Principles of Good Interior Lighting

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Quality Visual Environment

1. Daylighting + Views
2. Layers of Light + Controls
3. Occupant Feedback
1. Daylighting and Views
Our pattern of light and dark
(from Lisa Heschong)

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Ancestral

Modern ?

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Start with daylight!

Light colored carpet around the perimeter reflects sunlight to the ceiling, providing a soft brightness to the open offices. Mesh roller shades automatically adjust to shade sunlight from the workstations.
Views

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Health and Well Being

“Patients recovering from surgery with views of nature required 20% less pain medication”

• Reduces stress
• Better modeling
• Less eye strain

• VIEWS are very important

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Headlines – “Students with the MOST daylight did better on test scores”
When is direct sun too much?
2. Layers of Lighting
Importance of Surface Brightness
Illuminating the bright white ceiling creates a bright workspace with soft, low-glare light. The direct, downward light provides brightness and clarity to the workstations.

- 25-30 Footcandles on desks
- 0.45 Watts/Sqft

Ambient Light

Photo Credit: Eric Laignel
Mood Differences
Personalized Lighting

LED task lights at each workstation provide individualized lighting control.
- 6 watts,
- 75 Footcandles
- Fully adjustable and dimmable.
Personalized Lighting

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Undercounter Lighting
Accents add interest

Translucent images of nature glow with backlight from the ambient lighting and daylight, providing brightness and visual interest with no additional lighting.
Using daylight as art
Electric lighting support

- Do not duplicate daylight!!
- Supplement the daylight
- Effective electric lighting - light surfaces
- Controls, controls and more controls

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Layers of Light = 50% energy reduction

Layers of Light
- Low glare ambient lighting
- Personalized lighting

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Selecting the Right Luminaires
Selecting the Right Equipment

• DOE: Next Generation Luminaires
  http://www.ngldc.org/
3. Integrating Light with Controls
Daylight Controls

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Transparency and Information

Lighting Control Capabilities
- Daylight Dimming
- Occupancy Sensing
- Manual-On / Auto-Off (Daytime)
- Auto-On / Auto-Off (Nighttime)
- Time of Day Control
- Extended Night Views
- HVAC Occupancy Setback
- Intuitive Manual Dimming
- Preset Lighting Scenes
- Small Dimming Zones
- Energy Monitoring Dashboard
- Audio / Visual Interface
- Conference Room Partitioning
- Load Shed Priority Dimming
- Plug Load Control
USGBC Lighting Energy Usage = 0.1 watts/SF average

Empire State Building

- Partner companies: 5
- Energy-efficiency ideas vetted: 60+
- Final projects recommended: 8
- Iterative design process: 8 mos.
- Annual energy savings: $4.4M
- Energy reduction: 38%
ESB - Tenant Finish Pre-Builts (complete with controls!)

http://www.wbdg.org/references/cs_esb.php

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ESB – Exceeding Energy Predictions by 15.9% (Lighting accounts for 55%)

Innovative Empire State Building Program Cuts $7.5M in Energy Costs Over Past Three Years

World’s Most Famous Office Building exceeds energy efficiency savings for third consecutive year. This year, the iconic property beat its energy-efficiency guarantee by 15.9%, saving $2.8 million.

https://www.youtube.com/watch?v=17i7Q5Dr3PA

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911 Call Center (emergency calls) – Occupant Feedback
Existing Conditions
Experiment Equipment Layout
Results: CCT Preference

![Graph showing CCT preference across workstations]

- Workstation 3: CCT value at 2500K
- Workstation 4: CCT values range from 3500K to 4000K
- Workstation 5: CCT values range from 4000K to 4500K
- Workstation 6: CCT values range from 4500K to 5000K

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Results: Intensity Preference

Max = 27W  8W  24W  44W

Workstation #
Results: CCT by Gender

- Female (n=14)
- Male (n=6)
Results: CCT by Age

- 20-24 (n=2)
- 25-29 (n=1)
- 30-34 (n=6)
- 35-39 (n=3)
- 40+ (n=8)
Results: General Assessment

- Used Task Light: 4
- Lighting Comfortable: 5
- Like Intensity Control: 8
- Like Color Control: 7

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Results: Overall Lighting Preference

Workstation 6 (indirect light):
“Best illumination of the workspace with minimal shadows or reflection, excellent range of adjustment, absolutely no eye strain”
Evaluation Feedback – What they did not like

• Downlight (too glary, bright, harsh)
• Existing track lighting (too bright)
Evaluation Feedback – What they liked:

- Indirect pendant (uniform, low glare lighting)
- Lighting behind computers (monitors less bright)
- Personal controls for dimming and color tuning
- Warmer CCT
Evaluation Feedback – Other Feedback:

• Monitors blocked the back panel lighting
• Sunrise causes glare
Action Items responding to feedback

• Combine strategies (indirect lighting with personalized lighting)
• Personalized controls
• Shading options