



Sustainable Lighting Design

2017 SOLID-STATE LIGHTING
TECHNOLOGY R&D WORKSHOP

Why Keep Pushing on Efficacy?

11.08.17



1. Perception of Light
2. Design Process
3. Applications



Perception of Light

Approach to Lighting Design

Human Perception of Light





LIGHTING METRICS:

- Light Levels
- Energy Codes

The Exploratorium
AIA COTE Top Ten, Net Zero, LEED Platinum
EHDD Architects

Photo by: WE-EF

Visibility

- Visibility has nothing to do with Light Levels
- Brightness based design



University of Reno Nevada Student Union
Collaborative Design Studio
LEED Silver

Photo by: Brennan Schumacher

Factors in Visibility

- Contrast
- Size
- Duration
- Luminance



Spring Mountain Gateway
LG Architects

Surface Reflectance



- Building surfaces are key to visual comfort
- Illuminate building surfaces
- Use light colors

Indian Springs School
LEED Gold
Lake | Flato Architects

Photo by : Halkin Photography LLC

Science of Light and Human

- Evolution from fire to electric light
- Impact on sleep cycles
- Biophilia
- Circadian Stimulus



Indian Springs School
LEED Gold
Lake | Flato Architects

Photo by: : Halkin Photography LLC



Design Process

Integrate

- To form, coordinate, or blend into a functioning or unified whole
- To make into a whole by bringing all parts together; unify
- Recognize Interdependence



Sustainability Tree House
AIA COTE Top Ten, Off Grid, LEED Platinum
Mithun & BNIM Architects

Photo by: Joe Fletcher Photography

Integrated Lighting Design

- Integrated lighting features that save energy



University of Reno Nevada Student Union
Collaborative Design Studio
LEED Silver

Photo by: Ed Lacasse

Daylight

- Use daylight as primary source



Spring Mountain Gateway
LG Architects

Electric Light

- Integrated lighting design
- Reduce connected load
- Illuminate surfaces
- Align with future technology



Layers of Light

- Ambient
- Accent
- Task



Spring Mountain Gateway
LG Architects

Lighting Controls

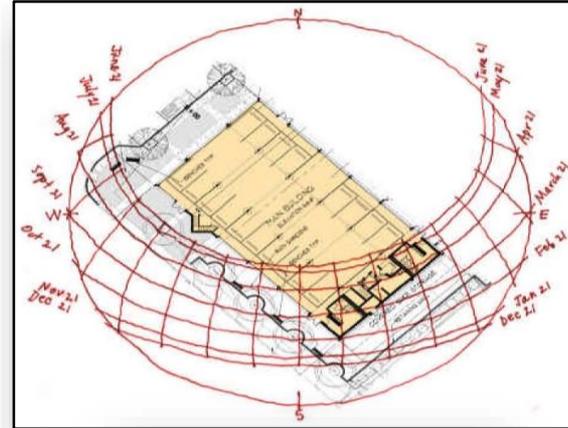
- Automated vs User Control
- Central vs Distributed
- Integrated Systems





Applications

Daylighting Analysis Tools



Daylighting Modeling

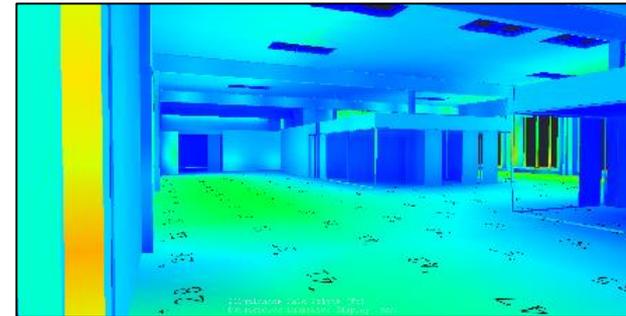
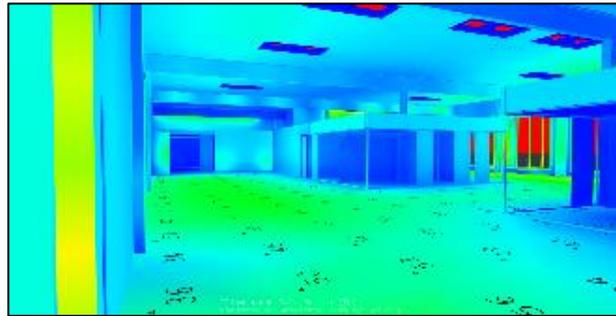
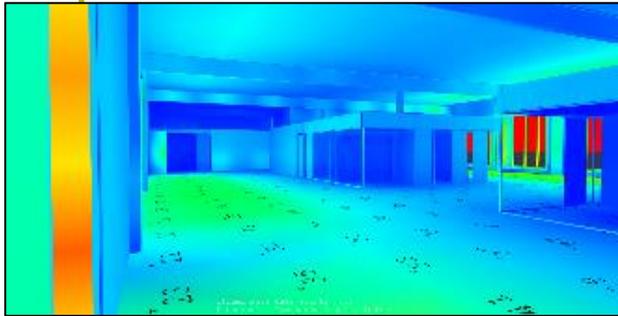
Base Case



Clear Skylight

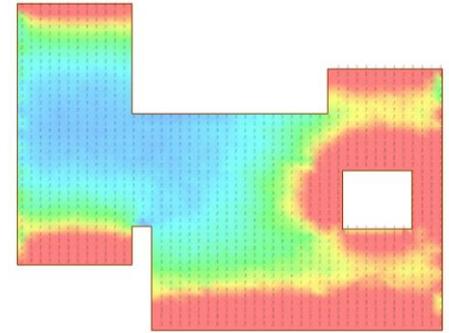
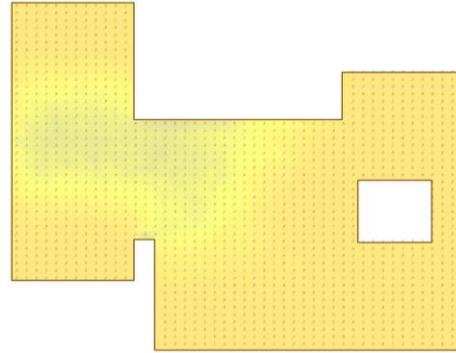
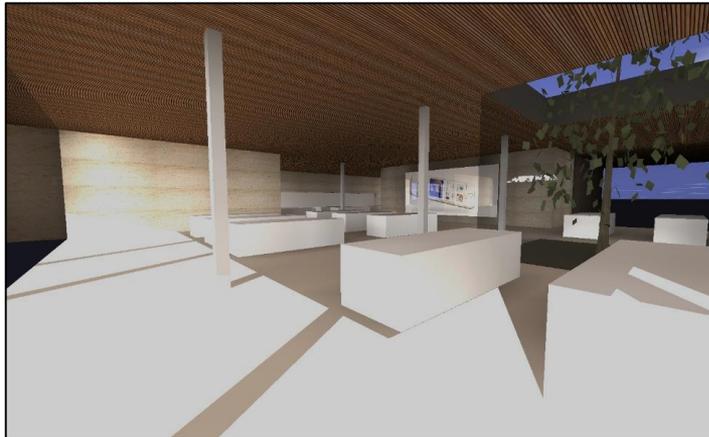


Diffuse Skylight

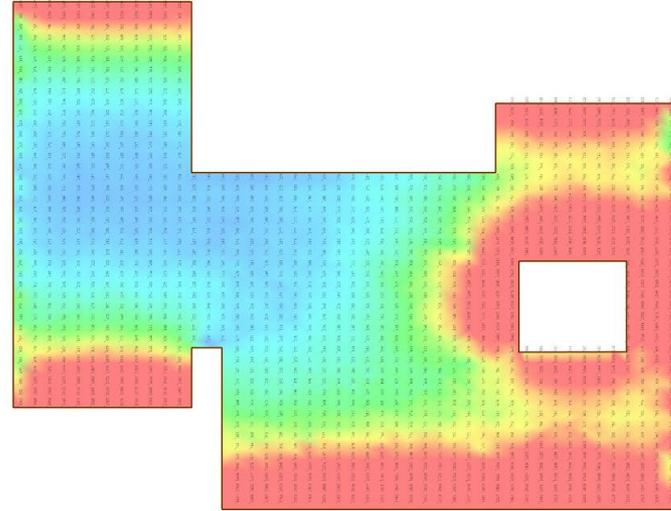
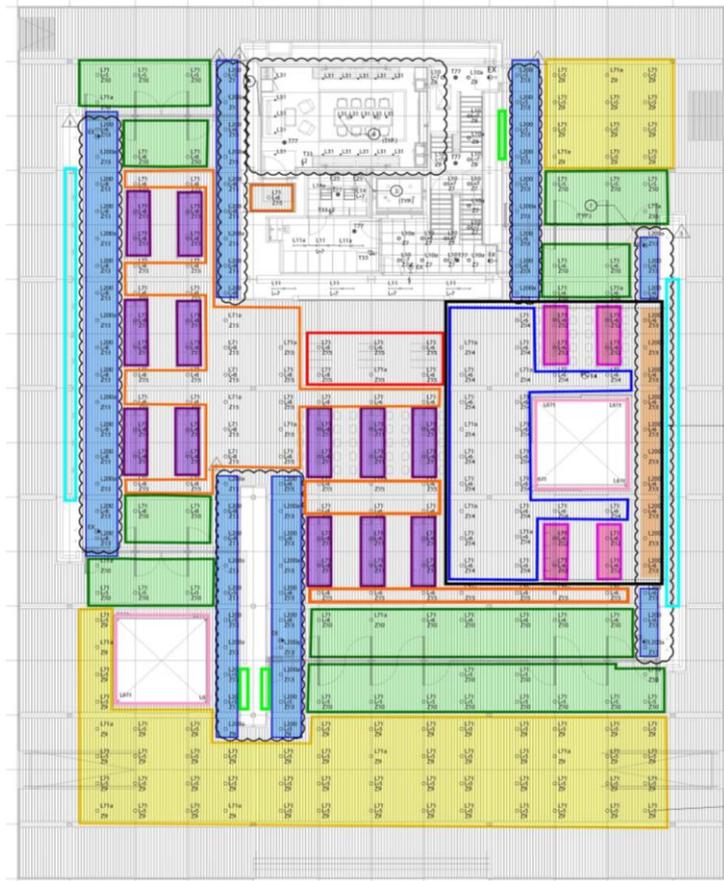


Simulation Results: December 21st, Overcast Sky

Daylight Modeling



Lighting Integration



Annual Daylight Exposure [K fc-h]

0 130 250 380 500 630 750 880 1000



Luminaire Evaluation

A	2"	4"
	94-100 lm/w	106-111 lm/w
B	3"	
	117 lm/w	
C	2"	4"
	91-94 lm/w	97 lm/w
D	2"	4"
	NA	117 lm/w



Rocky Mountain Institute, Innovation Center
Net Zero, Passive House, LEED Platinum
ZGF Architects

Photography: Tim Griffith

Rocky Mountain Institute

2015

- 0.5w/sf
- 70-90 l/w

2017

- 0.35w/sf
- 90-120l/w



Rocky Mountain Institute, Innovation Center
Net Zero, Passive House, LEED Platinum
ZGF Architects

Photography: Tim Griffith

Lighting Power Density Progress

Year	Project Type	Allowed LPD (w/sf)	Actual LPD (w/sf)	% Reduction
2004	School (CO)	1.6	1.04	35%
2006	Office (WA)	1.25	0.82	34%
2009	Museum (CA)	1.5	0.78	37%
2012	Lab/Office (CA)	1.1	0.84	24%
2014	School (AL)	1.2	0.63	48%
2015	Office (CO)	0.9	0.51	45%
2017	Office (CO)	0.83	0.35	52%

LED Sources

- Efficacy vs Efficiency
- Rated Life vs Lamp Life
- CRI & CCT
- Warranty
- Delivered Lumens vs Total
- POE



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Dynia Architects with Carney Architects