Interoperability & Precision in Daylight Modeling

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RNL Design
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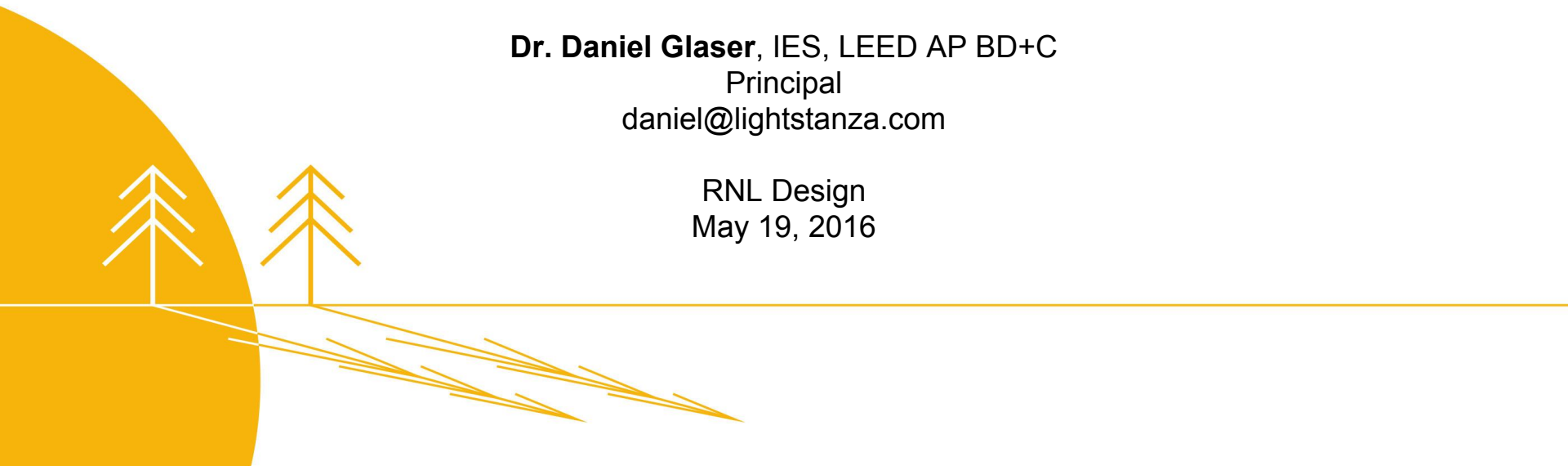

Daylight Matters

Chapel of Notre Dame du Haut, Ronchamp, France

LightStanza

Daylight Matters

Ashesi University, Ghana

Agenda

1. Introductions
2. Daylight and Industry Standards
3. Critical Aspects of Proper Daylight Simulations
4. How To Apply Accurate Daylighting to Energy Tools
    a. Integration
    b. Interoperability
5. Opportunities for Streamlining Interoperability
6. Open Discussion

LEED v4

The newest version of LEED, which will be **mandatory in October 2016**, is designed to improve overall occupant experience, with 4 main focuses.

1. Environmentally friendly materials
2. Smart grids for Demand Response
3. Water efficiency
4. **Performance-based design**
    a. Indoor environmental quality to ensure improved occupant comfort

LEED v4

The number of daylighting credits has increased from 1 credit (LEED v2009) to 3 credits (LEED v4).

LEED v2009 IEQc8.1 - Daylight
1 Point

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 v4 EQc7 - Daylight
2-3 Points

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

Architecture 2030

Promote transforming climate change problems into solutions through design of the built environment. 2-step process:

1. Design: Integrate sustainable and passive design strategies that are low-cost or no-cost.
   a. This can get you to 70-80% of the way there.
   b. "Done with building orientation, shaded glass, incorporating daylighting and passive heating and cooling strategies, and the materials and systems you specify"
2. Fossil-fuel-free energy

(Ref: http://architecture2030.org/buildings_problem_why/the-solution/)

Net Zero Energy Building

They require daylight modeling that includes:

1. A detailed simulation of the amount and quality of natural light entering a building, as well as the energy savings from dimming the electric lighting.
2. Simulations that allow the team to address glare issues during the design through proper selections of overhangs, louvers, and glazing.

2015 IECC Commercial Codes to Increase Energy Efficiency with Daylighting

1. Extend the minimum skylight area requirement (CE149).
2. More requirements for daylighting controls and zones (CE294).
3. Require commissioning of occupancy sensors and daylighting controls (CE357).

(Ref: http://www.neep.org/sites/default/files/resources/2015%20IECC%20Summary_2013%20ICC%20Public%20Comment%20Hearings%20Handout%20%281%29.pdf)

WELL Building Standard

WELL Building believes that buildings should be developed with people's health in mind, and wellness at the center of design.

1. Lack of exposure to natural light has harmful effects on quality of sleep, level of alertness, emotional state, and overall wellbeing.
2. WELL Building introduces protocols to help the body maintain circadian alignment, including
    a. Providing the ideal lighting levels for various tasks
    b. To reduce eye-strain and glare
    c. To increase alertness
    d. To improve the quality of sleep
    e. To decrease seasonal affective disorder
    f. To promote Vitamin D synthesis

(Ref: http://nowinteractive.net/delos-downloads/WBS-Executive%20Summary-Apr2014.pdf)

To achieve this, the WELL Building Standard requires:

LIGHT FEATURE LEVEL MATRIX

COMPLIANCE CERTIFICATION	PRECONDITION / PRECONDITION	OPTIMIZATION / OPTIMIZATION	Core & Shell	Tenant Improvement	New Construction
53 VISUAL LIGHTING DESIGN					
1: Visual Acuity for Working			-	P	P
2: Task Lighting			-	P	P
54 CIRCADIAN LIGHTING DESIGN					
1: Melanopic Light Intensity in Work Areas			-	P	P
55 ELECTRIC LIGHT GLARE CONTROL					
1: Lamp Shielding			-	P	P
56 SOLAR GLARE CONTROL					
1: View Window Shading			O	P	P
2: Daylight Management			O	P	P
57 LOW-GLARE WORKSTATION DESIGN					
1: Workstation Orientation			-	O	O
58 COLOR QUALITY					
1: Color Rendering Index			-	O	O
59 SURFACE DESIGN					
1: Work Area Wall and Ceiling Lightness			-	O	O
60 AUTOMATED SHADING AND DIMMING CONTROLS					
1: Automated Sunlight Control			-	O	O
2: Responsive Light Control			-	O	O
61 RIGHT TO LIGHT					
1: Lease Depth			O	O	O
2: Windows and Workspaces			-	O	O
62 DAYLIGHT MODELING					
1: Healthy Sunlight Exposure			O	O	O
63 DAYLIGHTING FENESTRATION					
1: Window Sizes for Workspaces			O	O	O
2: Window Transmittance in Work Areas			O	O	O
3: Uniform Color Transmittance			O	O	O

Proper Daylighting Simulations are Critical

- ASE/sDA
- Blinds Operation
- Daylight Glare Probability
- Focus on occupied spaces
- Qualitative measurements for occupant comfort
- Glazing
- Wall thickness, mullions, overhangs, skylights, etc.

And many other tools...

**All output shown in this presentation was generated in LightStanza*

Annual Sunlight Exposure

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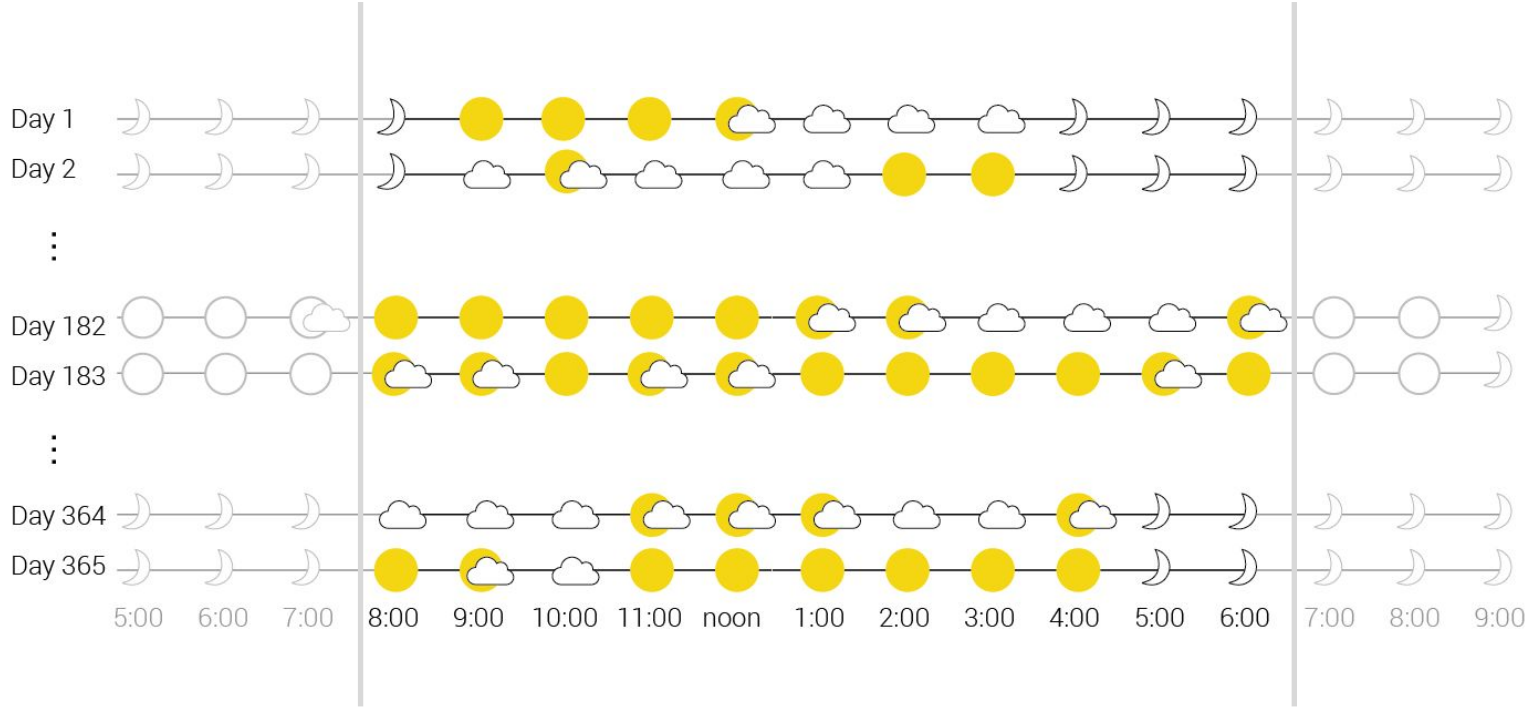
Annual Sunlight Exposure

Daylight Autonomy

- Measuring direct sunlight that will hit the workplane over entire year as an hourly analysis that uses weather data

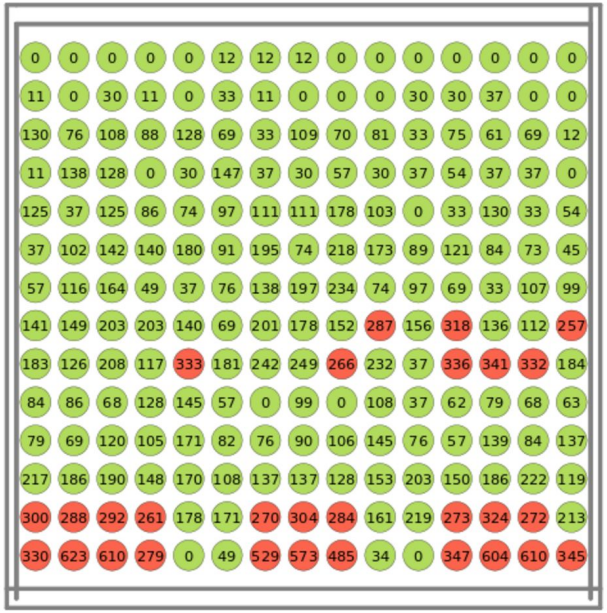


Annual Sunlight Exposure 1000,250h : 8 am-6 pm (ASE)

Floor1

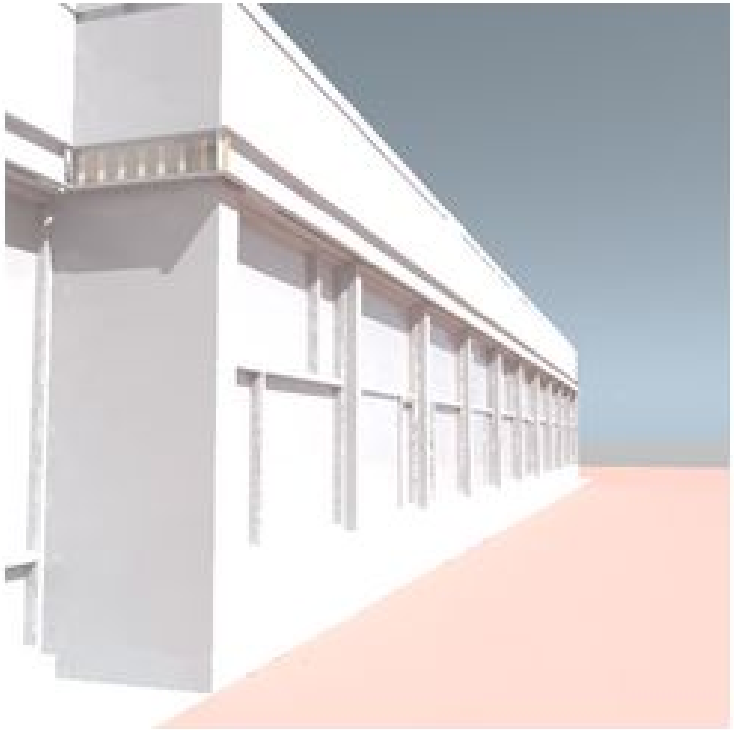
Quick Zoom

✕ 13.81 %



0 250

Should Also Assess Daylight Availability & Quality

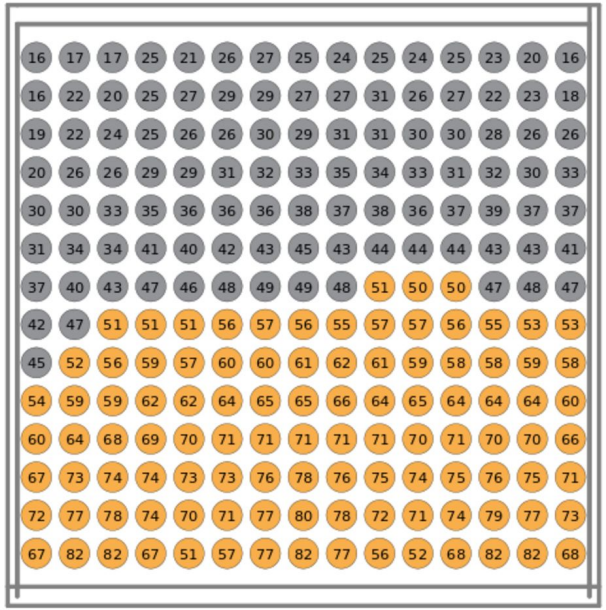


Spatial Daylight Autonomy 300/50% : 8 am-6 pm (SDA)

Floor1

Quick Zoom

✕ 49.52 %



0 50

Blinds Operation Informs Electricity Use

Blinds Operation

March 21, 09:00 AM

March 21, 09:00 AM

Focus on Occupied spaces with Workplane

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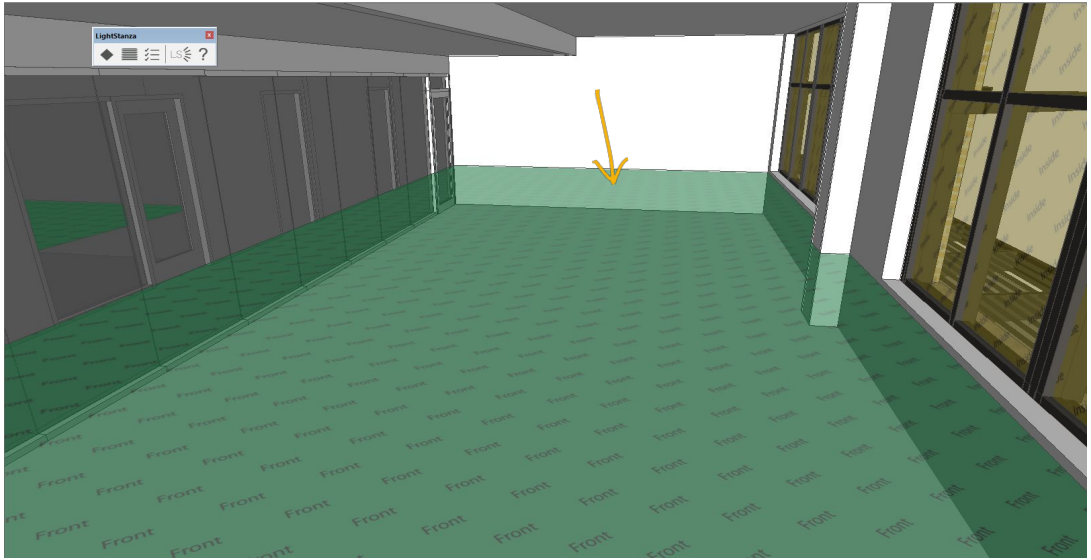
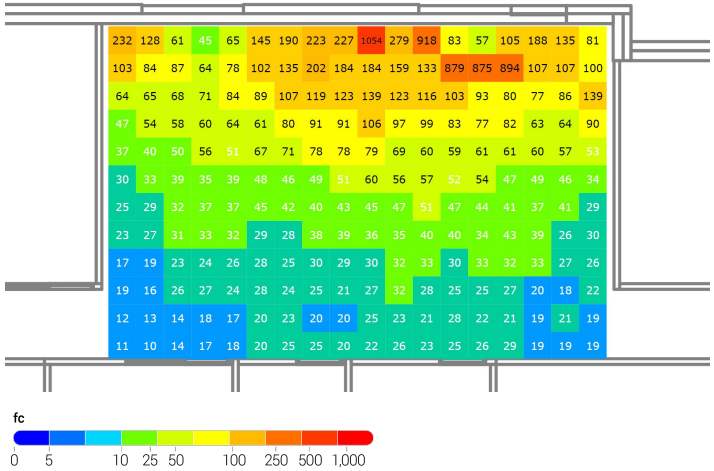
Can Occupied Spaces Work with Thermal Zones?

Focus on Occupied spaces with Workplane, etc.





Model Design by RNL Design

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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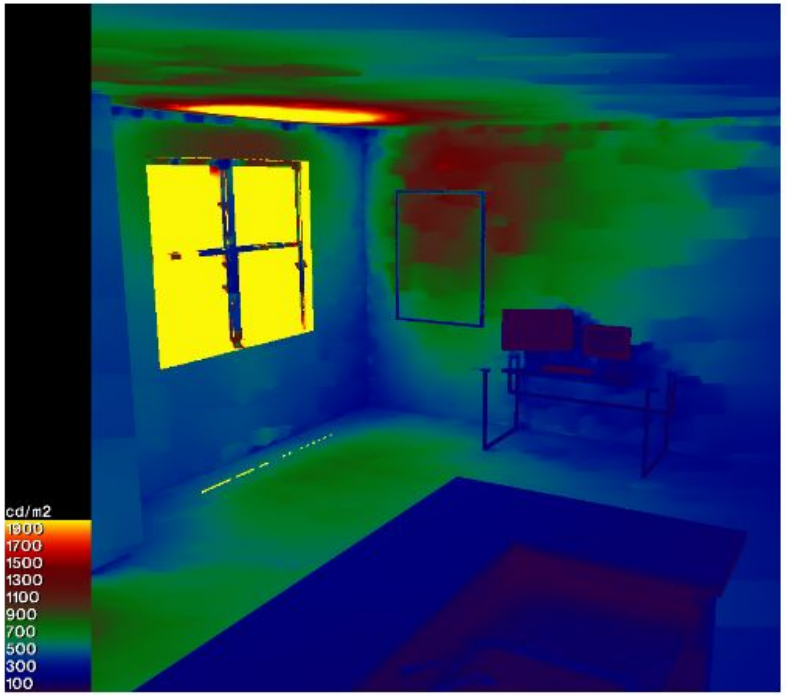
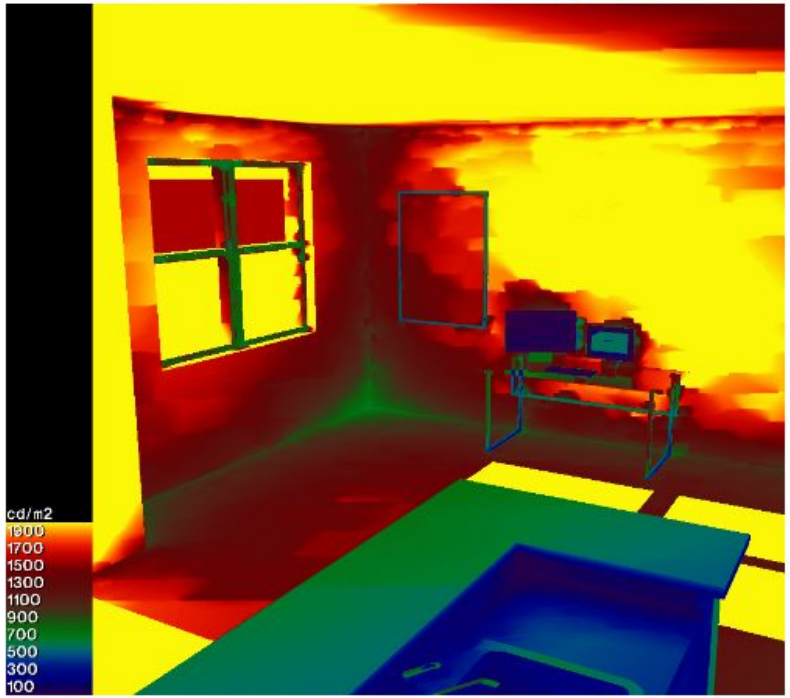
Qualitative Measurements for Occupant Comfort

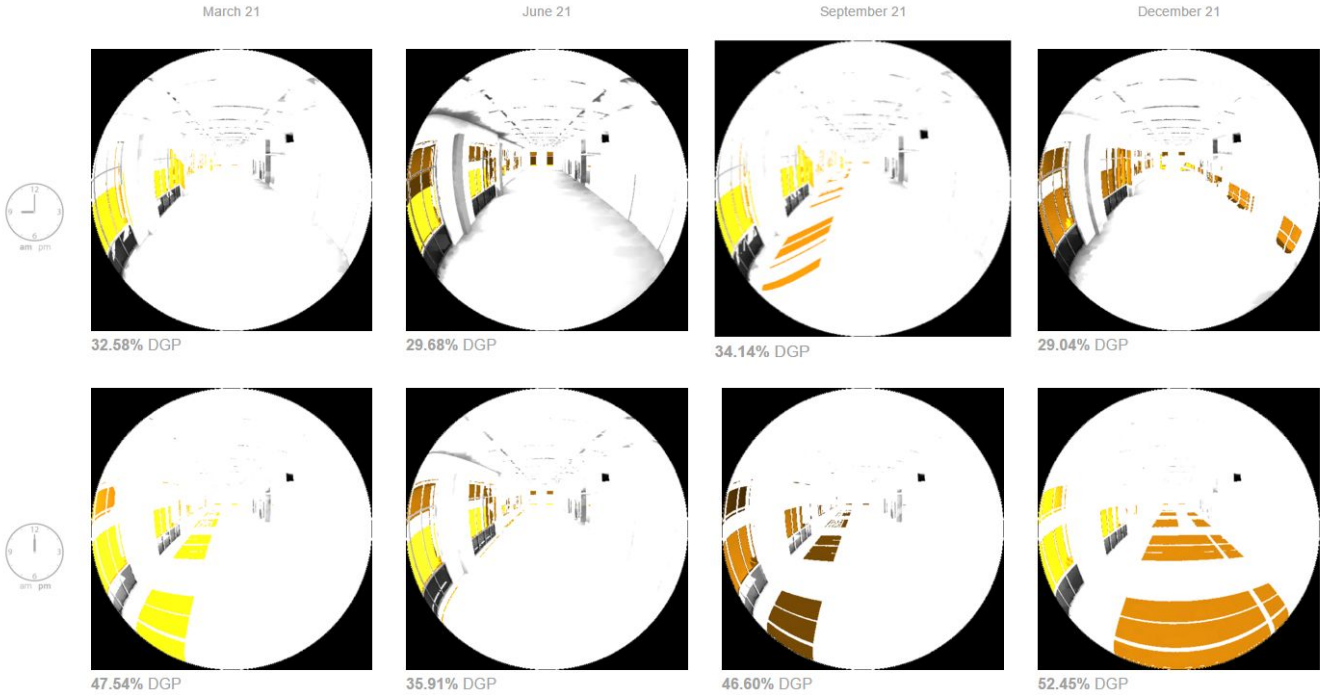
June 21, 12:00 pm



December 21, 12:00 pm



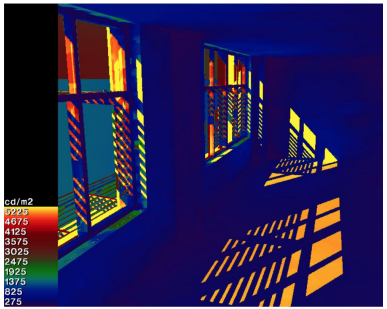
Daylight Glare Probability



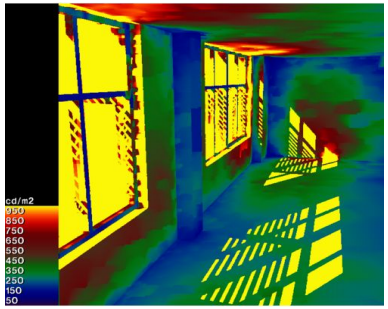
0-35% Imperceptible, 35-40% Perceptible, 40-45% Disturbing, 45-100% Intolerable

Iterations of Glazing Properties

40% Window Transmittance (VLT)



60% Window Transmittance (VLT)



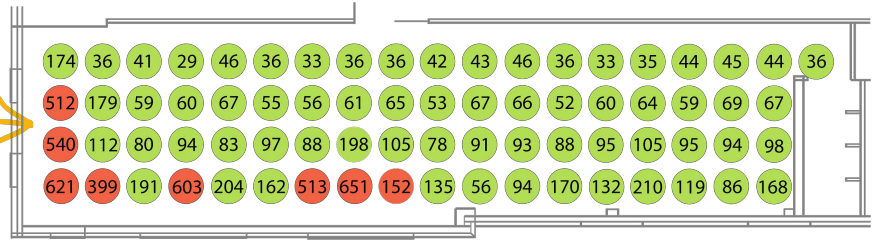
Model Design by RNL Design

Iterations of Glazing Properties

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

ASE score **15.07%**

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

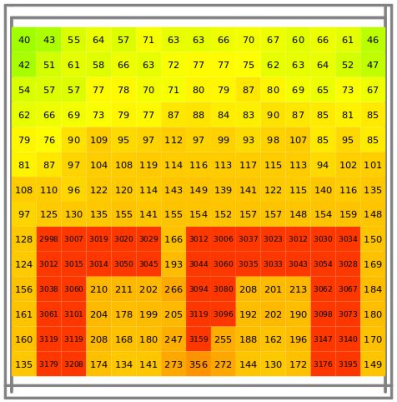


ASE score **10.96%**

Experiment with Different Products

80% VT

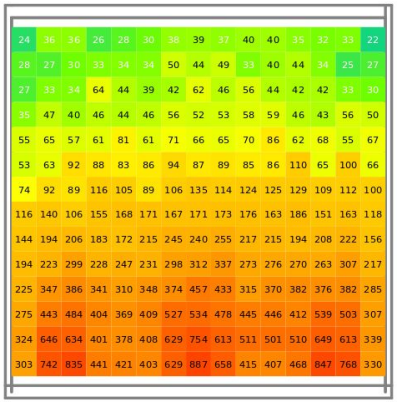
December 21, 12:00 PM



December 21, 12:00 PM

Redirecting Film 1

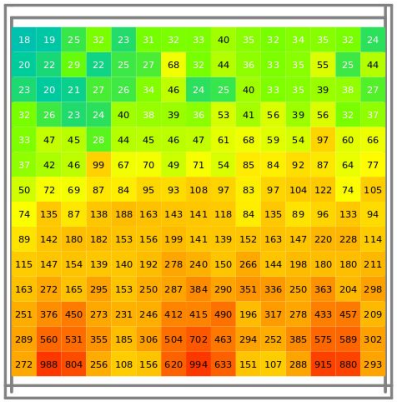
December 21, 12:00 PM



December 21, 12:00 PM

Redirecting Film 2

December 21, 12:00 PM



December 21, 12:00 PM

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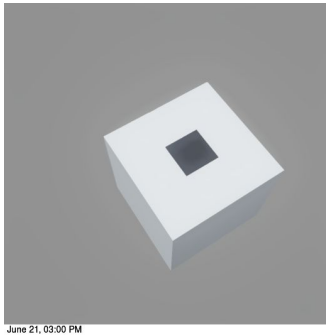
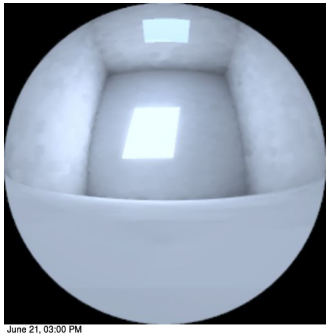
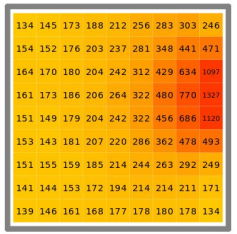
Wall Thickness, Skylights

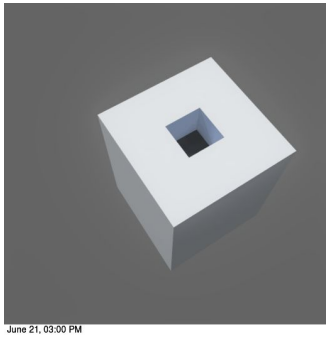
< 1in wall thickness on ceiling
3x3 foot skylight

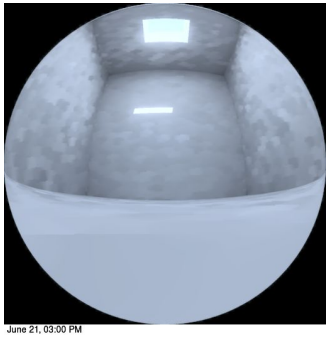


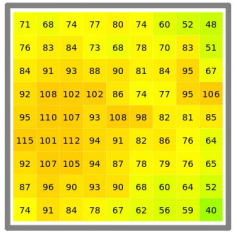


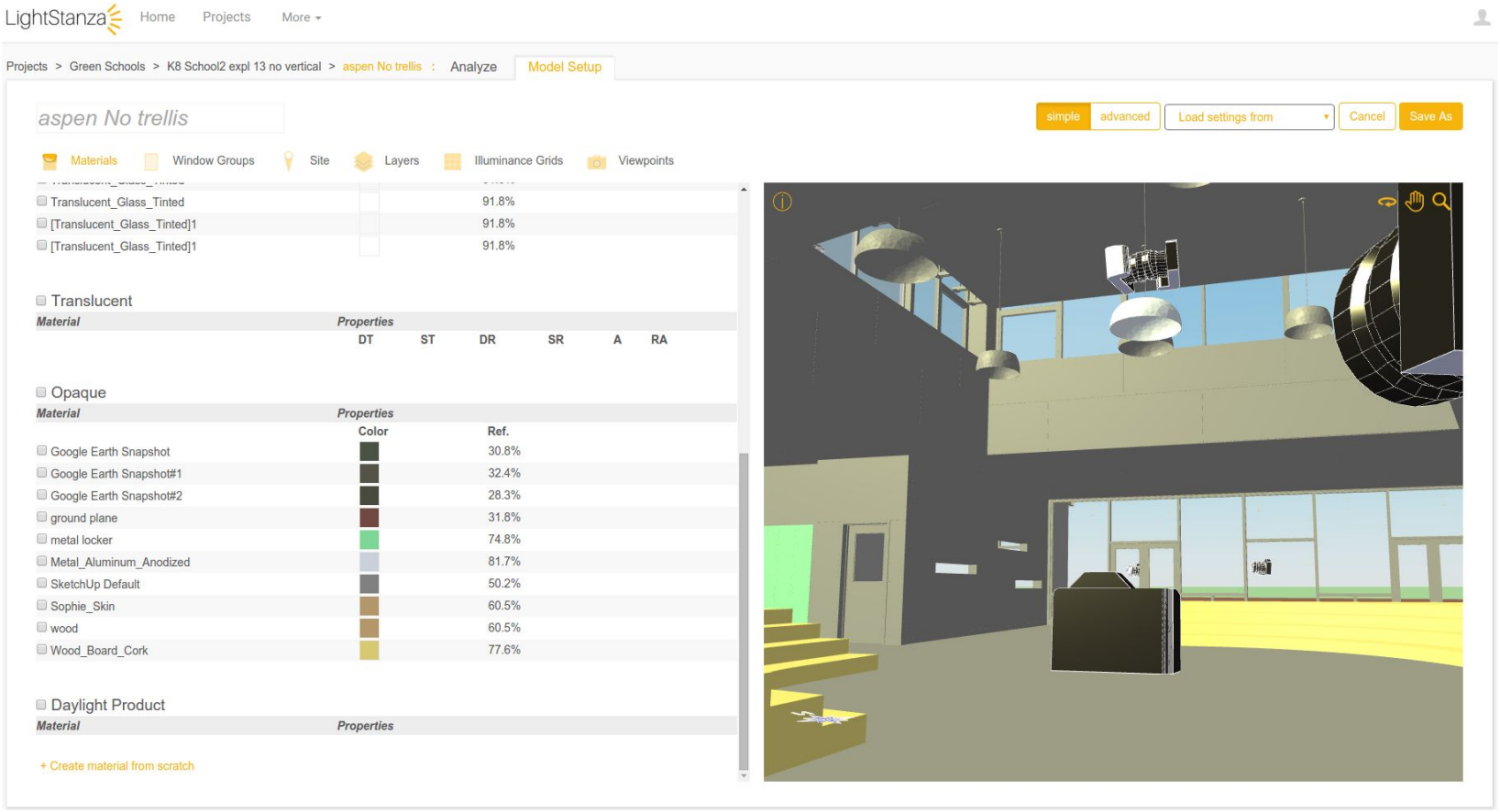


3ft wall thickness on ceiling
3x3 foot skylight

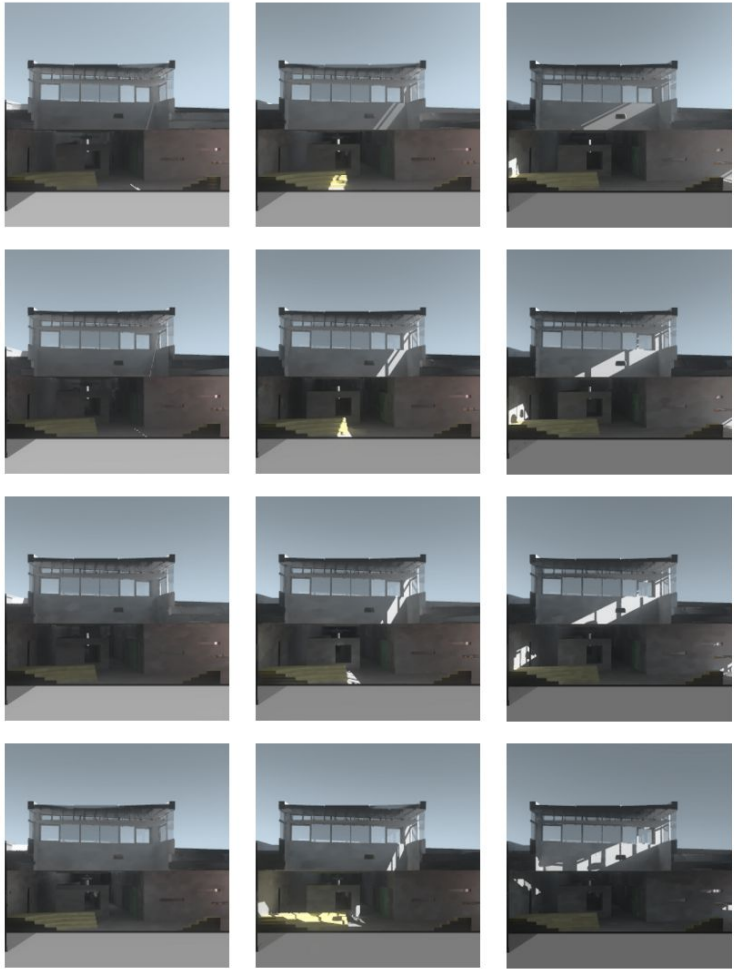








Cuningham Group, Architect of Record



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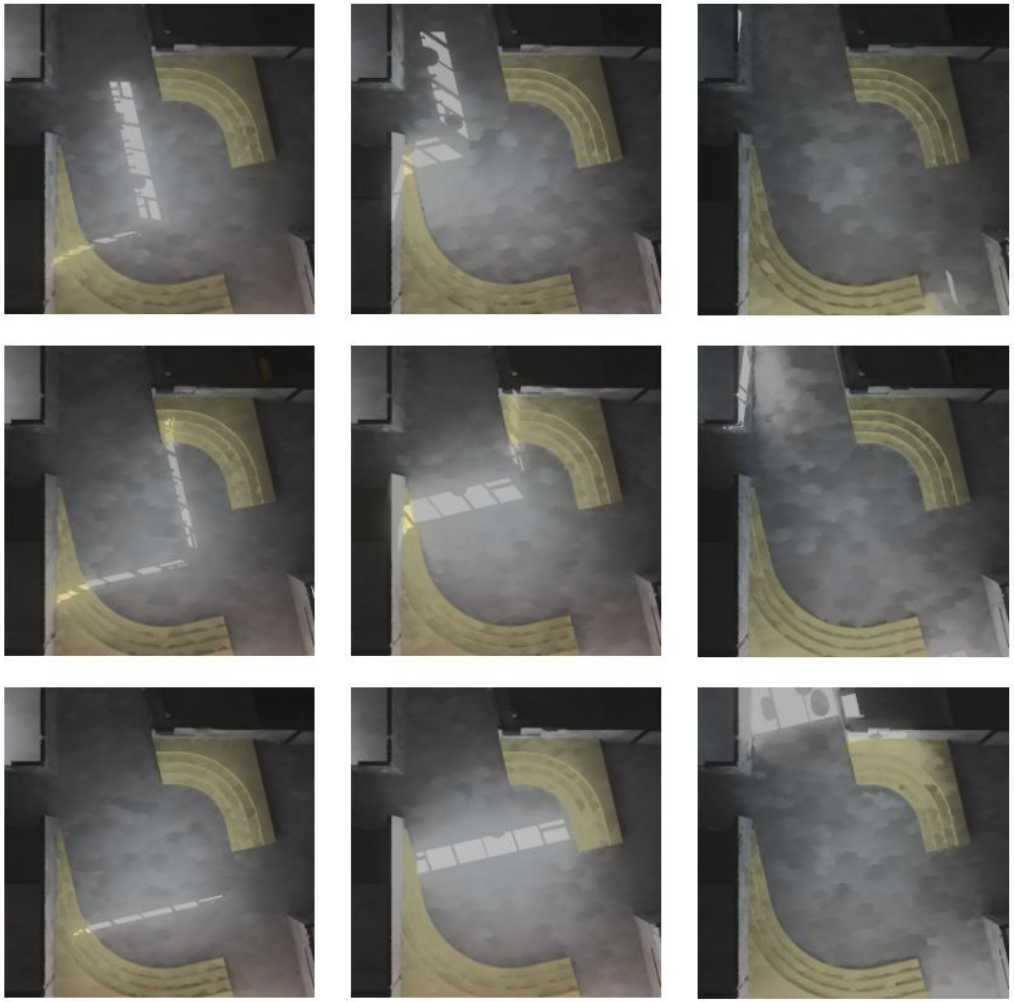

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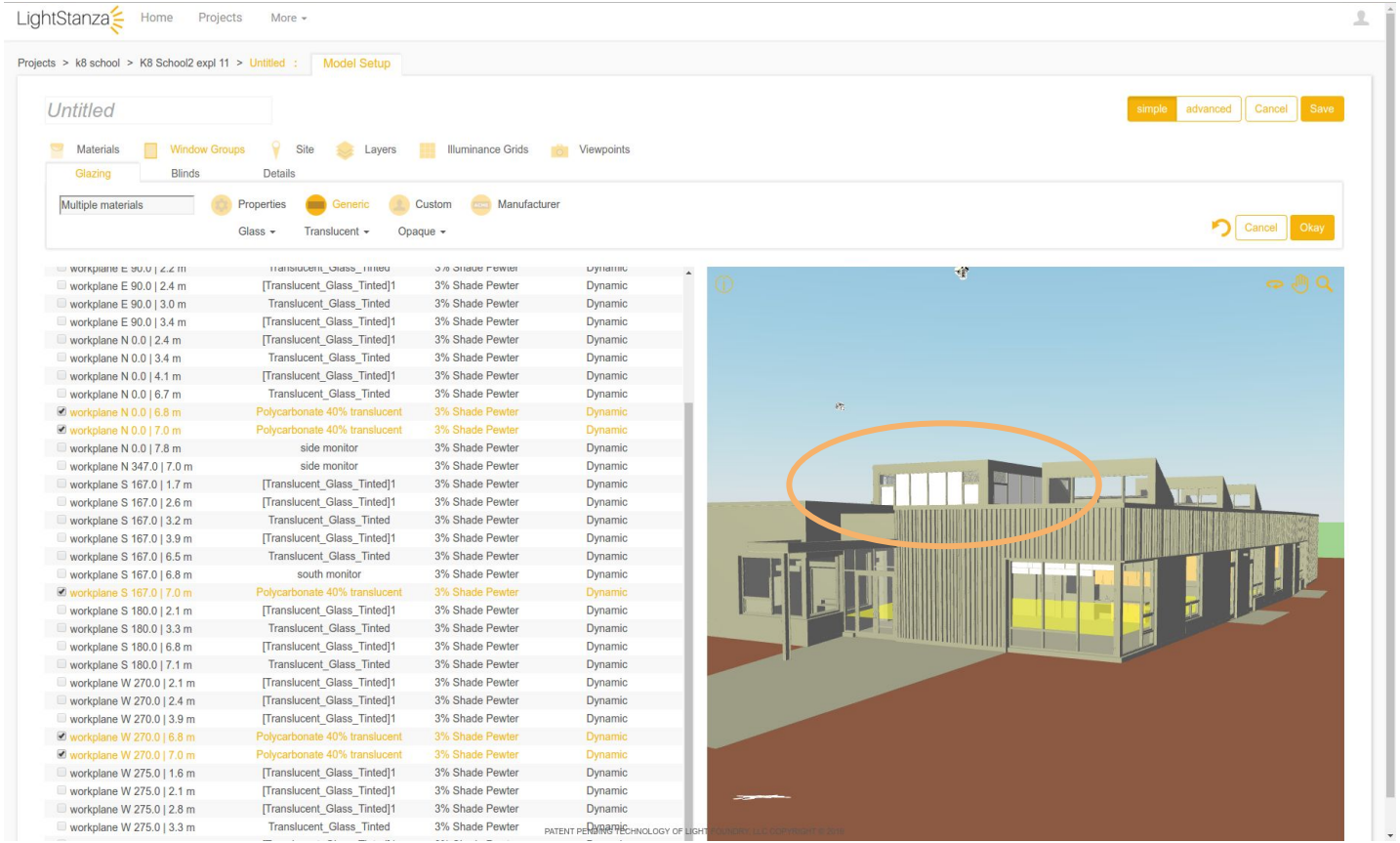


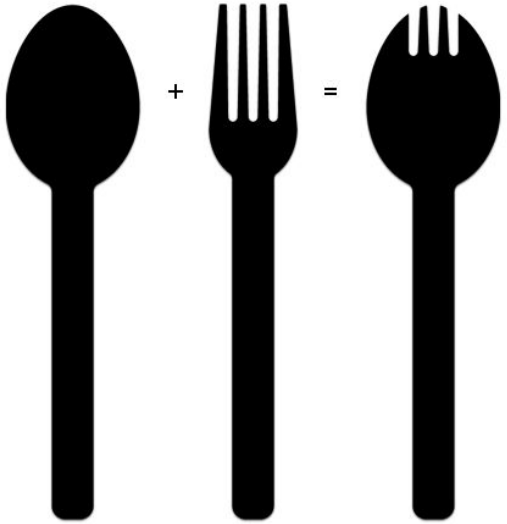
Cuningham Group, Architect of Record

Cuningham Group, Architect of Record

How to Apply Accurate Daylighting to Energy Tools

Integration vs. Interoperability

- Integration: the process of linking together different computing systems and software applications physically or functionally, to act as a coordinated whole.
- Interoperability: the ability of computer systems or software to exchange and make use of information



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Integration vs. Interoperability

vs.

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Integration

Pros:

1. Can simulate energy savings with daylight taken into account without file conversions and time spent moving between tools.
2. Potential lower cost
3. Only one tool / user interface to learn

Cons:

1. Energy models do not require the same precision as daylight models, so it is hard to do accurate in-depth daylighting analysis with the same model
    a. Cannot do a robust analysis of diffusing light into a space (light sensors may not take into account light bounces, quality of light, etc.)
    b. Blinds operation can be simplified
    c. Glare analysis requires more detail
    d. Difficult to apply things like tubular daylight devices or daylight redirecting films

Interoperability

Pros:

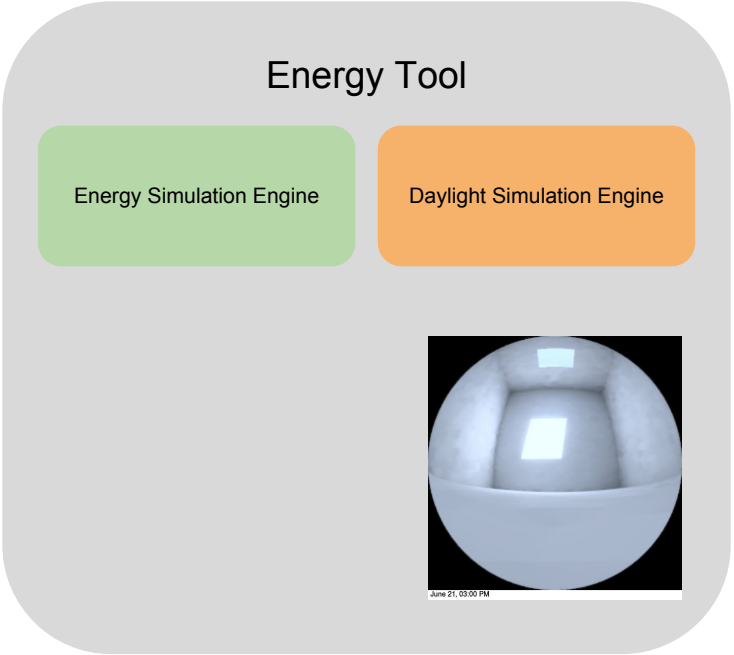
1. Allows in-depth analysis of daylight performance to confidently meet the changing / expanding requirements for daylighting in unique spaces (i.e. WELL Standards, LEED v4, etc.)
2. Current products on the market have spent many years making advancements in their area (energy modeling or daylight modeling), so combining analysis from two different specialized products can help guarantee the best results

Cons:

1. Time required to move between programs
2. File conversions/lack of standards
    a. Different file types allow different levels of detail

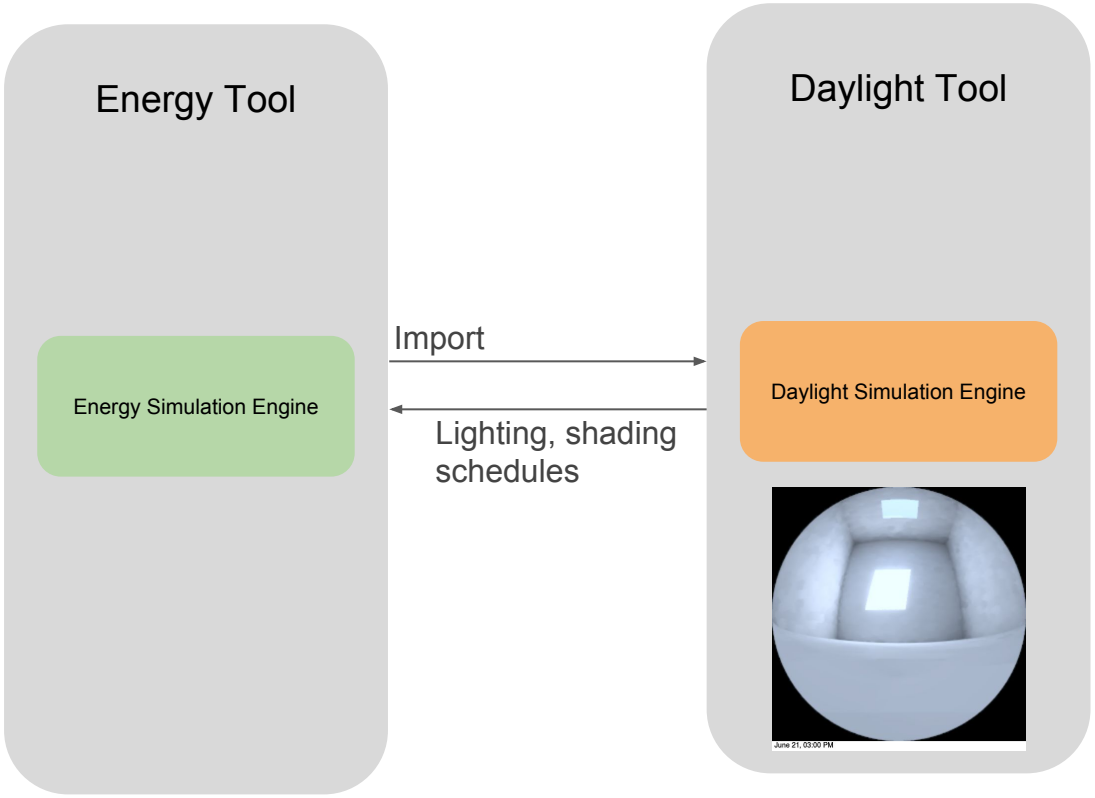
Integration

- Develop improved capabilities inside energy tool
- Increases the scope of tool



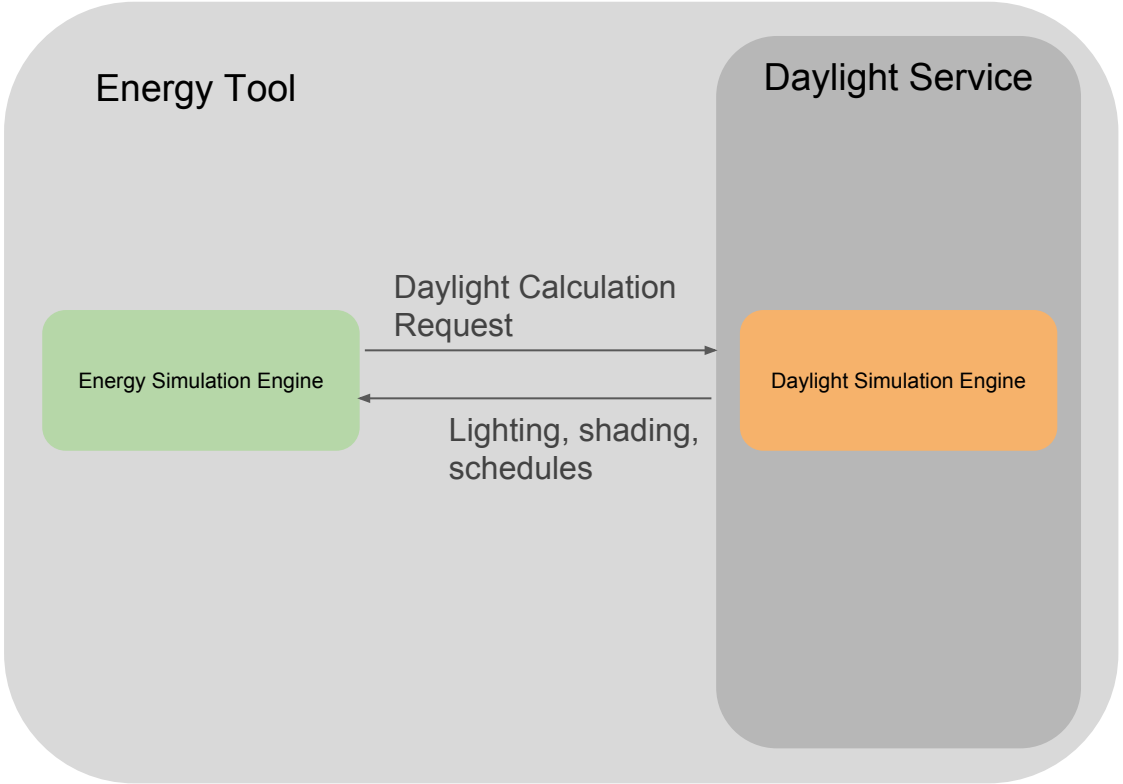
Interoperability, Sequential

- Energy → Daylight
  - gbXML
  - IFC
  - Radiance project format
  - .osm
- Daylight → Energy
  - LPD schedules
  - Blind schedules

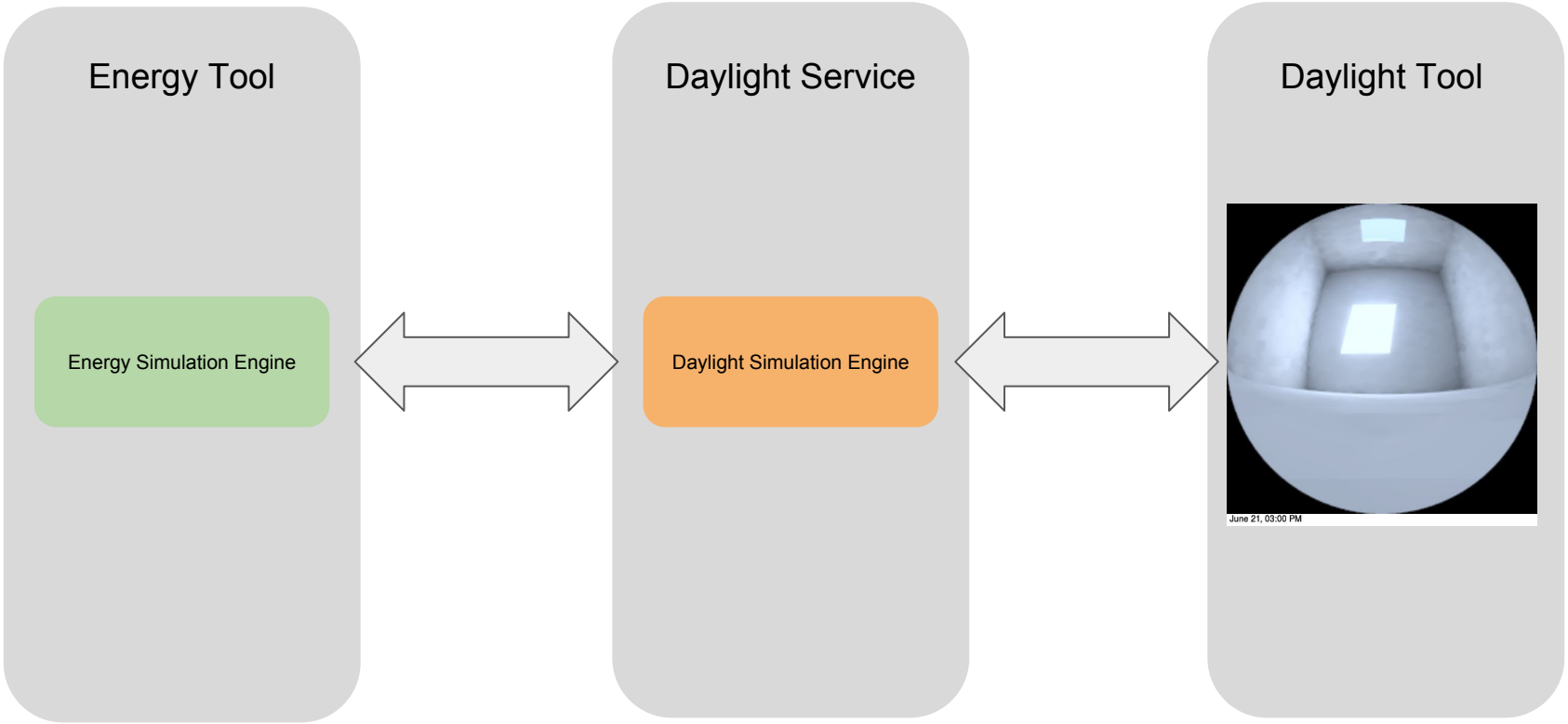


Dynamic Interoperability

- Daylight as a Service
- Protocols
  - Existing
    - Lighting Power Density
    - Shading Schedules
  - To be developed
    - Daylighting Model



Dynamic Interoperability



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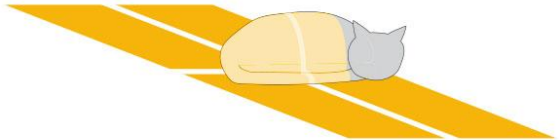
What do you think?

- What tools do you use to simulate energy and daylight?
- Have you had any issues with the accuracy of your daylighting simulations?
- What are your main pain points with interoperability between energy and daylighting tools, if any?
- How do you model occupant behavior and/or comfort with your current tools?
- From a user/workflow standpoint, what are the 3 most critical aspects that developers of energy and daylighting tools must “get right” in terms of interoperability?

Acknowledgements



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- Peter Ellis, President at Big Ladder Software
- Sukreet Singh, Associate; Director, Energy Analytics at Cuningham Group
- Colin Inderwish & RNL Design
- Dan Macumber, NREL

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