Daylight Management in Commercial Spaces with Shading Systems

AIA HSW/SD Program Number DMCS09
1.0 Learning Unit

LUTRON

Daylight Management in Commercial Spaces

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Daylight Management in Commercial Spaces with Shading Systems

AIA/CES HSW/SD Program Number DMCS09 (1.0 Learning Units)

Daylight Management in Commercial Spaces

- Learning Objectives
  - By examining the different types and availability of daylight, participants will be able to successfully identify the challenges daylight might present for their project.
  - By understanding the goals of daylight management, participants will discover how it can be used to improve the comfort, functionality, and efficiency of any space.
  - By examining the impact of fabric selection and shade style on daylight management, participants will learn how to meet goals for both design and daylight control.
  - By understanding the many control and integration options that exist, each participant will be able to specify a system that meets the requirements of their space, while enhancing occupant comfort and sustainable design.

Daylight Management in Commercial Spaces

- Agenda
  - Understanding daylight
  - Defining daylight management
    - Benefits and goals
  - Impact of fabric selection
  - Types of shading systems
  - Control options for shading systems
  - Integration with lighting control systems
    - Effective daylight harvesting

Understanding Daylight

- The Benefits of Daylight
  - Lowers dependency on electrical lighting
  - Increases productivity
    - Maintain alertness, reduce errors
    - Improve moods, lower absenteeism
  - Improves patient health and student performance

Understanding Daylight

- The Challenges of Daylight
  - Glare and Solar heat gain
    - Visual discomfort
      - Washed out display screens
    - Physical discomfort
      - Direct sunlight brings heat
  - Fluctuations in availability
  - Damaging UV rays



Understanding Daylight

- Types of Daylight
  - Direct sunlight
  - Reflected sunlight
  - Diffused sunlight
- Factors Influencing Availability
  - Weather conditions
  - Seasonal solar variation
  - Building location & orientation
  - Siting
  - Window composition







Understanding Daylight

- Daylight Factors
  - Weather conditions
    - Clear, sunny skies - Direct sunlight = 7,000-10,000 fc
    - Overcast conditions - Diffused sunlight = 1,000-5,000 fc
  - Seasonal solar variation
    - Summer vs. Winter
      - Angle of sunlight
      - Time elapsed from sunrise to sunset



Solargraphy Pin-Hole Photography (6-month elapse)

Photo ©Justin Quinnell, www.pinholephotography.org

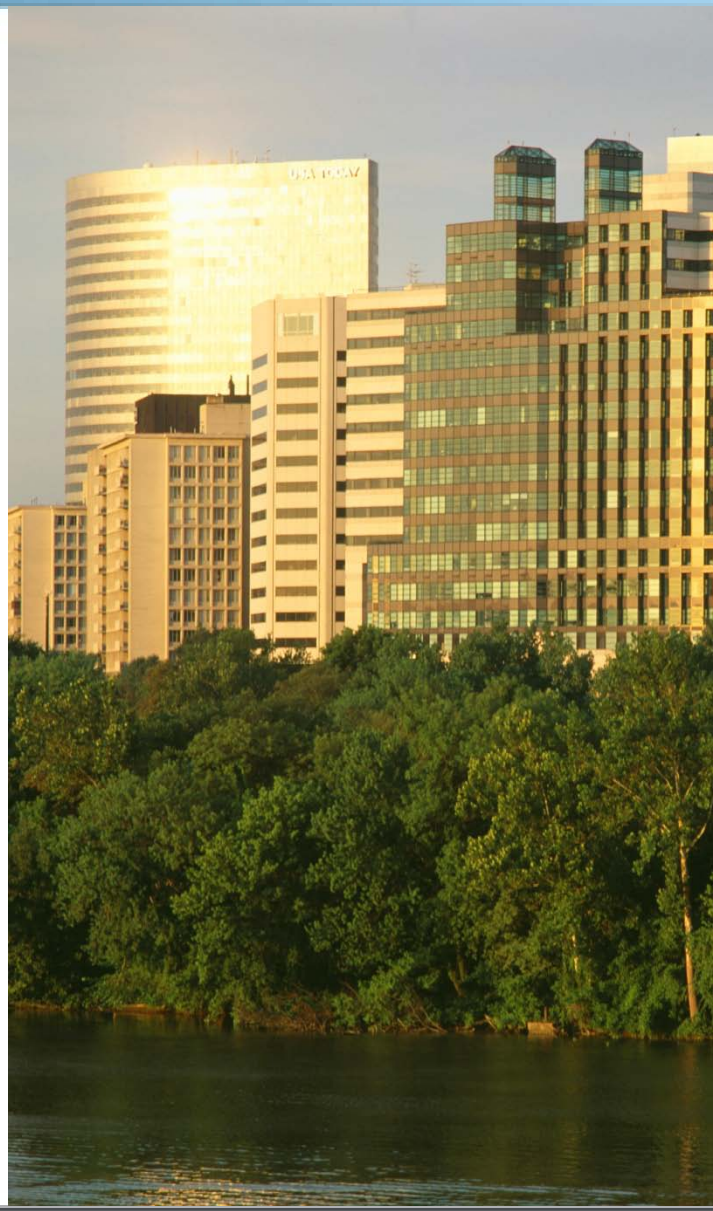
Understanding Daylight

- Daylight Factors
  - Building location & orientation
    - These characteristics affect…
      - The amount of seasonal variation in the sun's path
      - The type of daylight available
  - Siting
    - Neighboring structures can…
      - Provide shade by blocking direct sunlight
      - Create glare by reflecting light onto the building's façade



Understanding Daylight

- Daylight Factors
  - Window Composition
    - Window size
      - Daylight can penetrate a space up to 1.5x the height of the window
    - Glass Type
      - Tinted or reflective glass will reduce solar heat gain but also limits the amount of visible light



Daylight Management

- Daylight management
  - Practice of regulating the intensity and penetration of daylight for the benefit of building occupants
    - Easily accomplished by specifying shading systems
- Shade positioning is critical
  - Automation is essential for effective daylight management
    - Multiple shade adjustments needed throughout the day
    - Must limit direct sunlight but allow ambient light to enter

Daylight Management

- Benefits of Implementing Daylight Management
  - Energy efficient
    - Uses daylight as a light source
    - Reduces load on AC system
  - Increases comfort and boosts productivity
    - Diminished glare
    - Reduced solar heat gain
    - Increased daylight exposure



Daylight Management

- Energy Savings through Daylight Management
  - Sun used as a light source
    - Lower energy usage for lighting
  - Typically, 10% HVAC savings
    - 9% of cooling savings
      - Reflecting solar energy
      - Dimming lights to remove heat
    - 1% of savings in heating
      - Lowering shades at night to improve heat insulation
    - Actual savings will vary based on building characteristics



Daylight Management

- Shade Positioning
  - Open or closed shades will accomplish different goals
  - Shades open:
    + Reduce need for electrical lighting
    + Provide unobstructed views
    + Maintain alertness
    - Allow heat and glare into the space
    +/- Effect on heating and cooling



Daylight Management

- Shade Positioning cont'd…
  - Shades closed:
    + Decrease glare
    + Reduce solar heat gain
    + Increase privacy and security
    + Helps insulate the building
    - May obstruct outdoor views
    - May require use of electric lights
    +/- Effect on cooling system
  - Automation prevents shades from remaining static



Daylight Management

- Daylight Design Goals
  - Design your space with well-defined daylight goals
    - Incorporate
      - Functional task lighting
      - Ambience in the space
    - Remove
      - Block daylight in areas that occasionally require darkness



Daylight Management

- LEED
  - Shading systems can help a project secure LEED credits in the following areas…
    - Light Pollution Reduction
    - Energy and Atmosphere
    - Materials and Resources
    - Indoor Environmental Quality
    - Daylight and Views
    - Innovation and Design



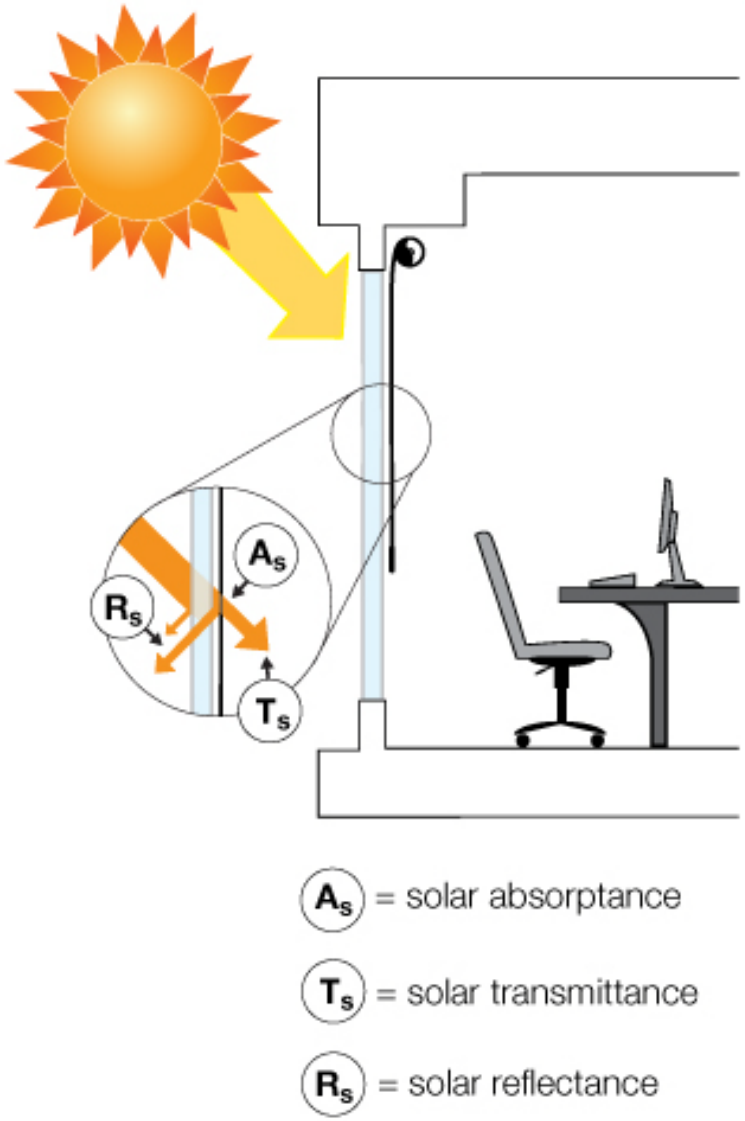
Impact of Fabric Selection

- Shading systems are only as effective as the fabric placed between the sun and the interior space.

- Fabric Performance
  - Amount of solar energy entering the space, absorbed by the shade, or reflected back towards the glass
  - Defined by solar performance metrics and impacted by the openness factor, color, and composition of the fabric

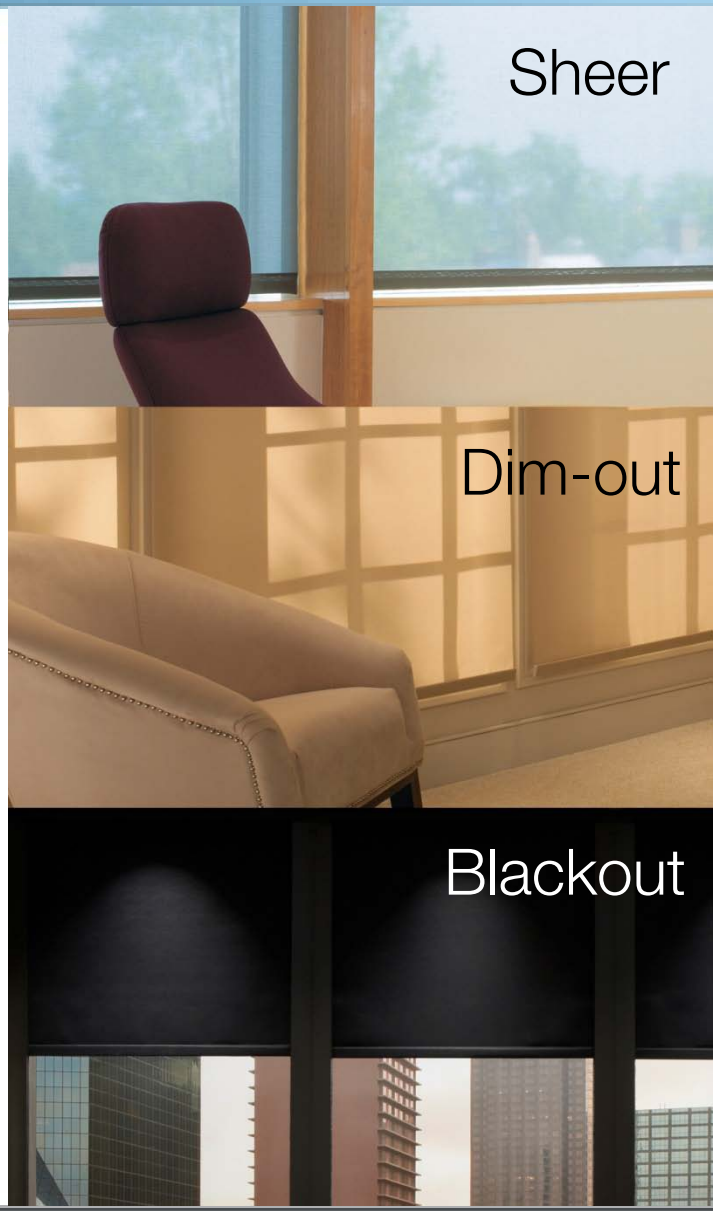
Impact of Fabric Selection

- Solar Performance Metrics
  - **Solar Transmittance (T_S):** percentage of solar radiation that passes through the fabric
  - **Solar Absorptance (A_S):** percentage of solar radiation absorbed by the fabric
  - **Solar Reflectance (R_S):** percentage of solar radiation reflected back out by the fabric
  - For every fabric, $T_S + A_S + R_S = 100\%$



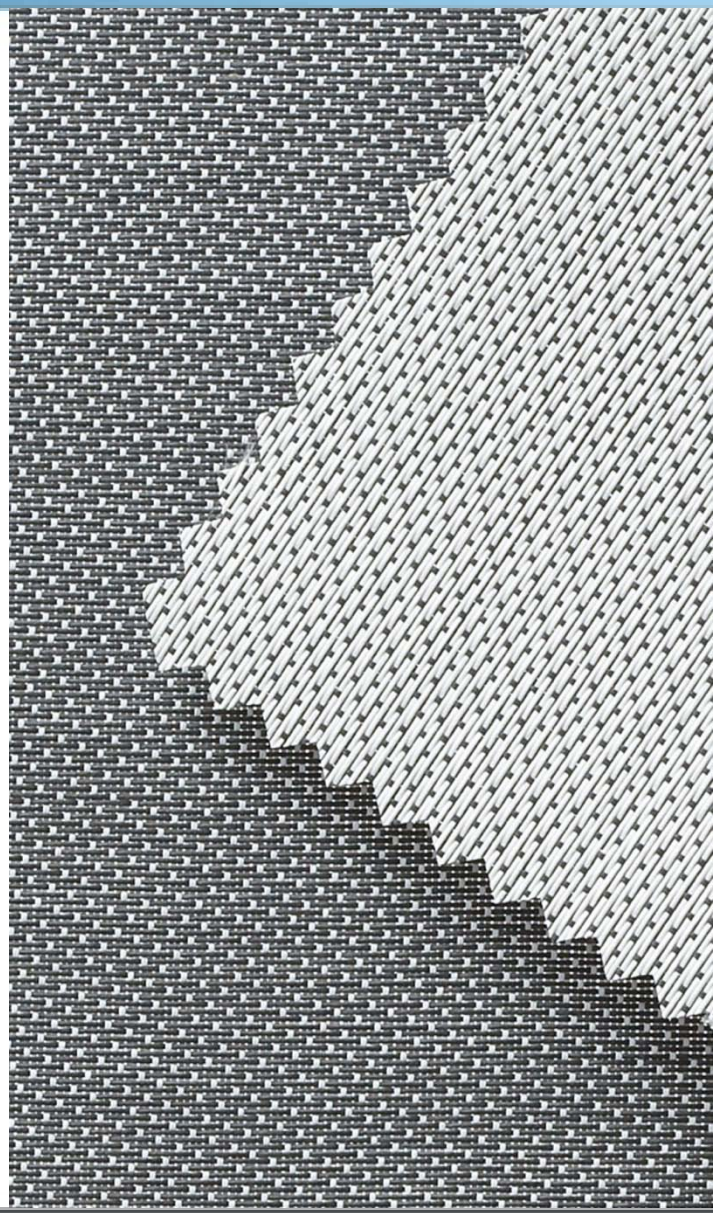
Impact of Fabric Selection

- Openness factor
  - Impacts the amount of light entering the space and visibility
  - Different openness factors can help manage the requirements of different building façades
  - Fabric types are associated with particular openness factors
    - Sheer: 1%, 3%, 5%, or 10%
    - Dim-out: < 2%
    - Blackout: 0%



Impact of Fabric Selection

- Fabric Color
  - Strongly impacts visibility and glare management
    - Light colors
      - Reflect solar heat gain
    - Dark colors
      - Minimize glare, reduce eyestrain
      - Preserve outdoor views
  - Dual-sided fabrics
    - Preserve views, reflect solar heat gain and minimize glare
    - Dark material faces interior, light material faces window



Impact of Fabric Selection

- Fabric Composition
  - Composition impacts a fabric's
    - Ability to reduce glare
    - Light filtering capability
    - Affect on indoor air quality
    - Resistance to fading
  - Common materials include fiberglass, polyester, acrylic, natural fibers, and blends
  - Sustainable fabrics can be PVC-free, Third-party certified or 100% recycled



Types of Shading Systems

- Cellular shades
- Roman shades
- Drapery tracks
- Top-down/Bottom-up
- Skylight shades
- Vertical and Horizontal blinds *
- Roller shades *

* Most common for commercial settings

Types of Shading Systems

- Vertical and Horizontal blinds (Mini-blinds)
  - "Lift and tilt" system provides privacy and light control
  - View is compromised when blinds are tilted or closed
  - Aluminum blinds conduct heat and can be poor insulators



Types of Shading Systems

- Roller Shades
  - Ideal for large, commercial window installations
  - Reduce glare, solar heat gain, and UV penetration
  - Maintain outdoor views
    - Roll tightly or “vanish” into a pocket for an unobstructed view
    - Some fabric options preserve views while shades are down



Control Options for Shading Systems

- Manual Controls
  - Manual shades
  - Electronically controlled shades
- Automated Controls
  - Timeclocks
  - Open loop solar tracking
  - External sensors (Closed loop)
  - Internal sensors (Closed loop)

Control Options

- Manual Control
  - Occupants must actively position the shade or blind to meet their daylight management needs
    - Adjustments are time consuming
    - Large shades are heavy and difficult to manipulate
    - Aligning multiple shades can be challenging
  - Manual shades often become static
    - Shades are closed by the occupant to block heat or glare, but rarely get raised or opened again

Control Options

- Electronic Control
  - Adjust heavy or hard-to-reach shades at the touch of a button
    - Ease of use may lead to more efficient Daylight Management
  - Control shades via:
    - Electronic keypads
    - Remotes (IR and RF)
  - Context:
    - Conference room; private office



Control Options

- Electronic Control
  - Motorization technologies available for electronically controlled shades
    - Battery powered motors
    - Tubular motors
      - AC-powered (line voltage)
      - DC-powered (low voltage)
    - Low-voltage electronic drives



Control Options

- Timeclocks
  - Shades go to preset positions during scheduled “events”
  - Types:
    - Time-of-Day: daily schedule
    - Astronomic: determined by sunrise and sunset
  - Context:
    - Open office space



Control Options

- Timeclocks
  - Advantages
    - Easy to understand, program, and customize
  - Disadvantages
    - Must be manually programmed, they cannot generate shade schedules on their own



Control Options

- Open vs. Closed Loop Solar Management Systems
  - Open Loop (algorithm-based): no direct feedback
    - Equations precisely calculate the sun's path to create inputs, which are then used to create outputs
  - Closed Loop (sensor-based): requires inputs/feedback
    - Inputs are sent from sensors, then processed to yield outputs

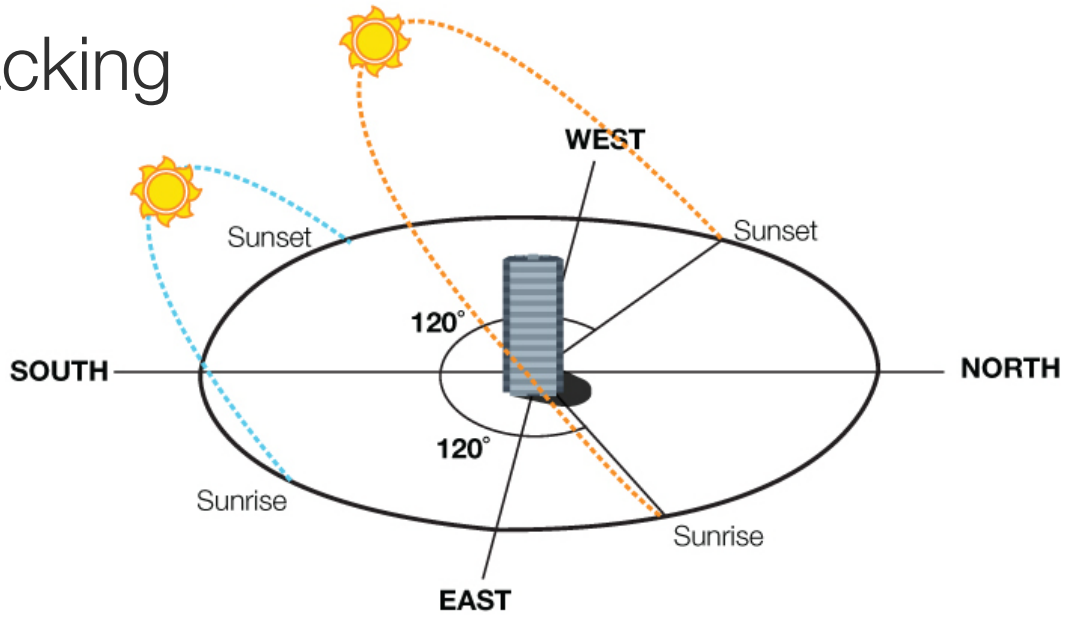


Solargraphy Pin-Hole Photography
(6-month Elapse)

Photo ©Justin Quinnell,
www.pinholephotography.org

Control Options

- Open Loop Solar Tracking
  - Manages seasonal changes in the sun's path throughout the year



  - Open Loop Systems
    - Use astronomical equations, not sensors, to find the sun
    - Create a 4-dimensional model of the sun's position in relation to the building for each day of the year
  - Context:
    - Atriums and open office space

Control Options

- Open Loop Solar Tracking
  - Advantages over sensors
    - Easy to set-up, quick to install
    - Low maintenance costs
    - Can be less distracting to building occupants
  - Disadvantages
    - Lacks weather accommodation in overcast conditions
    - Cannot inherently account for shadows or reflected glare



Control Options

- External Sensors
  (Closed loop system)
  - Often go on the roof to monitor the sky for overcast conditions
  - Types
    - Radiometers: measure the power of the sun's rays
    - Photosensors: measure the amount of light hitting the sensor
  - Context:
    - Adds weather accommodations



Control Options

- External Sensors
  - Advantages
    - Weather accommodation
    - Provides outdoor views more often
  - Disadvantages
    - Typically, cannot account for glare
    - Installations are more complicated
    - Regular maintenance is needed
    - May cause distracting shade movements in certain conditions



Control Options

- Internal Sensors
  (Closed loop system)
  - Measure light levels inside individual spaces
  - Common placements
    - Inside the space
    - Between the window and the shade
  - Context:
    - Manage glare within the space



Control Options

- Internal Sensors
  - Advantages
    - Monitors light levels and responds on an individual basis
    - May account for glare/shadows
  - Disadvantages
    - Not mounted on the work surface
      - Proper relationship between light levels must be calculated
    - Added Costs
      - regular maintenance; complex installations; more components
    - May cause distracting shade movements in certain conditions



Control Options

- The Human Element
  - The majority of corporate costs are people, not things
    - "A typical office building's annual energy costs are $2.25 per ft^2; the human costs are $318 per ft^2"

      - Scot Horst, senior VP USGBC's LEED program
  - Considerations when choosing a control option
    - Will it provide manual overrides?
    - Is it flexible to changing needs?
    - Can it limit the number of shade movements in each zone?



Integration with Lighting Control

- Combining shade and lighting control can add functionality to any space

- Daylight harvesting lighting systems will benefit significantly from automated shading systems

Integration with Lighting Control

- Basic Lighting Integration
  - Preset “scenes”
    - User selects a scene, lights and shades adjust to preprogrammed positions and light levels
  - Typically used in single-space applications
    - Ex. conference rooms or private offices



Integration with Lighting Control

- Daylight Harvesting Systems
  - Goal: preferred light levels, minimal electric light usage
    - Sensors measure total light levels within the space
    - Lighting fixtures automatically dim or brighten in response to variations in available daylight
    - Low impact on visual environment
  - Integration with automated shades provides maximum energy savings



Shades open, Lights dim

Integration with Lighting Control

- Why Harvest Daylight?
  - Reduce energy consumption
    - Protect the environment
    - Save money!
  - Maintain preferred light levels with limited distractions
    - Increase comfort and productivity
  - Additional benefits from automated shading systems
    - Daylight in the office space
    - Outdoor views



Shades close, Lights brighten

Integration with Lighting Control

- Automated Shades and Daylight Harvesting
  - Transform available daylight to provide superior daylight harvesting while minimizing heat and glare
  - Optimizing both daylight and electric light levels can cut lighting costs by 15% or more



Integration with Lighting Control

- Integration through BACnet IP
  - BACnet is "a data communication protocol for building automation and control networks" that governs data exchanges over a computer network
    - BACnet compatibility simplifies integration between systems
  - BACnet IP integration allows a Building Management System (BMS) to monitor and control shades
    - BMS can also allow shades to be controlled by other inputs
      - EX. Occupancy sensors, fire alarms, etc.

Summary

Achieving effective daylight management in a commercial space can be challenging due to the inconsistent nature of available daylight. However, incorporating daylight as a free light source provides some enticing benefits. Shading systems can be extremely effective at daylight management, but the choice of control strategy must be dependent on needs of the space. In order to specify a shading system that meets all of your design goals, you must understand how fabric selection, shade styles and control options, affect daylight management in the space. With this knowledge, you will be able to transform the available daylight into the type of light required for your commercial space.

Any Questions?

This concludes the formal CEU presentation