Emerging Technologies Showcase
September 18, 2013

Presenters: Jerry Mix – Finelite, Inc
            Kelly Cunningham – California Lighting Technology Center

Welcome. Today’s webinar is being recorded and will be posted at:

- www.E3Tnw.org
- www.ConduitNW.org
Jerry Mix, Finelite, Inc.

Finelite, Inc. designs and builds innovative, high-performance lighting systems for offices, educational and healthcare facilities.

Finelite's commitment to developing better, more energy-efficient lighting has brought innovation and unmatched customer service to the industry for over 20 years.
Task /Vertical/Ambient Lighting Research
**The Office Solution**

Task/Vertical/Ambient, the layered lighting approach, reduces the watts per square foot and improves the quality of lighting in your space.
**Key Research Findings**

1. Reduced energy use by 28-59% for office space

2. Achievable lower lighting power density ranges from 0.50 to 0.65 W/f²

3. The quality and energy efficiency of office lighting is directly related to the quality and energy efficiency of task lighting

4. Poor-quality task lighting is costly

5. The LED-task/low ambient lighting outcome results in greatly improved user satisfaction

6. The LED-task/low ambient strategy is cost effective
We were able to document: *Traditional fluorescent task lights place 3 to 4 times more light on the surfaces than is recommended!*

**Task Lighting Technology**

- **25-30W Fluorescent Undercabinet Light**
  - Often 100-200 fc
  - WORK SURFACE
  - Often 90-120 fc

- **6-8 watt LED Undercabinet Luminaire**
  - 30-70 fc
  - WORK SURFACE
  - 30-70 fc
Task Lighting Technology

We were able to document: Traditional fluorescent task lights place 3 to 4 times more light on the surfaces than is recommended!
The Multi-Generational Workforce is Here to Stay

Light Required As The Eye Ages

- 75 fc
- 60 fc
- 50 fc
- 30 fc

Age

20 40 50 60
The following examples show how the decrease in retinal illuminance causes a decrease in the ability of the viewer to see contrast between text and background.
LED Task Luminaires Are a Critical Decision

Summary:
• Cut energy use by 50%
• Deliver the right light levels and luminance uniformity
• Make it beautiful
• Achieve strong user preference
• Keep within existing budgets
Vertical Lighting
Understanding the Criteria

Summary:

• Define the architecture through vertical brightness

• Use fixture energy effectively

• Average 20fc on a 50% reflective surface
Wall Washing

• Use luminaire with a forward throw asymmetric distribution

• Provides uniform overall glow
Wall Grazing

- Emphasize texture

Source: Yarnell Assoc.
Vertical Brightness

- Defines space
- Improves appearance
- Reduces ambient fixture count
- Reduces energy
Ambient Lighting
Understanding the Criteria

- 30fc maintained ambient
- Uniformity 3:1 max to min in immediate work area
- Lighting Power Density = 0.4 w/ft\(^2\)
- Use the right number of fixtures – may be able to reduce the number of ambient fixtures
Application Effectiveness
Typical Industry Practice

Ambient: 2T8 on 12' centers

Standard Layout:
• 544 linear feet of ambient luminaires
• Avg. illuminance: 77fc
• LPD: 0.95 W/ft²
• No user control
• 12 power feeds
Application Effectiveness
Typical Industry Practice

Task: 8w LED desk lamp
Vertical: (6) 1T8 luminaires
Ambient: 1T8 on 16’ centers

• 420 linear feet of luminaires (vertical + ambient)
• Avg. illuminance: 32fc
• LPD: 0.44 W/ft²
• User control: 30-80fc
• 9 power feeds
Suspended Luminaires

• Fluorescent or LED
• Specify efficacious luminaires
• 70-80% uplight distribution with widespread optics
• Shielding for downlight distribution
• Luminous element
• Quality construction for clean lines
High Performance Recessed Luminaires

• Fluorescent or LED
• Wide, even distribution for spacing flexibility
• Uniform brightness and visually comfortable
• Specify luminaires that are easy to install and maintain
• Below-ceiling access
• Sturdy and low-cost construction
Meets Targets

Luminance Uniformity Ratios
Around Seating Area = 11:1
Across Broad Viewing Areas = 26:1
Vertical

Illuminance (fc)

26

5

2

2

1

Meets Targets

Luminance Uniformity Ratios
Around Seating Area = 33:1
Across Broad Viewing Areas = 1.3:1

Meets Targets

Luminance Uniformity Ratios
Around Seating Area = 33:1
Across Broad Viewing Areas = 1.3:1
Task & Vertical

Illuminance (fc)

- Around Seating Area = 6:1
- Across Broad Viewing Areas = 2.2:1

Meets Targets

Luminance Uniformity Ratios

- E3T Energy Efficiency
- Emerging Technologies

FINE LITE
Better Lighting

Washington State University Extension Energy Program

Energy Services Western Area Power Administration
Ambient Only

Illuminance (fc)

- Around Seating Area = 5:1
- Across Broad Viewing Areas = 0.5:1

- Meets Targets

Luminance Uniformity Ratios
Task + Vertical + Ambient

Illuminance (fc)

35
30
70
28

Meets Targets

Luminance Uniformity Ratios
Around Seating Area = 2.6:1
Across Broad Viewing Areas = 1.5:1
Energy Savings

Standard Practice
ASHRAE 90.1 - 2004

Ambient 78%
Task 22%
1.1 w/ft²

Breakthrough Low Ambient

Documented 56%
Total Energy Savings

Ambient 83%
Vertical 8%
Task 8%
Savings

0.48 w/ft²
Lower Installed Cost

Installed Project Costs ($/sf)

- Standard Practice: $3.70 per sf (Ambient 78%, Task 22%)
- Task Low Ambient: $3.59 per sf (Ambient 65%, Vertical 9%, Task 26%)
Layers of Light In Practice
Efficiency Strategies for Lighting Include:

• Pendant luminaires with 1T8 lamp on 16’ centers
• 6W LED task lamps
• Task Low Ambient Approach
• Massive energy savings
• 44% below ASHRAE 90.1
• Double LEED Platinum
Task/Low Ambient Approach

- 0.5 w/ft² for Task, Vertical, and Ambient
- 1T8 lamp on 18’ spacing
- Recessed and wall-mounted vertical illumination
- 7.4W dimmable LED desk lamps
Task/Low Ambient Approach

- Toward Net-Zero building
- T8 lamps on 16’ spacing
- 6W LED desk lamps
Thank You For Your Attention

Jerry.Mix@finelite.com
Task / Vertical / Ambient Lighting:
Strategies for integration & a California code update

Kelly Cunningham
Outreach Director
California Lighting Technology Center
University of California, Davis
Mission

To accelerate the development and deployment of energy-efficient lighting and daylighting technologies in partnership with utilities, manufacturers, end users, builders, designers, researchers, academics, and governmental agencies.

MISSION-DRIVEN ACTIVITIES:

• Research & Development
• Demonstration & Outreach
• Education & Training
CLTC Focus Areas

- Indoor Lighting
- Outdoor Lighting
- Daylighting
- Advanced Controls
- Lamp Testing
- Market Assessment
- Lighting Education
- Policy, Codes and Standards
Select the appropriate:
Source
+ Luminaire
+ Controls
for the application
Luminous Efficacy
• One time, long duration change
• Reduction of baseline
  – Light Source Efficacy
  – Luminaire Efficacy
  – Application Efficacy

Lighting Controls
• Continuous, real-time change
• Fluctuations from base line
  – Occupancy / Vacancy
  – Daylighting
  – Demand Response
  – Tuning
  – Personal Control
Adaptive Lighting Systems...

automatically adjust their light output...

- Total Luminous Flux
- Spectral Power Distribution
- Candle Power Distribution

based on sensor input from the space they serve...

- Occupancy / Vacancy
- Daylight
- DR Signals

...to optimize space and building performance.

- Comfort
- Energy Savings
- Peak Demand Reduction
Overall Integrated Control Strategy

During occupancy focus on **comfort**
- Adjust fenestration for daylight penetration
- Adjust electric lighting for daylight contribution
- Offer manual control options
- Adjust electric lighting for demand response signal
- Adjust HVAC

During vacancy focus on **energy efficiency**
- Adjust fenestration for cooling/heating loads
- Turn electric lighting off or dim down
- Adjust electric lighting for demand response signal
- Adjust HVAC
Integrated Office Lighting Systems

• Reduce ambient lighting
  – Select tunable, efficacious luminaires
  – Match distribution to need

• Utilize vertical surfaces

• Provide high-quality task lighting

• Design for automatic and manual control
Energy Efficiency
Emerging Technologies

Integrated sensors
Simple:
Multi-level Switching + Occupancy Sensors

Multi-level switching allows occupant to choose the level of lighting in the room, while the occupancy sensors save energy by turning off lights when the room is vacant.
Simple:
Multi-level Switching + Occupancy Sensors

- No Lighting
- Reduced Lighting
- All Lights On

- Automatic On to 50%
- Manual Control Only
- Automatic On to 100%

PERCENT OF OCCUPIED TIME

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
More complex, daylighting + occupancy control:
Not enough daylight: 100% lighting
“Enough” daylight: 50% lighting
Even more daylight: 0% lighting
No occupants: 0% lighting
Complex (for now): **Networked Lighting**
Next: Ultra Smart Luminaires

- One or more light sources
- Multiple integrated sensors
  - Occupancy sensing
  - Photo sensing
  - Temperature sensing
  - ...
- Communications
  - With other luminaires
  - With utilities
  - ...
- Control logic based on multiple sensor signals
  - From same luminaire
  - From neighboring luminaires
- Automated, continuous calibration
E3T Energy Efficiency Emerging Technologies
Title 24: California’s Energy Code

- New code goes into effect January 1, 2014
- Multi-level lighting requirements expanded
- Plug load control for office spaces introduced
- Automated Demand Response requirements expanded
- Acceptance testing for lighting controls requirements expanded

- Task / ambient lighting best practices can be used to fulfill code!
Title 24 2013 Multi-level lighting controls: Changes from 2008

- Required in areas ≥ 100 sq ft with a LPD greater than 0.5 w/sf now, was 0.8 w/sf
- Requirements based on source type, was only one control step between 30% and 70% of full output
- Additional control strategy required, previously no additional requirements
- There are some exceptions
Multi-level lighting controls

Areas ≥ 100 ft² with connected lighting load > 0.5 W/ft² must meet control and uniformity requirements of Table 130.1-A

Must also use one of the following control strategies:

– Manual dimming
– Lumen maintenance
– Tuning
– Automatic daylighting
– Demand response
### Table 130.1-A

<table>
<thead>
<tr>
<th>Luminaire Type</th>
<th>Minimum Required Control Steps (Percent of Full Rated Power)</th>
<th>Uniform Level of Illuminance Shall Be Achieved by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line-voltage sockets except GU-24</td>
<td></td>
<td>Continuous dimming 10–100%</td>
</tr>
<tr>
<td>Low-voltage incandescent systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LED luminaires and LED source systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GU-24 rated for LED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GU-24 sockets rated for fluorescent &gt; 20 W</td>
<td></td>
<td>Continuous dimming 20–100%</td>
</tr>
<tr>
<td>Pin-based compact fluorescent &gt; 20 W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GU-24 sockets rated for fluorescent ≤ 20 W</td>
<td>Minimum one step between 30–70%</td>
<td>• Stepped dimming or</td>
</tr>
<tr>
<td>Pin-based compact fluorescent ≤ 20 W</td>
<td></td>
<td>• Continuous dimming or</td>
</tr>
<tr>
<td>Linear fluorescent and U-bent fluorescent ≤ 13 W</td>
<td></td>
<td>• Switching alternate lamps in a luminaire</td>
</tr>
<tr>
<td>Linear fluorescent and U-bent fluorescent &gt; 13 W</td>
<td>Minimum one step in each range:</td>
<td>• Stepped dimming or</td>
</tr>
<tr>
<td></td>
<td>20–40%</td>
<td>• Continuous dimming or</td>
</tr>
<tr>
<td></td>
<td>50–70%</td>
<td>• Switching alternate lamps in each luminaire, having a minimum of 4 lamps per luminaire, illuminating the same area and in the same manner</td>
</tr>
<tr>
<td>Track lighting</td>
<td>Minimum one step between 30–70%</td>
<td>• Step dimming or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Continuous dimming or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Separately switching circuits in multi-circuit track with a minimum of two circuits</td>
</tr>
<tr>
<td>HID &gt; 20 W</td>
<td>Minimum one step between 50–70%</td>
<td>• Stepped dimming or</td>
</tr>
<tr>
<td>Induction &gt; 25 W</td>
<td></td>
<td>• Continuous dimming or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Switching alternate lamps in each luminaire, having a minimum of 2 lamps per luminaire, illuminating the same area and in the same manner</td>
</tr>
<tr>
<td>Other light sources</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Shut-Off Controls: Changes from 2008

Specific requirements for partial ON/OFF occupancy sensors; *none required in 2008*

- Parking garages
- Other indoor parking areas
- Indoor loading and unloading zones
- Library book stacks*
- Stairwells and corridors*
- Warehouse aisle ways and open areas*

Reduced exception for egress lighting; before 0.3 w/sf anywhere, now **0.05 w/sf** in office buildings only
Shut-off Controls

All indoor lighting must have controls that:

– Automatically turn off lighting when unoccupied
– Controls each floor of a building separately
– Controls each space of a building separately

Shut-off controls exceptions

– Where the lighting is in use 24/7, 365 days a year
– Lighting for emergency egress
– Electrical equipment rooms
Occupant sensing controls are required to shut off all lighting when area is vacant

– Offices 250 ft² or smaller
– Multipurpose rooms 1000 ft² or smaller
– Classrooms
– Conference rooms
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For More Information:

Department of Energy
www.energy.ca.gov/research

New Buildings Institute – Advanced Lighting Guidelines
http://www.newbuildings.org/ALD.htm

Emerging Technologies Coordinating Council
http://www.etcc-ca.com

LEED
http://www.usgbc.org/

IESNA
http://www.iesna.org/

ASHRAE
http://www.ashrae.org/