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 with Light Levels

- Brightness based design
Factors in Visibility

- Contrast
- Size
- Duration
- Luminance
Surface Reflectance

- Building surfaces are key to visual comfort
- Illuminate building surfaces
- Use light colors
Science of Light and Human

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

- Integrated lighting features that save energy
Daylight

- Use daylight as primary source
Electric Light

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

• Ambient
• Accent
• Task
Lighting Controls

- Automated vs User Control
- Central vs Distributed
- Integrated Systems
Applications
Daylighting Analysis Tools
Daylighting Modeling

Simulation Results: December 21st, Overcast Sky

- Base Case
- Clear Skylight
- Diffuse Skylight
Daylight Modeling
Lighting Integration
## Luminaire Evaluation

<table>
<thead>
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<th>2&quot;</th>
<th>4&quot;</th>
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<tbody>
<tr>
<td>A</td>
<td>94-100 lm/w</td>
<td>105-111 lm/w</td>
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<tr>
<td>B</td>
<td>3&quot;</td>
<td>117 lm/w</td>
</tr>
<tr>
<td>C</td>
<td>2&quot;</td>
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<tr>
<td>D</td>
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Photography: Tim Griffith

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

2015
- 0.5w/sf
- 70-90 l/w

2017
- 0.35w/sf
- 90-120 l/w
<table>
<thead>
<tr>
<th>Year</th>
<th>Project Type</th>
<th>Allowed LPD (w/sf)</th>
<th>Actual LPD (w/sf)</th>
<th>% Reduction</th>
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<tbody>
<tr>
<td>2004</td>
<td>School (CO)</td>
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<td>School (AL)</td>
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<td>0.63</td>
<td>48%</td>
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<tr>
<td>2017</td>
<td>Office (CO)</td>
<td>0.83</td>
<td>0.35</td>
<td>52%</td>
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</table>
LED Sources

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