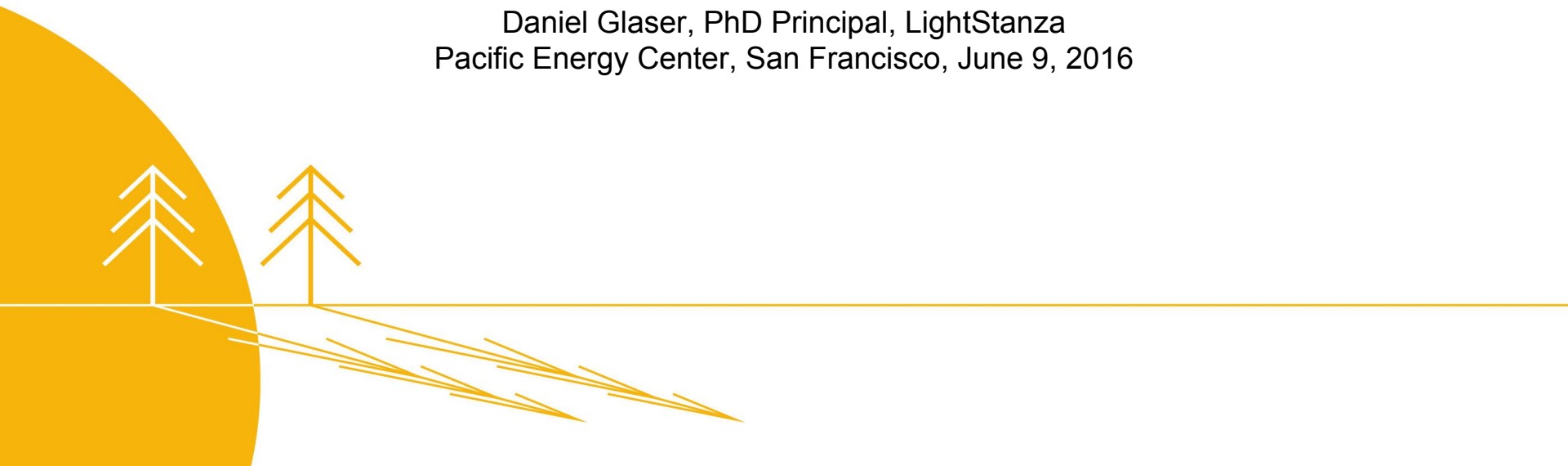
Spring Education Seminar:
A Complete Picture of Daylight

Daniel Glaser, PhD Principal, LightStanza
Pacific Energy Center, San Francisco, June 9, 2016



Agenda

1. Overview of major differences between LEED v2009 & LEED v4
2. LEED v4 Daylighting EQc7: Compliance Paths
3. Daylighting Metrics: How to Engage & Interpret
4. Going Beyond the Workplane
5. Advanced Topics
6. Daylight Metrics In-Class Exercise
7. Case Study/Demo
8. Q&A

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How do you use daylighting?

- Architects? Consultants? Lighting Designers? Engineers? Students? Software Developers?
- Who has pursued the LEED v2009 daylight credit?
- Who has pursued the LEED v4 daylight credit?
- What specifically do you want to get from this talk?

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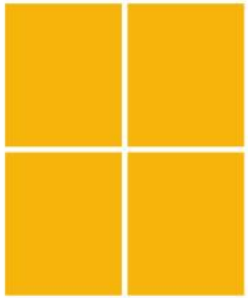

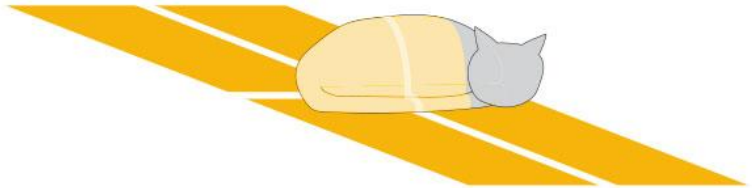

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LEED v2009 vs. LEED v4: Intent

To provide building occupants with a connection between indoor spaces and the outdoors through the introduction of daylight and views in the the regularly occupied areas of the building.

LEED v2009 IEQc8.1 - Daylight

To connect building occupants with the outdoors, ***reinforce circadian rhythms***, and ***reduce the use of electrical lighting*** by introducing daylight into the space.

LEED v4 EQc7 - Daylight

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LEED v2009 vs. LEED v4: Daylight Prevalence

Indoor Environmental Quality: 4/15

LEED v2009 IEQc8.1 - Daylight

Indoor Environmental Quality: 6/16

LEED v4 EQc7 - Daylight

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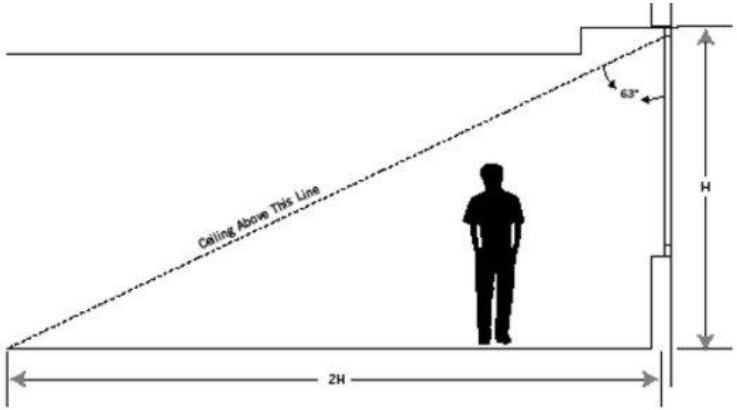
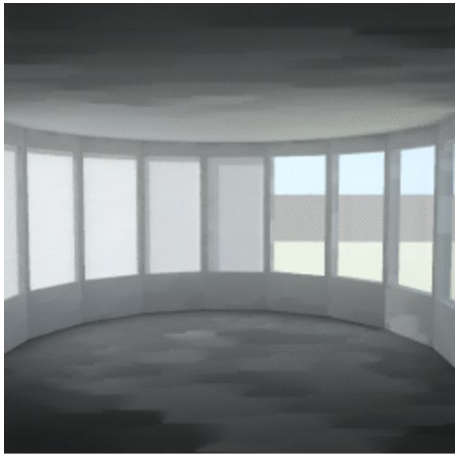
LEED v2009 vs. LEED v4: Process



Allows simplified **prescriptive** path for full credit.

LEED v2009 IEQc8.1 - Daylight



March 21, 09:00 AM

Requires robust **annual simulation** (ASE & sDA) for full credit.

LEED v4 EQc7 - Daylight

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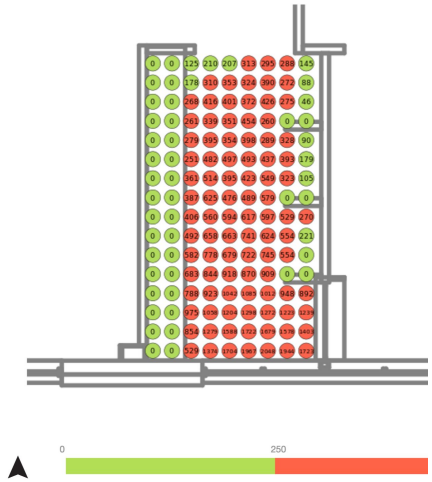
LEED v4 Daylighting EQc7: Compliance Paths

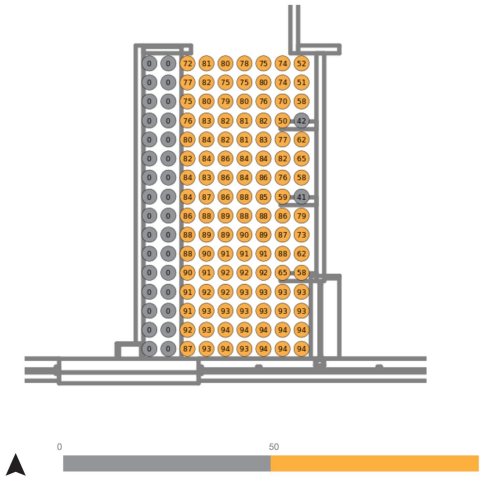
ASE

✕ 65.28 %



sDA

✓ 75.69 %



Option 1 (2-3 Points): Simulation: Spatial Daylight Autonomy (sDA) & Annual Sunlight Exposure (ASE)

1. Demonstrate through annual computer simulations that Spatial Daylight Autonomy$_{300/50\%}$ of at least 55%, 75%, or 90% is achieved. Use regularly occupied floor area.
2. Demonstrate through annual computer simulations that Annual Sunlight Exposure$_{1000,250}$ of no more than 10% is achieved. Use regularly occupied floor area that is daylit per the sDA simulations.

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LEED v4 Daylighting EQc7: Compliance Paths

✕ 67.36% September 21, 9:00am & 3:00pm

Option 2 (1-2 Points): Simulation: Illuminance Calculations

1. Demonstrate through computer modeling that illuminance levels will be between 300 lux and 3,000 lux for 9 a. m. and 3 p.m., both on a clear-sky day at the equinox. Use regularly occupied floor area.

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Daylighting Metrics: How to Engage & Interpret

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How to Simulate for Daylight?

Varies by Sky Type

Varies by Season

Varies by Hour

Precedents: DA, cDA, & UDI

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Daylight Autonomy (DA)

*The percentage of the time-in-use that a certain user-defined lux threshold is reached through the use of just **daylight**. DA is a useful metric for determining potential savings with an on/off dimming system.*

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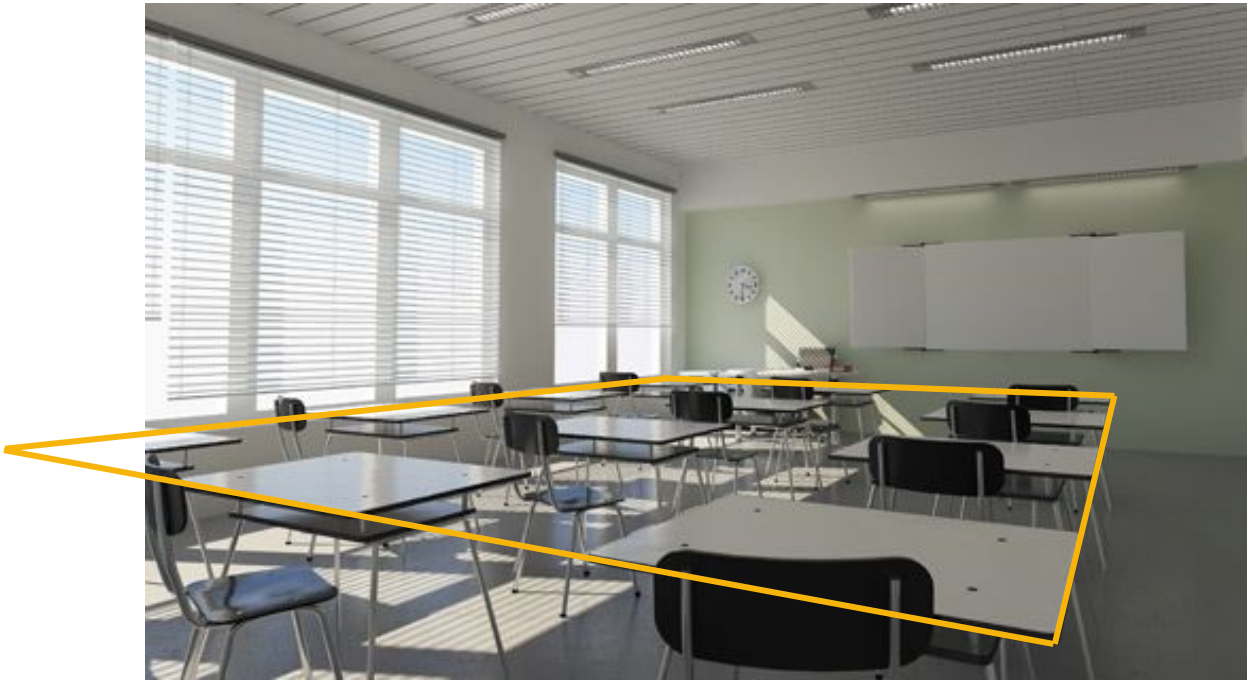
Daylight Autonomy (DA)

*The percentage of the time-in-use that a certain user-defined lux threshold is reached through the use of just **daylight**. DA is a useful metric for determining potential savings with an on/off dimming system.*



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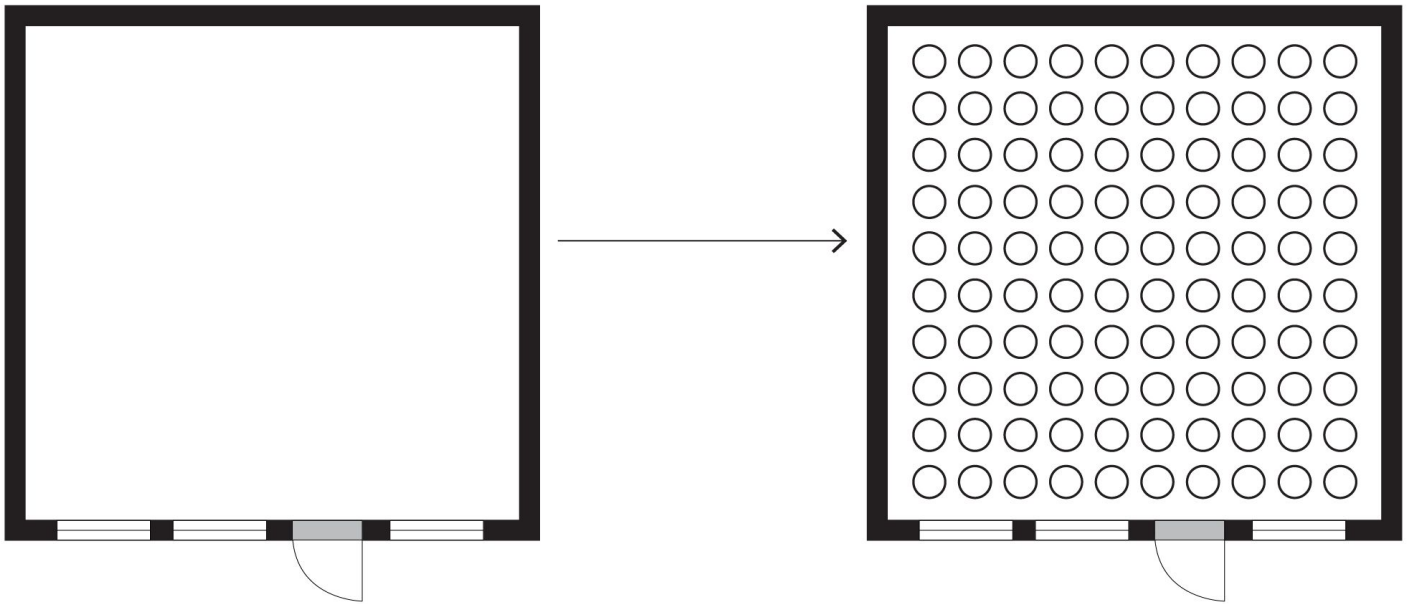
Create A Grid



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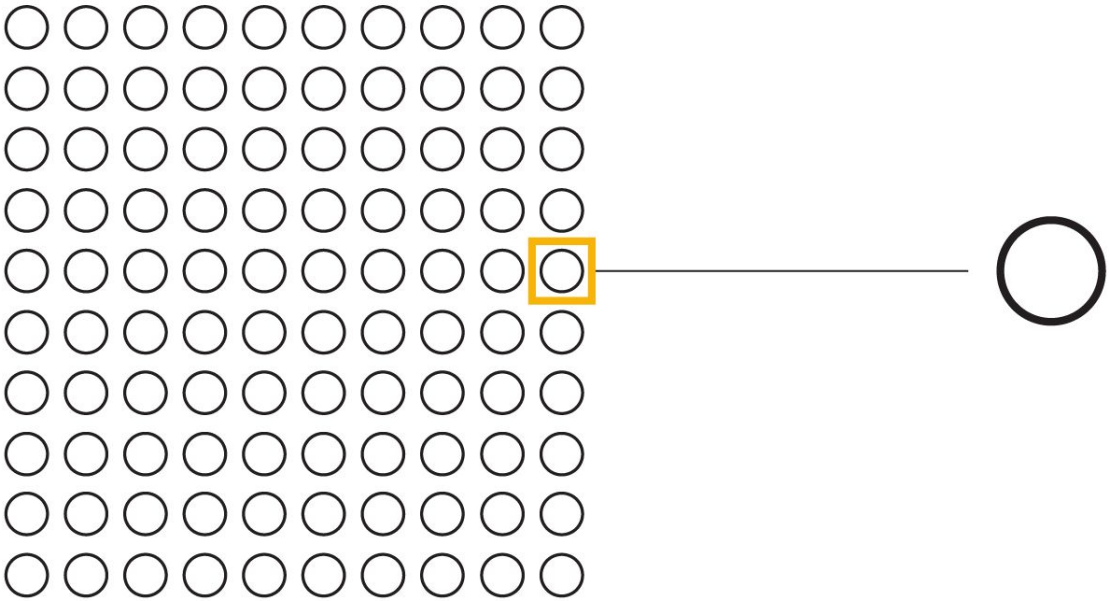
Start By Looking at a Single Point



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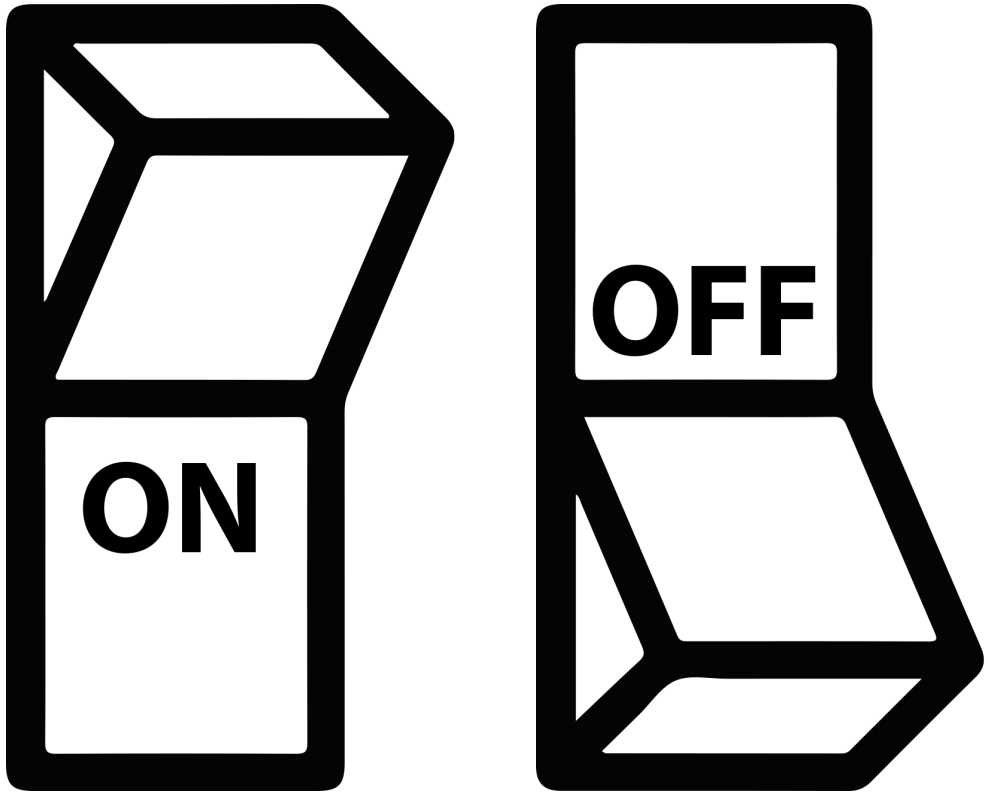
23

342



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Measure Point's Illuminance Hourly

	9 am	10 am	11 am	12 pm	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm
January 1	72	101	118	137	154	317	371	314	0	0
July 1	102	261	365	462	489	454	412	349	335	312
December 31	72	99	118	137	110	302	368	305	0	0

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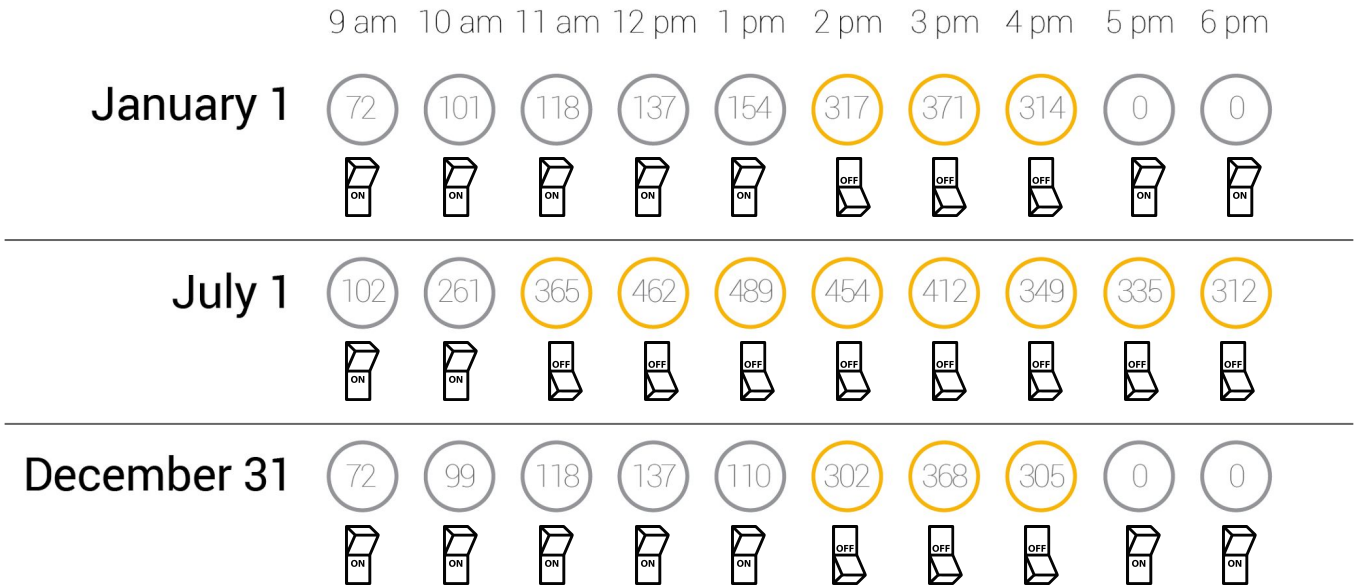
Determine if Point Meets Target Threshold (300 lux)



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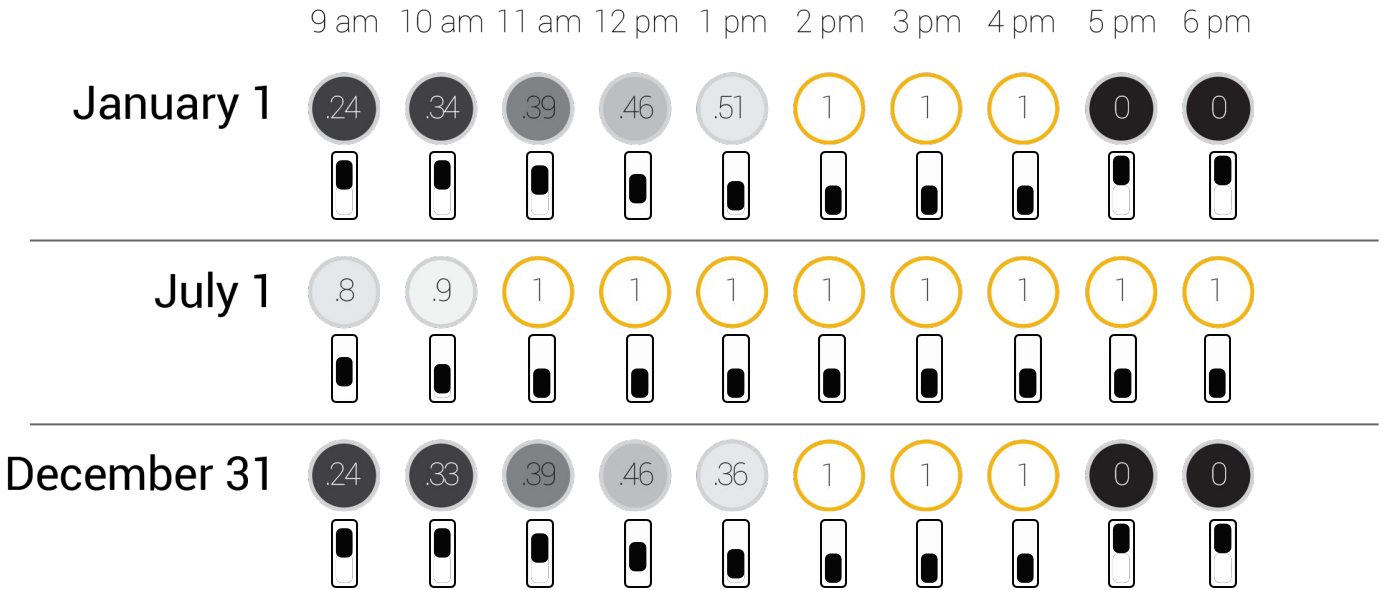
Continuous Daylight Autonomy (cDA) - Partial Credit



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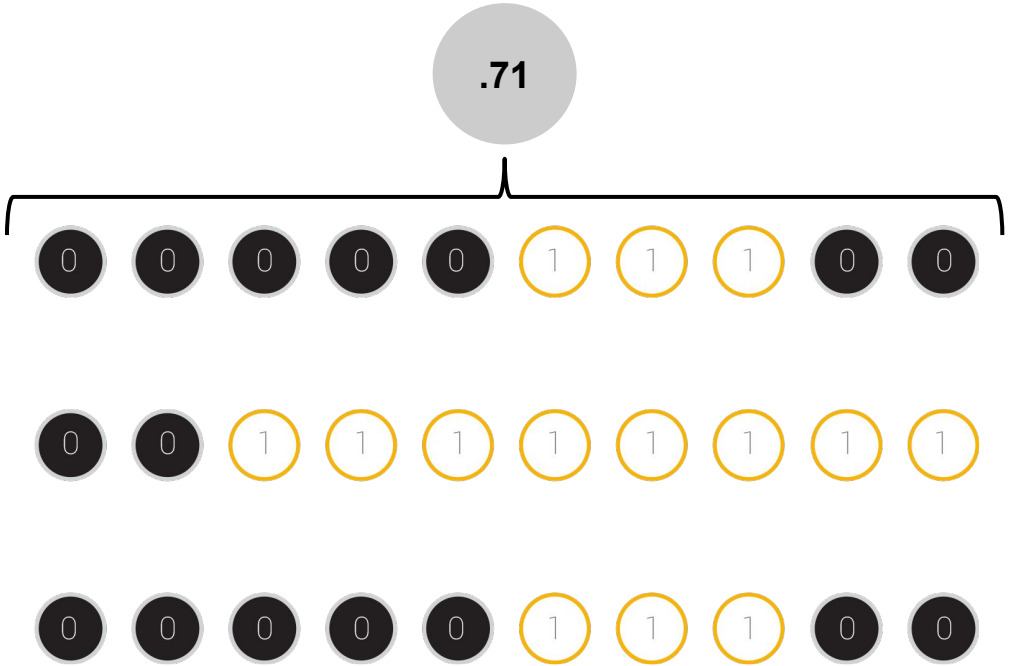
Average Across Year



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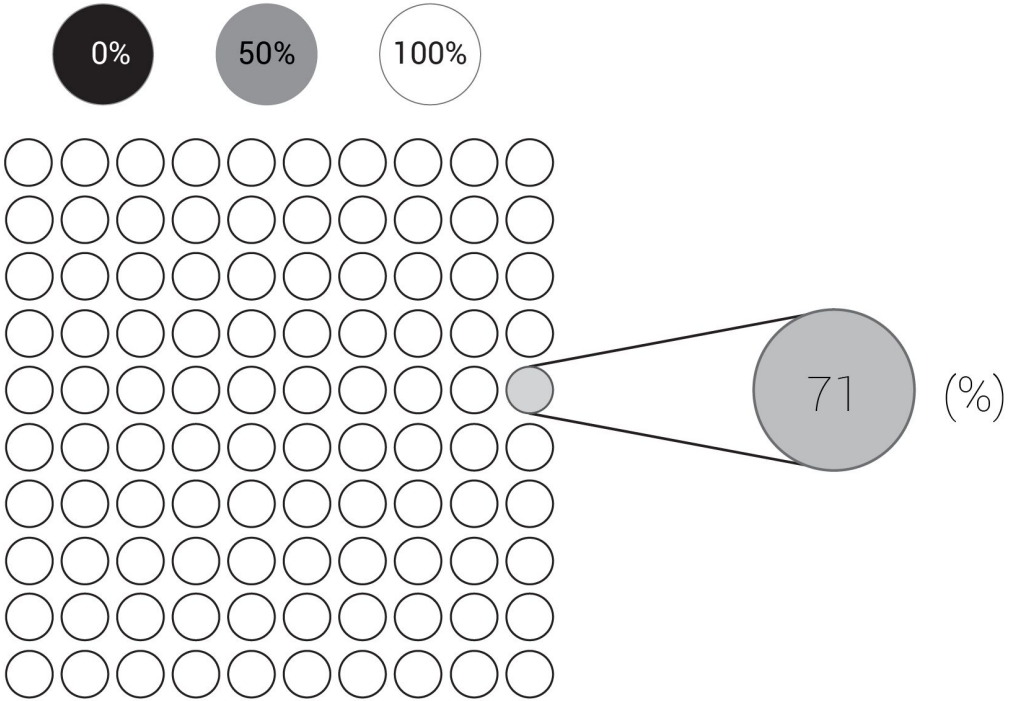
Score Each Point

Percent of time at or above illuminance threshold of 300 lux



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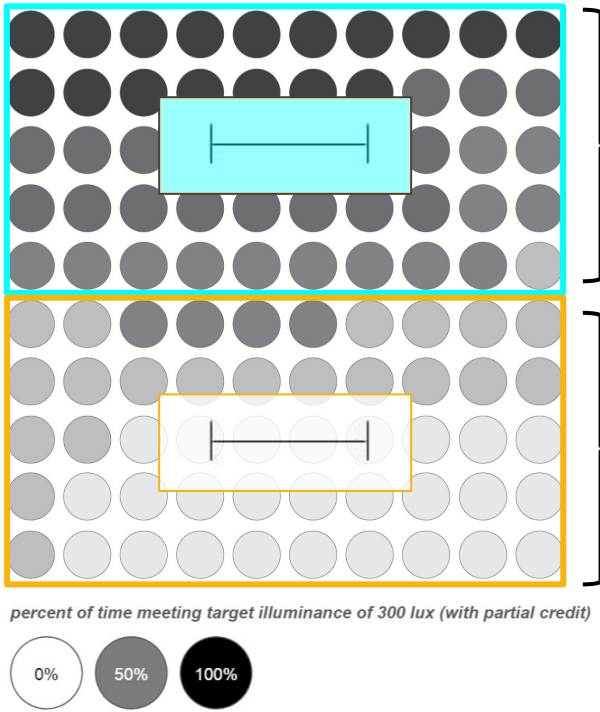
Final Result



Daylight Autonomy 300 lux = 27%
- Light **On**

Daylight Autonomy 300 lux = 82%
- Light **Off**

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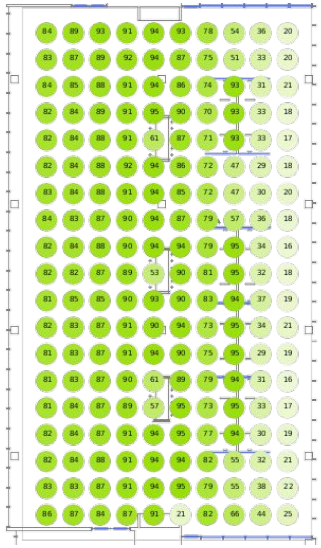
Useful Daylight Illuminance (UDI)

72.39 %



percent of time within target illuminance range (100 - 3000 lux)

0% 50% 100%

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The New LEED v4 Metrics: ASE & sDA

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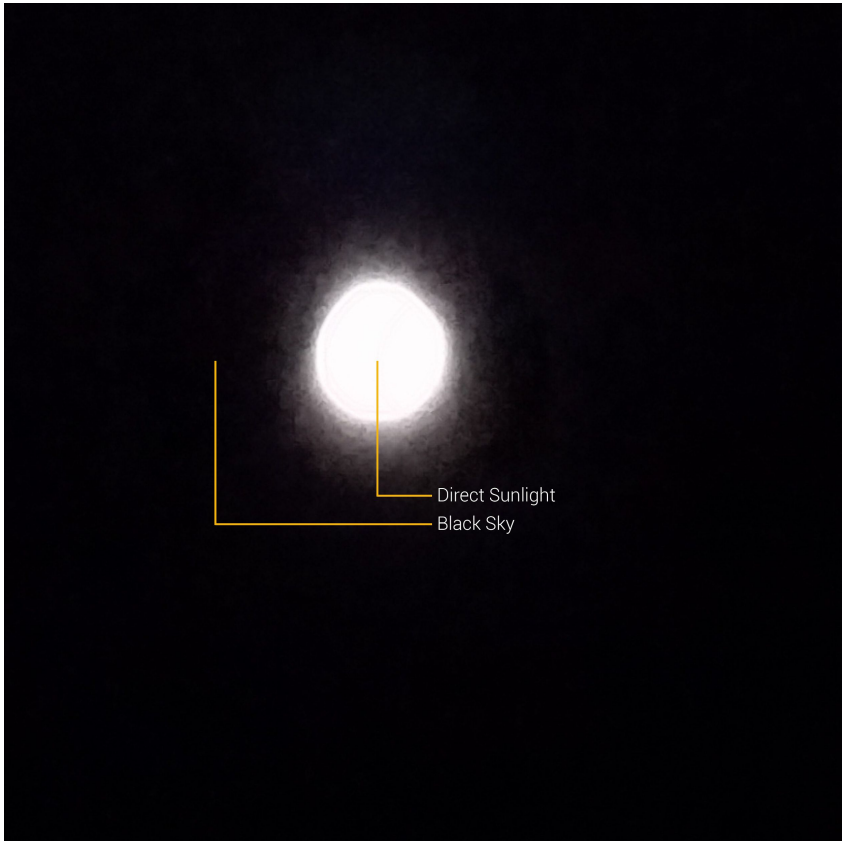

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Annual Sunlight Exposure

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Annual Sunlight Exposure: First Measure Workplane

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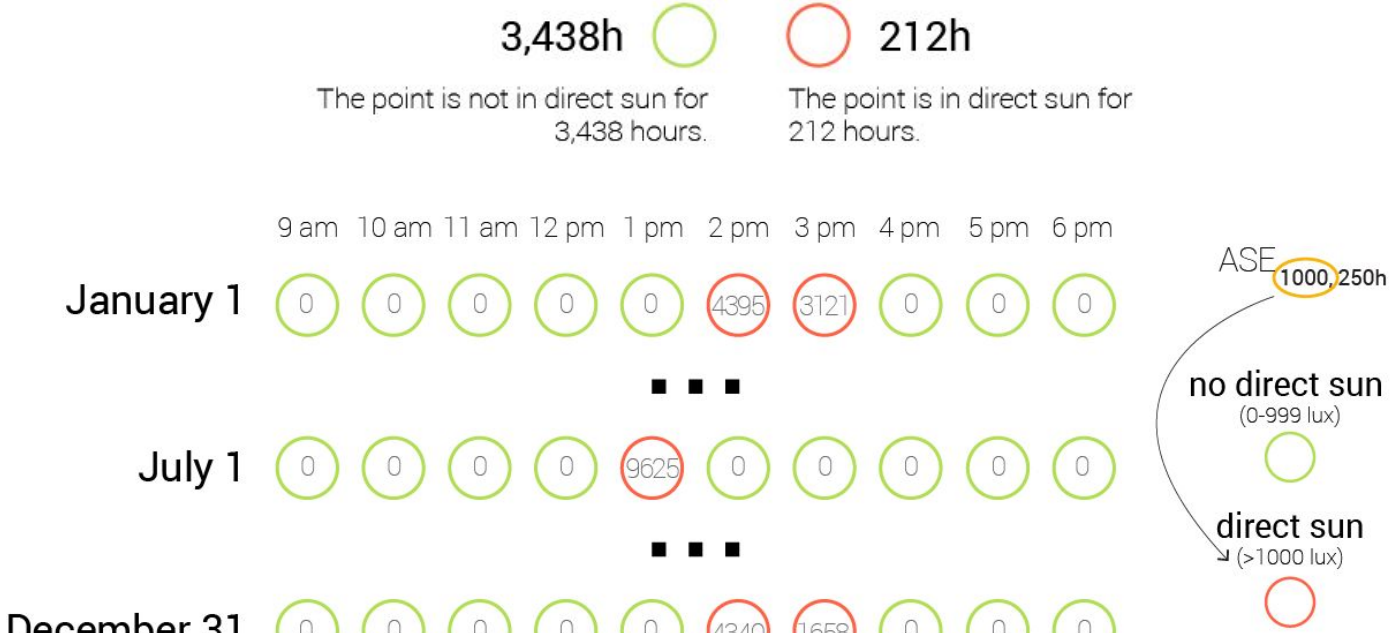
Evaluate Lighting Levels



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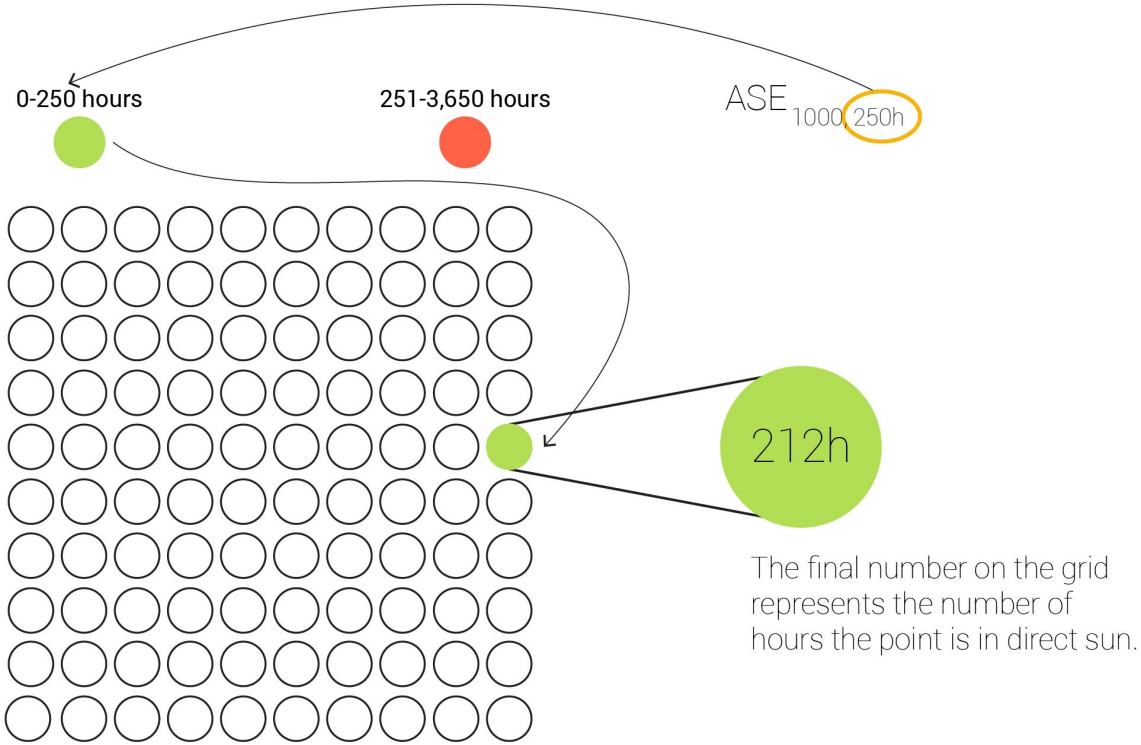
Score Each Point



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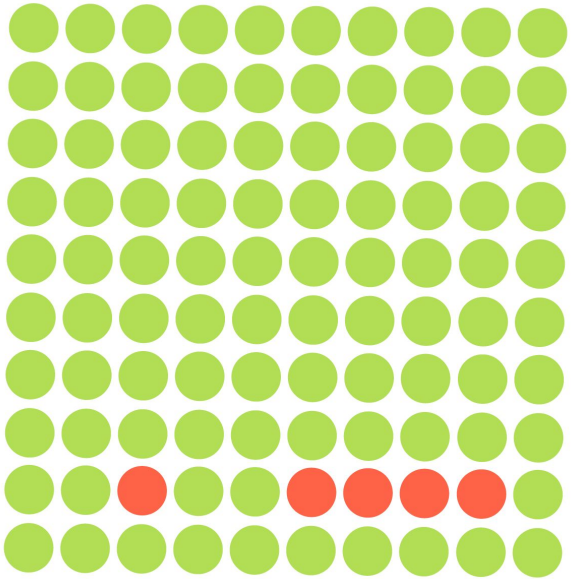
Final Result



95

Points on the grid that are in direct sun for **less than 250 hours.**

5

Points on the grid that are in direct sun for **more than 250 hours.**

0-10% - acceptable
10.01-100% - unacceptable

5% - acceptable

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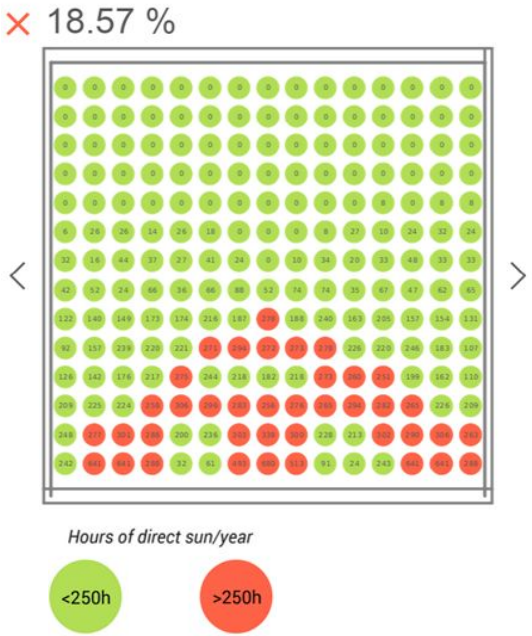
Classroom Example: No Overhangs or Shelves



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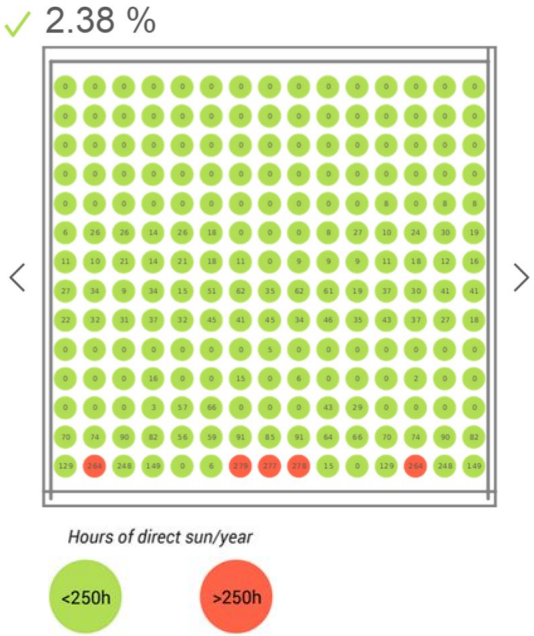
Classroom Example: With Overhangs and Shelves



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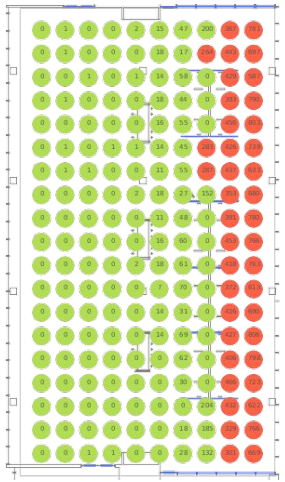
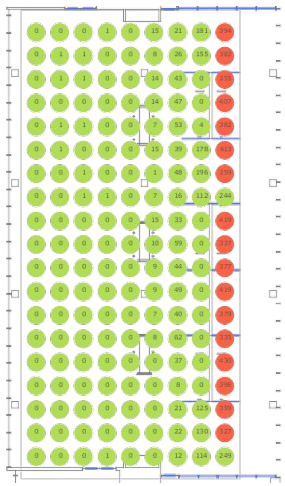
Office Example

Removal of Circulation Area:

ASE = 21.5% ✗



ASE=9.5% ✓



Hours of direct sun/year

<250h >250h

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Institutional Example

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$sDA_{300/50\%}$

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Blinds Operation Informs Electricity Use

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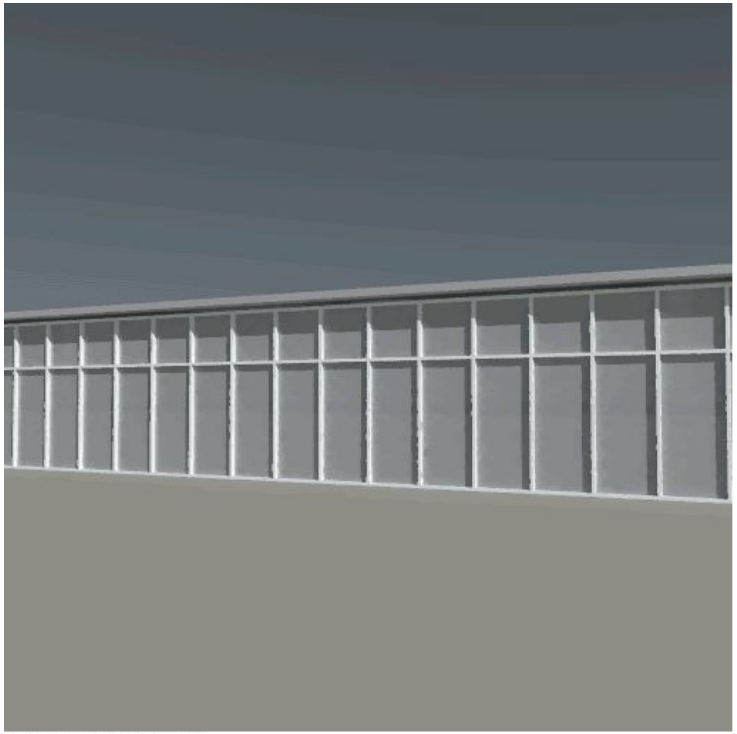
Blinds Operation: Human Aspect



March 21, 09:00 AM

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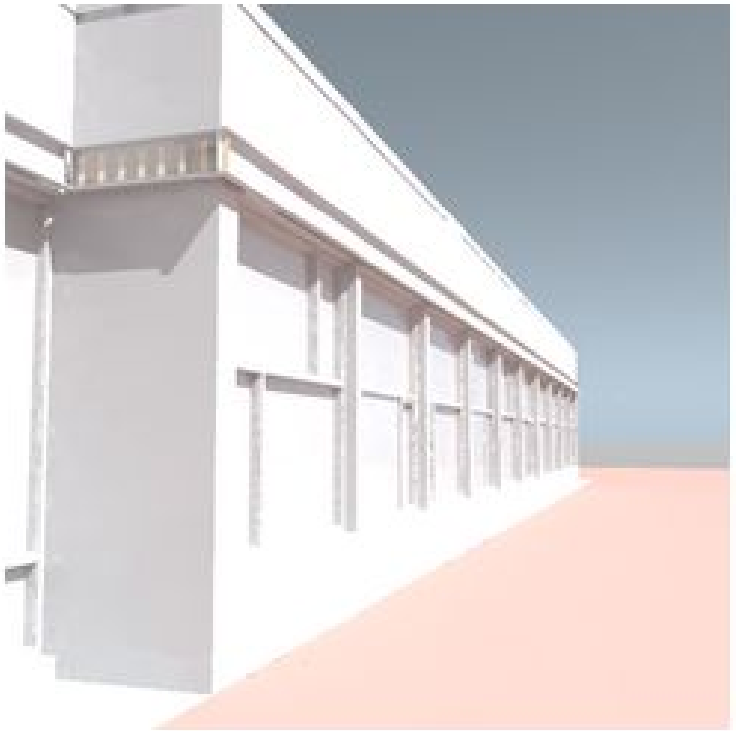
sDA Measures Realistic Daylight Availability



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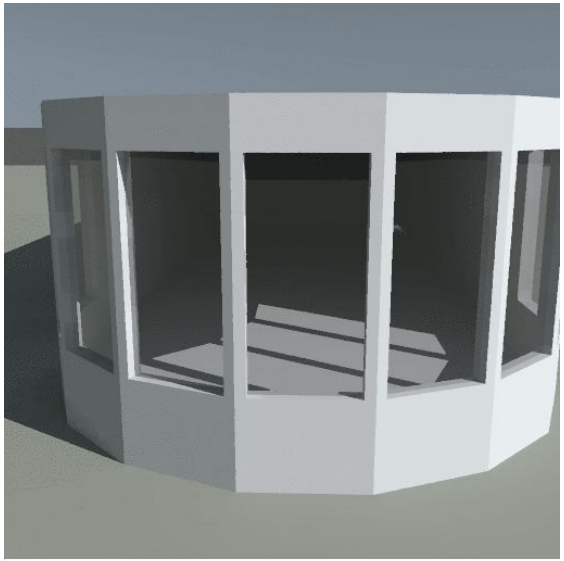
40.015, -105.271
Blinds sDA Specification



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40.015, -105.271
Blinds sDA Specification

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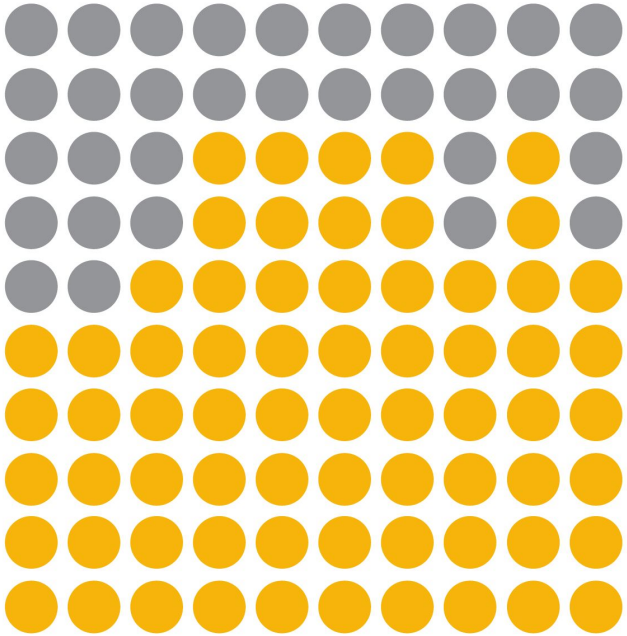
$sDA_{300/50\%}$ Sample Space



68

Points on the grid meet the threshold for at least 50% of the time.

32

Points on the grid do not meet the threshold for at least 50% of the time.

68% - *nominally acceptable*

0-54.99% - unacceptable
55-74.99% - nominally acceptable (2 points)
75-100% - preferred (3 points)

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Over Predicting Daylight Availability

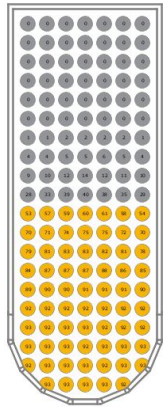
WITH BLINDS

Spatial Daylight Autonomy$_{300,50\%}$ (SDA)

Workplane

1x Quick Zoom

✕ 49.28 %



% of time at minimum illuminance threshold

< 50% (0-1,824 hours)

> 50% (1,825-3,650 hours)

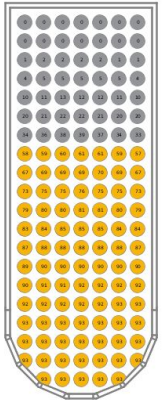
WITHOUT BLINDS

Spatial Daylight Autonomy$_{300,50\%}$ (SDA)

Workplane

1x Quick Zoom

✓ 64.49 %



% of time at minimum illuminance threshold

< 50% (0-1,824 hours)

> 50% (1,825-3,650 hours)

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Workplane Limitations

N

12	11	10	15	18	19	19	20	23	23	21	23	22	23	20
12	12	13	15	14	18	17	24	20	21	20	20	20	17	14
13	13	13	12	14	16	16	16	20	20	21	21	19	14	11
13	13	15	13	14	17	18	17	20	22	24	24	24	16	2
14	16	17	17	17	17	20	20	26	27	29	32	38	15	3
18	17	16	18	18	20	20	22	24	33	36	33	36	22	18
21	19	19	19	21	22	24	28	34	40	40	47	55	70	171
21	21	23	22	24	27	28	36	41	41	41	46	71	157	246
22	24	27	27	32	33	35	36	40	45	51	59	75	167	179
26	27	28	31	32	36	37	42	47	51	118	123	129	148	93
31	33	34	36	38	40	43	51	52	60	66	82	94	108	84
34	37	41	42	46	47	52	56	59	61	77	81	102	128	160
36	41	46	48	52	55	54	66	66	69	81	85	99	139	175
35	43	44	50	60	60	63	53	59	63	75	89	106	146	172
28	29	31	36	38	41	41	41	43	51	59	64	83	100	99

N

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Going Beyond the Workplane

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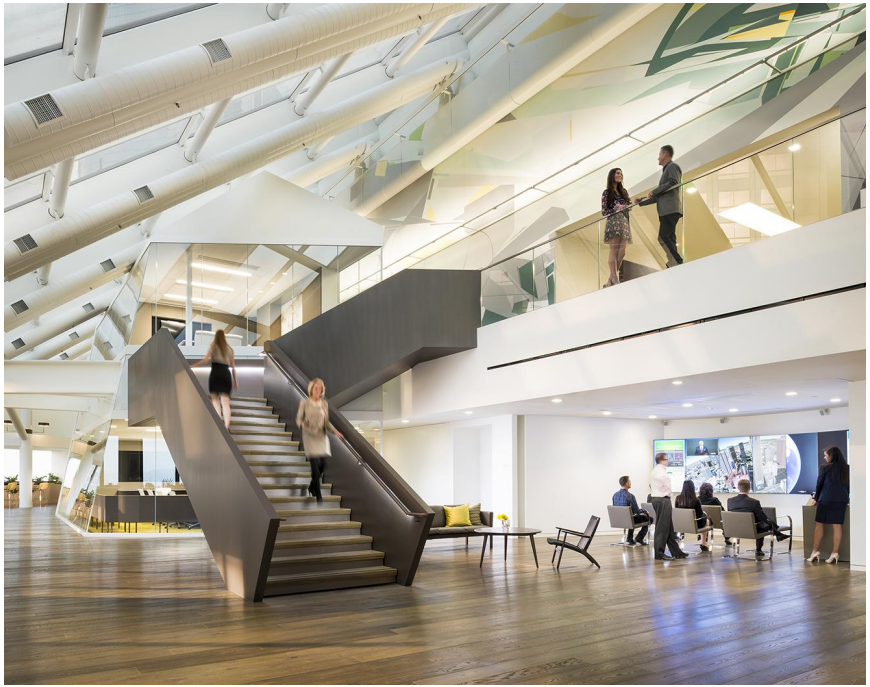
New Standards Like WELL™ Focus on Occupant Comfort

1. Lack of exposure to natural light has harmful effects on quality of sleep, level of alertness, emotional state, and overall wellbeing.
2. Up and coming protocols to help the body maintain circadian alignment and achieve:
    a. ideal lighting levels for various tasks
    b. reduced eye-strain and glare
    c. increased alertness
    d. improved quality of sleep
    e. decreased seasonal affective disorder
    f. Vitamin D synthesis



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First WELL Certified™ Office

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Qualitative Measurements for Occupant Comfort

June 21, 12:00 pm

34,833.4 max 0.0 min 650.9 avg 0.0 avg/min 53.5 max/avg 0.0 max/min

December 21, 12:00 pm

10,997.8 max 0.0 min 1,455.7 avg 0.0 avg/min 7.6 max/avg 0.0 max/min

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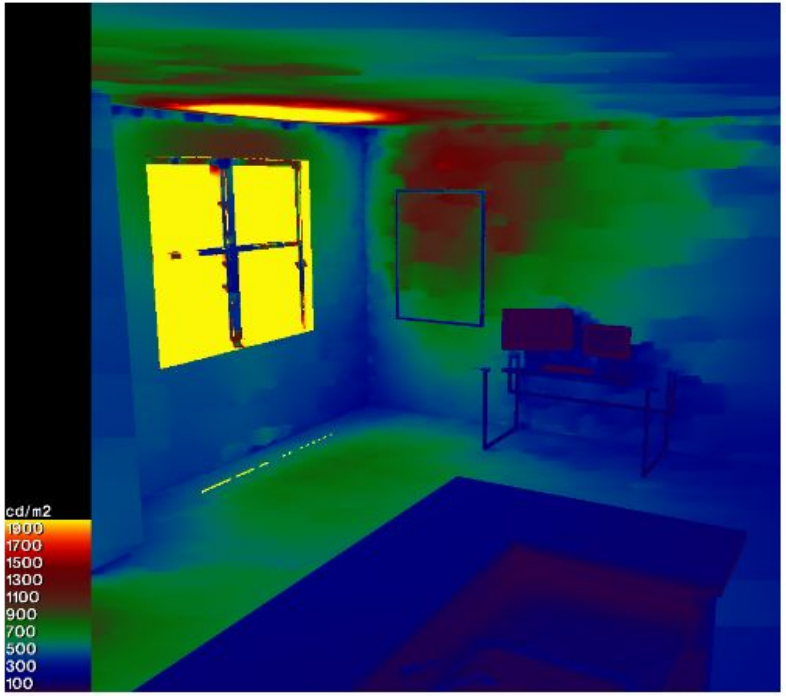
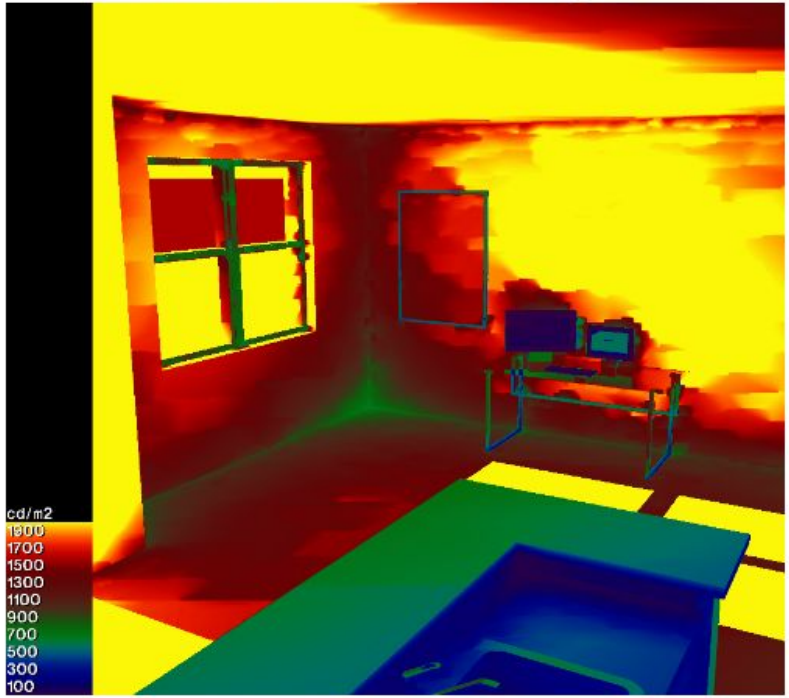
Qualitative Measurements for Occupant Comfort

June 21, 12:00 pm



December 21, 12:00 pm



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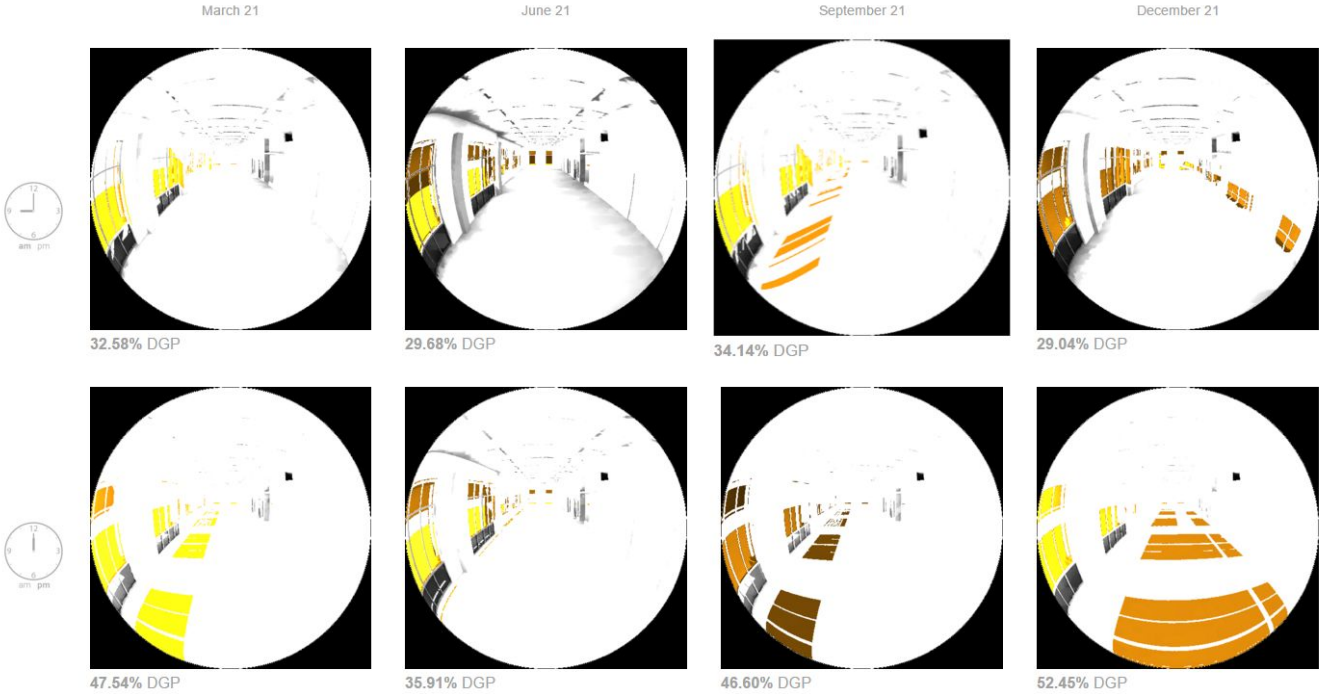
Daylight Glare Probability



0-35% Imperceptible, 35-40% Perceptible, 40-45% Disturbing, 45-100% Intolerable

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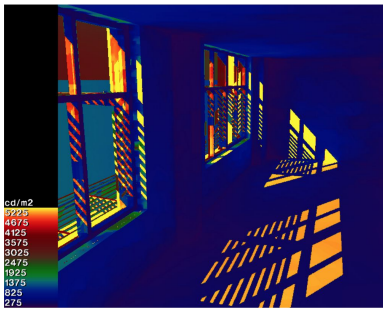
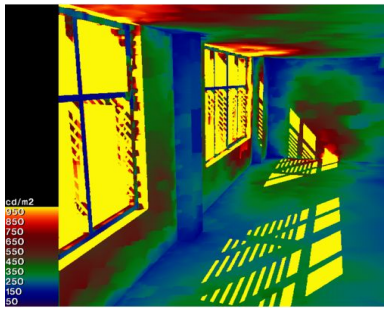
Iterations of Glazing Properties

40% Window Transmittance (VLT)



60% Window Transmittance (VLT)



Model Design by RNL Design

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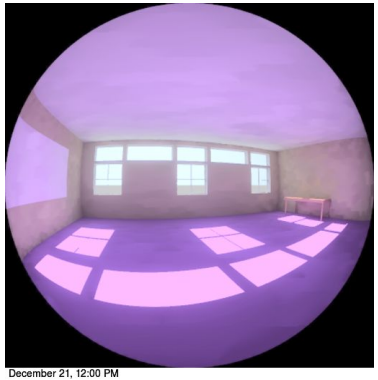
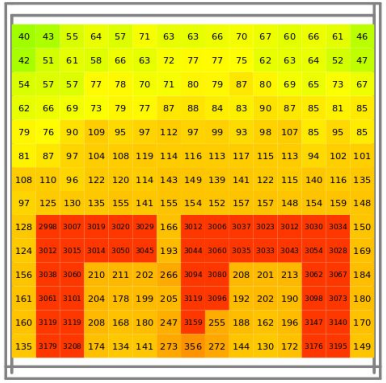
Experiment with Different Products

80% VT



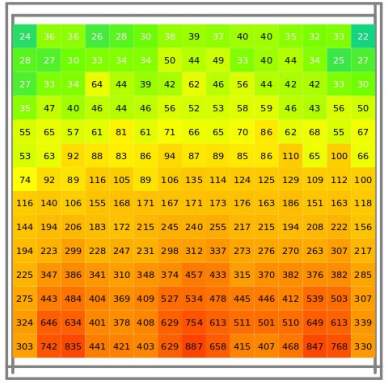
December 21, 12:00 PM



December 21, 12:00 PM

Redirecting Film 1

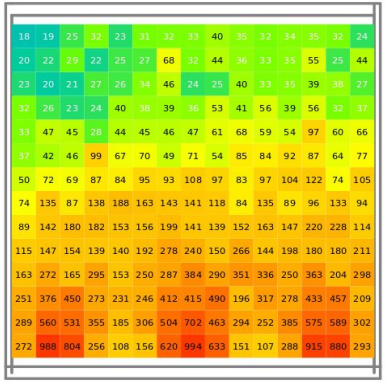
December 21, 12:00 PM



December 21, 12:00 PM

Redirecting Film 2

December 21, 12:00 PM



December 21, 12:00 PM

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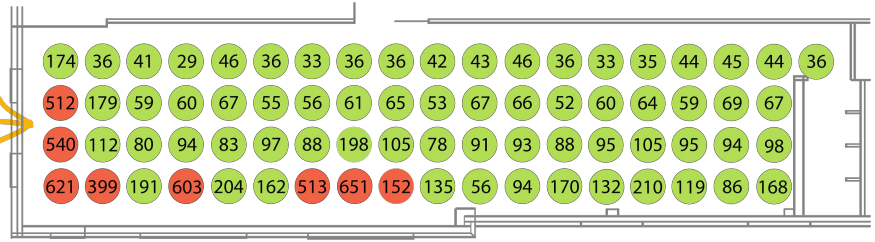
Iterations of Glazing Properties

Open Office 123 windows at **60% VT**

ASE score **15.07%**

Open Office 123 windows at **40% VT**



ASE score **10.96%**

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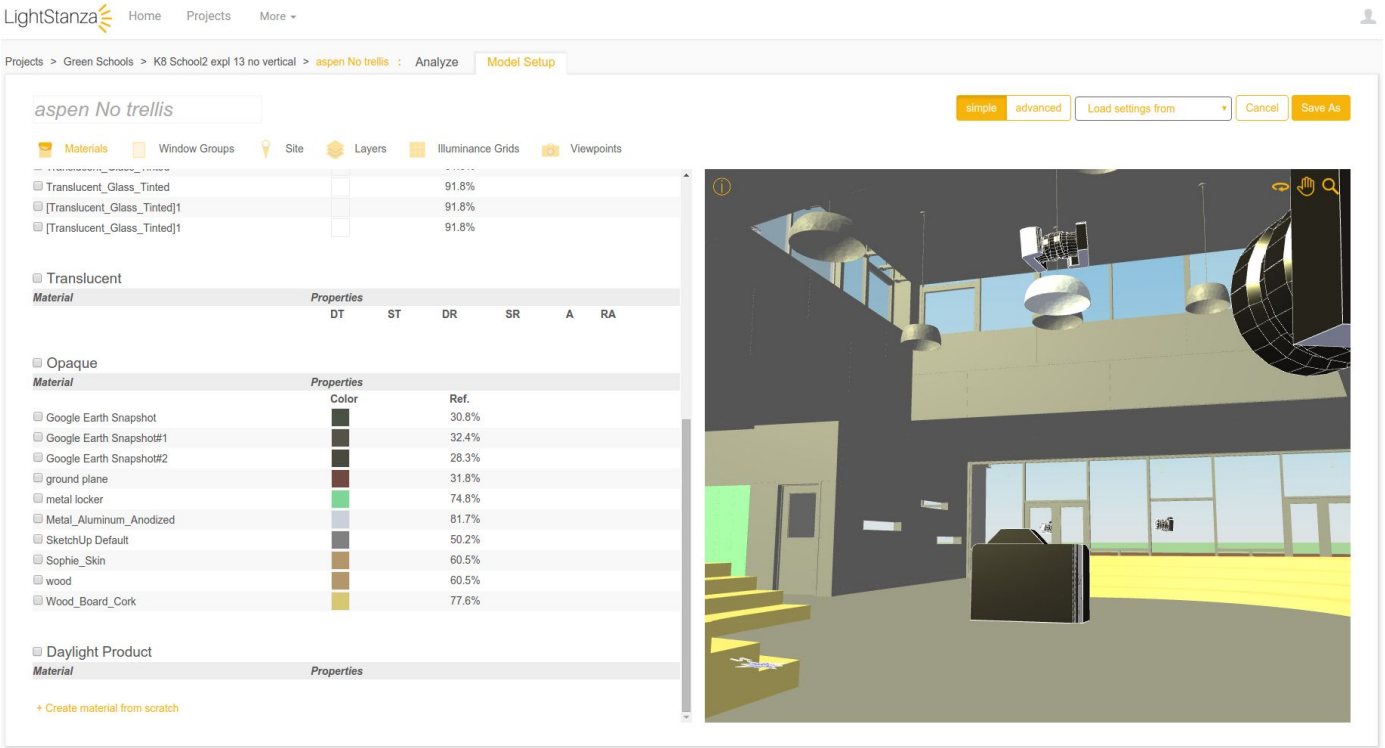
Case Study: Focus on Details



Cuningham Group, Architect of Record

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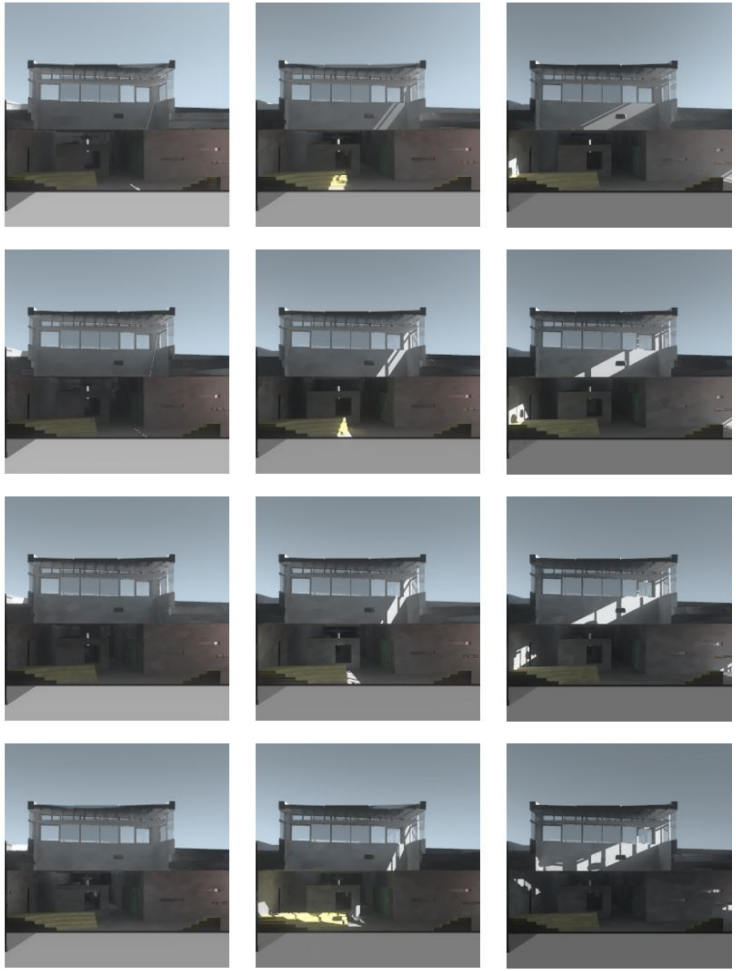

Cuningham Group, Architect of Record

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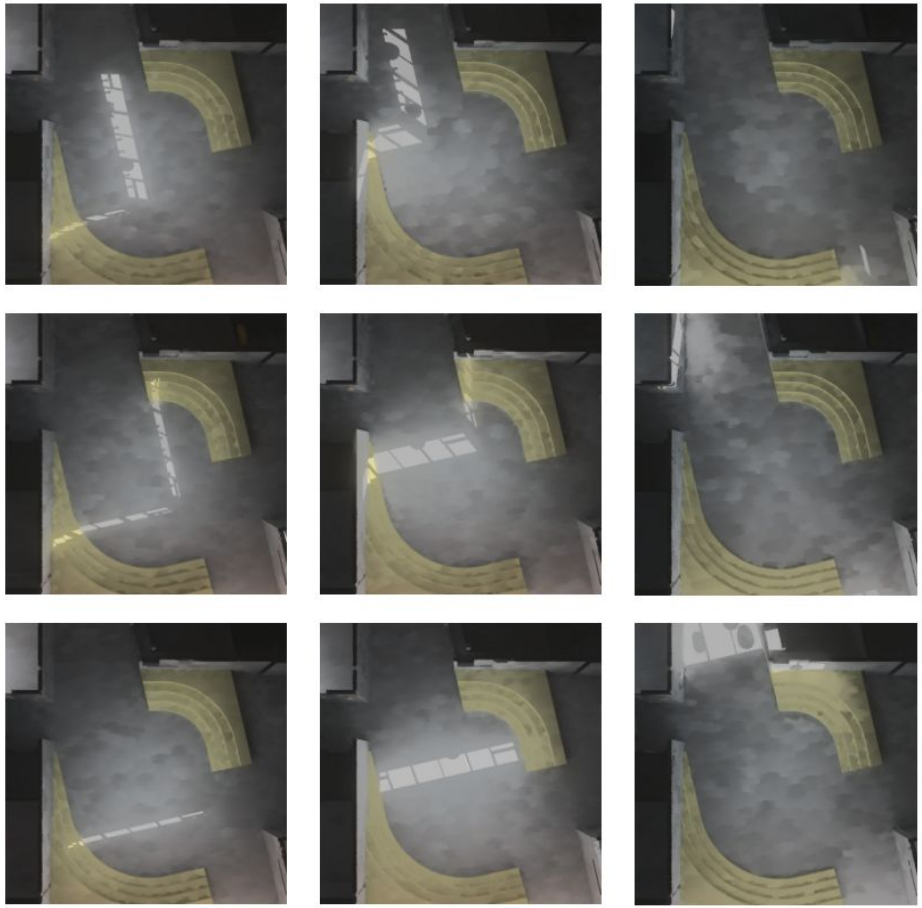

Cuningham Group, Architect of Record

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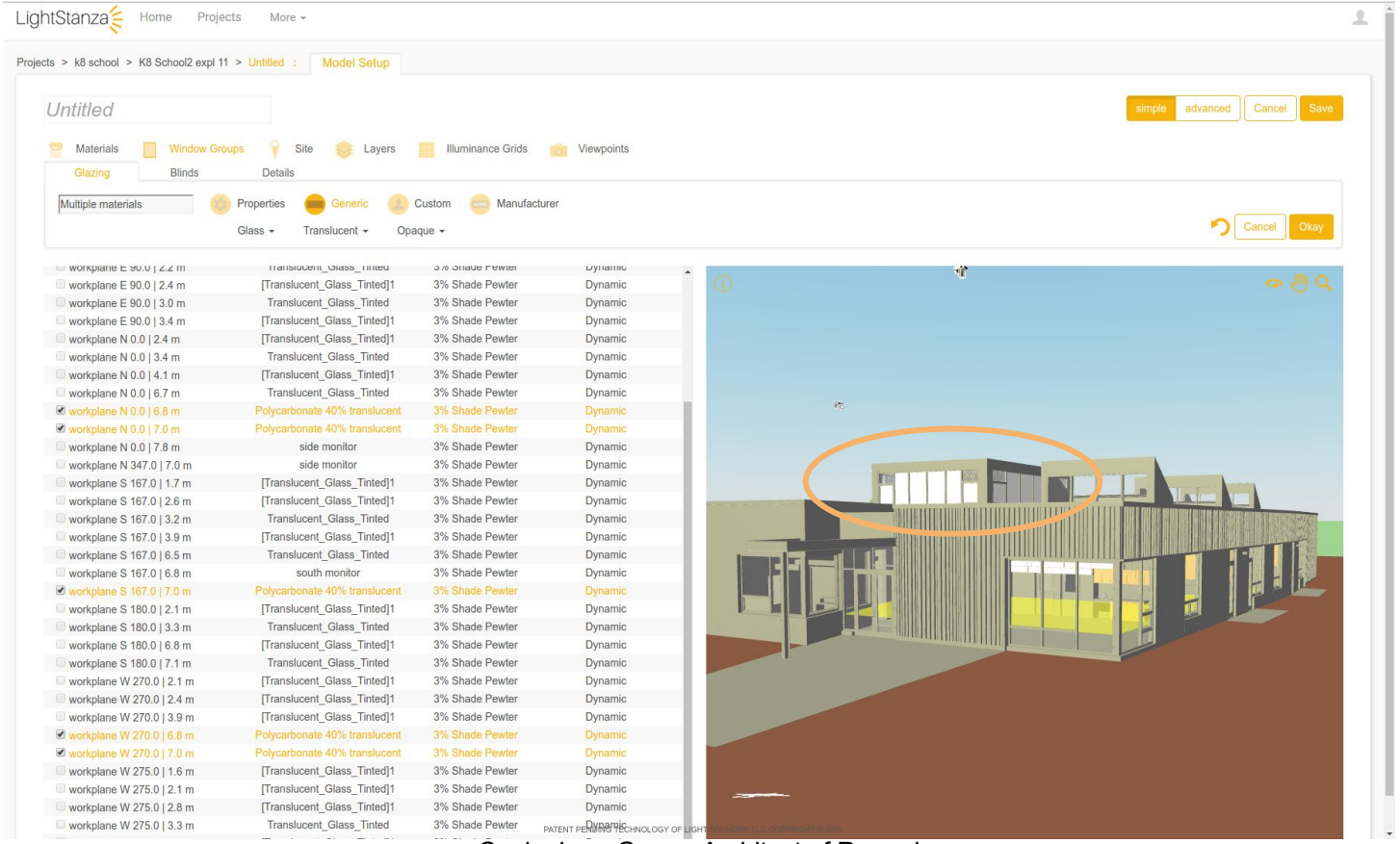

Cuningham Group, Architect of Record

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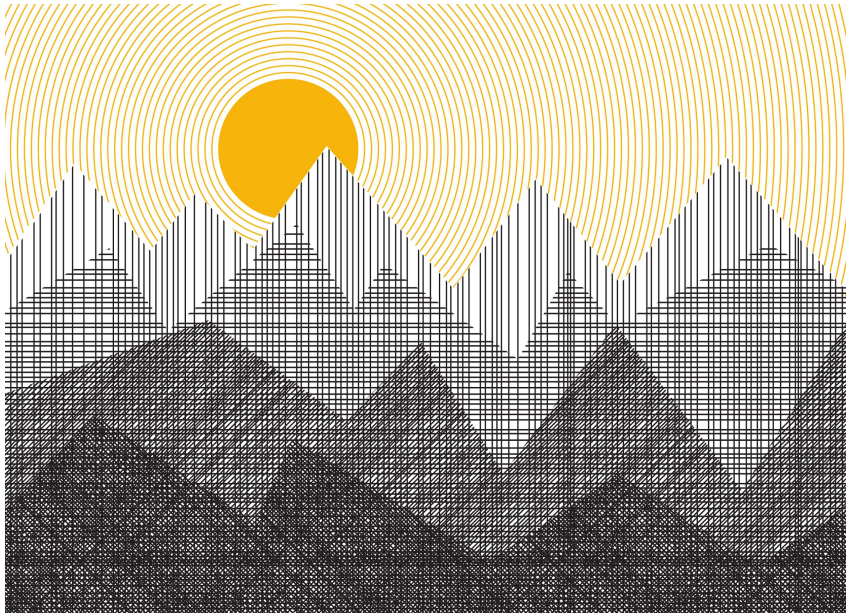
Summary



- LEED v2009 vs. LEED v4
- Daylight metrics are complicated, important for LEED v4 Credit
  - ASE, sDA
  - Think beyond the workplane
- Go beyond the workplane!
  - Occupant well-being
  - Point-in-time analysis; false color
  - Glazing, wall thickness, etc.
  - Climate variability

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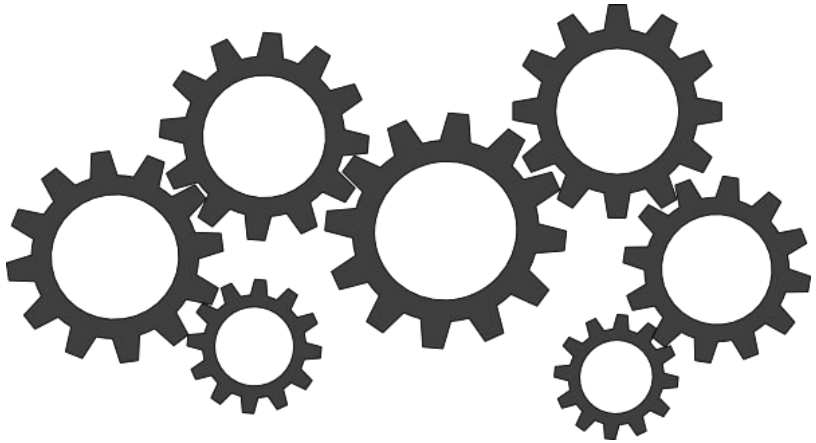
Advanced (But important!)



- Modeling Details
- Grid spacing
- Occupied Spaces
- Window Groups
- 2% Rule

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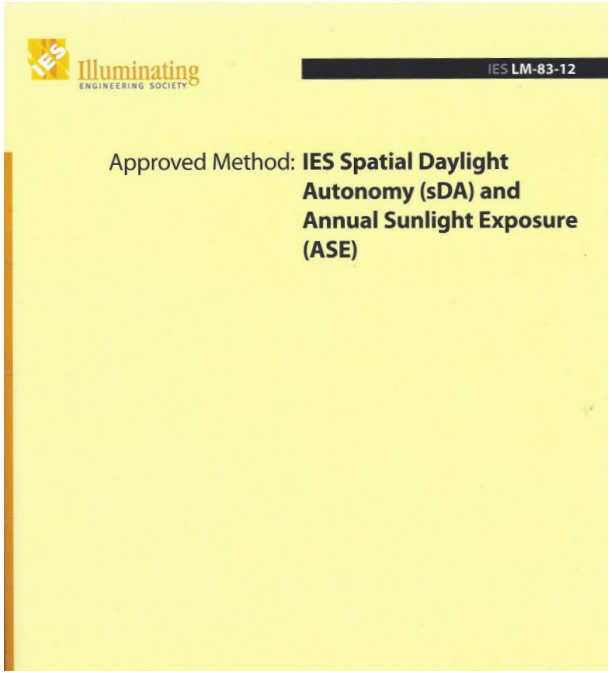
Modeling Details (IES LM-83-12 Excerpts)



2.2.8 Exterior Obstructions Exterior obstructions shall be modeled using at least the minimum level of detail described below.

1. Model all buildings and opaque structures within at least 100' of the spaces under study, including any surfaces of the modeled building itself. Such exterior obstructions shall be modeled with at least a resolution of 10' increments in dimensions.

2. Model trees as appropriately sized cones, spheres, or cylinders with 20% reflective component. More accurate shapes are allowable.

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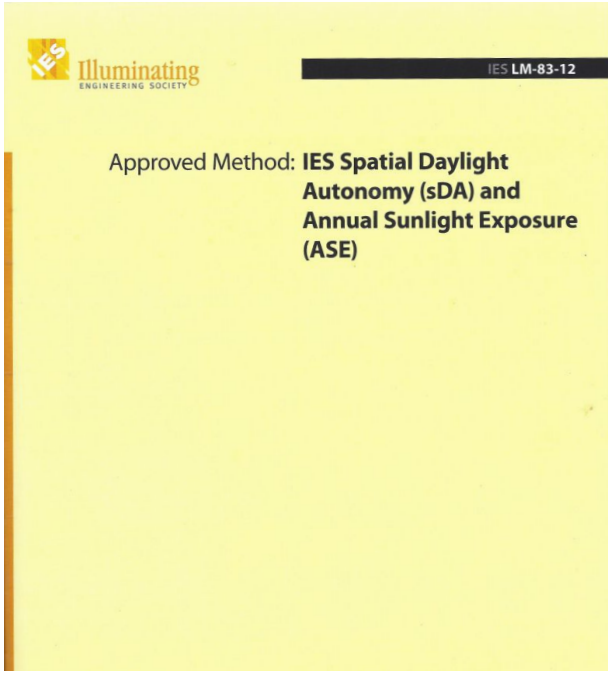
Modeling Details (IES LM-83-12 Excerpts)



2.2.9 Window openings should be modeled in three dimensions, per below.

2. Any window detail (sills, jambs, mullions, etc) greater than 2" in any dimension shall be modeled as such.

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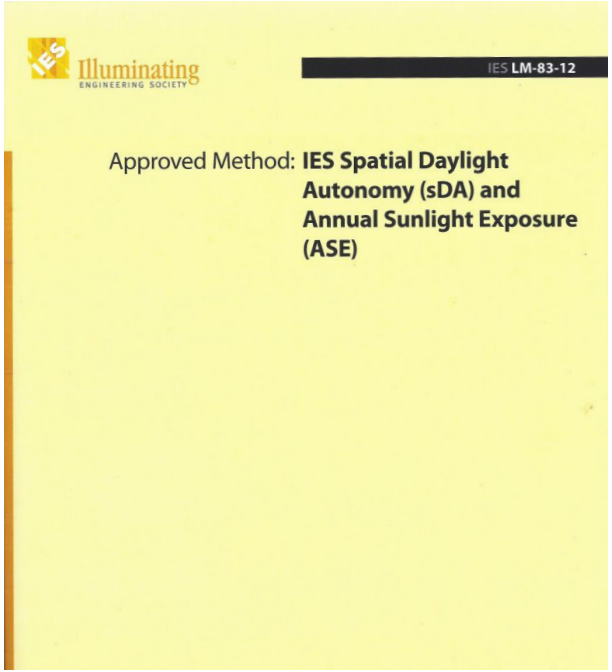
Modeling Details (IES LM-83-12 Excerpts)



2.2.11 Furniture and Partitions Furniture and opaque interior partitions shall be modeled.

1. Any partition or furniture element extending 36" above the floor or more shall be modeled to within 6" accuracy.

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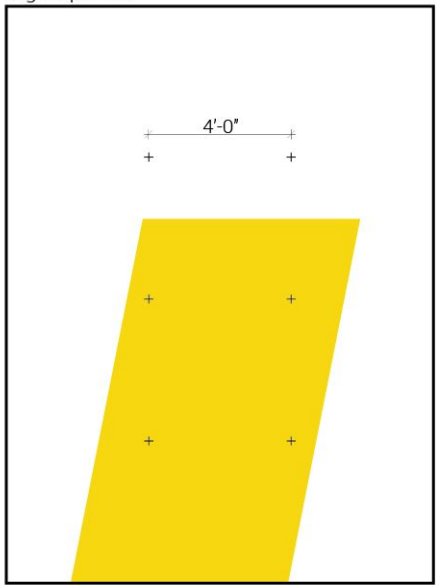
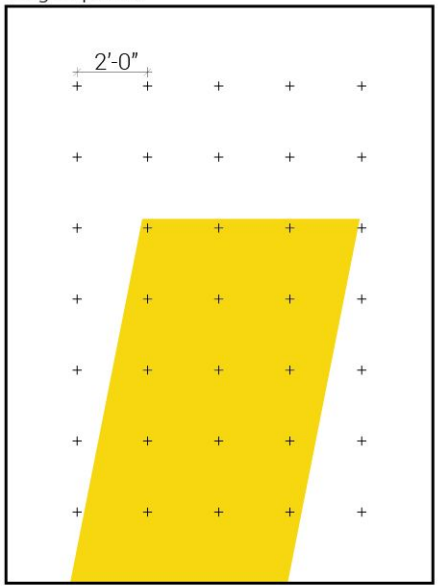
Grid Spacing Matters!

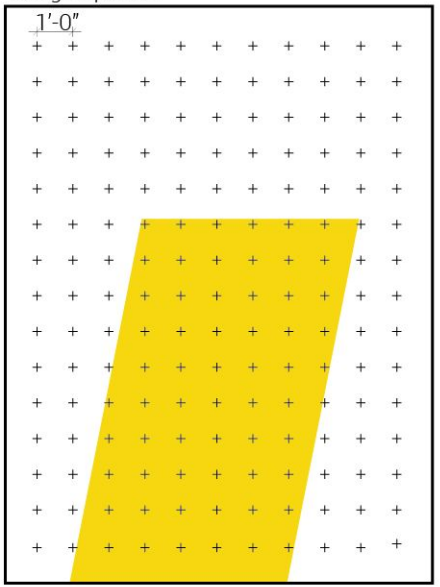
4′-0″ point spacing
6 grid points



2′-0″ point spacing
35 grid points



1′-0″ point spacing
165 grid points



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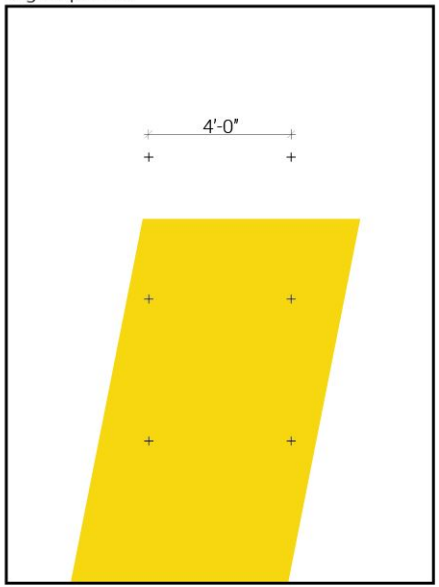
Grid Spacing Matters!

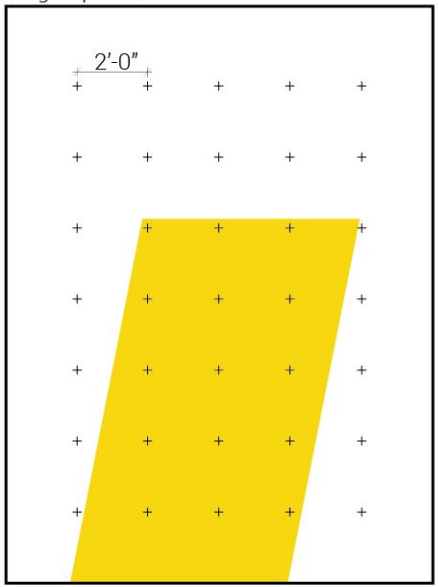
4′-0″ point spacing
6 grid points

67%



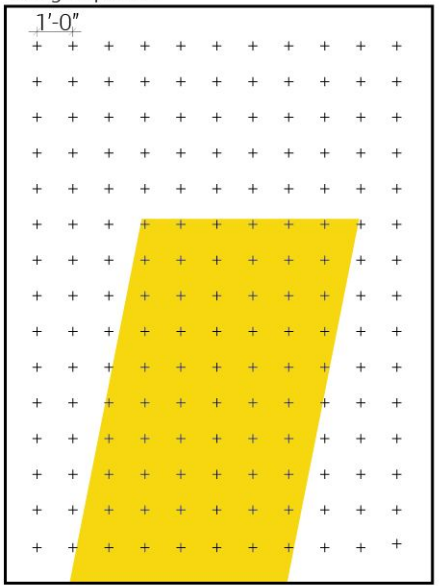
2′-0″ point spacing
35 grid points

42%



1′-0″ point spacing
165 grid points

33%



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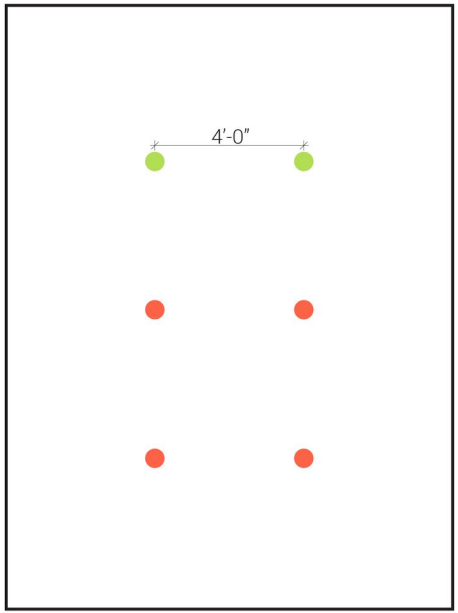
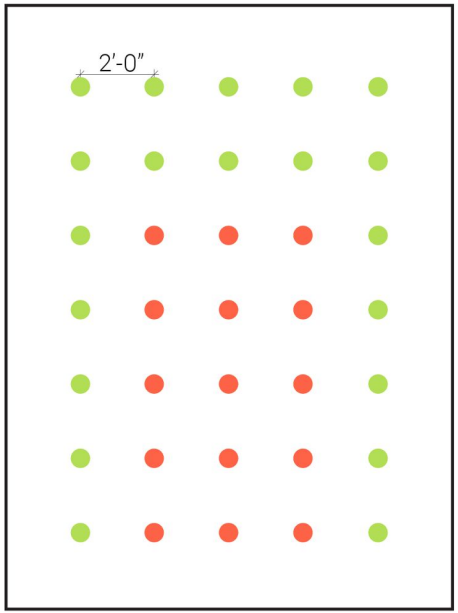
Grid Spacing Matters!

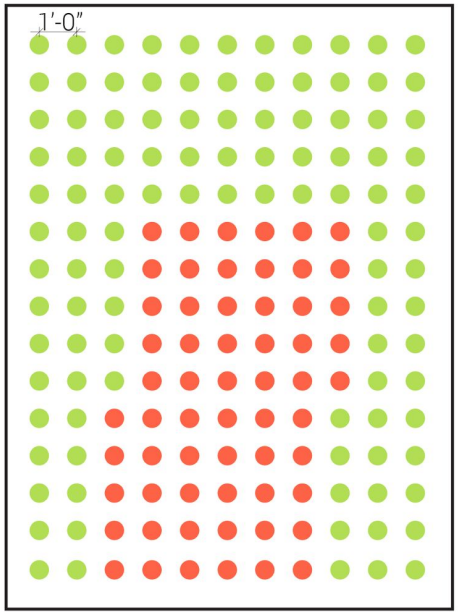
4′-0″ point spacing
6 grid points



2′-0″ point spacing
35 grid points



1′-0″ point spacing
165 grid points



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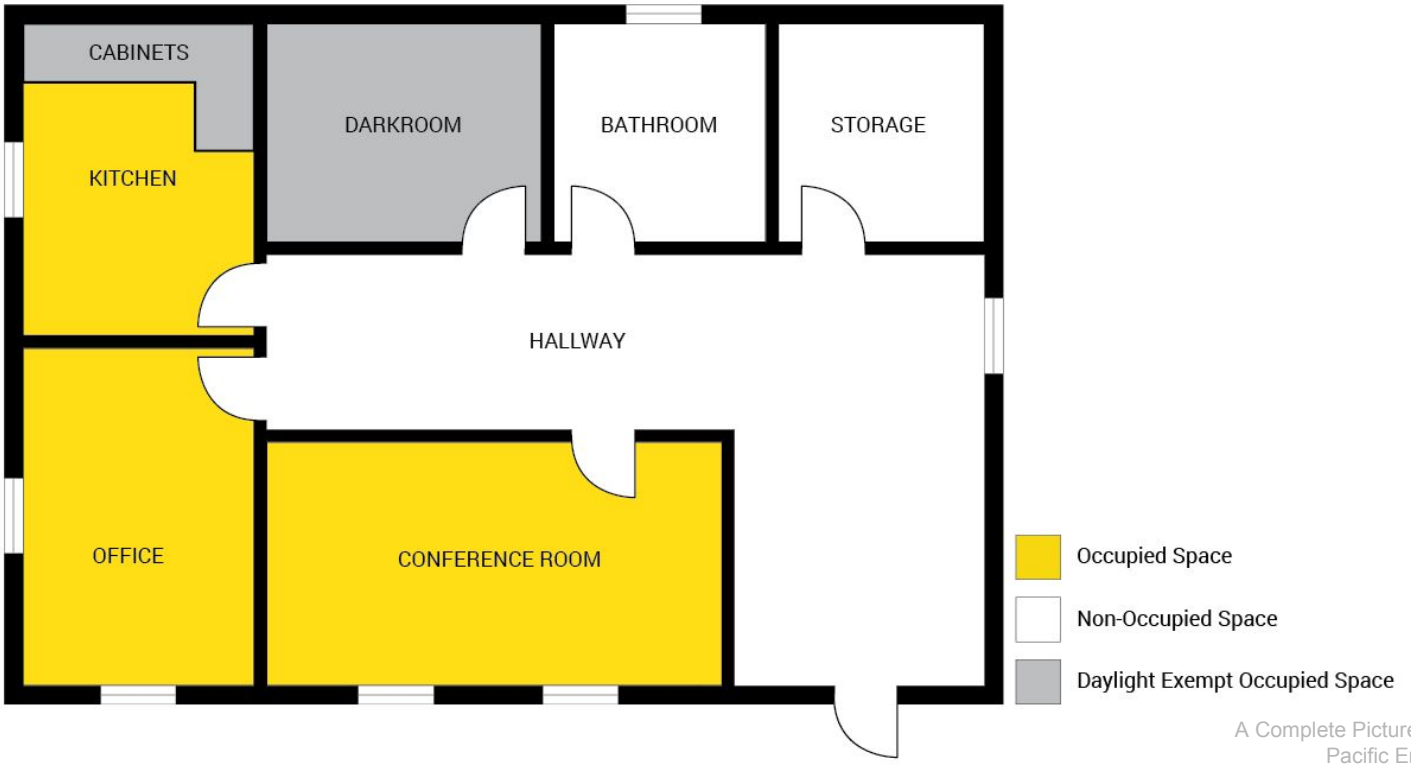
Focus on Workplane in Occupied Spaces



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Pacific Energy Center, 6/9/2016
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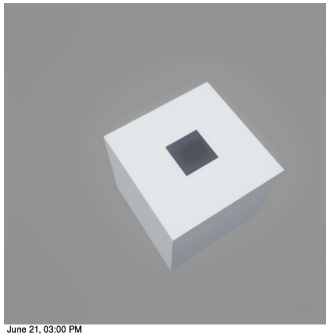
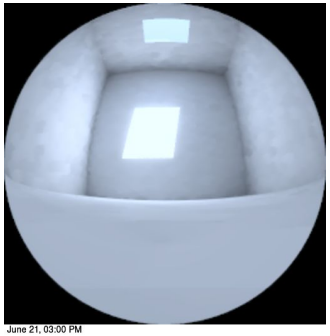
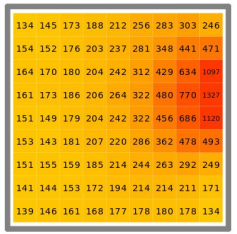
Wall/Ceiling Thickness, Skylights

< 1in ceiling thickness
3x3 foot skylight

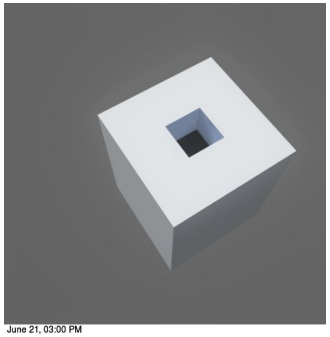


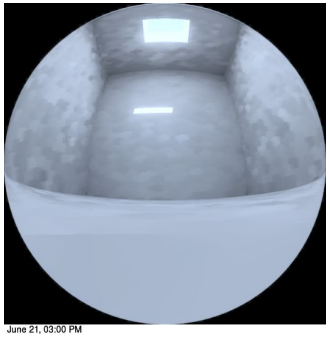


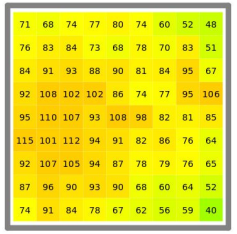


June 21, 03:00 PM

3ft ceiling thickness
3x3 foot skylight







June 21, 03:00 PM

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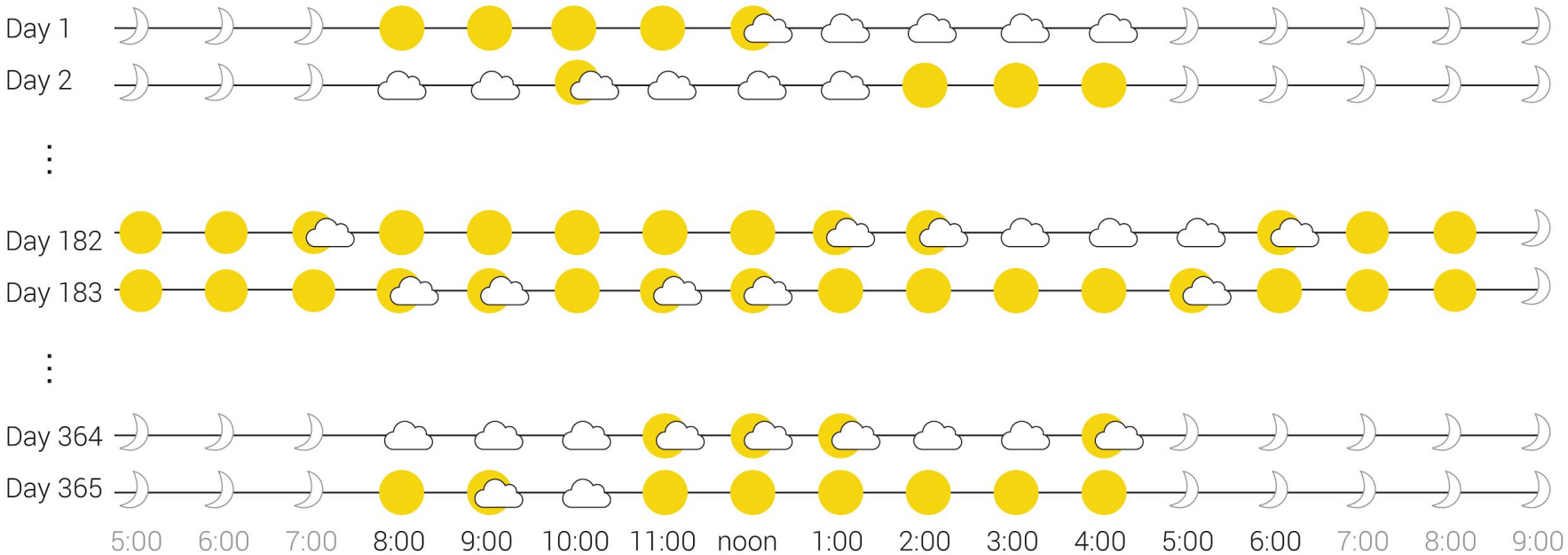
Climate Variability



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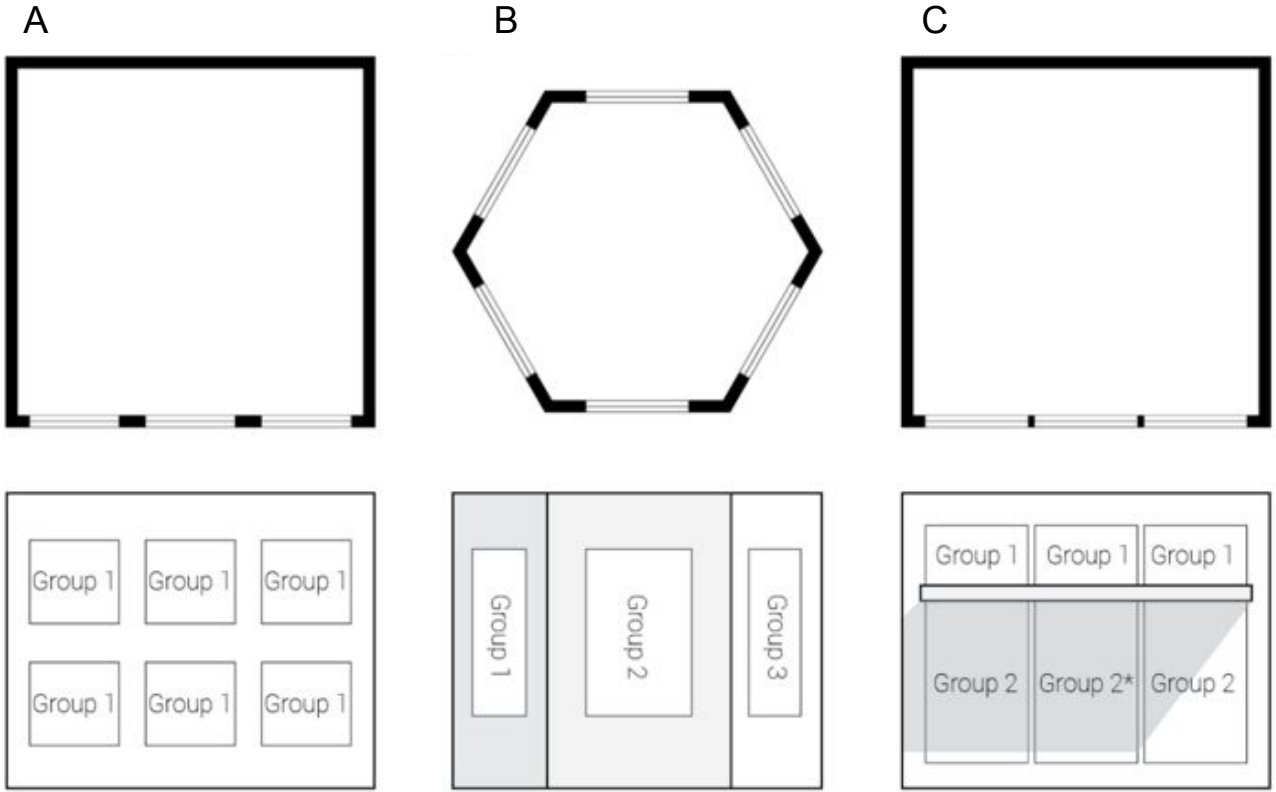
Window Groups



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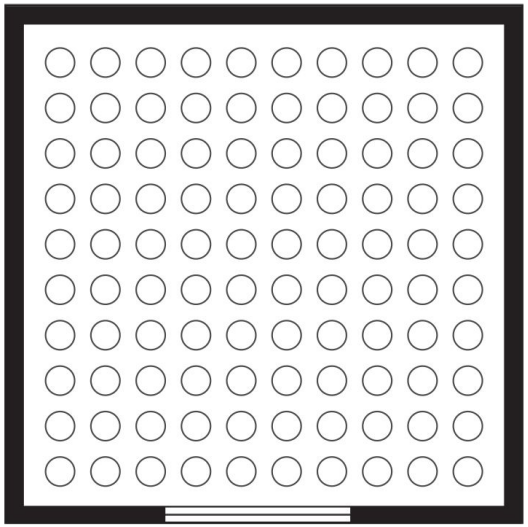
Example: Illuminance Grid with 100 Grid Points and 1 Window



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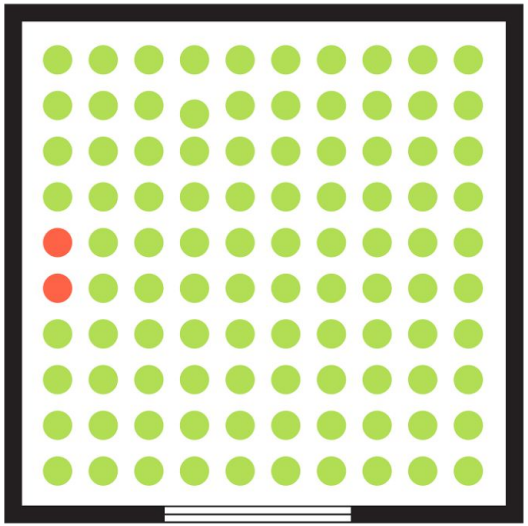
2% Rule: Blinds Stay Open



Dec 21st at 10:00 a.m.
Blinds open

2%

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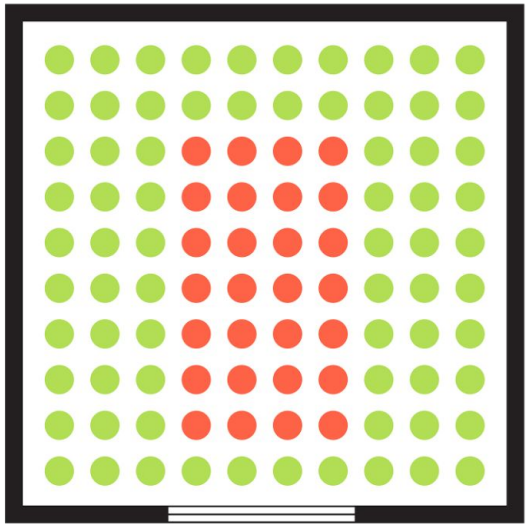
2% Rule: Exceeding 2% Direct Sunlight Before Blinds Operate



Dec 21st at noon
Blinds open

28%

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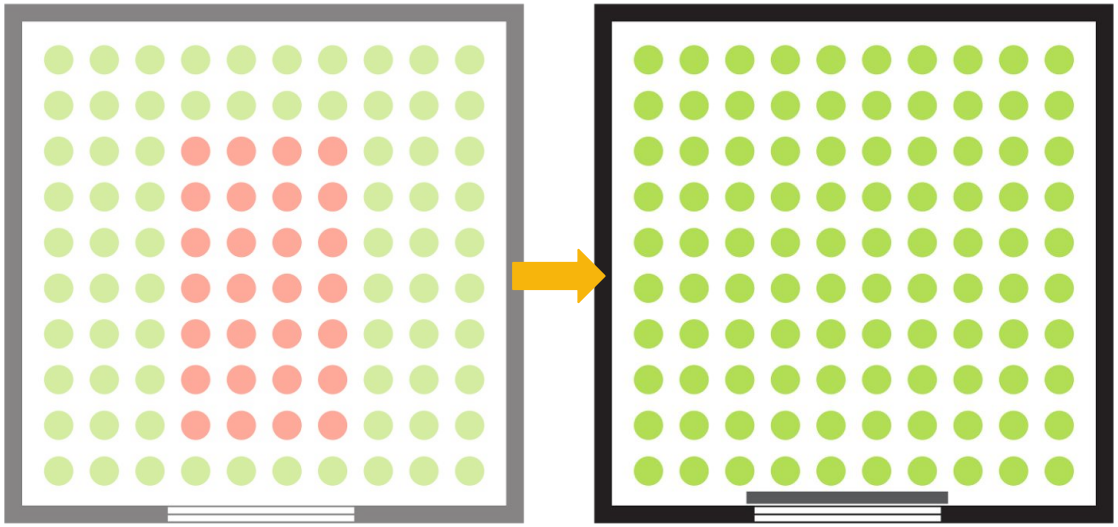
2% Rule: Blinds Close



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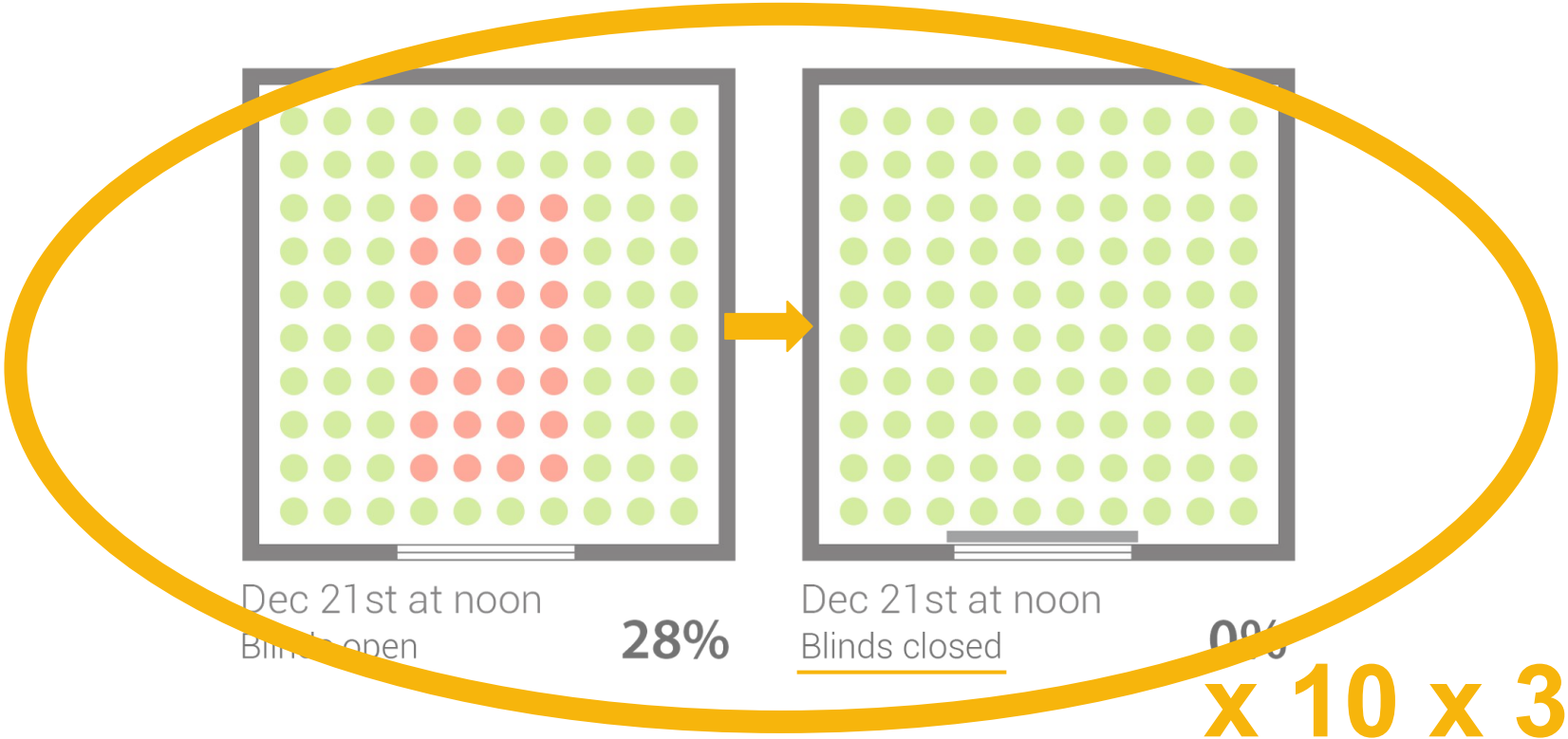
Blinds Operate for 1 Year



x 10 x 365

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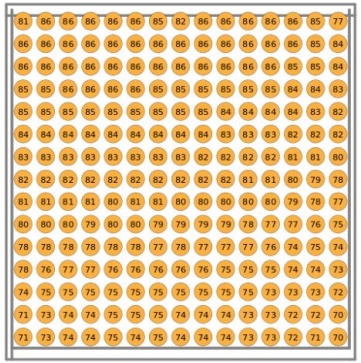
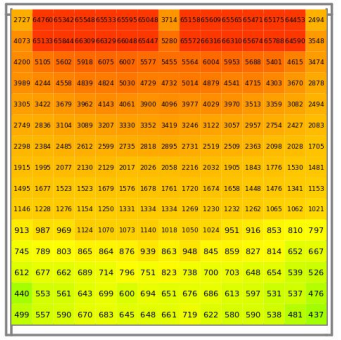
Daylight Metrics In-Class Exercise

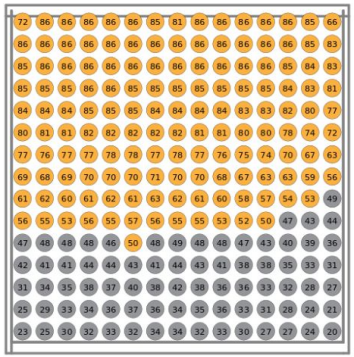
Classroom Model with Blinds NOT Operating:



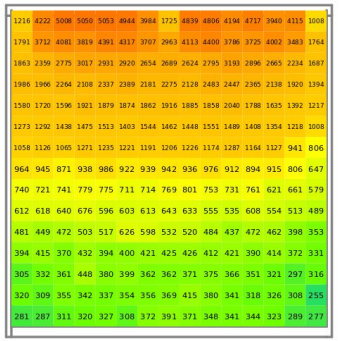
sDA: 100.00%



Classroom Model with Blinds Operating:



sDA: 64.89%



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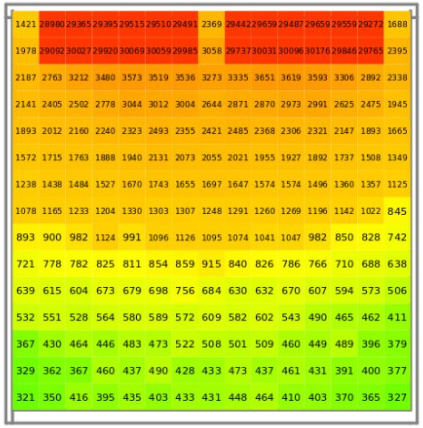
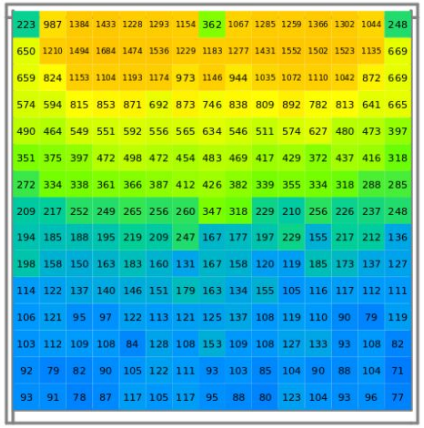
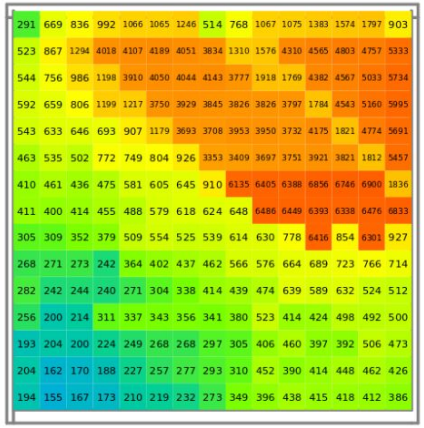
Classroom Model with Blinds NOT Operating:







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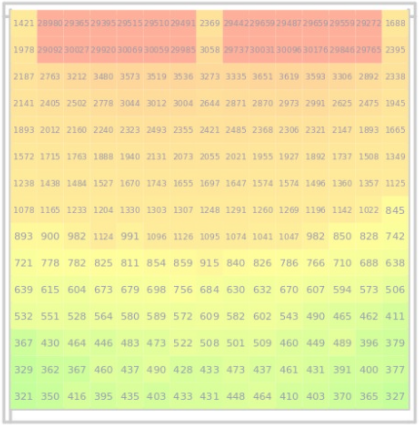
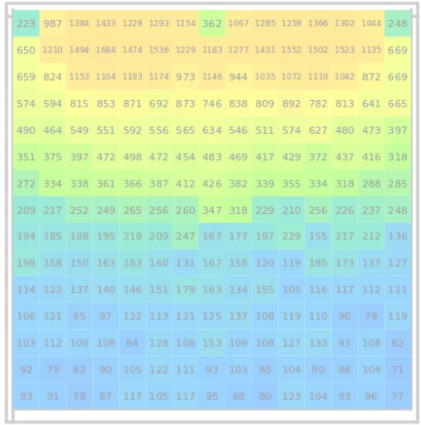
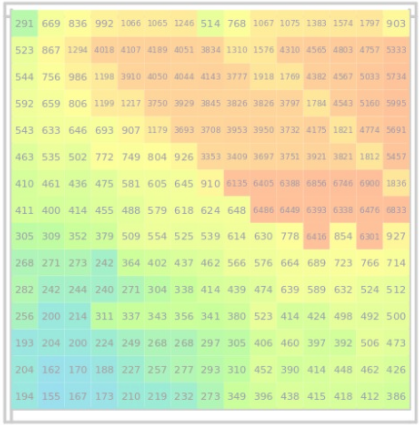
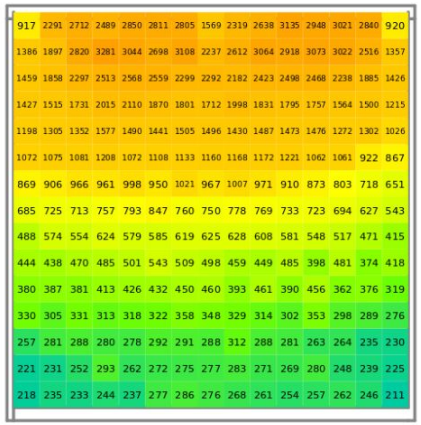
Classroom Model with Blinds NOT Operating:

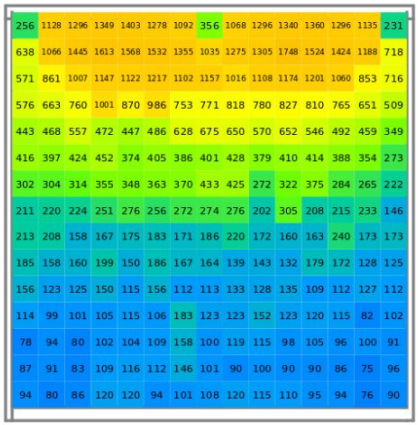


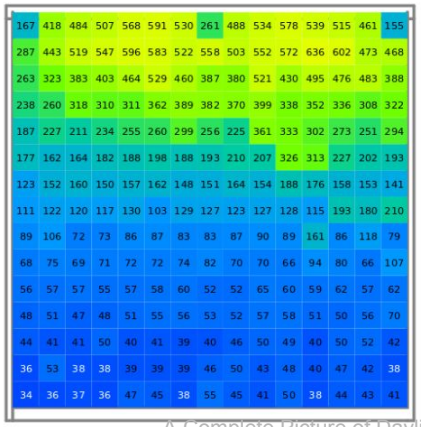




Classroom Model with Blinds Operating:







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Pacific Energy Center, 6/9/2016
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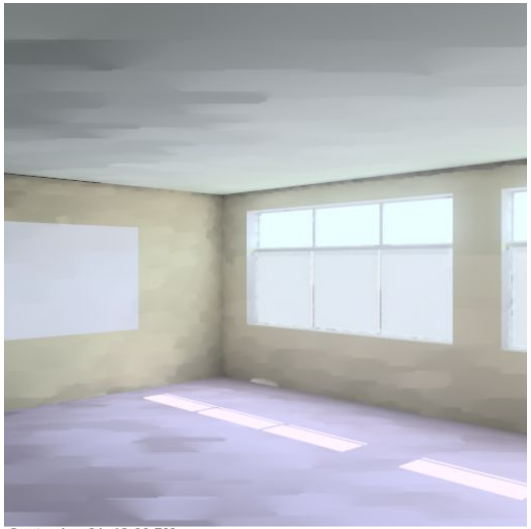
Daylight Metrics In-Class Exercise

Design A

- Clear Glass (90% VLT) Windows
- Windows facing S



Design B

- Clear Glass (90% VLT) Windows
- Windows facing NW

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Classroom facing NW

Materials | Window Groups | Site | Layers | Illuminance Grids | Viewpoints

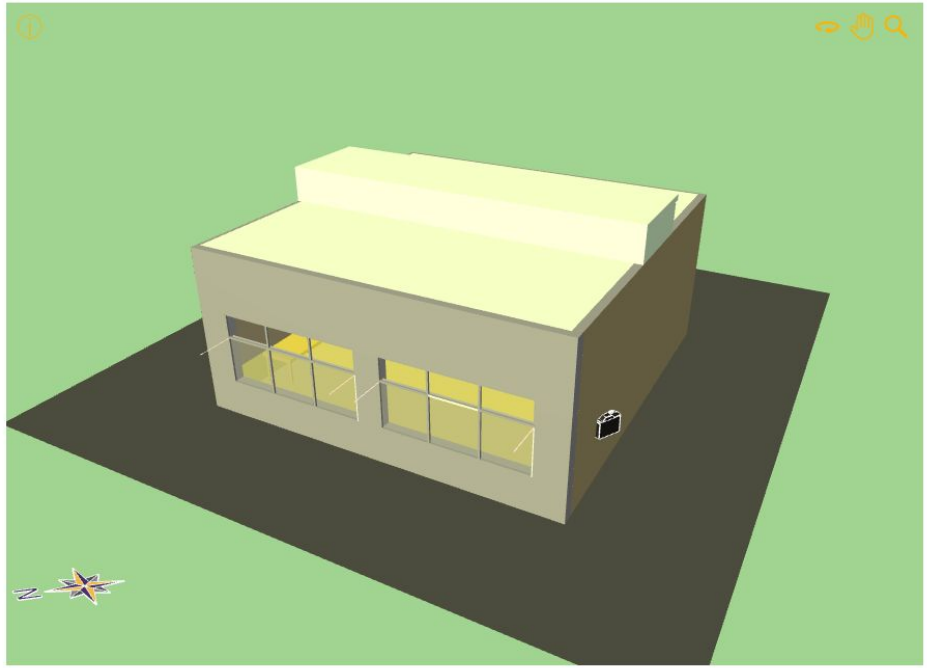
Custom Material		91.8%
Glass 50%		45.9%

Translucent

Material	Properties					
	DT	ST	DR	SR	A	RA

Opaque

Material	Properties	
	Color	Ref.
Ceiling		86.6%
Exterior Shelf		80.1%
floor		47.0%
Ground Plane		23.9%
Light Shelf		78.7%
Mullions and Sill		49.8%
Side Shade		74.4%
SketchUp Default		50.2%
Skylight_Sides		93.6%
Walls		53.3%
White Board		94.1%
Wood - Door and Desk		46.4%



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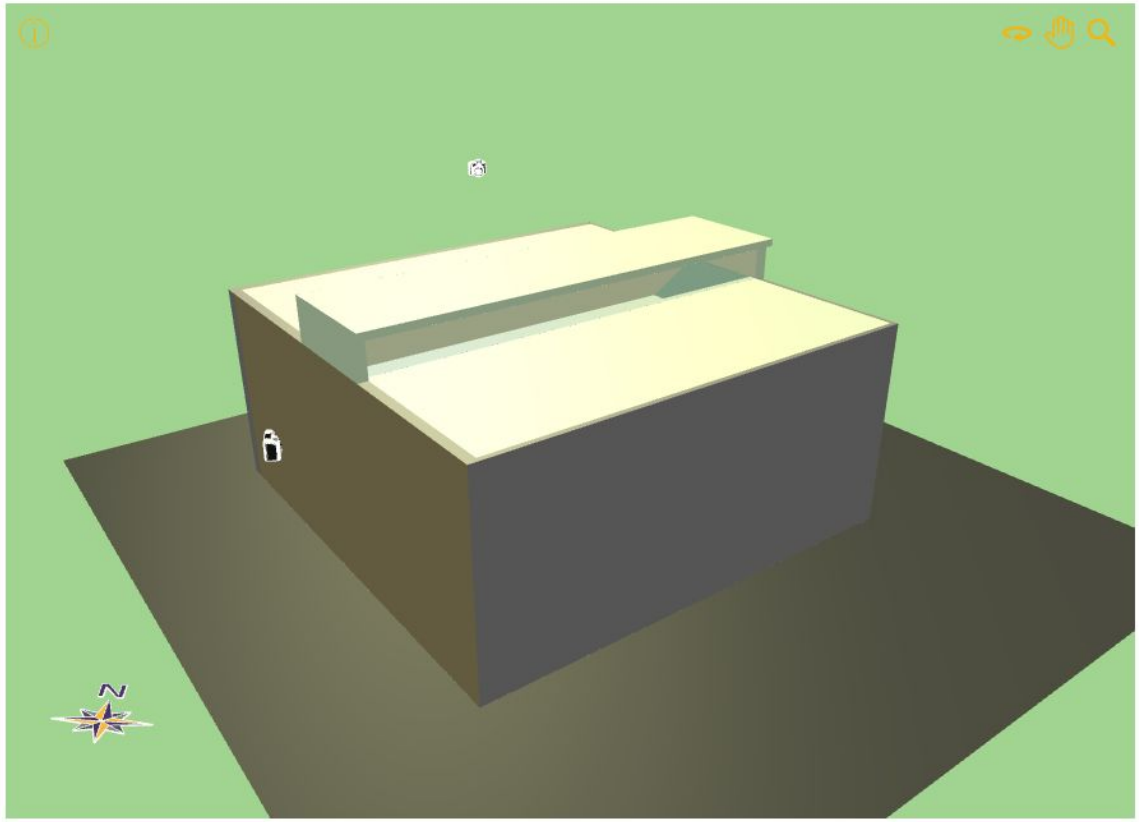

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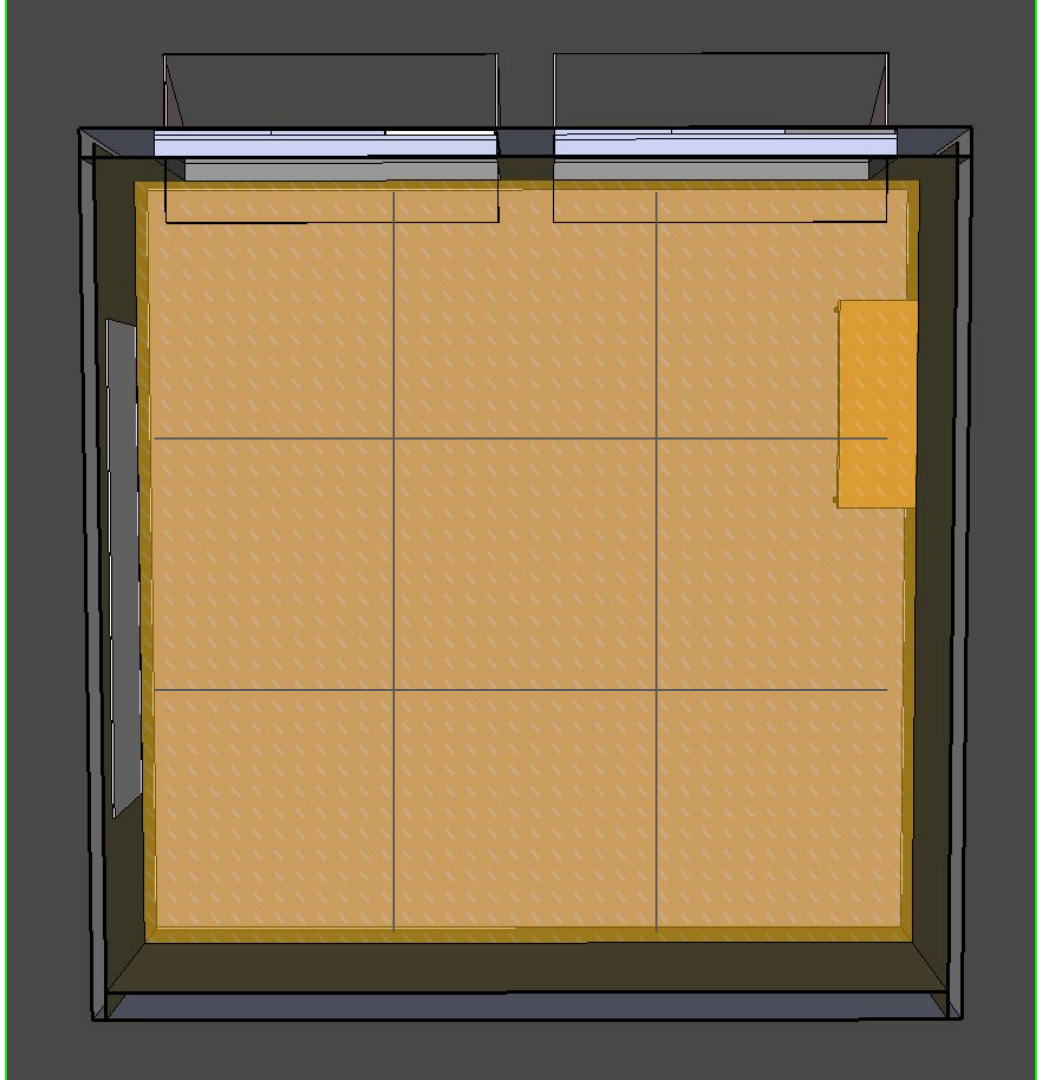

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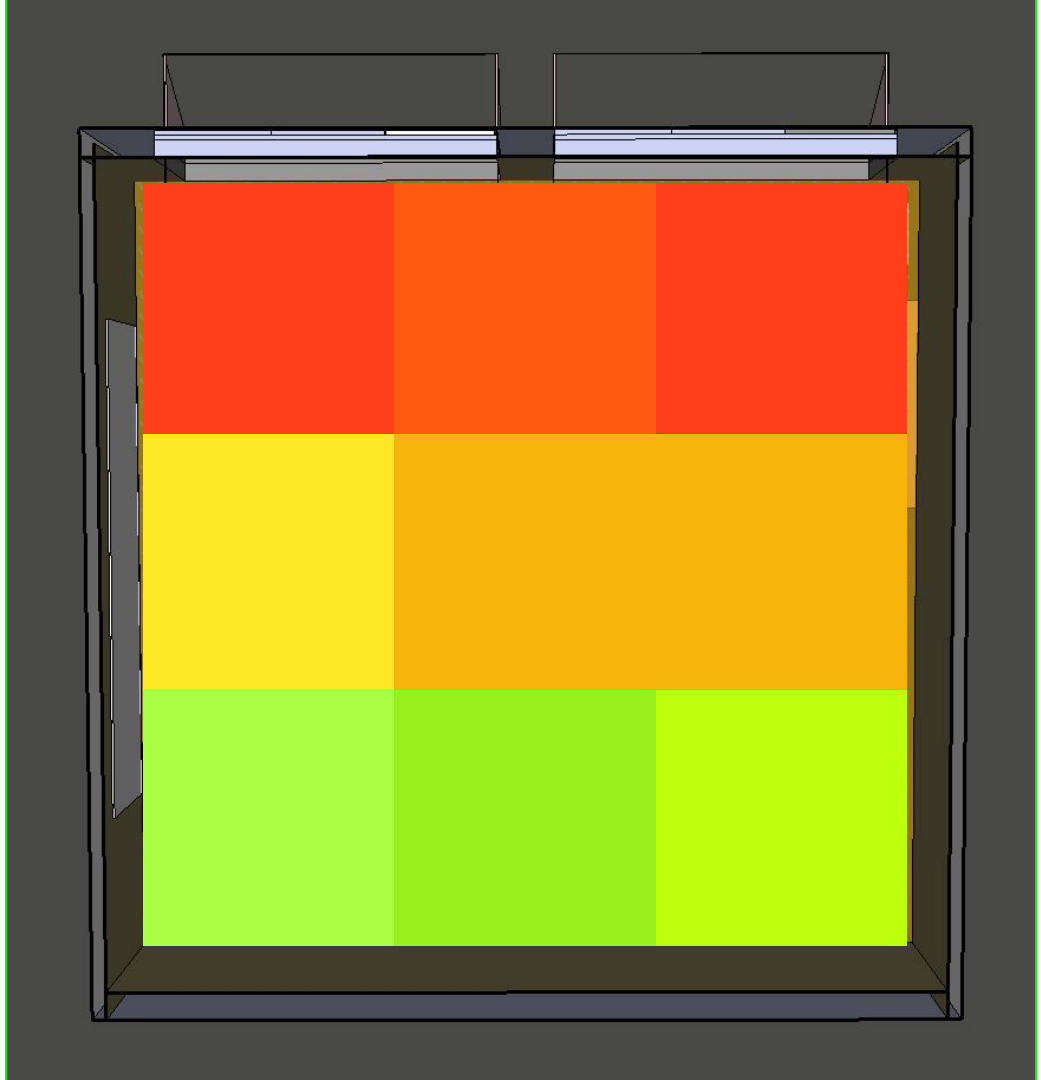

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Daylight Metrics In-Class Exercise

Directions:

- Get into groups of 2-3
- Get assigned an individual square (grid point) in the 3x3 grid
- At each square (for all 30 of the timepoints in the handout) determine whether or not the value is above/equal to or below the threshold of 300
  - If above/equal to 300, mark as 1
  - If below 300, mark as 0
- Total your 1's and write down a final score (between 0 and 30) in the last row of empty grids
- After your final score is computed, divide by 30 and write this percent
  - If this % is ≥50, give your square a **PASS**
  - If this % is <50 give your square a **NO PASS**

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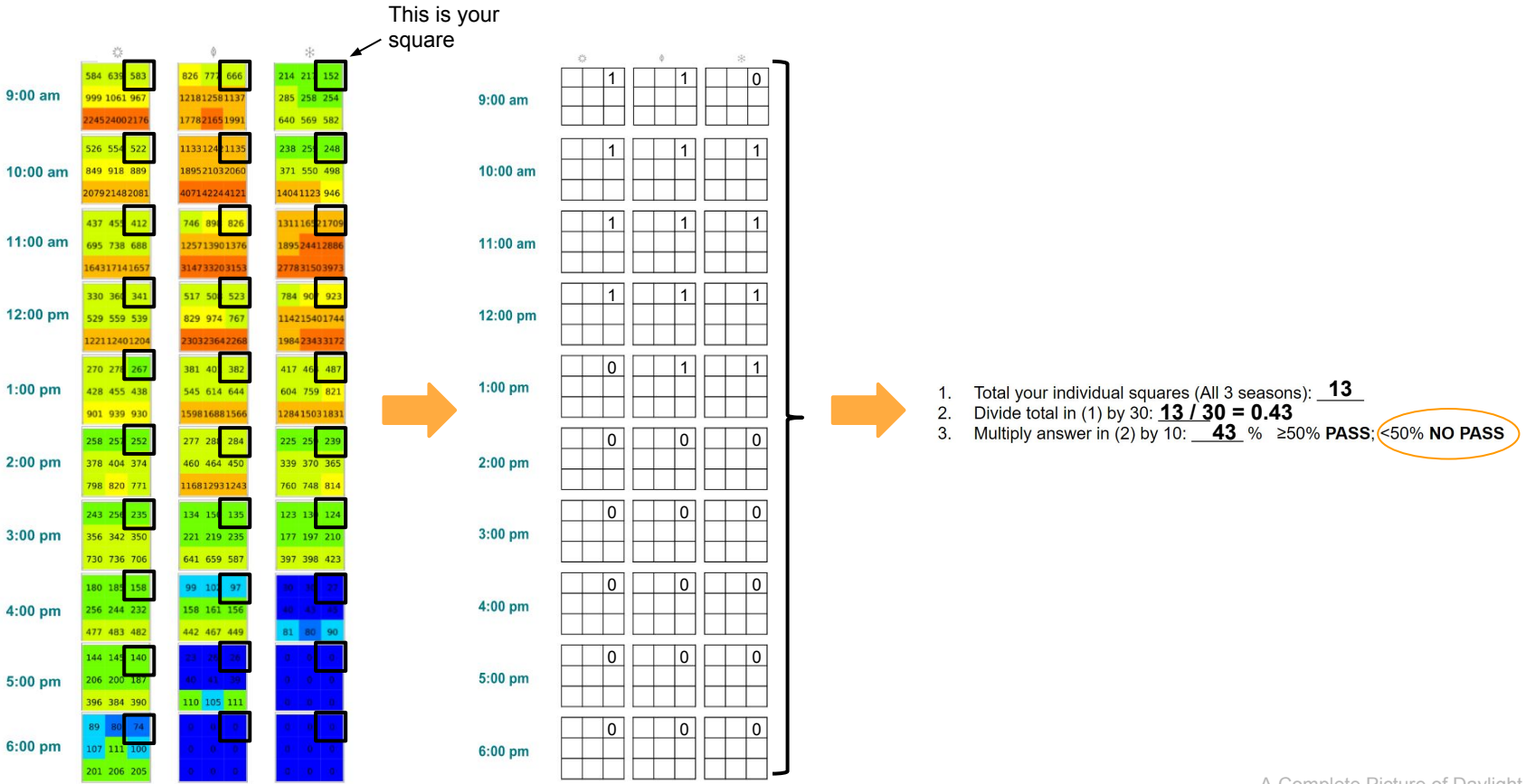
For Example:



1. Total your individual squares (All 3 seasons): **13**
2. Divide total in (1) by 30: **13 / 30 = 0.43**
3. Multiply answer in (2) by 10: **43** % ≥50% **PASS**; <50% **NO PASS**

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Artifacts

S-Facing 12:00pm September 21st

NW-Facing 6:00pm June 21st

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Final LEED v4 Score: Design A=100%=3 credits

83%*	87%*	80%*
77%*	67%*	67%*
63%*	63%*	57%*

Total Passed:

Total Squares:

(total passed) / (total squares):

≥55% - 2 LEED v4 points

≥75% - 3 LEED v4 points

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Final LEED v4 Score: Design B=67%=2 credits

83%*	83%*	83%*
70%*	77%*	73%*
33%	43%	30%

Total Passed:

Total Squares:

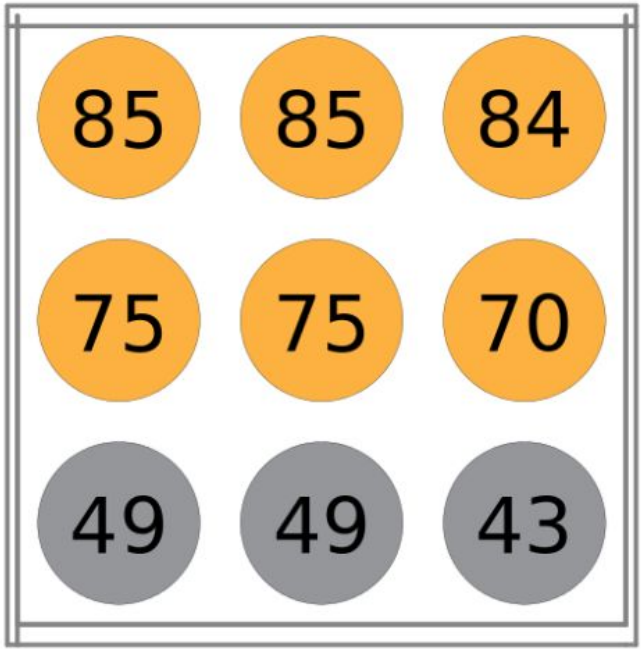
(total passed) / (total squares):

≥55% - 2 LEED v4 points

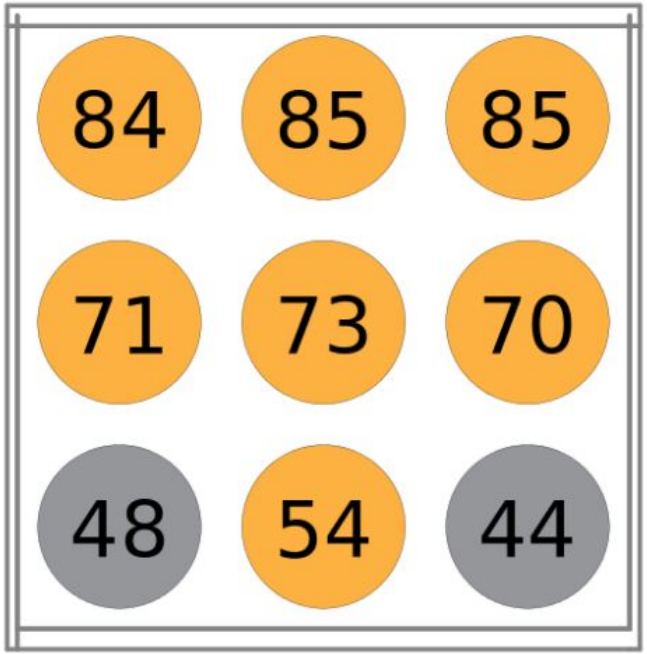
≥75% - 3 LEED v4 points

Actual sDA scores for Designs A and B

Design A (Windows Facing S) 66.7%



Design B (Windows Facing NW) 77.8%



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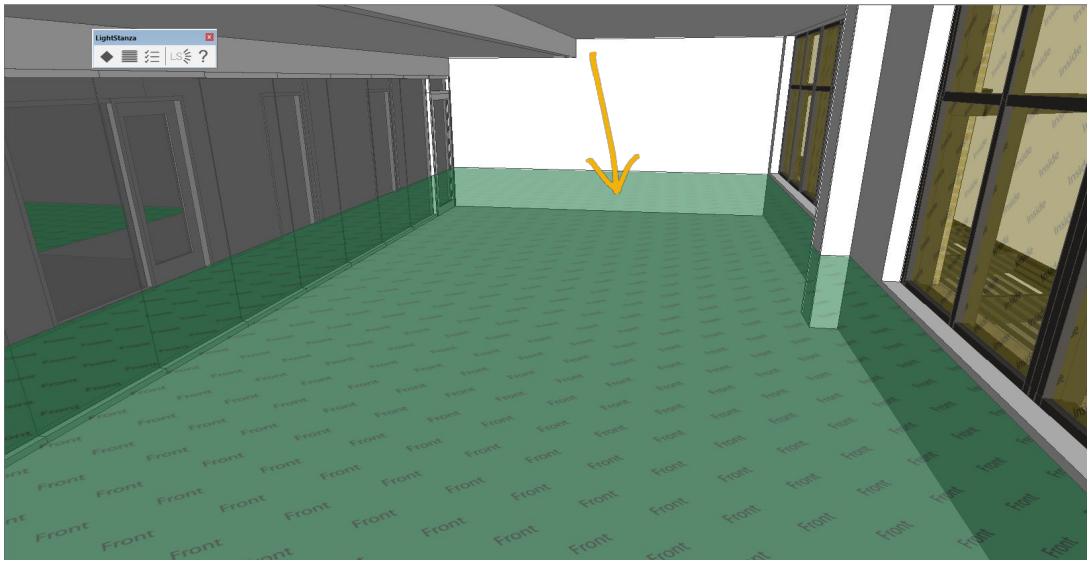
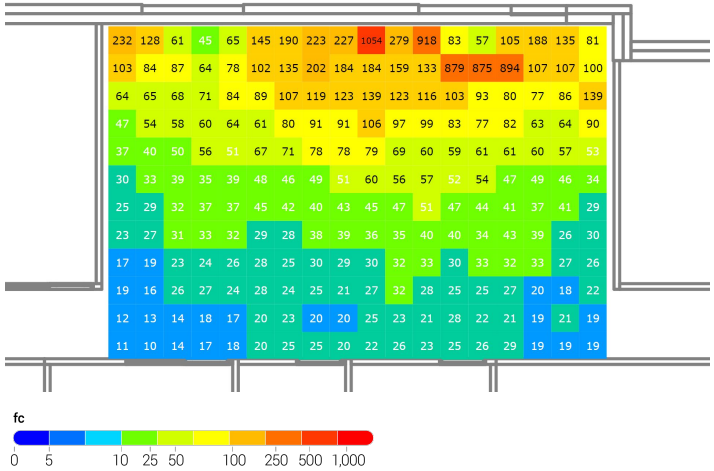
Demo

Create Illuminance Grids in SketchUp





Model Design by RNL Design

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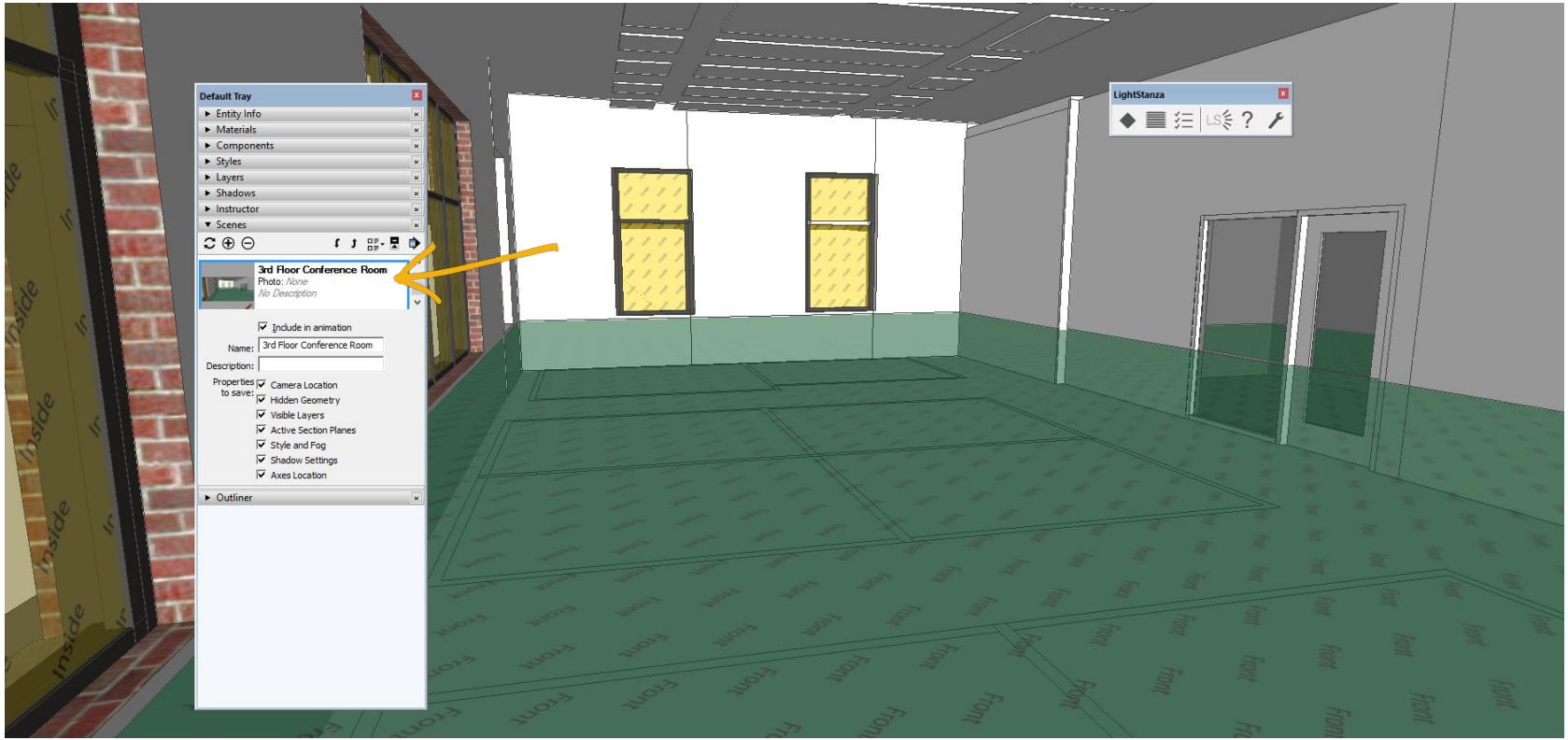
Create Viewpoints in SketchUp



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Questions/Comments?

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Contact Us!

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