



Principles of Good Interior Lighting



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Quality Visual Environment



1. Daylighting + Views



2. Layers of Light +
Controls



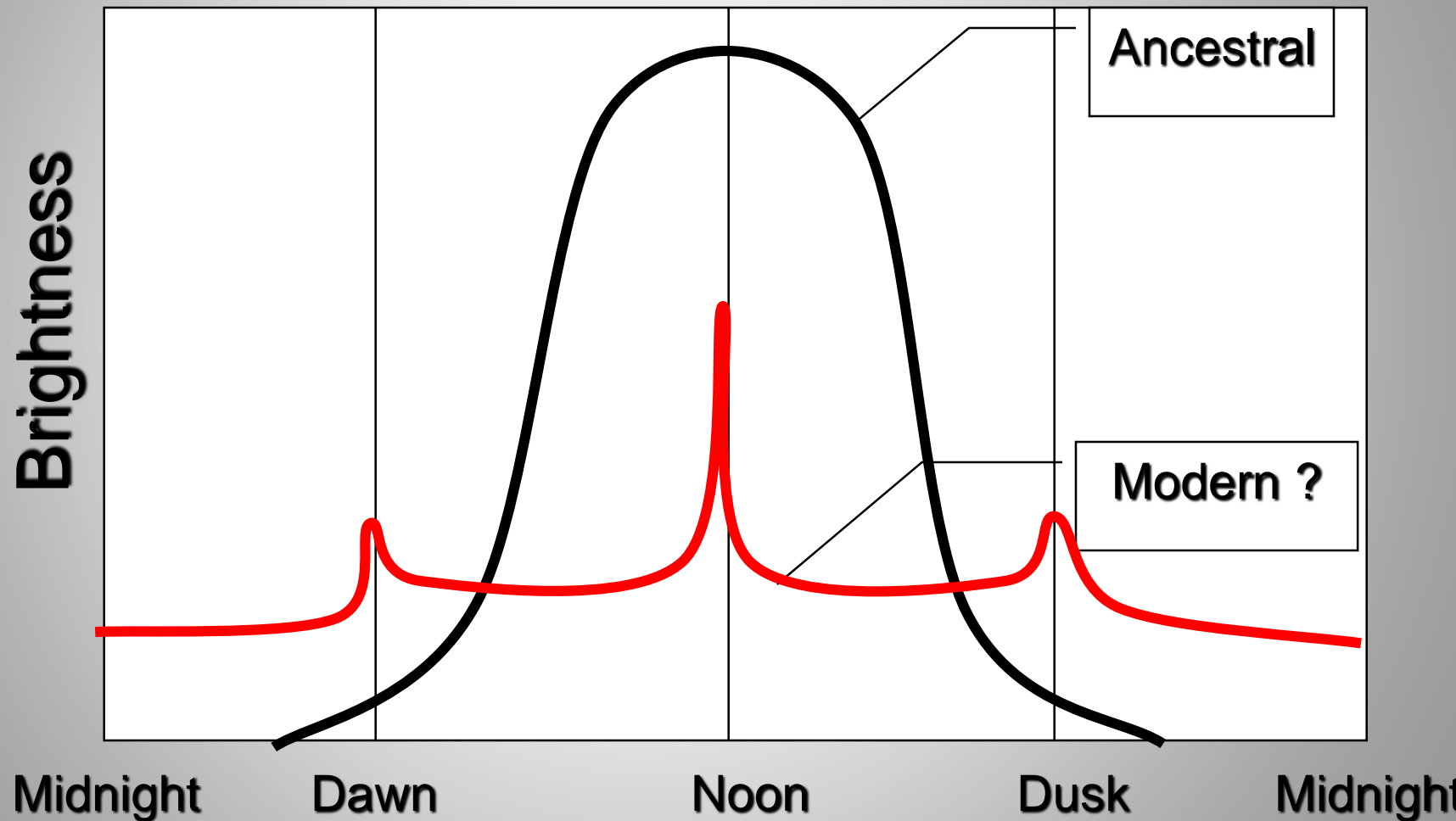
3. Occupant Feedback

1. Daylighting and Views



Our pattern of light and dark

(from Lisa Heschong)

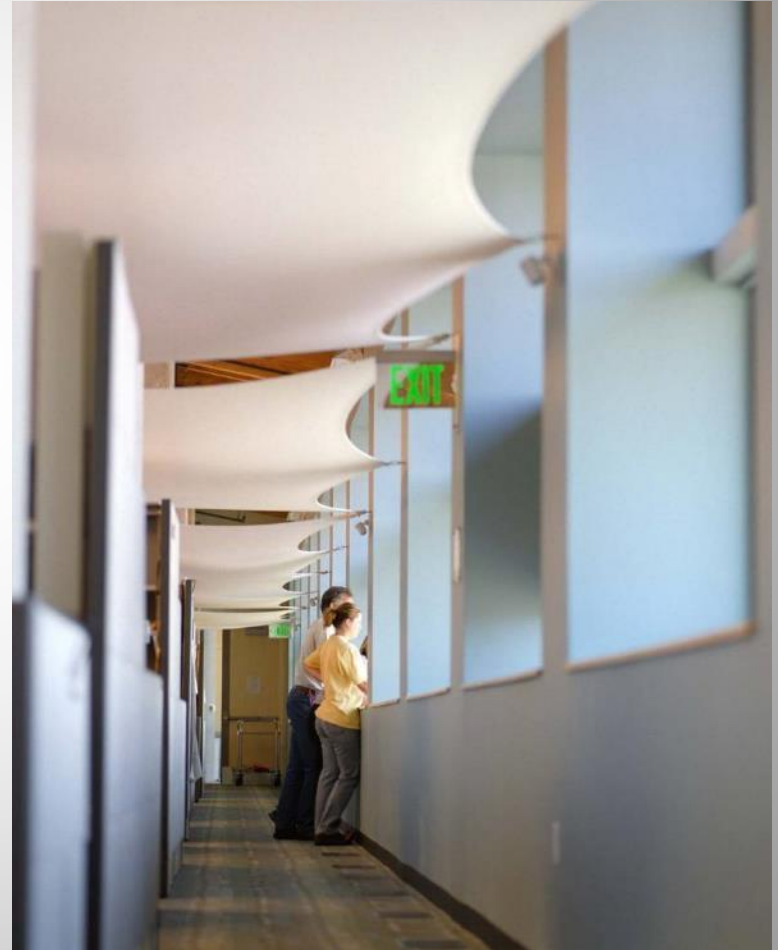


Start with daylight!



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.

Daylight



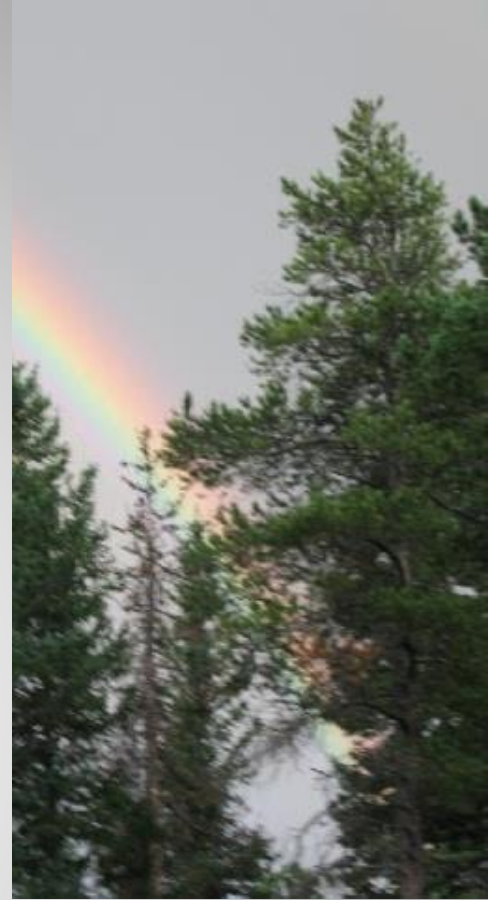
Views



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



Headlines – “Students with the MOST daylight did better on test scores”



Fossil Ridge High School

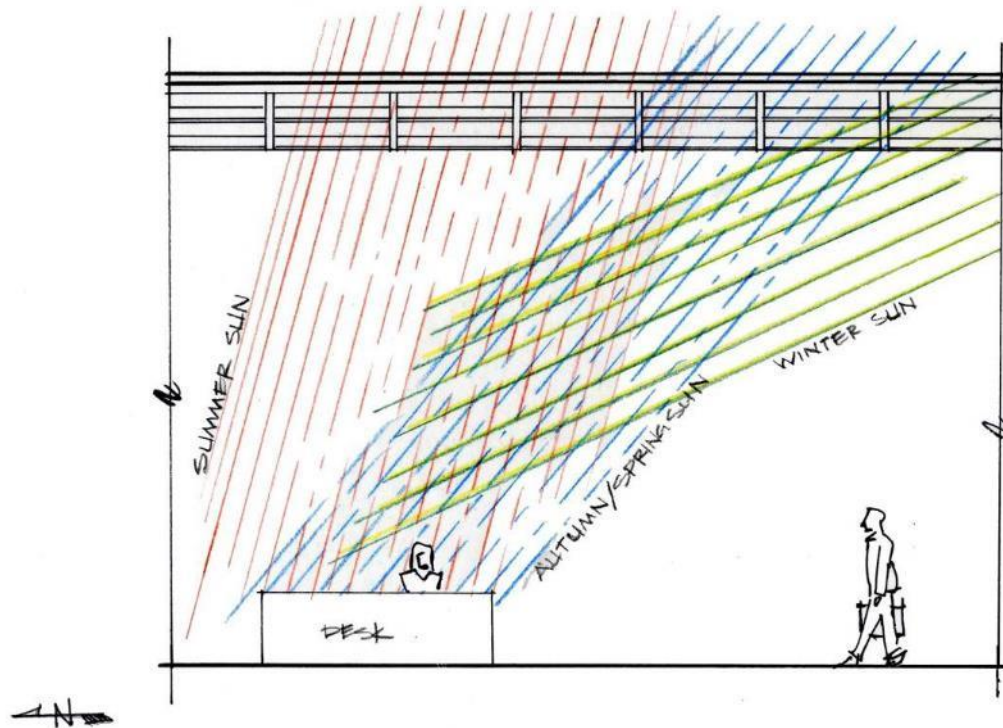


4th and LeHigh School

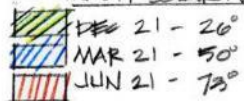
When is direct sun too much?







NOON SOLAR ANGLES



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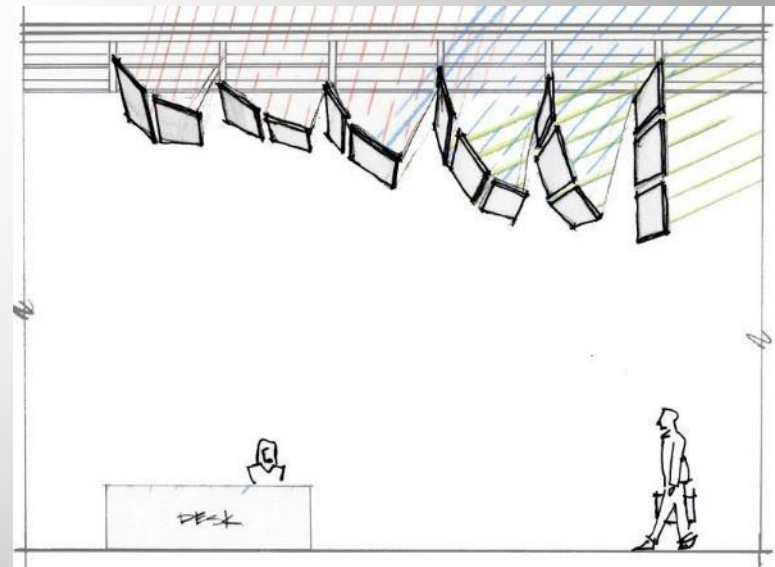
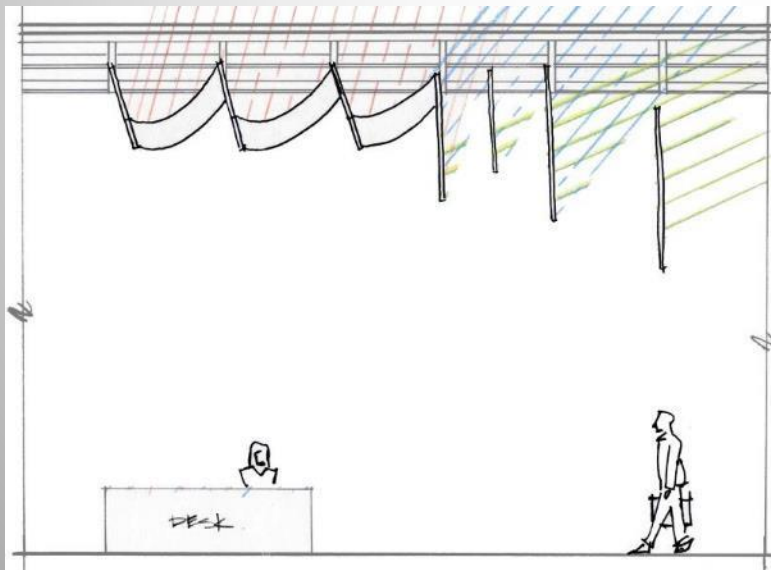
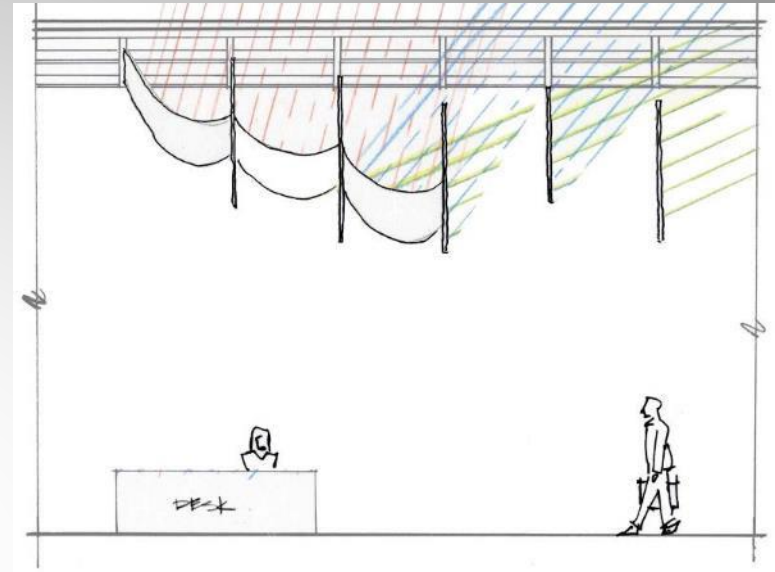
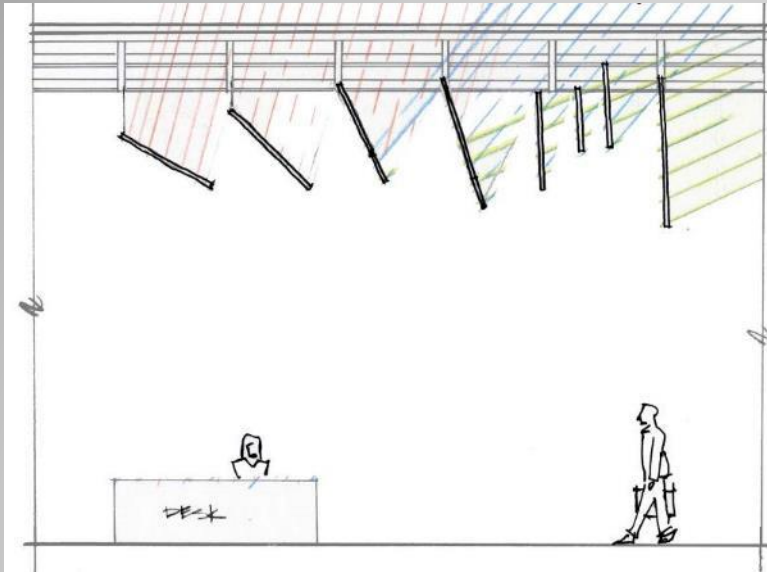
Title: LOBBY SECTION - SUN PATH

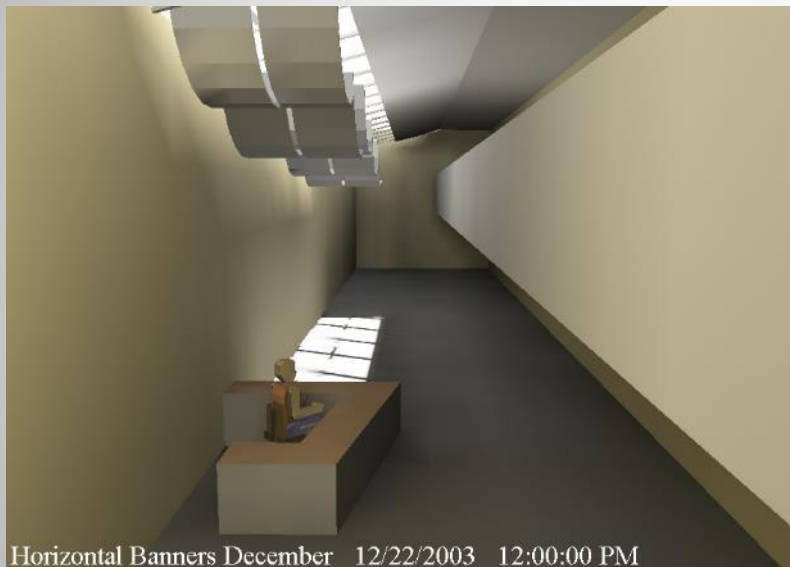
Date: 29 October 2003

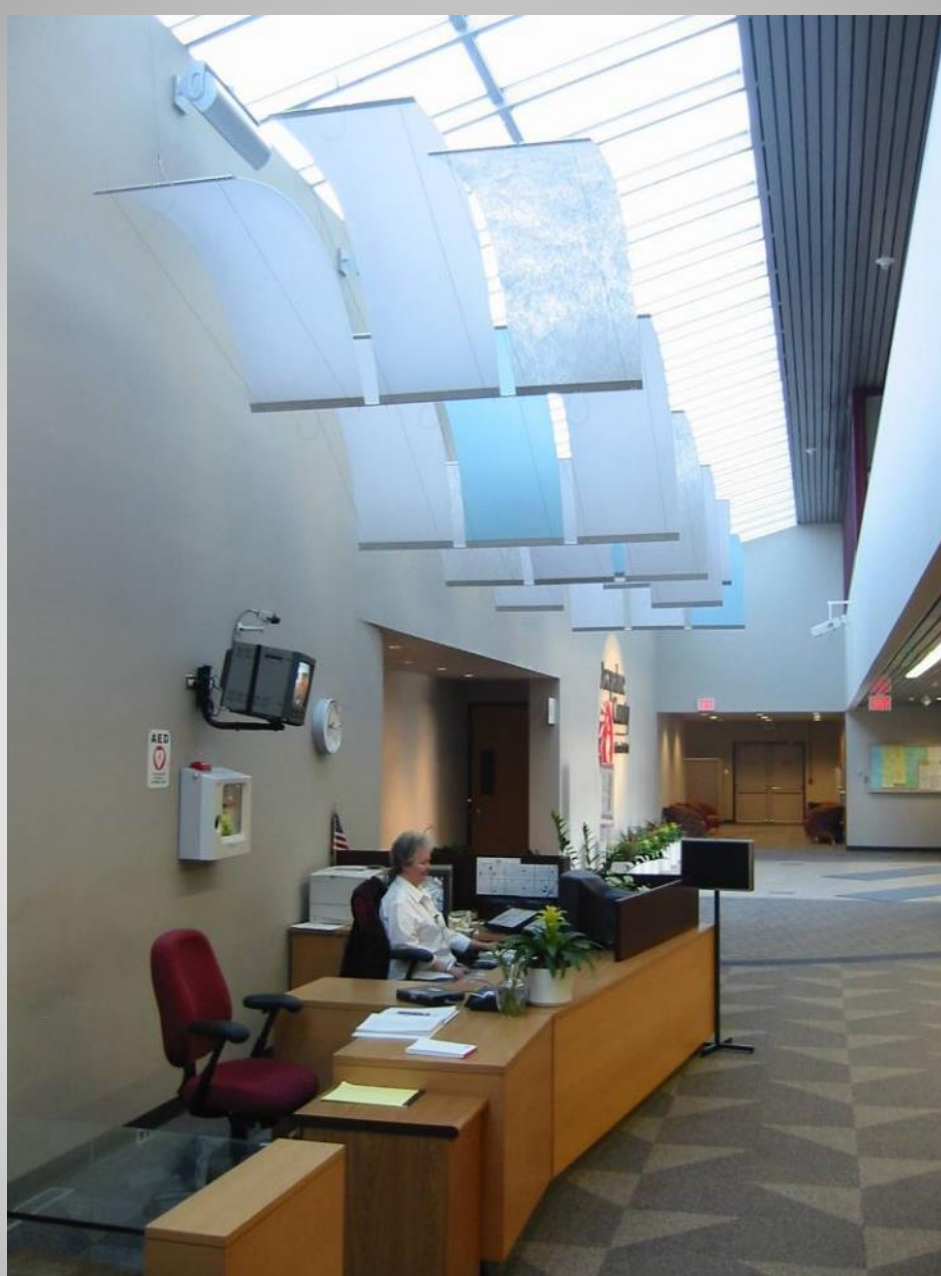
Scale: Approx. 1/4" = 1'-0"

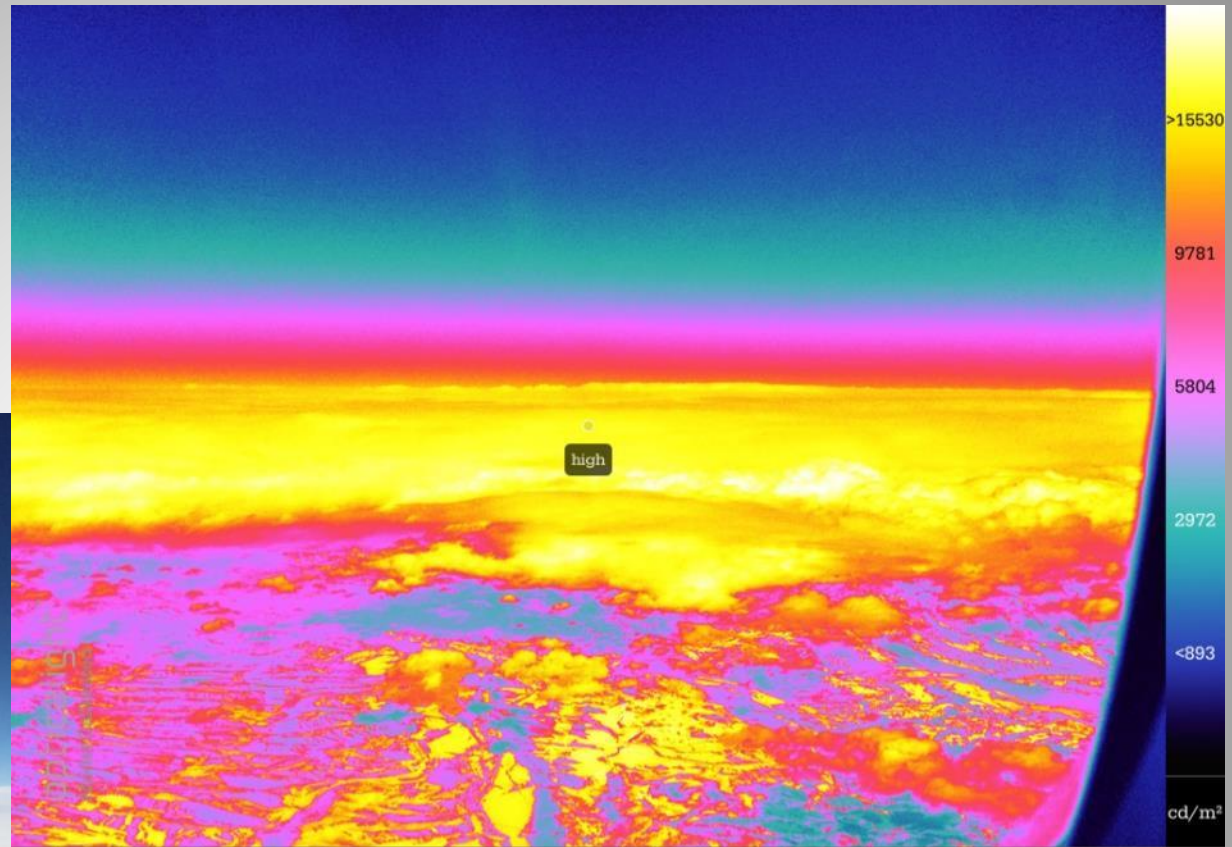
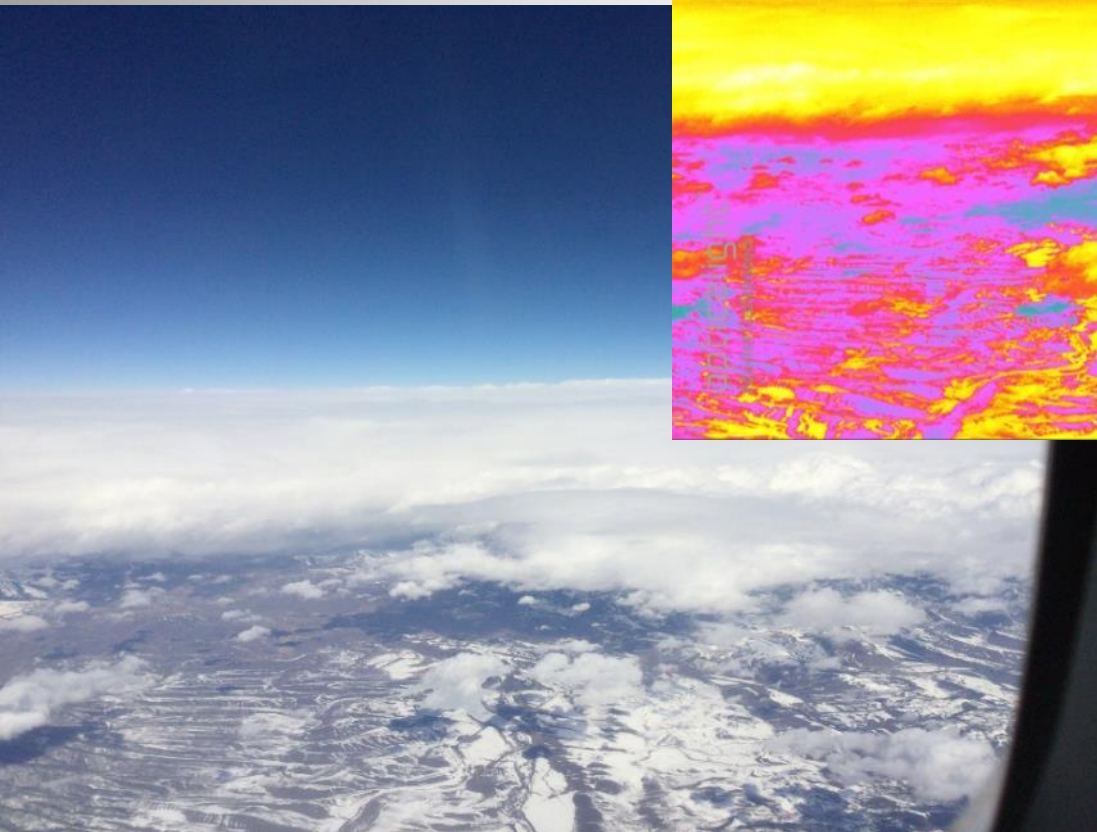
Project: Arapahoe County - Daylighting Study

Drawn By: DS









2. Layers of Lighting

Importance of Surface Brightness





Surface Brightness Ambient

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



Photo Credit: Eric Laignel

Ambient Light



Mood Differences



Personalized Lighting

Task Light



LED task lights at each workstation provide individualized lighting control.

- 6 watts,
- 75 Footcandles
- Fully adjustable and dimmable.

Personalized Lighting



Undercounter Lighting



Accents add interest

Accent Light

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

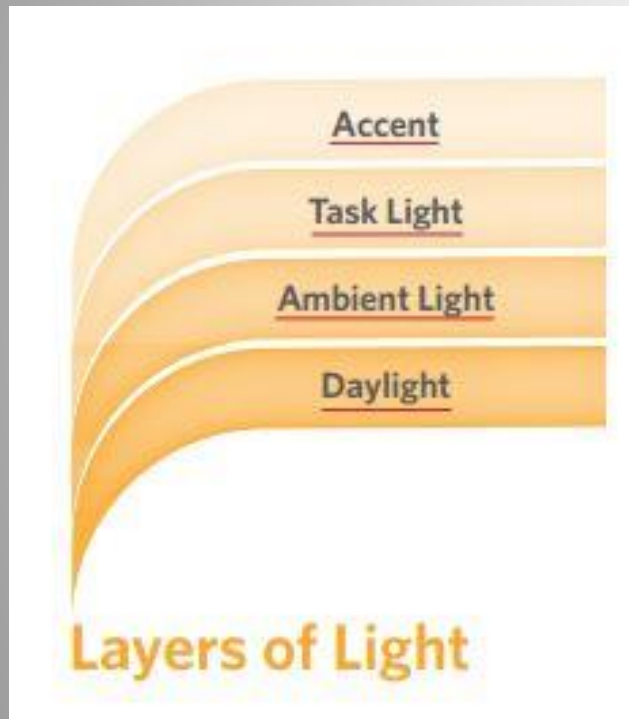


Electric lighting support

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



Layers of Light = 50% energy reduction



Layers of Light

Low glare ambient lighting

Personalized lighting

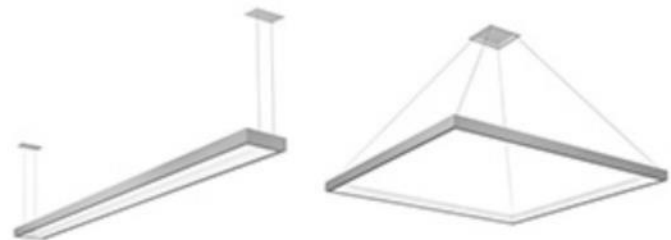
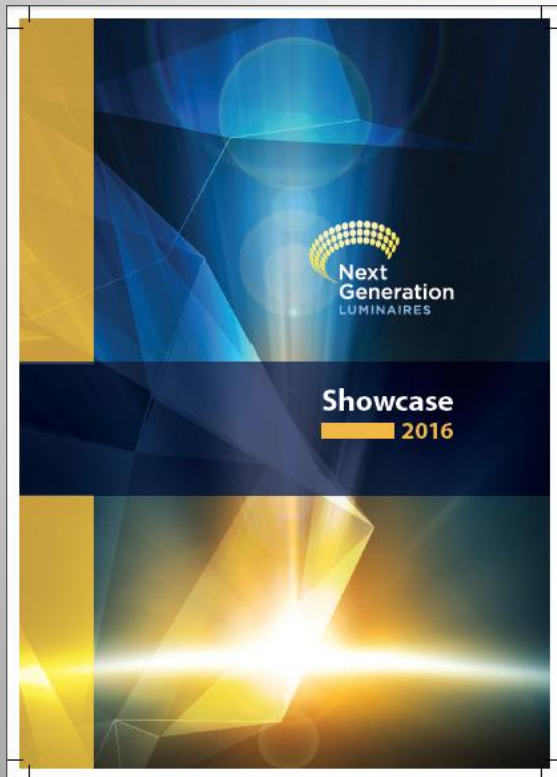


Selecting the Right Luminaires



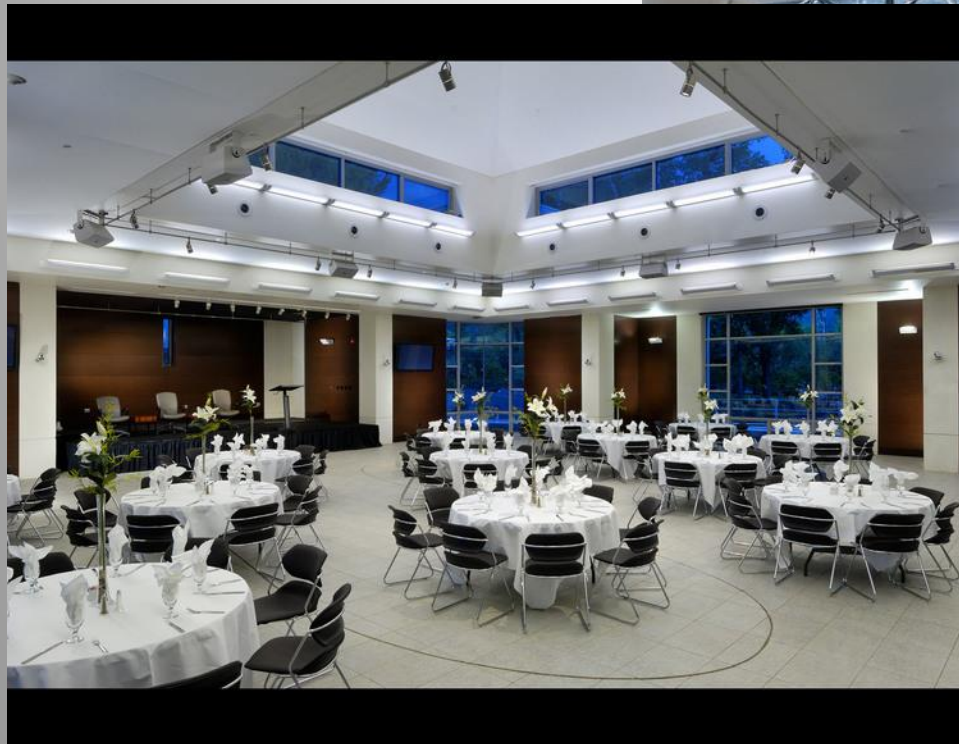
Selecting the Right Equipment

- DOE: Next Generation Luminaires
<http://www.ngldc.org/>





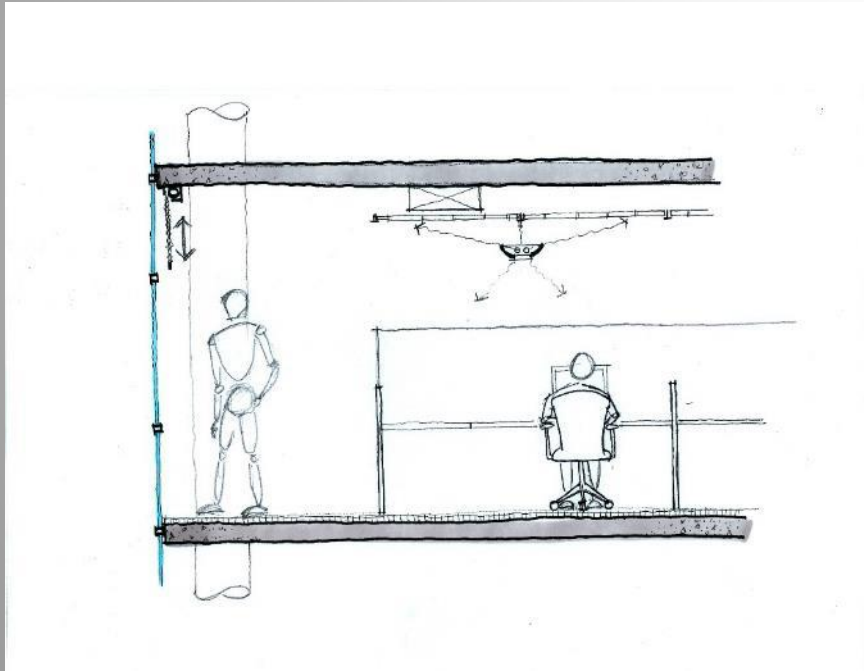








3. Integrating Light with Controls



Daylight Controls



Transparency and Information

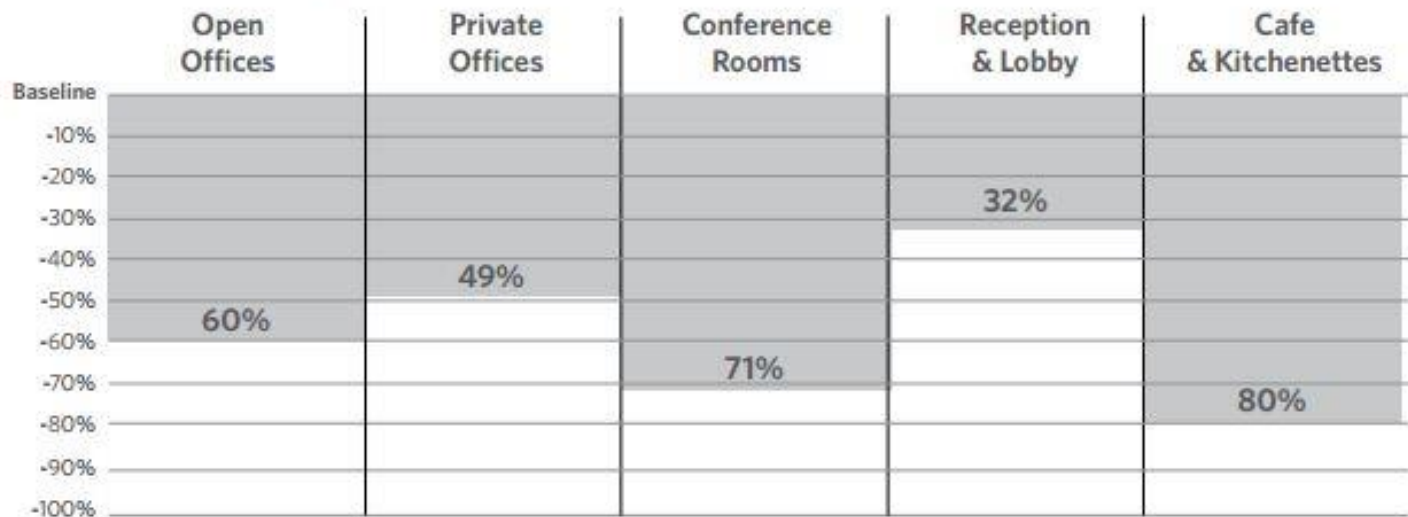


Lighting Control Capabilities

- 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

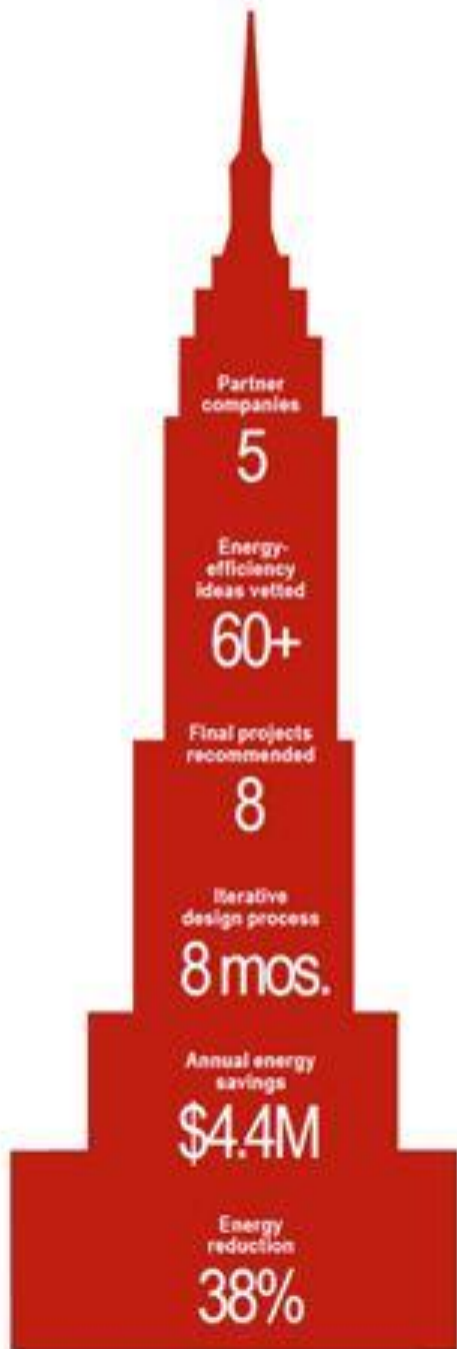
USGBC Lighting Energy Usage = 0.1 watts/SF average

COMPARING ENERGY USE AT THE HEADQUARTERS VERSUS THE 90.1 ASHRAE BASELINE



<http://www.usgbc.org/Docs/Archive/External/Docs8711.pdf>

Empire State Building



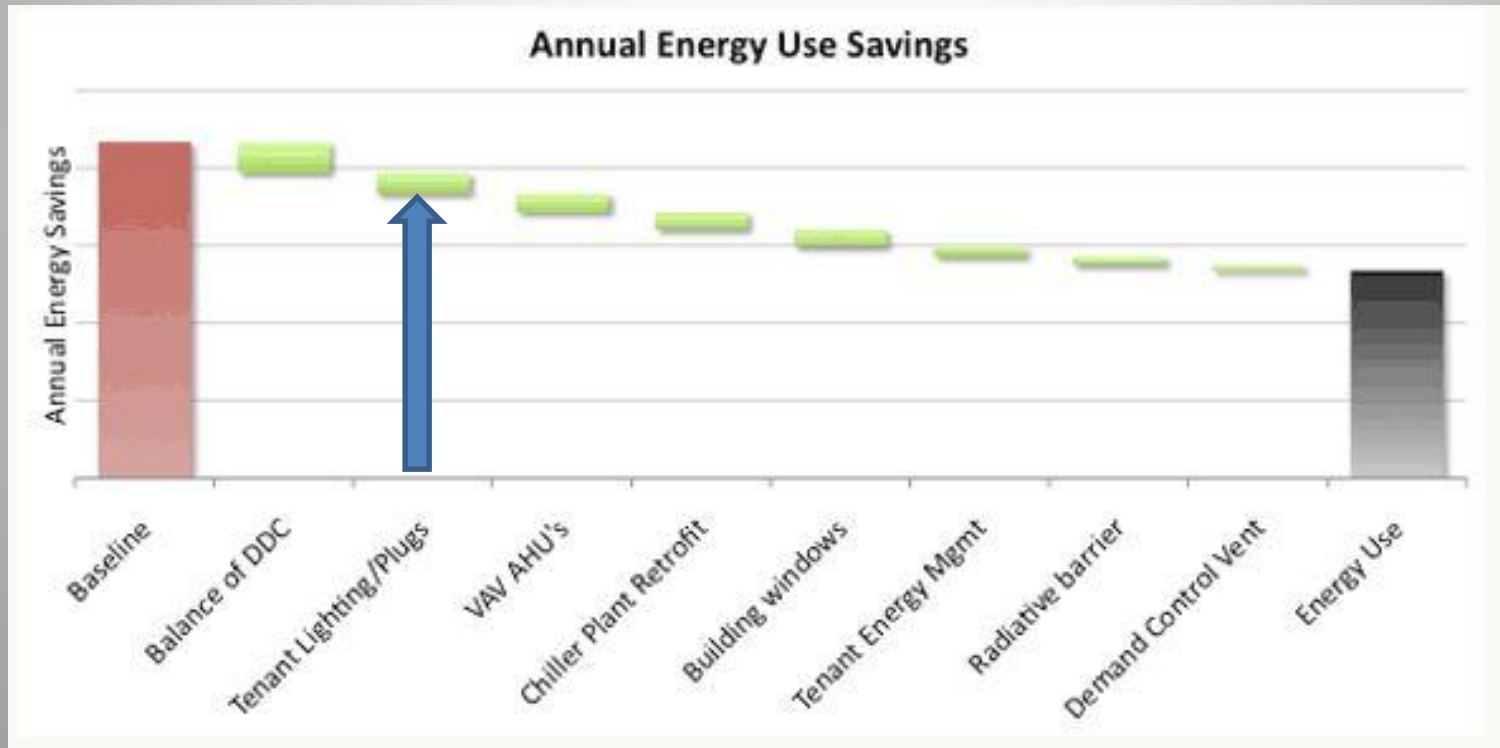
ESB - Tenant Finish Pre-Builts (complete with controls!)



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

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>

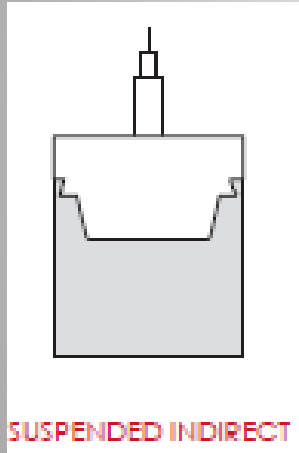
911 Call Center (emergency calls) – Occupant Feedback



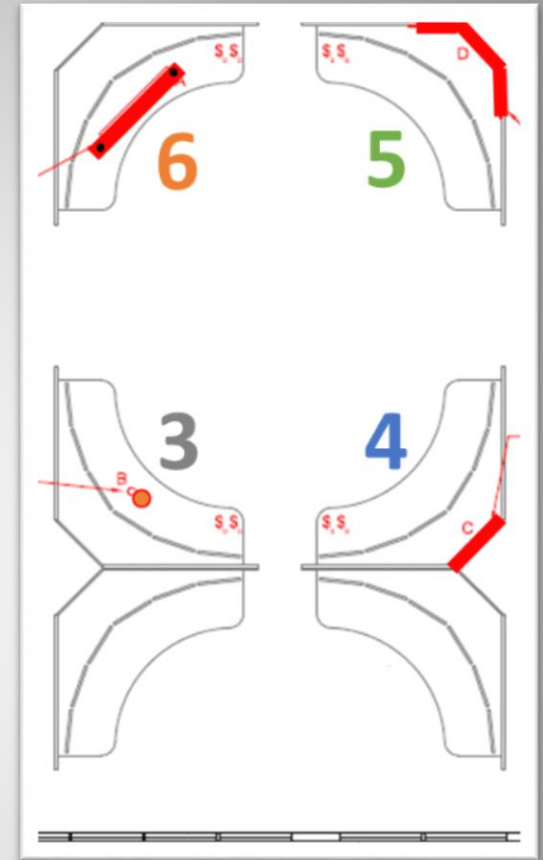
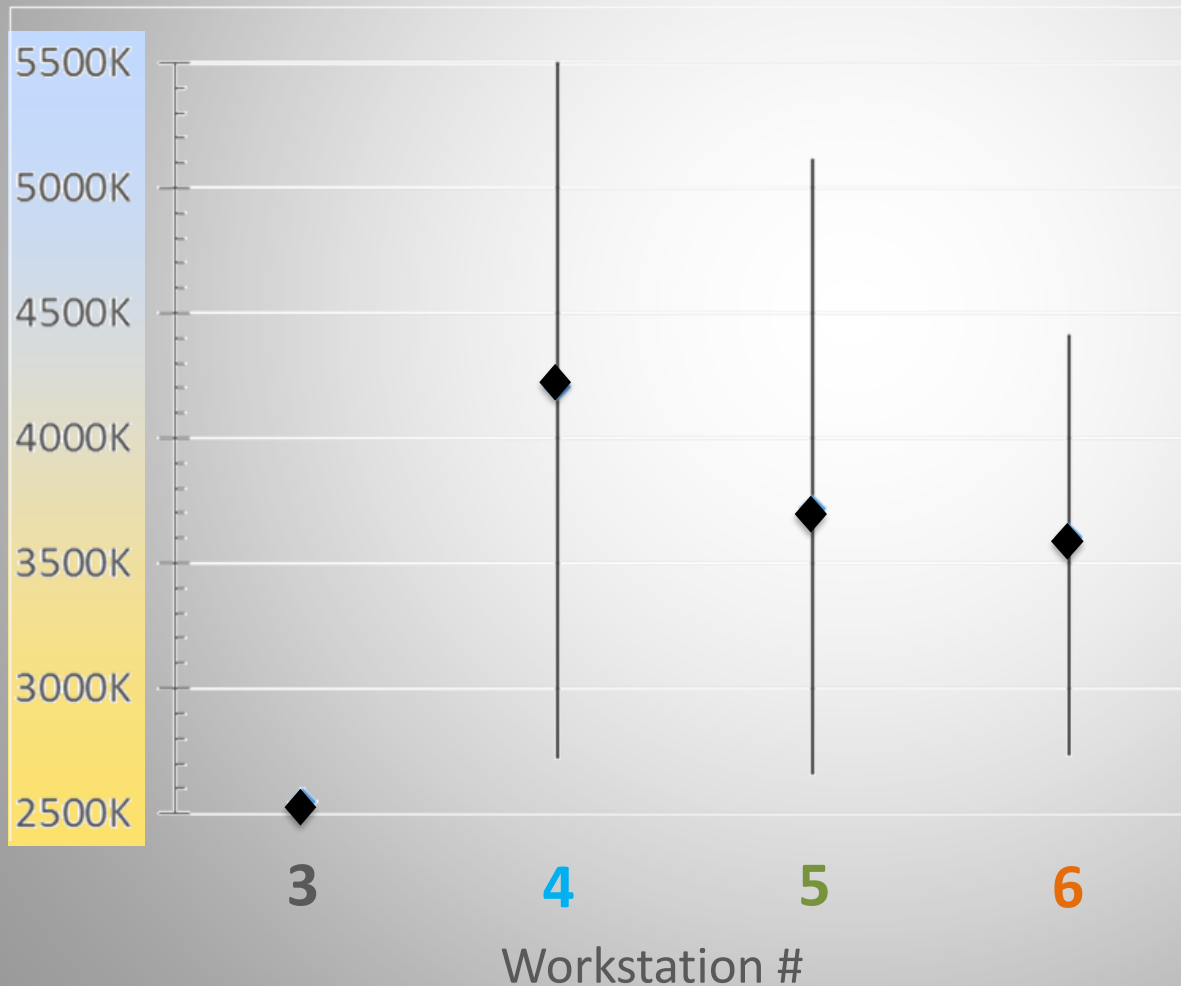
Existing Conditions



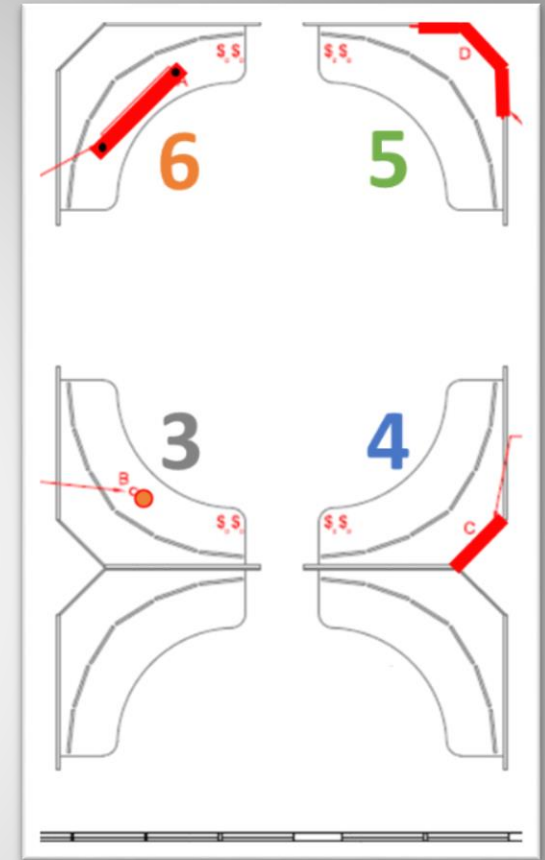
Experiment Equipment Layout



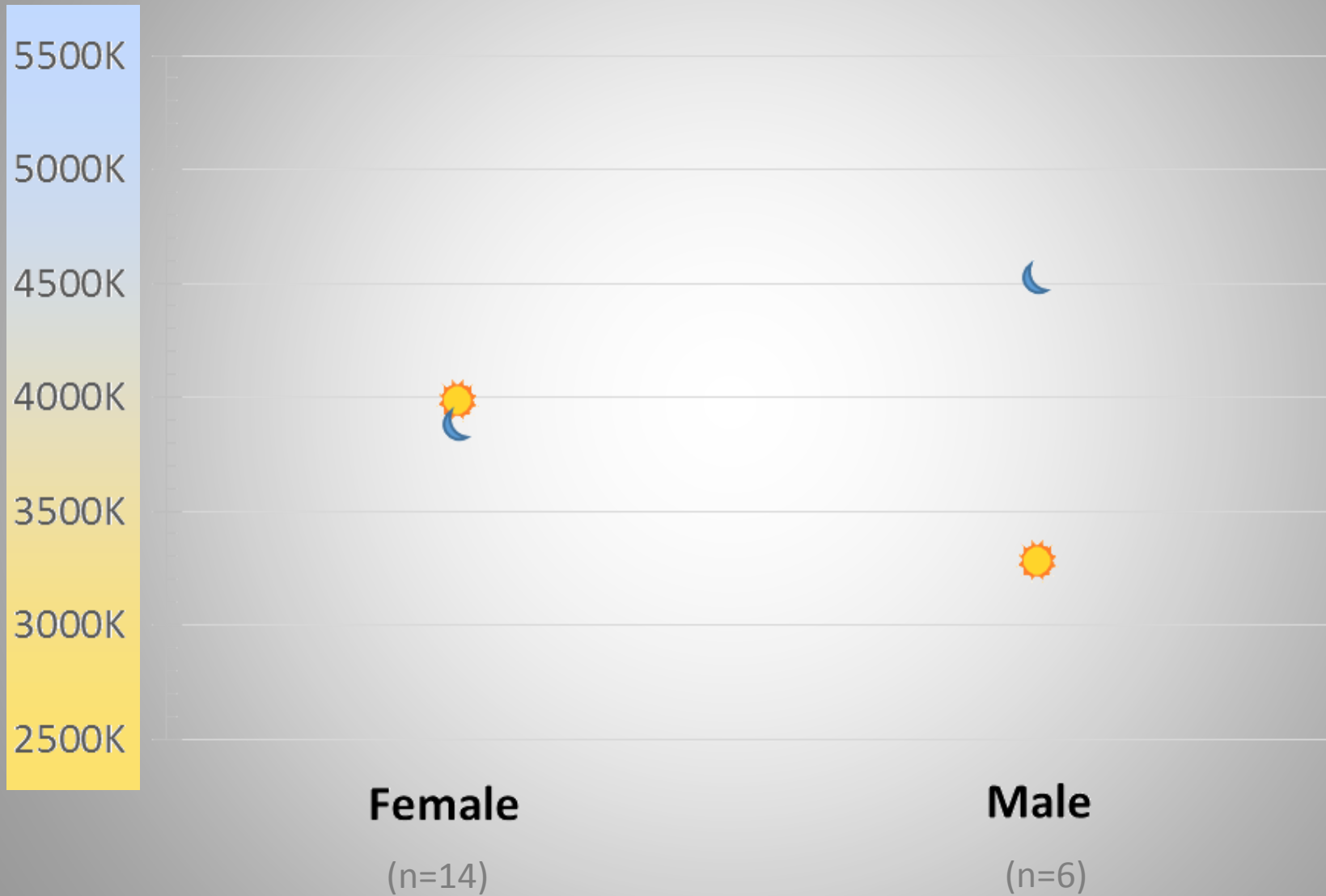
Results: CCT Preference



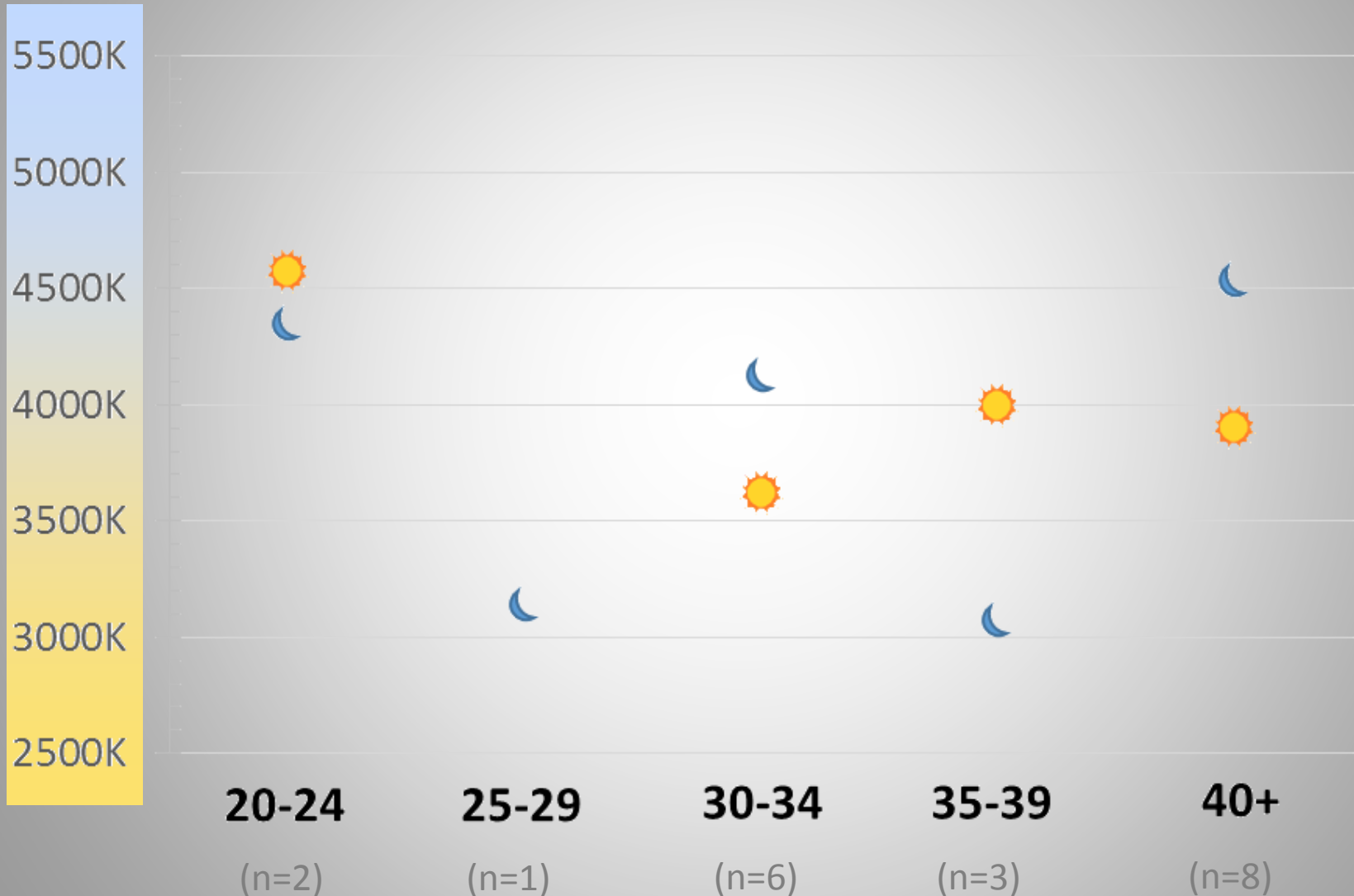
Results: Intensity Preference



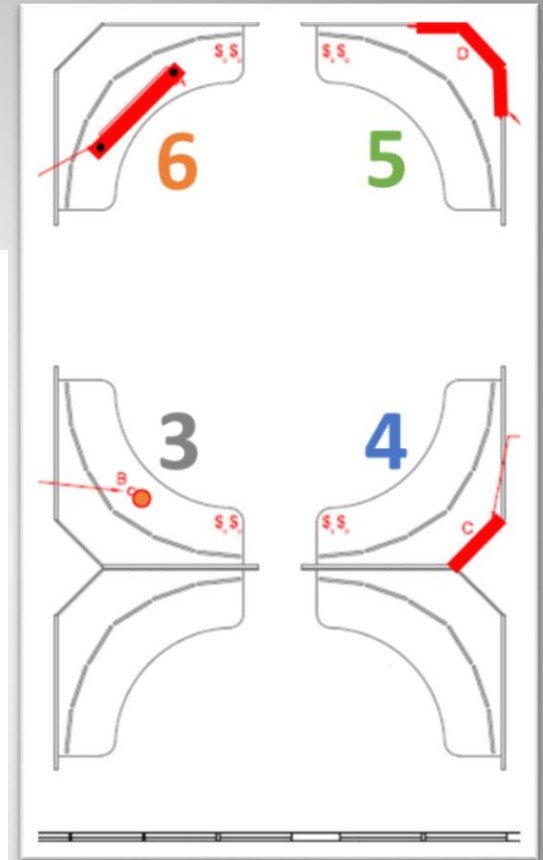
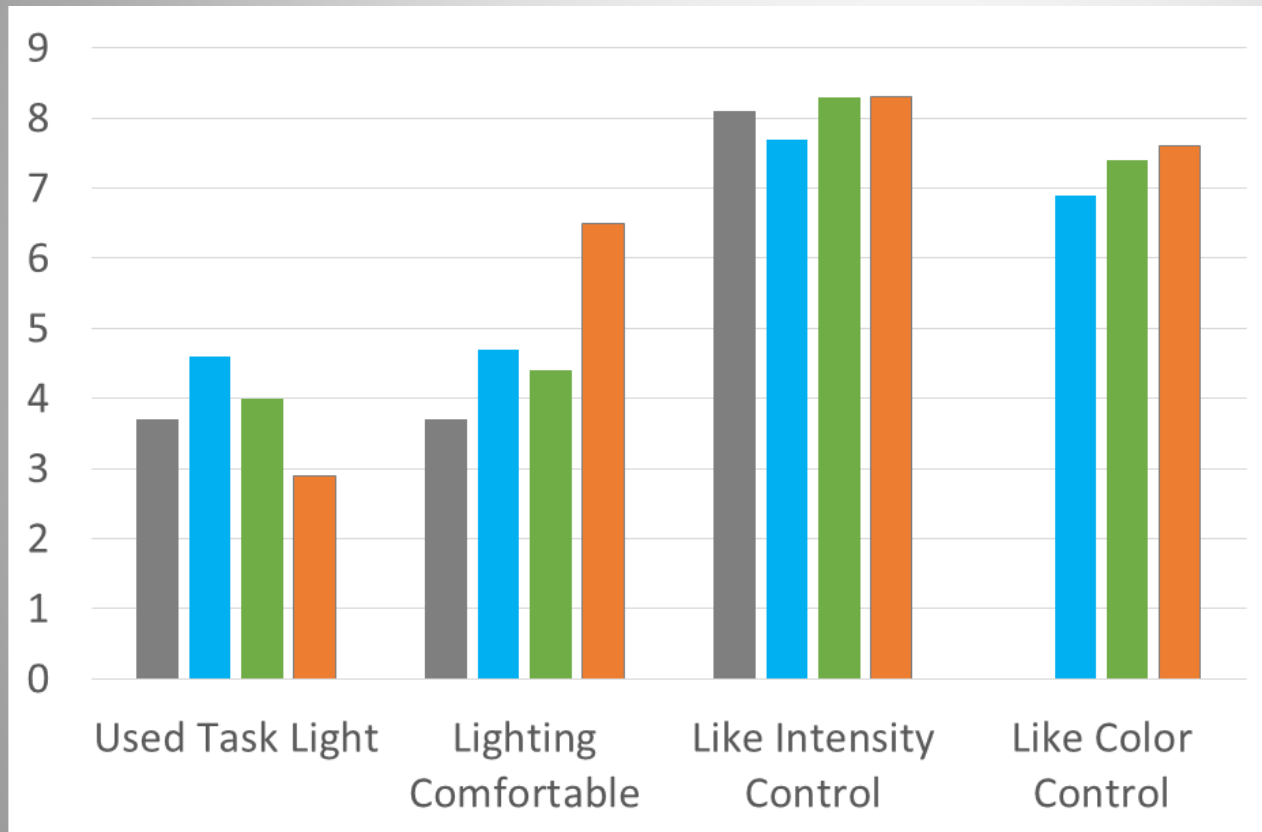
Results: CCT by Gender



Results: CCT by Age



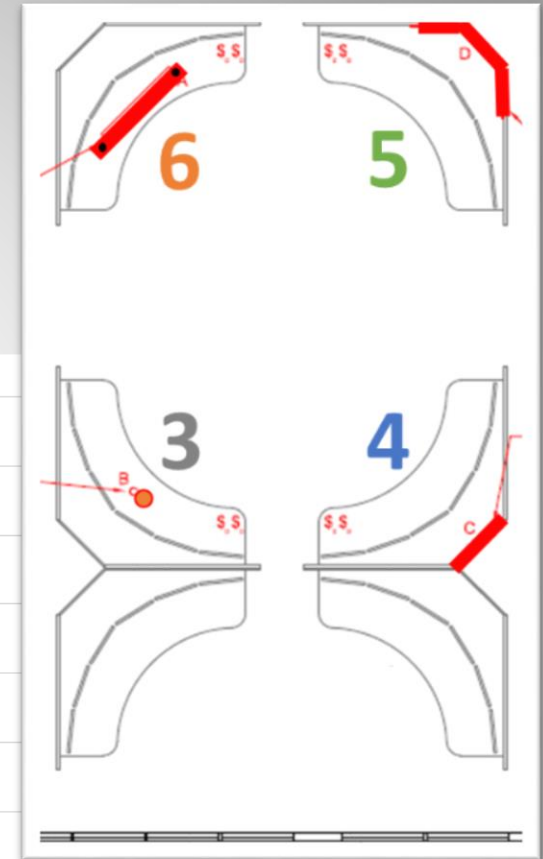
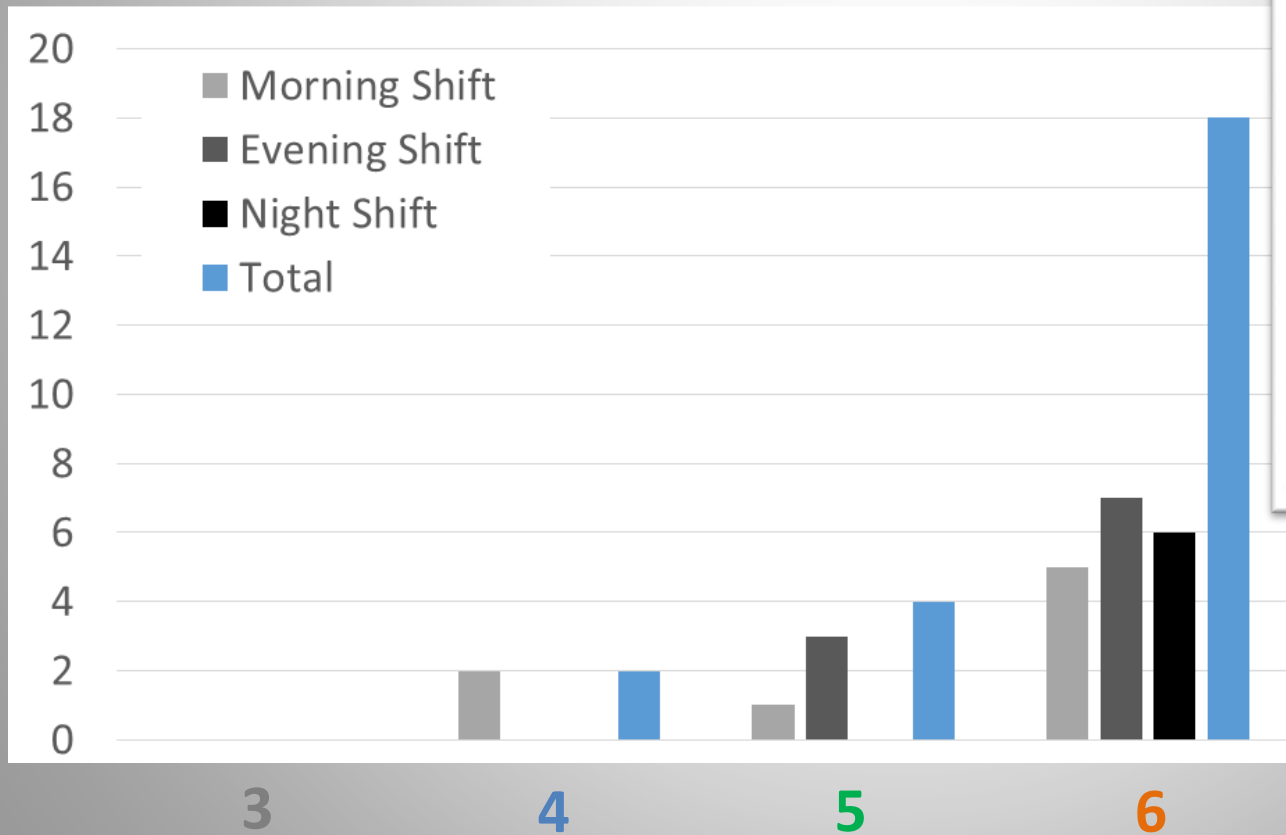
Results: General Assessment



Results: Overall Lighting Preference

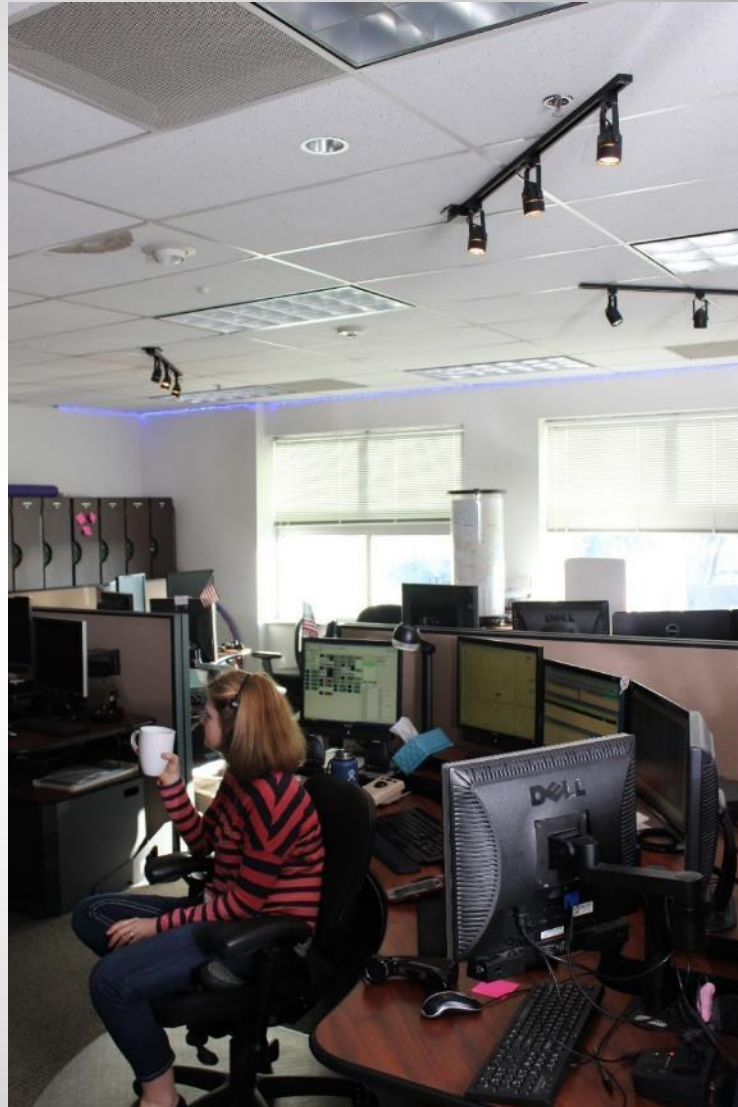
Workstation 6 (indirect light):

“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)



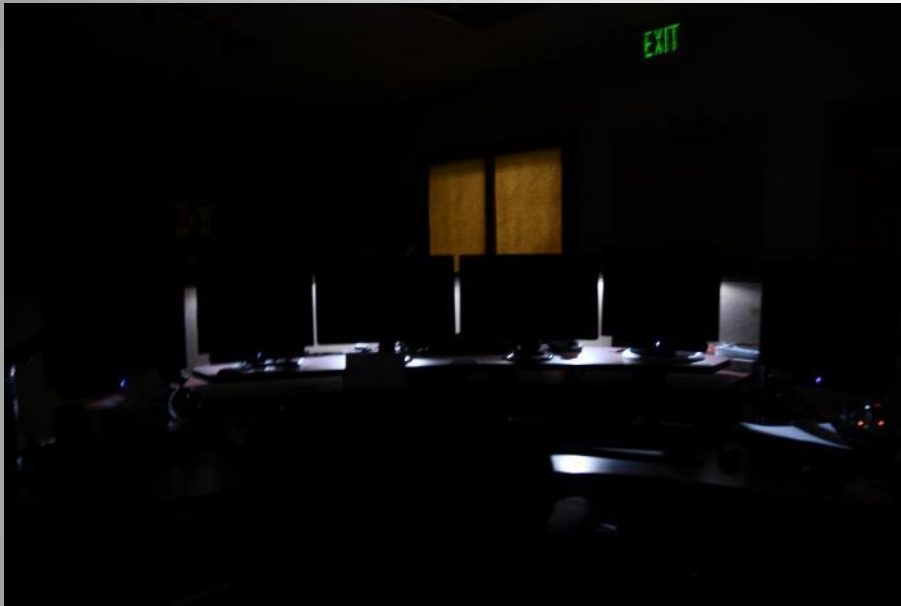
Evaluation Feedback – What they liked:

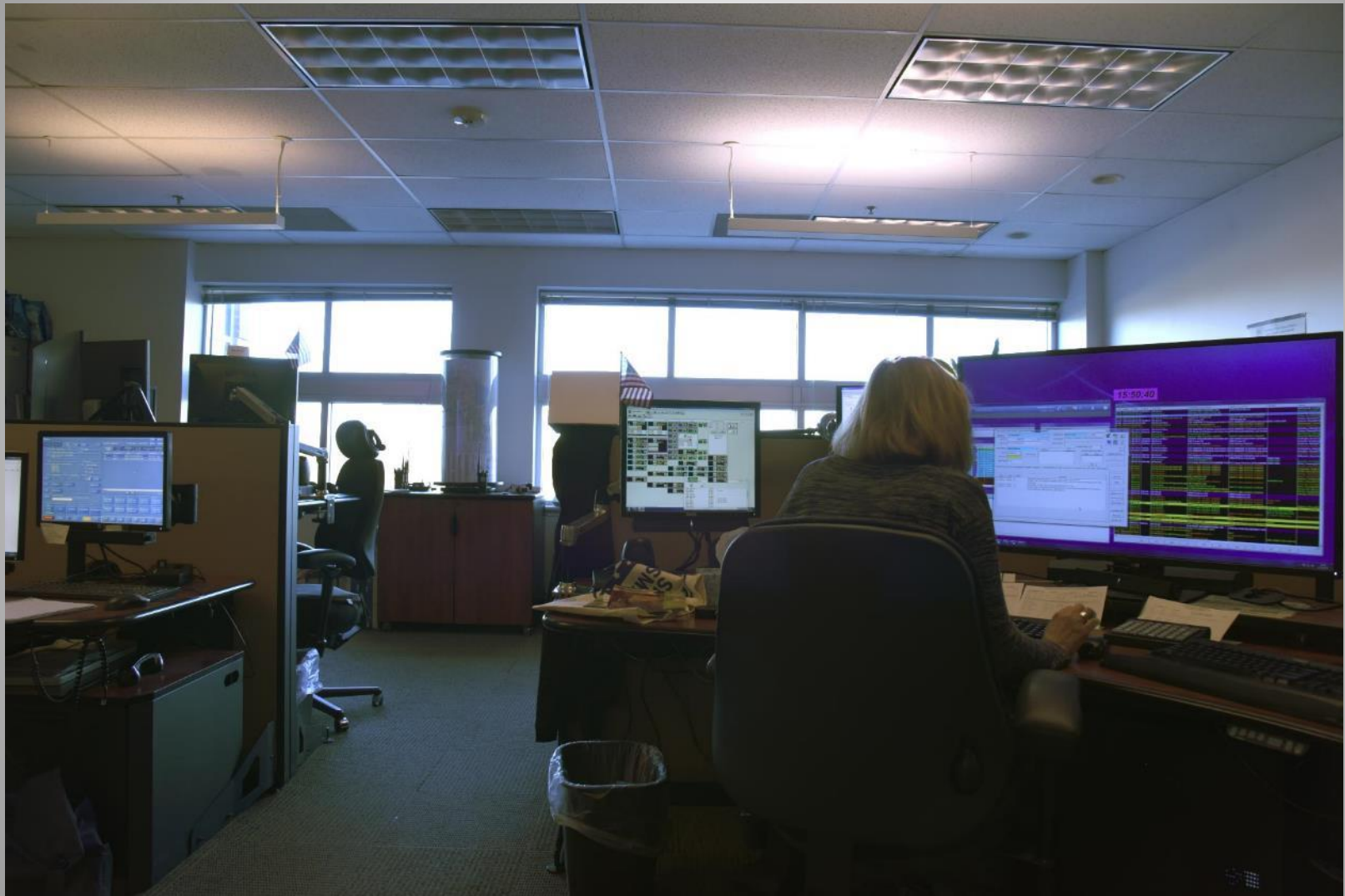
- Indirect pendant (uniform, low glare lighting)
- Lighting behind computers (monitors less bright)
- Personal controls for dimming and color tuning
- Warmer CCT



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

