light source. (These spaces also have the highest footcandles as shown on previous slide).

There is more glare on surfaces because of the types of reflective materials used in the space.



B.1: Energy Savings - Electric Lights

Electrical light fixtures: 8 - 2' x 4' troffer 178W (4 4' lamps in each troffer)

Control Scheme: Mode 1- 1,246 watts Mode 2- 178 watts

Operable: Mode 1- controls 7 troffers Mode 2- controls 1 troffer

Classroom Use: 9:30 AM - 3:30 PM

Sufficient Daylighting:

- Clear Skies: 11:00 AM - 3:30 PM (6 hours)
- Cloudy Skies: 11:00 AM - 2:00 PM (3 hours)

Mechanical Light Needed:

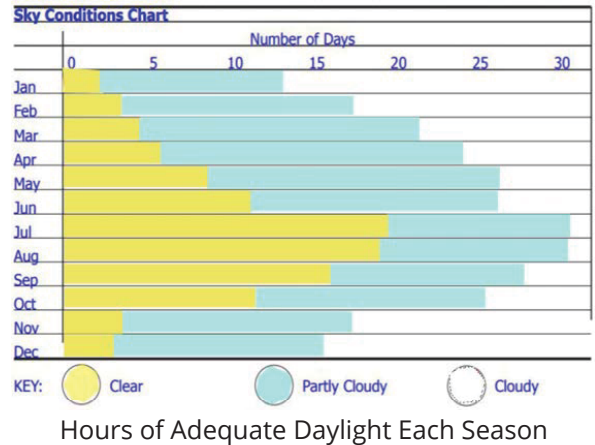
- Clear Skies: (2.5hrs) x (1,246 watts) = 3,115 watts
- Cloudy Skies: (6 hrs) x (1,246 watts) = 7,476 watts

Lights Off:

- Clear Skies: save 3,115 watts
- Cloudy Skies: save 7,476 watts

Yearly Savings:

- 104.8 x (3,115 watts) - 104.8 days (clear skies) = 326,347.2 watts/year
- 94.2 x (7,476 watts) - 94.2 days (cloudy) = 704,145 watts/year



B.4: Energy Savings - LBL Nomograph Comparisons

Base Case = Use no daylighting

Case 1 = Daylighting as designed

Case 2 = Daylighting redesign

The amount of window area in our redesign (Case 2) stayed the same as the initial design (Base/Case 1), the main difference in our design on this LBL Nomograph was the Design Illuminance Level (Red Arrow).

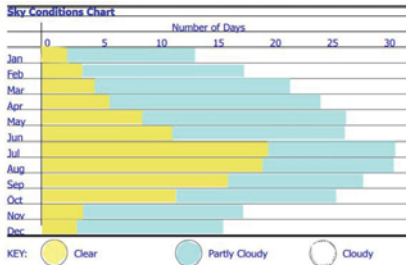
Annual Energy Savings Due to Daylight changed by 4% going from 47.0% to 52.0%.

		Base	Case 1	Case 2
1.	Enter LATitude of building location	LAT = 47	47	47
2.	Enter the Daily Occupancy Period Code from box below (1-11): 1=7a3p, 2=7a4p, 3=8a4p, 4=8a5p, 5=8a6p, 6=8a7p, 7=8a8p, 8=9a5p, 9=9a6p, 10=9a7p, 10=9a8p, 11=9a9p	DOPC = 3	3	3
3.	Enter Typical Floor Width (ft):	FL = 17	17	17
	Enter Typical Floor Length (ft):	FW = 37	37	37
	Typical Floor Area (ft) = FL * FW = FA =	629	629	629
4.	Enter Typical Floor Shape (Length - Width) = FS =	2.17647	2.17647	2.1765
5a.	Enter Lighting Control Type (1 = on/off; 2 = dimming):	LCT = 1	1	1
5b.	Enter Design Illuminance Level (30, 50, or 70 fc) =	DIL = 30	30	50
5c.	Enter window area, per floor above the workplane (sf)	WAAW = 420	420	420
	Enter typical ceiling height above floor (ft)	CH = 10	10	10
	Floor Perimeter (ft), FP =	108	108	108
	Side-Lighting Glass Area Fraction = WAAW / (CH * FP) = SLGAF =	0.389	0.389	0.389
	Enter skylight or monitor glazed area (sf):	0	0	0
	Top-Lighting Glass Area Fraction: glazed aperture area / floor area = TLGAF =	0	0	0
5d.	Enter Side-Lighting Glass Visible Transmittance (0-0.8) =	SLGVT = 0.8	0.8	0.8
	Enter Top-Lighting Glass Visible Transmittance (0-0.8) =	TLGVT = 0	0	0
	Enter Well Factor (0.2 to 1.0; depends on well depth and reflectance) =	WF = 1	1	1
6.	Enter Annual Hours of Occupancy (hr)	AHO = 1080	1080	1080
7.	Enter Installed Lighting Load (watts/st, typically 1.0 to 3.0)	ILL = 1.6	1.6	1.6
8.	Electricity Cost (\$/kWh, typically 0.10 to 0.25)	EC = \$0.10	\$0.10	\$0.10
9.	Enter No. of Floors:	NF = 1	1	1
	Enter daylighted width (ft; 15 is typ. for conventional windows)	DW = 24.5	24.5	24.5
	Gross Total Building Area = NF * GAFP = GTBA =	629	629	629
10.	Enter Non-Lighting Electric Load (watts/st; 3.0 is typical for office buildings)	1.0	1.0	1.0
11.	Peak Electric Utility Demand Rate (\$/kW-month; 2.50 is typical for office) (PDR) =	\$1.70	\$1.70	\$1.70
12.	Daylighted Hours (determined from DOS)	99.0%	99.0%	99.0%
13.	Total Daylighted Area (% of total; based on entered depth for sidelit; 100% for top)	TDA = 39%	39%	39%
14.	Control Effectiveness (determined by LCT, side or top-lighting, and DIL):	68%	68%	68%
15.	Enter Dimming Factor (0 - 1.0; typically 0.8 for dimming systems; 1.0 for on)	DF = 1	1	1
16.	Annual Energy Savings Due to Daylighting	47.0%	47.0%	52.0%
17.	Peak Load Savings Due to Daylighting	39.0%	39.0%	39.0%

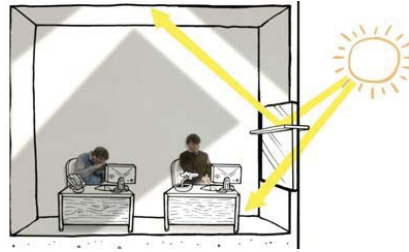
C.1/C.2: Daylighting Redesign

Recommended Daylighting Factor

VISUAL TASKS	ILLUMINATION (FC)	ILLUMINATION LUX
Circulation spaces & Dining	10 – 20 fc	100 – 200 lux
Light work space (reading, etc.)	20 – 40 fc	200 – 400 lux
Visually intense tasks (fabrication, etc.)	60 – 100 fc	600 – 1,000 lux
Display areas	100 – 150 fc	1,000 – 1,500 lux



Hours of Adequate Daylight Each Season



Proposed Light Shelf for Classroom

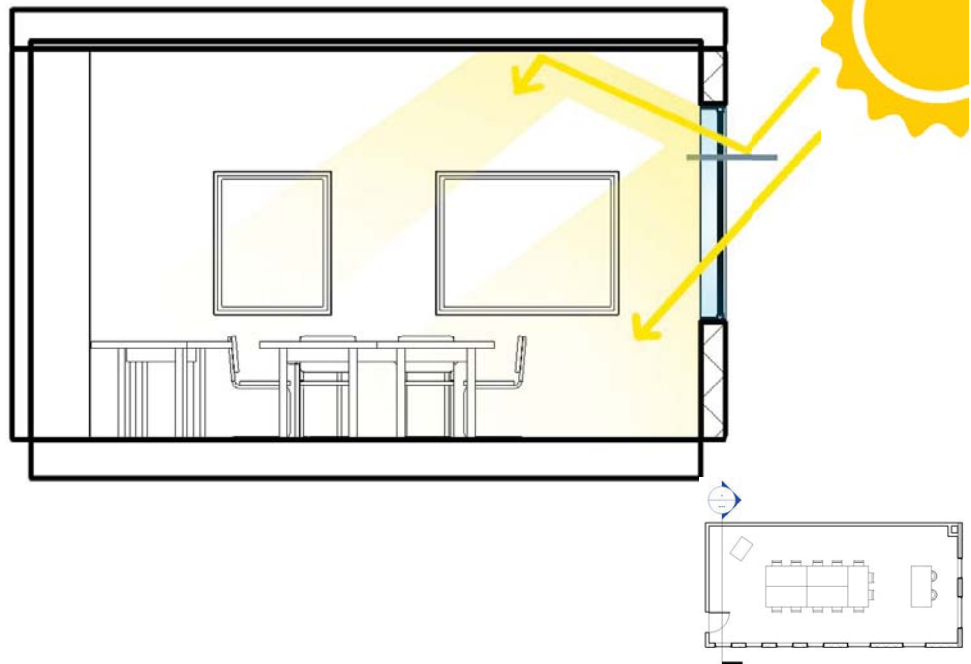
Building Type	Activity	DF (%)	Comments
All Public Buildings	Circulation	0.5-3.0	Minimum is sufficient; higher levels required in transition areas from bright space
	Lobbies, Foyers, Lounges	1	Individual task lighting may be necessary for reading.
	Reception Desks	1.0-2.0	Dependent on difficulty of task involved.
Assembly, Concert Halls	Restrooms	0.0-1.0	Need not be daylighted.
	General	0.0-1.0	Do not daylight if incapable of blocking out light for media presentations.
Banks	General	2.0	
	Pulpit	1.5-4.0	
Churches	Congregation	1.0	
	Wards, Public	1.0	Provide individual task lighting for reading.
Hospitals	Laboratories	3.0	Provide task lighting.
	Operating Room, Examining Room	3.0-5.0	Privacy and thermal considerations may override use of daylighting.
Industrial	High Resolution Work	5.0	Taplighting is recommended.
	Other Work	2.0-3.0	Provide task lighting where appropriate.
Libraries	Stacks	1.0	Additional artificial lighting is required.
	Reading, Study Areas	1.0	Provide individually controlled task lighting.
Musea, Galleries	General	1.0	Additional artificial lighting may be required for emphasis; daylighting may be inadvisable where light-sensitive materials are displayed.
	General	2.0	Provide task lights or lower DF with photocontrolled electric lighting.
Offices	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.
	Kitchens	2.0	Provide task light at work stations; recommended levels should penetrate one-third to three-quarters of the room; if elderly people are often present, higher levels are suggested.
Residential	Living Rooms	1.0	
	Bedrooms	0.5	
Schools	Assemblies, Classroom	2.0	
	Art Rooms	4.0	
	Laboratories	3.0	
Sports	Staff Areas	1.0	
	Playing	2.0	
Swimming	Water	2.0	
	Deck	1.0	

Reprinted from Schlier (ed.), Simulating Daylight with Architectural Models, 211-212

C.3: Daylighting Redesign

Redesign Solutions

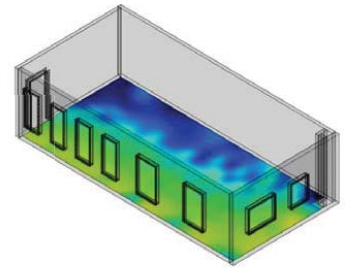
- Age-Old Adages #1 Openings high in the space distribute light deeply: Raise the windows on the East wall up to 3 ft sill height to help transmit light further into the classroom space and lowered total window height to 3ft 8in to line up with Northern window height.
- Add light shelves to diffuse the light more evenly throughout the space, reducing unwanted glare.
- Change glass type to Low-E to reduce solar heat gain, but still allow a maximum amount of daylighting into the space.
- Sensor operated lighting fixtures to reduce the unnecessary use of electrical light.
- Skylight over teaching area with retractable shading device for controlled over light exposure.
- Changed shiny smooth finishes to more granular finish to diffuse light.



C.3: Daylighting Redesign



Underlit: 33%
Well-Lit: 18%
Overlit: 49%

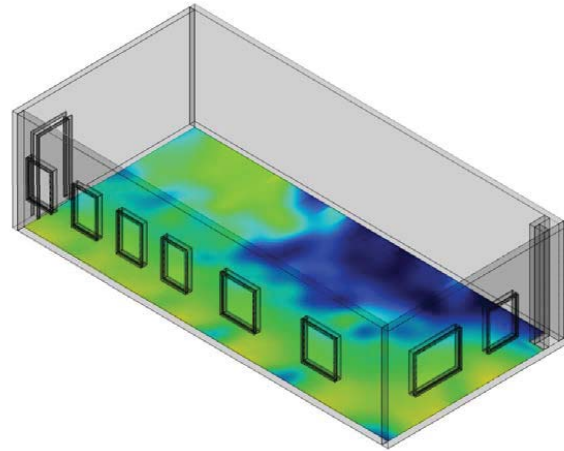


Redesign Analysis

- More light transmitted into back of room and dispersed evenly throughout.
- By minimizing the apertures on the East facade, it lowered the amount of overlit area in the space.
- The change of the shiny finished surfaces helps eliminate some of the unwanted glare, making the space more enjoyable to use during class hours.



Underlit: 32%
Well-Lit: 28%
Overlit: 39%



Percentage of occupied hours where illuminance is at least 28 footcandles, measured at 2.79 feet above the floor plate.

Original design

Percentage of occupied hours where illuminance is at least 28 footcandles, measured at 2.79 feet above the floor plate.

Conclusion

In conclusion, we learned what the appropriate levels of footcandles are for each type of activity going on within a space. Spaces with higher intensity activities have higher footcandles whereas tasks not as tedious allow for less light / footcandles. Having good daylighting can help cut down on electricity costs and minimize glare making the room a more comfortable space to be in.

