2015 DOE Solid-State Lighting R&D Workshop
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Adaptive Lighting

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The Fundamental Lighting Design Strategy

Provide

Right Light $\rightarrow$ **Spectral Power Distribution**

Where $\rightarrow$ **Candle Power Distribution**

& When $\rightarrow$ **Environmental Conditions**

Needed
Adaptive Electric Lighting Systems

- **Automatically adjust** their light output...
  - Candle Power Distribution (CPD) - *total flux & spatial distribution*
  - Spectral Power Distribution (SPD) - *CCT & CRI*
  - ...

- **...based on environmental conditions**...
  - Occupancy / Vacancy
  - Daylight Availability
  - Demand Response Signals
  - ...

- **...to optimize space & building performance**
  - Maximize Comfort
  - Minimize Energy Requirements
  - Minimize Peak Electricity Demand
  - ...
Adaptive Outdoor Lighting – Circa 2005

- Amber LED (2W) & CFL Light Sources
- Controlled based on Photo sensor & Occupancy sensor signals
CLTC Adaptive Lighting Control Strategy

During **Occupancy**
Focus on **Comfort**

During **Vacancy**
Focus on **Energy Efficiency**
Dual Source Bi-level Luminaire

Occupancy Mode
Dual Source Bi-level Luminaire

Vacancy Mode
Spectrally Tunable Lighting

- Independent control of Intensity & CCT
  - Change CCT maintaining Intensity
  - Change intensity maintaining CCT

- Emerging commercial technologies
  - Residential
  - Educational
  - Medical
  - Hospitality
  - ...
  - Outdoor
  - Retail
  - Industrial
  - ...
The Fundamental Lighting Design Strategy

Provide

Right Light → *Spectral Power Distribution*

Where → *Candle Power Distribution*

& When → *Environmental Conditions*

Needed
Right SPD? Right CPD?
Where would like to go for a walk?
Right SPD? Right CPD?

Before

After
Biological adaptation to the sun has evolved over billions of years.

The power to artificially override the natural cycle of light and dark is a recent event and represents a man-made self-experiment on the effects of exposure to increasingly bright light during the night as human societies acquire technology and expand industry.

Among the latter (health effects) are potential carcinogenic effects related to melatonin suppression, especially breast cancer. Other diseases that may be exacerbated by circadian disruption include obesity, diabetes, depression and mood disorders, and reproductive problems.

Due to the nearly ubiquitous exposure to light at inappropriate times relative to endogenous circadian rhythms, a need exists for further multidisciplinary research on occupational and environmental exposure to light -at-night, the risk of cancer, and effects on various chronic diseases.
The Fundamental Lighting Design Strategy

Provide

Right Light $\rightarrow$ Spectral Power Distribution

Where $\rightarrow$ Candle Power Distribution

& When $\rightarrow$ Environmental Conditions

Needed
Key Electric Lighting Control Strategies

- High-end Tuning
- Occupancy/Vacancy!
- Daylight Harvesting!
- Scheduling
- Demand Response!
- Manual Control
Traditional Daylight Sensing Strategies

Closed Loop Sensing

**Affected** by electric lighting

- Signal is affected by changes in the space
  - Geometry & reflectance of interior surfaces
  - Occupants moving through the space

**Main advantage**
- Measures light in the space

**Main disadvantage**
- Not affected by changes in the space
- Not an accurate indicator of daylight levels in the space
Dual Loop Daylight Sensing

Advantages
• Measures light in the space
• Can differentiate between true daylight changes and change in geometry and reflectance of interior surfaces
• Automatically & continuously accounts for changes in geometry & reflectance of interior surfaces

Disadvantages
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Thank You!

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