



Daylighting Design Principles and the LightLouver Daylighting System

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Presentation Outline



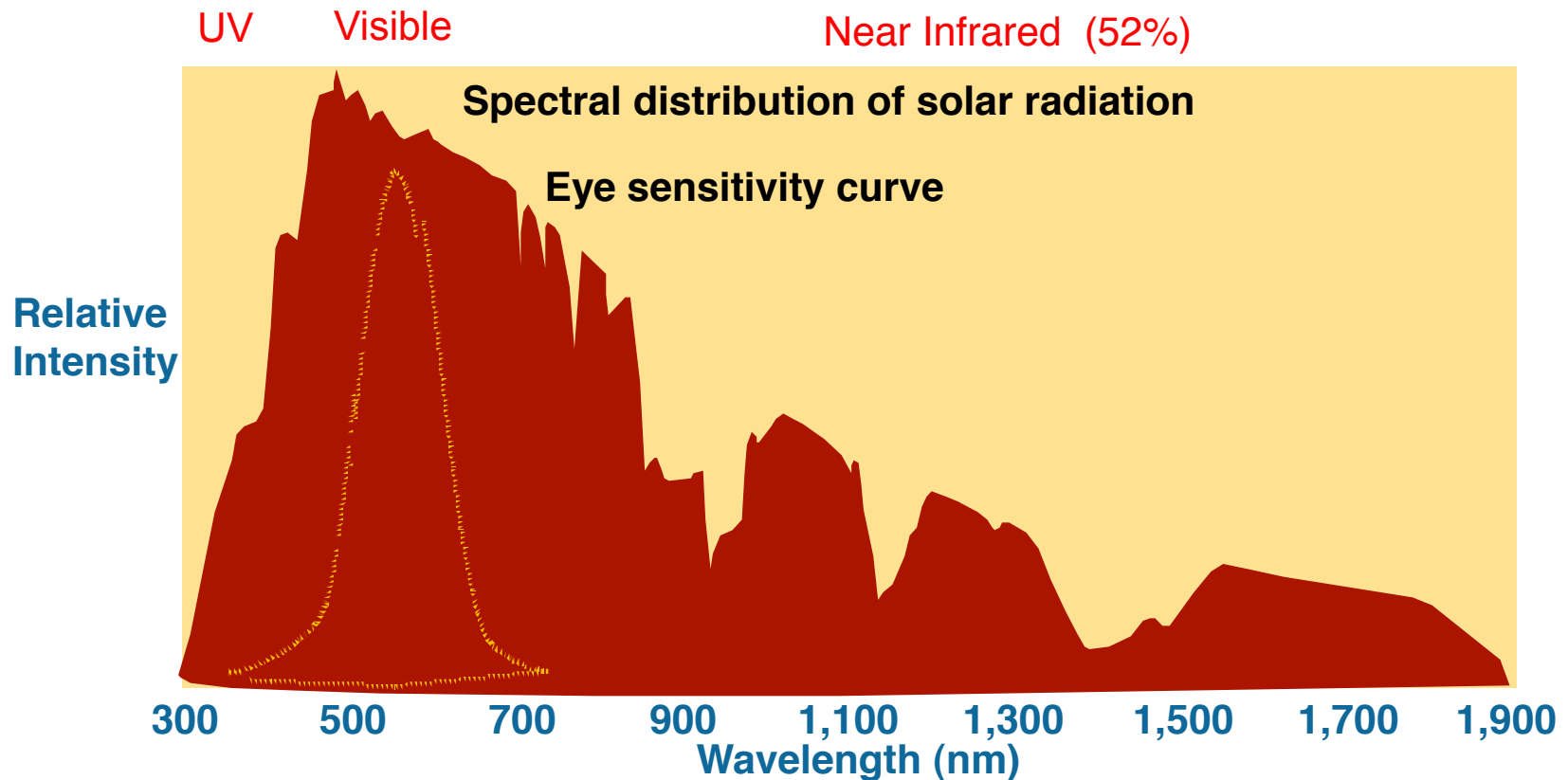
- Daylighting Basics
- Daylighting Design Goals and Characteristics of a Good Daylighting Design
- Daylighting Design Process and Design Strategies
- LightLouver Daylighting System
- Benefits of the LightLouver Daylighting System
- LightLouver Design Guidelines
- LightLouver Design Assistance Services and Contact Information

Daylighting Basics

What is Daylight?



The Solar Spectrum



Daylighting Basics

What is Daylight?



- The perfect light source
- Sets our body's Circadian rhythm / biological clock
- Highly variable (location, time & season)
- Controllable through design



Daylighting Basics

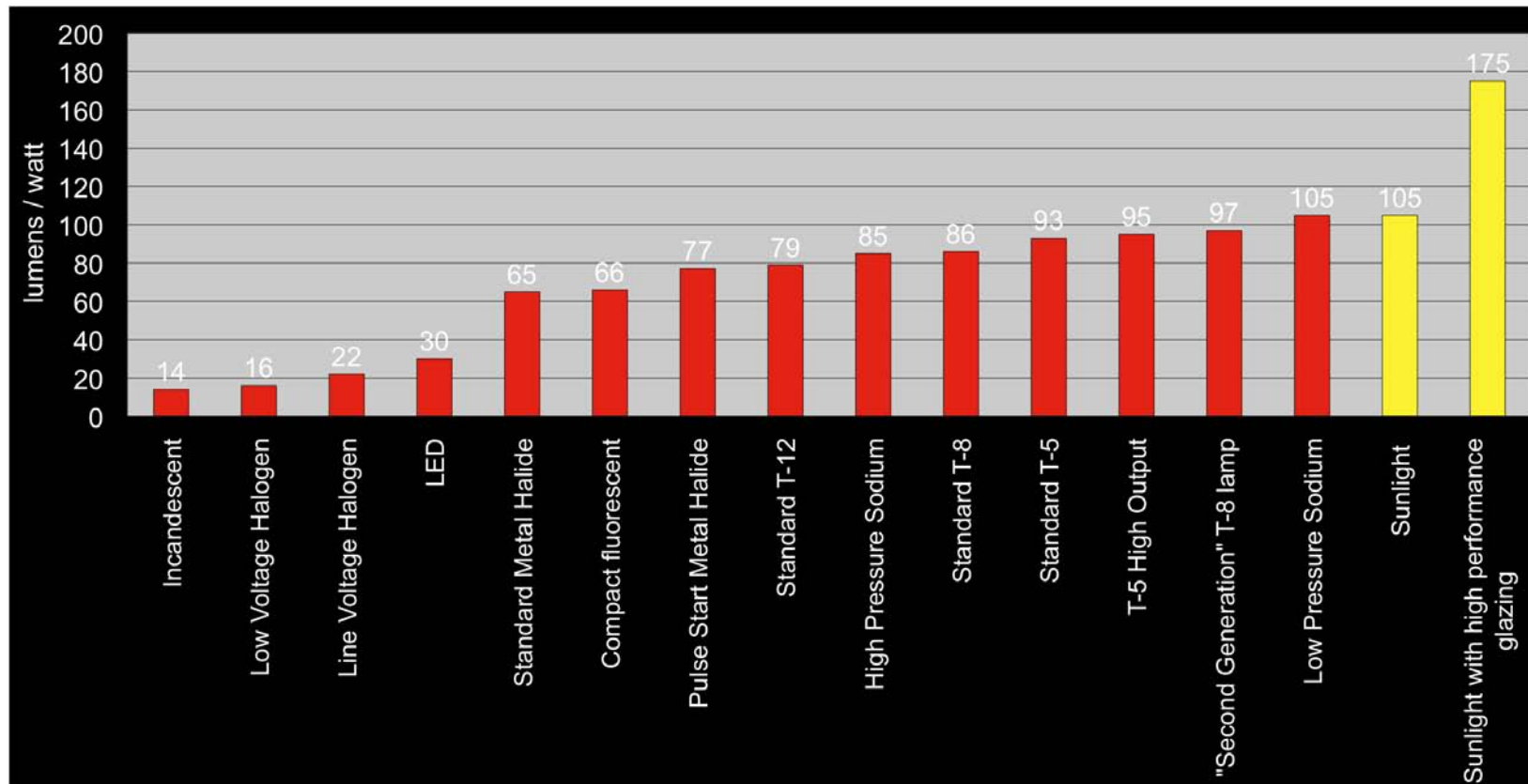
What is daylighting?

The purposeful use of sunlight to meet the illumination requirements of an architectural space.



Daylighting Basics

Lighting efficacy comparison (light to heat ratio)



- Daylight with no low-e coating: 90 – 120 lumens/watt
- Daylight with low-e coating and LightLouver: 150 – 250 lumens/watt
- For each 3 watts of lighting energy reduction, you get approximately 1 watt reduction in cooling energy

Daylighting Basics

Why Use Daylighting?

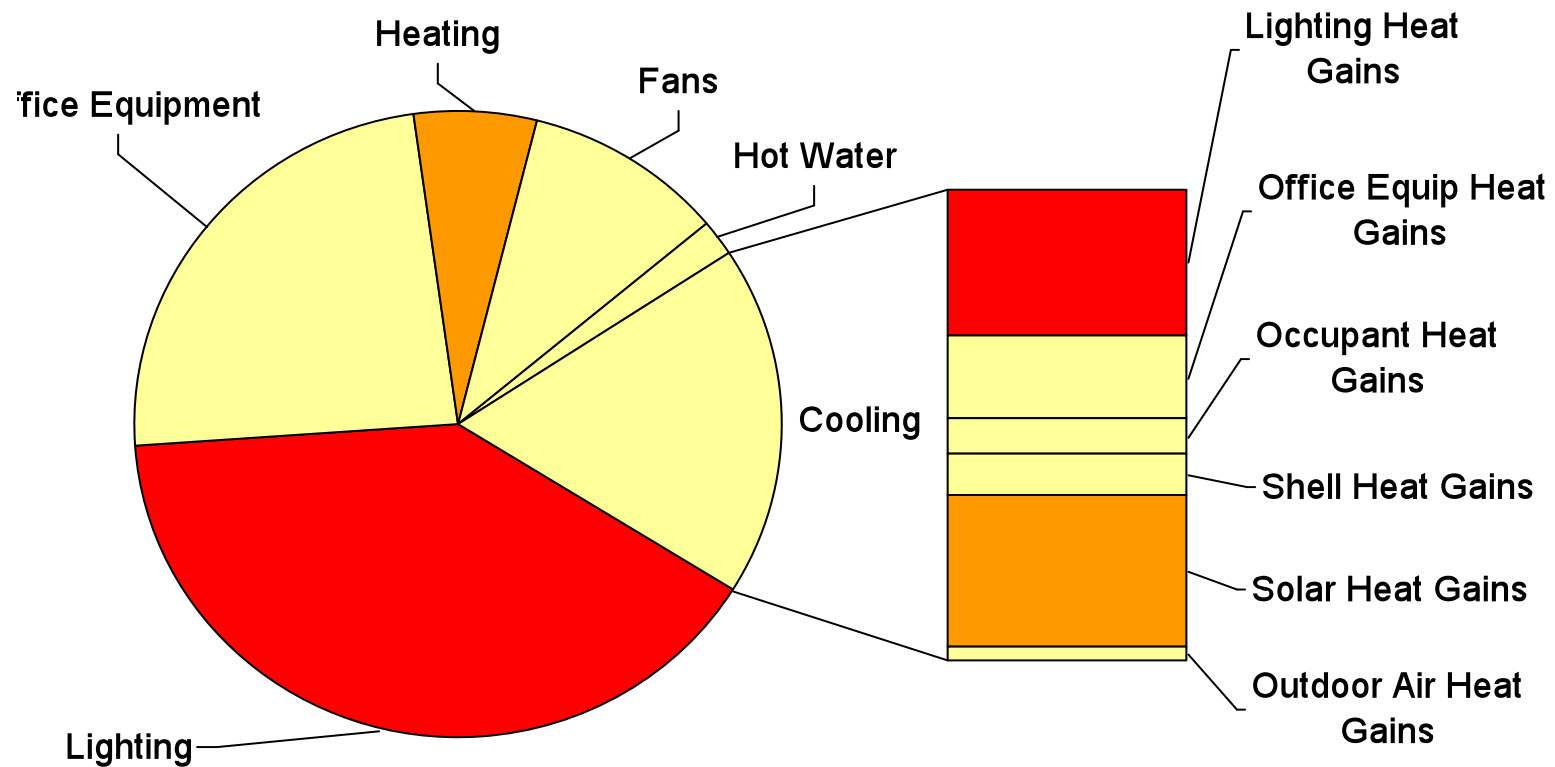


- **Architectural Factors**
 - Space definition
 - Establishes character of space
 - Establishes exterior expression
- **Human Factors**
 - Psychological connection to outdoors
 - Improve occupant health and well-being
 - Improve worker productivity
 - Improve occupant satisfaction with indoor environment
- **Energy Efficiency**
 - Lighting a major building load & cost
 - Reduces coincident peak electrical demand



Daylighting Basics

Typical Office Building Energy Costs



Electric lighting accounts for 30 - 50% of a building's annual energy cost:

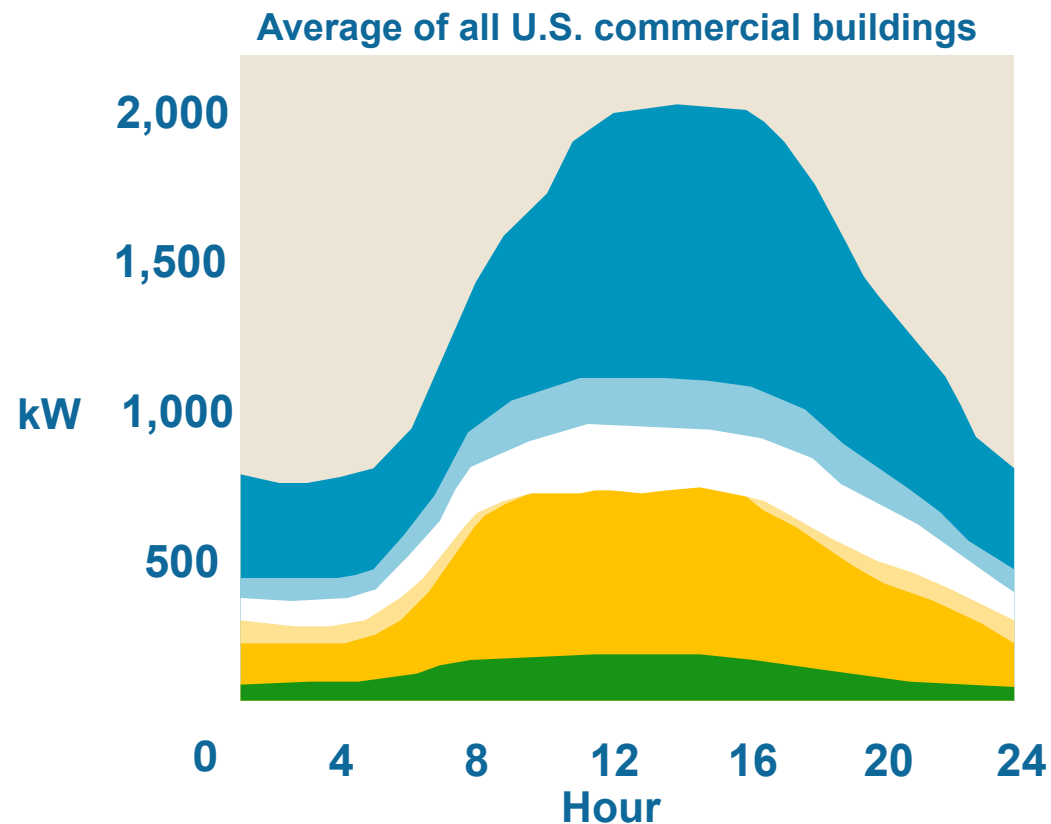
- Typically 50% or more of total electrical load
- Contributes to cooling load up to 30%

Daylighting Basics

Winter Day Electrical Load Shape



Summer Peak



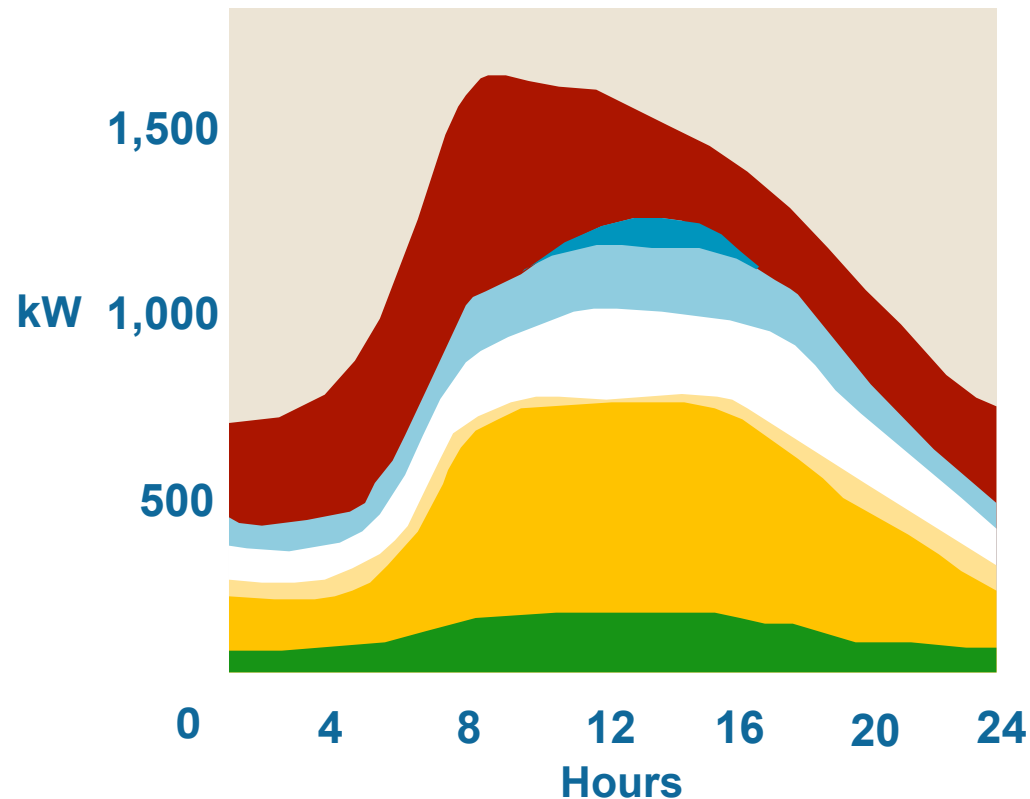
Daylighting Basics

Winter Day Electrical Load Shape



Winter Peak

Average of all U.S. commercial buildings

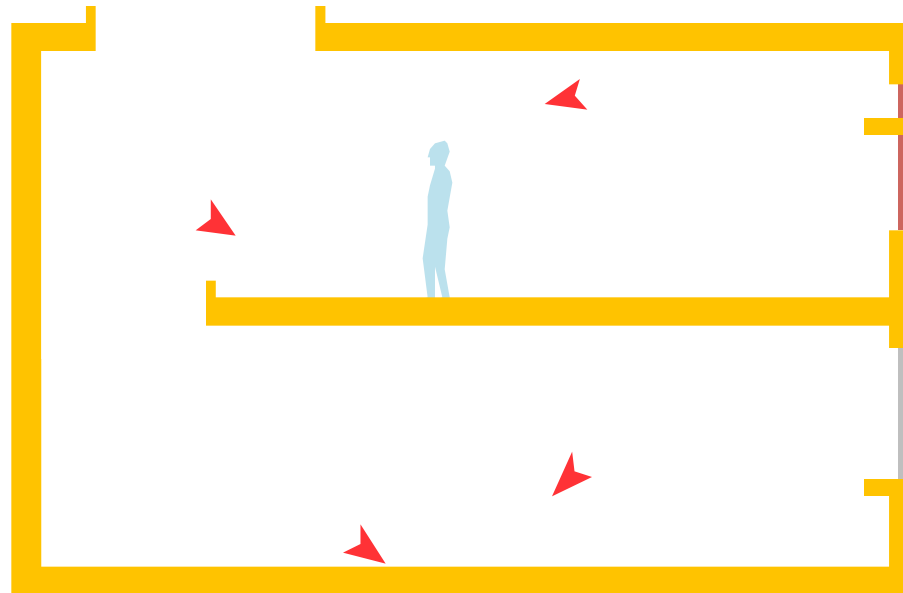


Daylighting Basics

Architectural Daylighting Strategies



Top daylighting



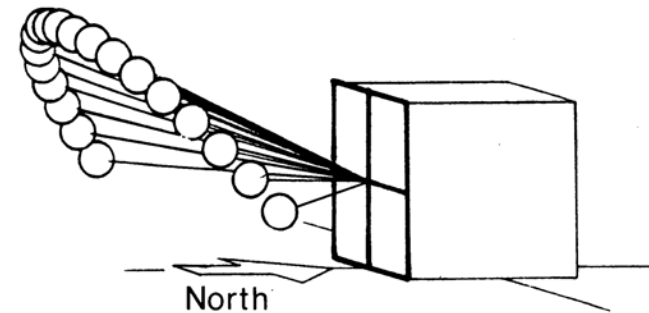
Side daylighting

Daylighting Basics

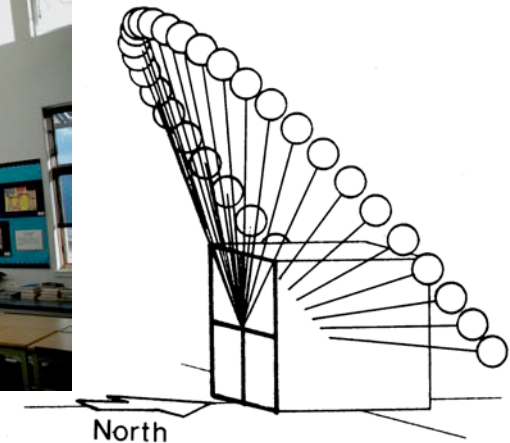
Side Daylighting Challenges



- Dynamic resource: difficult to control
 - Low winter sun angles, solar cut-off angle issues
 - Varying sky conditions
 - Reduced resource at higher summer sun angles when need for daylight is greatest
- Access to daylight
 - Deep floor plates
 - Orientation variation
 - Uniform distribution of daylight



Winter sun angles on a south-facing surface

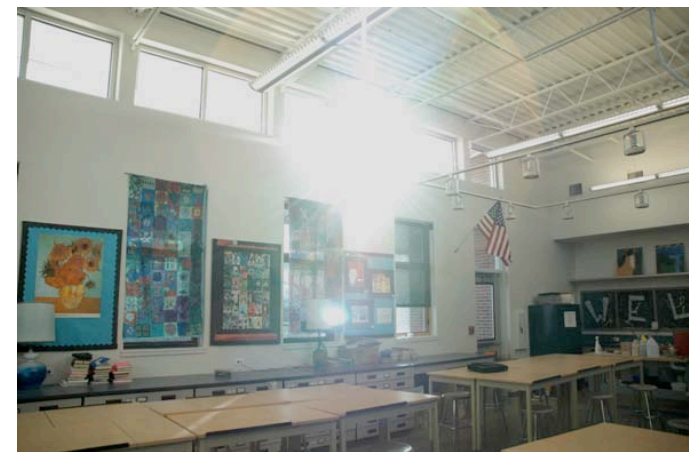
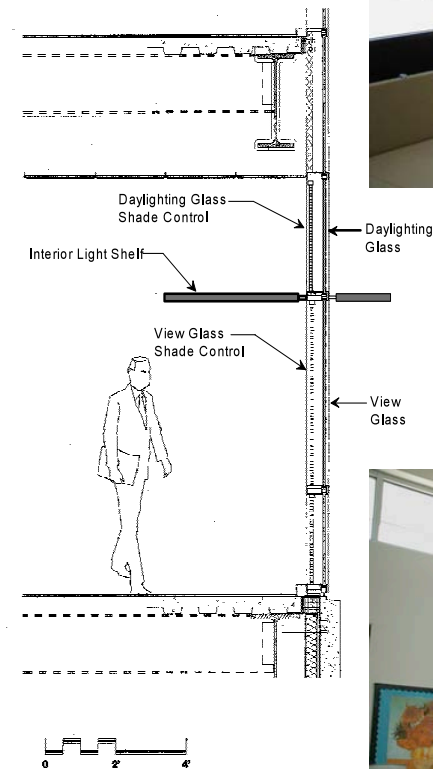


Summer sun angles on a south-facing surface

Daylighting Basics

Limitations of side daylighting approaches

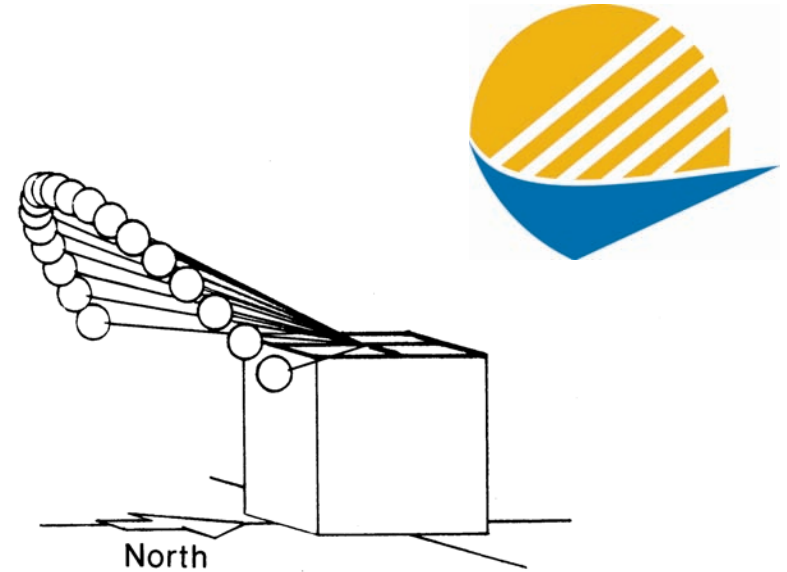
- Lightshelves
 - Expensive
 - Obtrusive
 - Medium daylight distribution (1-1.5x daylight zone)
 - Winter glare (cut-off angle) issues
- Translucent glazing
 - Low daylight transmission
 - Shallow light distribution
 - Glare / contrast ratio issues
- Overhangs
 - Poor summer performance
 - Poor glare control
- Shades and blinds
 - Poor daylight distribution, must have automated control



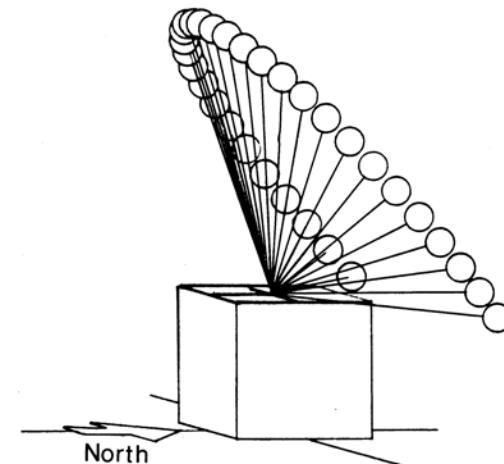
Daylighting Basics

Limitations of top daylighting approaches

- Skylights
 - Peak solar heat gain occurs during summer months, adds to the peak cooling load
 - Minimal solar heat gain during winter months, with corresponding greater heat loss
 - Limited to upper floor of a building
- Clerestories
 - Difficult architectural integration
 - Potential costly structure
 - Limited to upper floor of a building
- Roof openings prone to leaks



Winter sun angles on a horizontal surface



Summer sun angles on a horizontal surface

Elements of an Integrated Daylighting / Electric Lighting Design Solution



- “Daylight” aperture (glazing material properties)
 - Window, skylight, clerestory, fabric roof structure, sunlight concentrator
- Daylight distribution
 - LightLouver optical slats, fiber optics, lightshelf, light guide devices
- Daylight target
 - Ceiling, walls, floor, work surfaces
- Electric lighting system
 - Lighting fixtures, circuiting, controls
- Electric lighting system controls
 - Daylighting dimming controls for daylight harvesting
- Exterior aperture shading
 - Reduce solar heat gain on “vision” glazing
- Interior aperture shading
 - Control direct sunlight penetration and glare

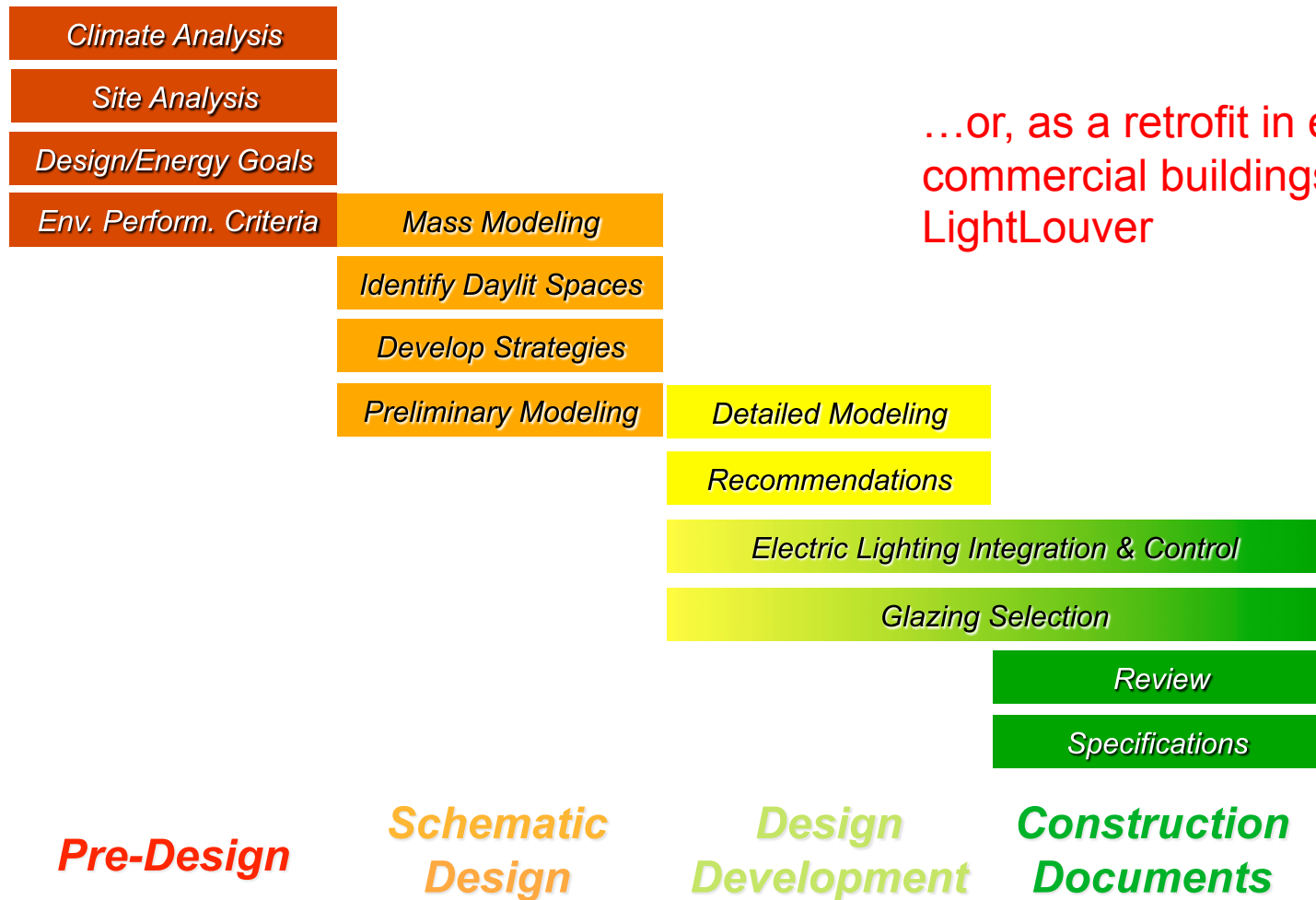


Daylighting Design Goals / Characteristics



- Quantity
 - Daytime ambient lighting provided by daylight for the majority of the year
- Quality
 - Uniform distribution of daylight to reduce uncomfortably high brightness ratios, and increase “daylit” area
 - Control of direct sunlight to reduce glare and visual discomfort
 - Solar heat gains utilized to reduce heating loads when beneficial
- Useability
 - Ensure access to adequate daylight for all occupants
 - Ensure views / connection to the outdoors for all occupants
- Building Integration
 - Fully integrated with the architectural design
 - Synergistic with other building systems – mechanical, lighting, etc...
- Economics
 - Integrated with daylight responsive electric lighting controls to maximize “daylight harvesting” and energy savings
 - Minimize first costs to reduce payback period from energy savings

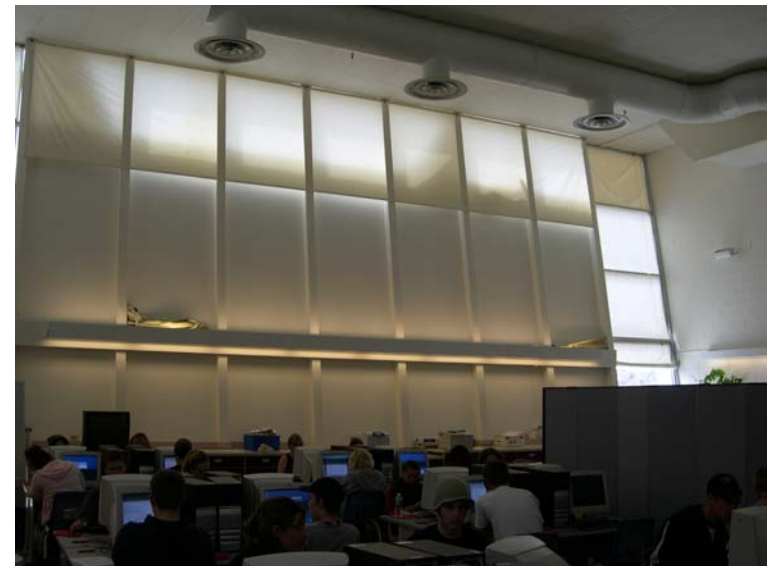
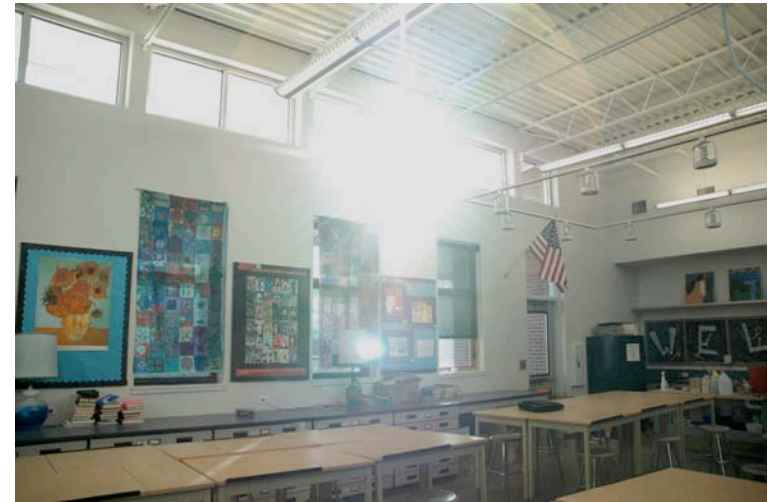
Daylighting Design Process





Typical Daylighting Design Problems

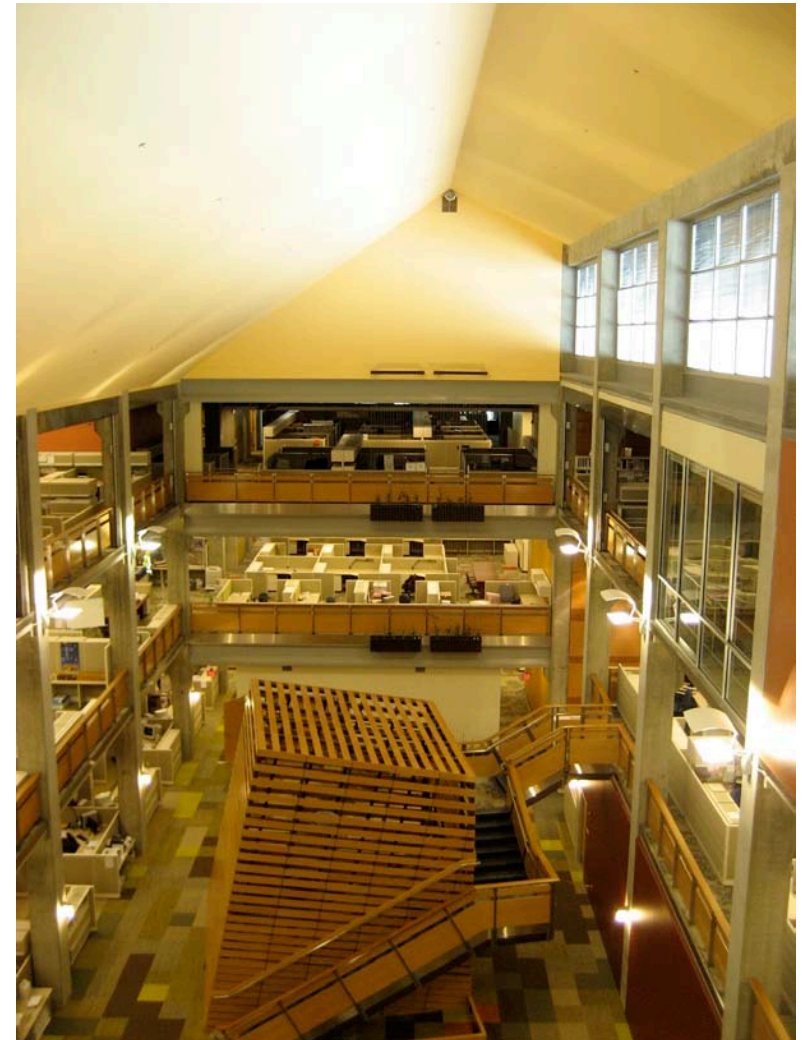
- Glare – visual discomfort
- Poor daylight distribution
- Ineffective electric lighting system integration
- Ineffective interior window treatment
- Inappropriate interior design and furniture selection



LightLouver Daylight System



A patented, passive optical side-daylighting device, mounted inboard of the “daylight” window, that intercepts and redirects sunlight onto the ceiling and deep into the interior space of a building, reducing glare and the requirement for electric lighting and mechanical cooling



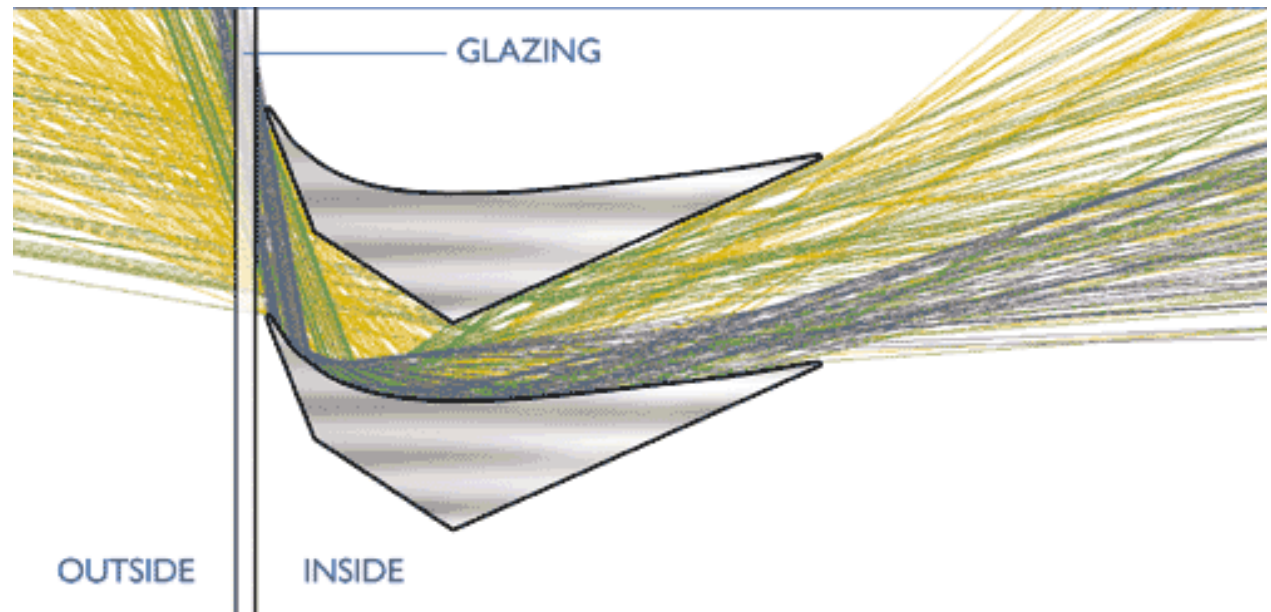
LightLouver Daylighting System



LightLouver Unit

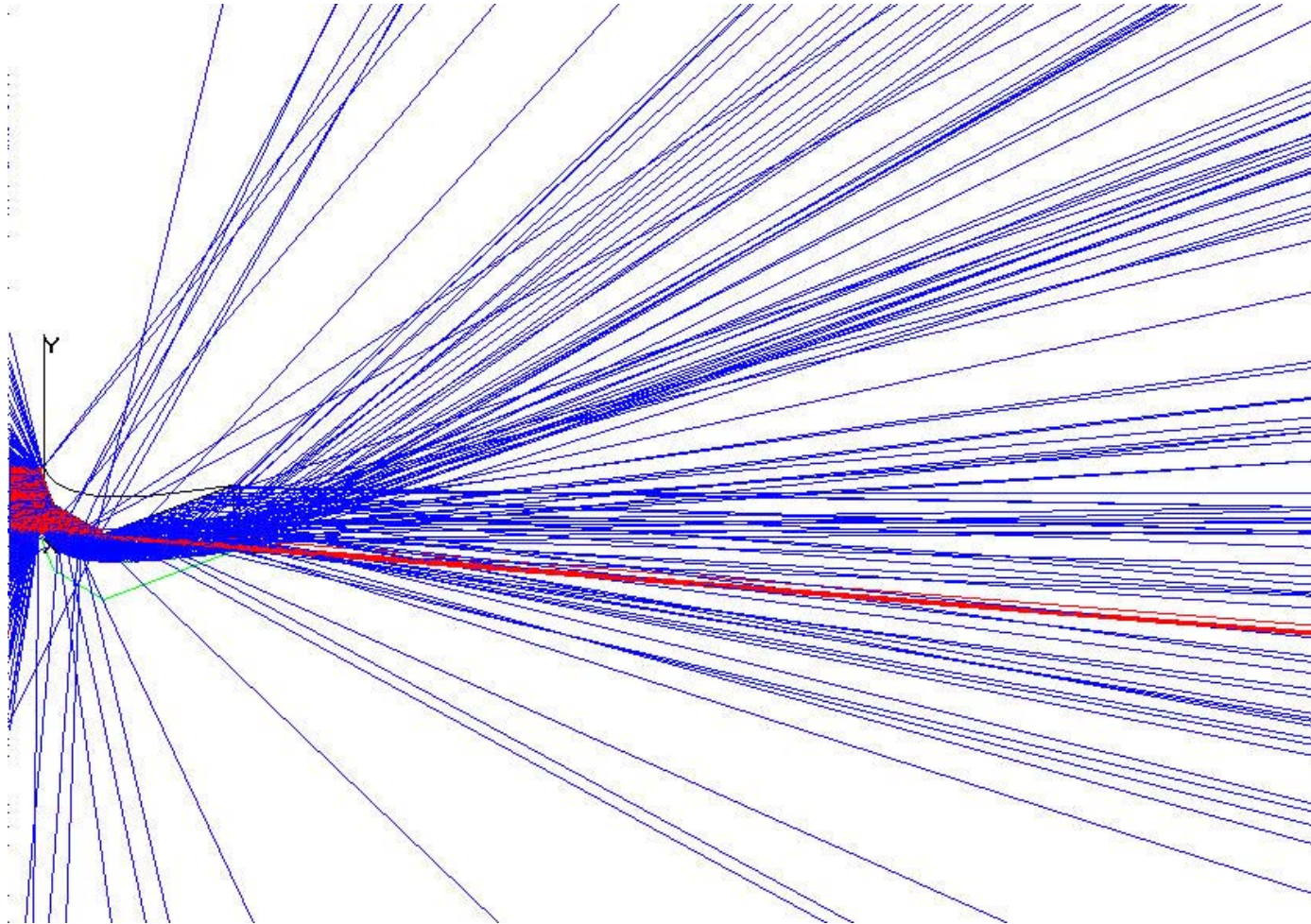


Patented Optical Slat Design



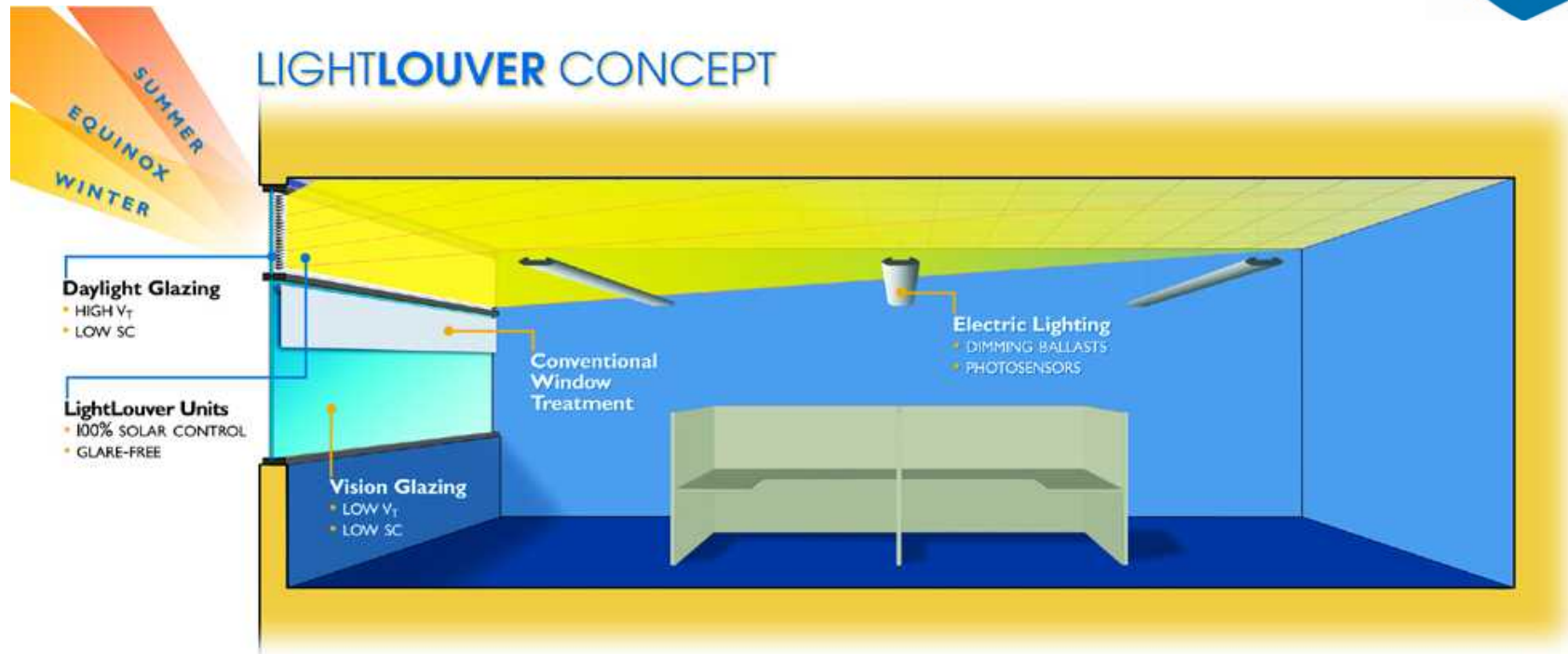
Raytracing diagram illustrating performance under all sun angles

LightLouver Daylighting System



Dynamic raytracing simulation of all sun angles

LightLouver Daylighting System



Benefits of LightLouver

Glare control



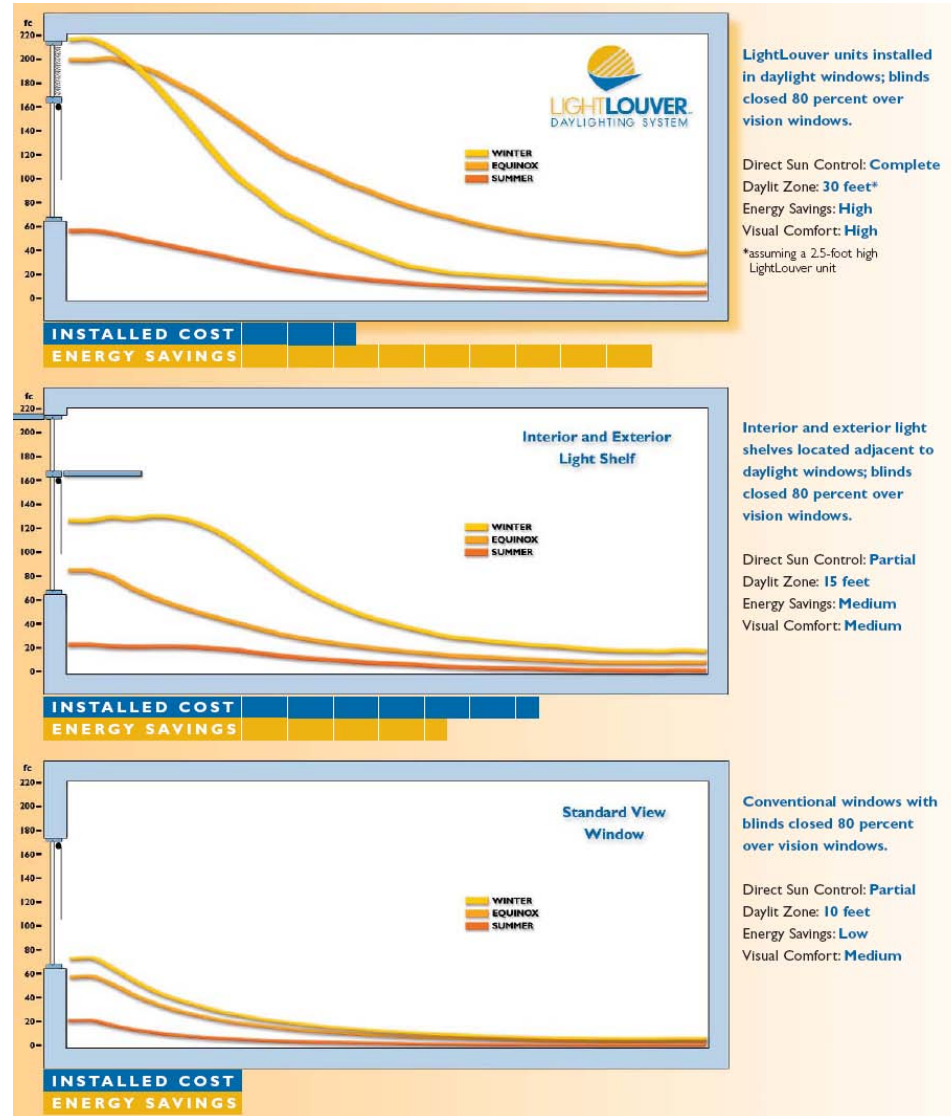
LightLouver reduces window brightness while increasing room surface brightness

Benefits of LightLouver

Deeper daylight distribution



Benefits of LightLouver Performance



Benefits of LightLouver

Ease of installation

- Easy to install, 8 – 12 units per hour
- Valence aligns support brackets in window frame for ease of installation
- Unit slips into support brackets and locks in place, while still allowing unit to pivot to clean the daylight window behind



Benefits of LightLouver

Ease of maintenance

- Dust as often as the daylight windows are cleaned
- Use Poly-duster for general cleaning of slats
- Use Swiffer 360 and cotton cloth for fingerprints and smudges



Benefits of LightLouver

Improved lighting



- **Quality of light**
 - Excellent color rendition
 - Less eye strain / high contrast ratios
 - Psychological benefits
 - Improved employee productivity
- **Lower energy use**
 - Very high luminous efficacies
 - Lowers energy cost, eliminates coincident peak demand
- **Increasing environmental regulations**
 - Complies with stringent energy codes and standards
 - Enables achievement of LEED daylight and energy efficiency credits

Benefits of LightLouver

Economics



Example: 30' x 30' classroom or office area

Electric Lighting

- 30 fc ambient lighting at 1.1 W/sf
- 2,000 kW/yr, \$240/yr, \$0.27/sf **per year** electric lighting costs

Daylighting with LightLouver

- 24 " high LightLouver units provide 30 fc annual average ambient light
- 50% + reduction in electric lighting costs plus reduced cooling energy costs
- \$2.20/sf of floor area single upfront cost

Return on Investment

- 6 - 8 year simple pay back
- Improved indoor environmental quality
- Heat gain (cooling load) associated with lighting reduced in half
- Improved productivity and educational performance

LightLouver Applications

Office Building -- Unitized curtain wall system



Old National Bank Headquarters

LightLouver Applications

Engineering Offices -- Punched daylight window with “view” window overhangs and an open structure



HB&A Headquarters

LightLouver Applications

Engineering Offices -- Punched windows -- Illustrates retrofit application



DuBois and King Corporate Headquarters



LightLouver Applications

Research Laboratory / Offices -- Storefront system



CDC Building 18 Laboratory / Office



LightLouver Applications

Municipal Office Building -- Storefront system
with “view” window overhangs



Commerce City Civic Center

LightLouver Applications

State Agency -- Clerestory windows above 3 story atrium



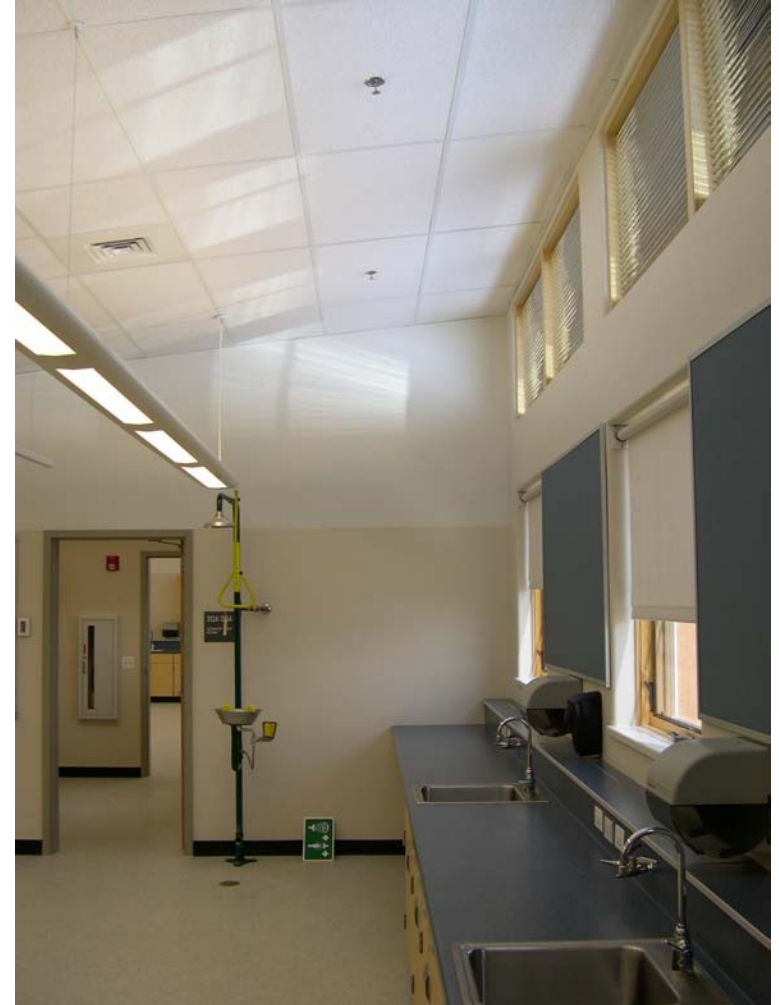
Caltrans District 3 Headquarters

LightLouver Applications

Middle School -- Punched window



Kinnard Middle School



LightLouver Applications

Middle School -- Continuous storefront system



Aspen Middle School



LightLouver Applications

Elementary School -- Continuous storefront system



AIA 2010 COTE Top 10 Project

Manassas Park Elementary School

LightLouver Applications

Elementary School -- Continuous storefront system



LightLouver Applications

Elementary School -- Continuous storefront system



LightLouver Applications

Research Support Facility -- Punched windows



Research Support Facility, National Renewable Energy Laboratory

LightLouver Applications

Research Support Facility -- Punched windows



Research Support Facility, National Renewable Energy Laboratory

LightLouver Applications

Research Support Facility -- Punched windows



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National Renewable Energy Laboratory

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Research Support Facility -- Punched windows



LightLouver Applications

Research Support Facility -- Punched windows



LightLouver Applications

Research Support Facility -- Punched windows



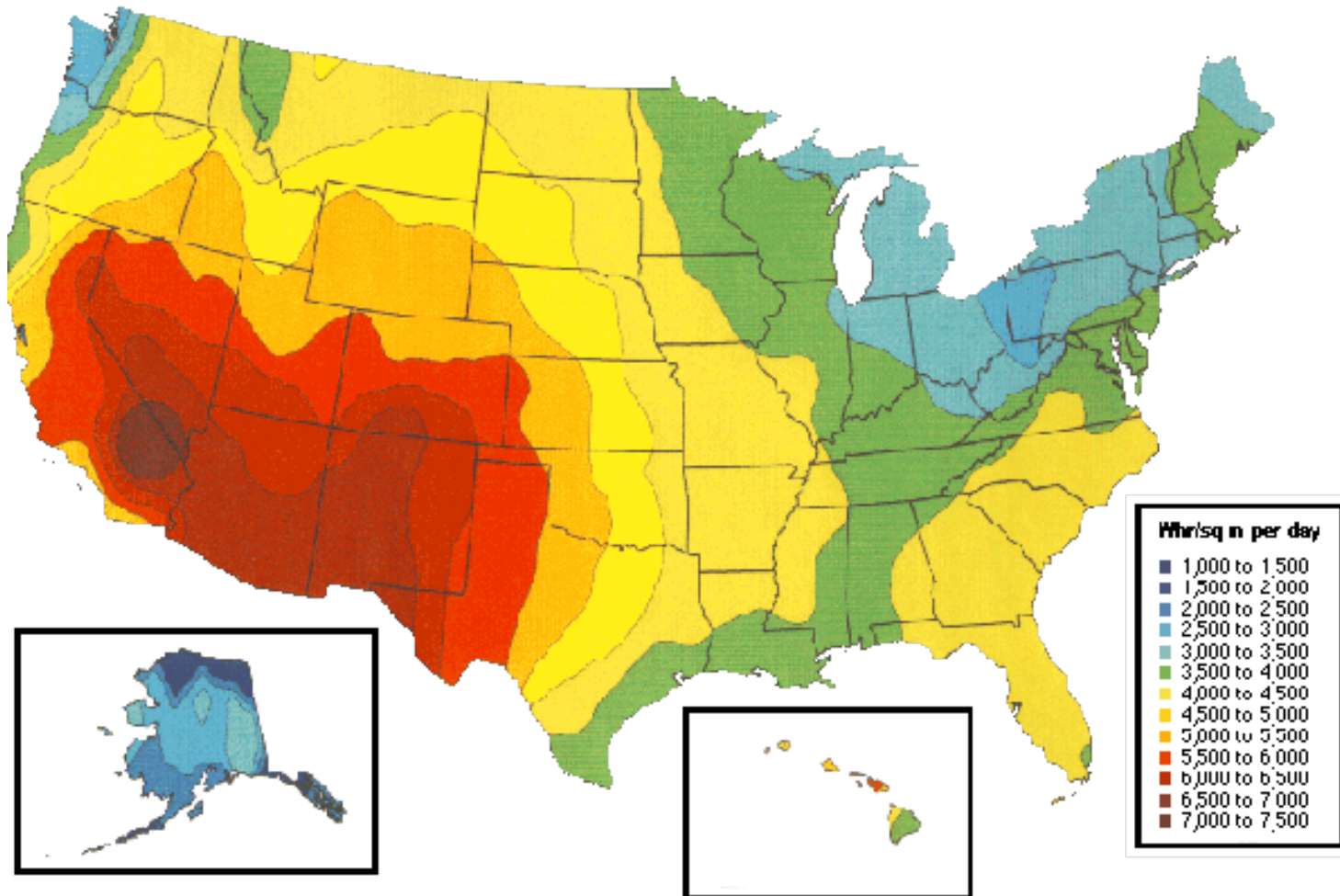
LightLouver Applications

Research Support Facility -- Punched windows



LightLouver Design Guidelines

Direct Sunlight Resource



LightLouver Design Guidelines

New Construction



LightLouver Location

- Side window walls
- Minimum of 7' AFF
- Continuous window preferred
East, West and South facades



LightLouver Design Guidelines

New Construction



LightLouver Unit Sizing

- One vertical foot of LightLouver unit provides uniform ambient light for a 12' – 14' daylit zone
- Minimum “Daylight” window opening height = 12”
- Window opening heights should be divisible by 1”
- Interior mullion depth >1.5”



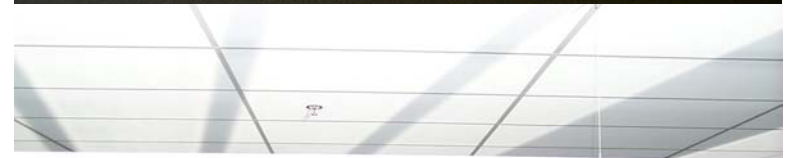
LightLouver Design Guidelines

New Construction



Daylit Space Types

- Optimal performance in large open spaces with minimal obstructions above 7' AFF
- Good east, west and south exposure to the sun with minimal shading from neighboring objects, such as trees, buildings, etc...



LightLouver Design Guidelines

New Construction



Electric Lighting System Integration

- Best with indirect lighting, both of which work best with a smooth reflective ceiling surface
- Provides ambient (20-30 fc) level of illuminance and integrates best with an ambient / task electric lighting design scheme providing the same ambient illuminance level
- Can use open and closed loop photosensor control system



Photosensor

LightLouver Design Guidelines

Ideal glazing and surface recommendations



- Daylight glazing
 - Visible light transmission, $T_{vis} = 0.6 - 0.9$
 - Low solar heat gain coefficient, $SHGC < 0.45$
- Vision glazing
 - $T_{vis} = 0.3 - 0.5$
 - $SHGC < 0.35$
- Smooth white, highly reflective ceiling surface
- Fabric shade cloth over “vision” windows: 3 – 5% openness factor



Benefits of LightLouver

Summary of features

- Distributes daylight deep and uniformly into the daylit space
- Works at any latitude
- Provides annual ambient light levels of 25-30 fc
- Unique self-shading design provides complete solar cut-off and glare control
- Can be used on east, west and south facades
- No moving parts or daily /seasonal adjustments
- Custom fabricated to fit specified window size and system
- Quick and easy installation
- Provides significant energy savings
- Low lifetime maintenance costs
- Less costly then other options, yet provides better daylighting and solar control performance in one product
- Made in the USA



LightLouver Design Assistance

Support services



Daylighting Design Assistance

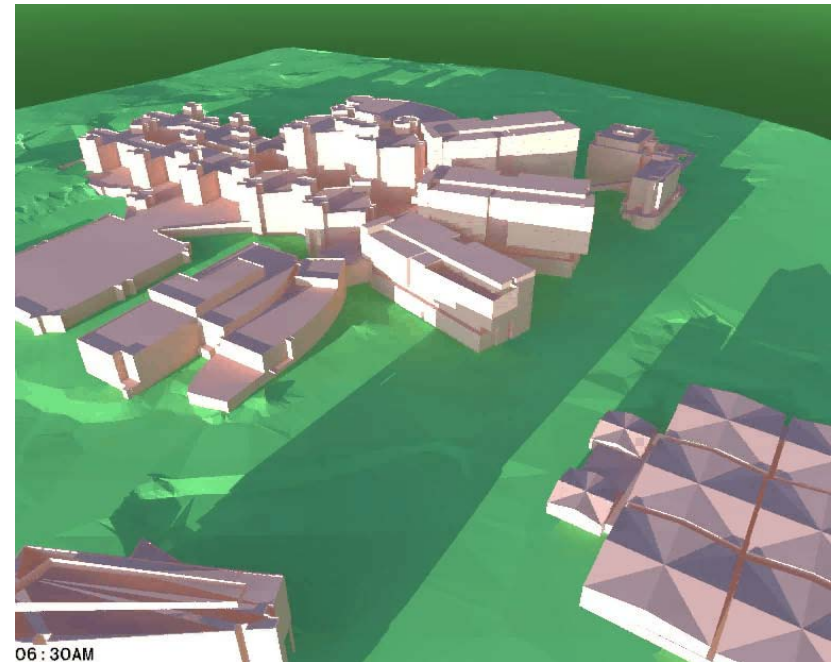
- Site shading and solar exposure mass modeling
- Daylighting concept design development
- Daylight modeling
- Solar control analysis
- Glazing selection and specification

LightLouver Unit Integration Assistance

Lighting System Integration Assistance

LightLouver Application Design Reviews

Troubleshooting

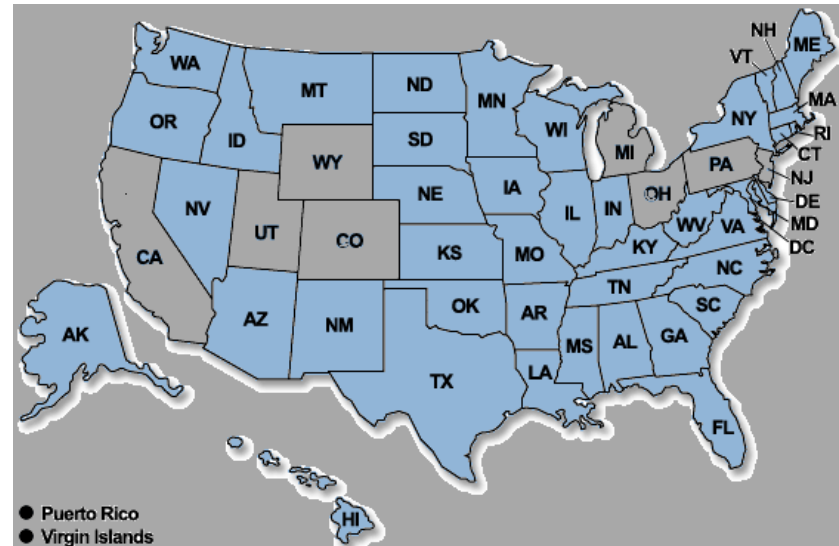


LightLouver Design Assistance

Contact Information



- E-mail:
 - sales@lightlouver.com for quotes and orders
 - tech@lightlouver.com for design assistance and analysis
- Websites:
 - www.lightlouver.com
- Phone:
 - LightLouver LLC - 303 444 8773





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