Daylighting Design Principles and the LightLouver Daylighting System
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

Spectral distribution of solar radiation
Eye sensitivity curve

Relative Intensity
UV   Visible   Near Infrared (52%)

Wavelength (nm)
300  500  700  900  1,100  1,300  1,500  1,700  1,900
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
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

- Heating
- Cooling
- Ventilation
- Exterior Lighting
- Interior Lighting
- Other
- Water heating, cooking, and refrigeration

Summer Peak
Average of all U.S. commercial buildings

0 4 8 12 16 20 24
Hour

kW
0 500 1,000 1,500 2,000
Daylighting Basics
Winter Day Electrical Load Shape

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Water heating, cooking, and refrigeration

Winter Peak

Average of all U.S. commercial buildings

KW 1,500
1,000
500
0 4 8 12 16 20 24
Hours

0 1,000
500

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
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
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

...or, as a retrofit in existing commercial buildings with LightLouver
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

LightLouver Concept

Daylight Glazing
- HIGH Vt
- LOW SC

LightLouver Units
- 100% SOLAR CONTROL
- CLARKE-FREE

Vision Glazing
- LOW Vt
- LOW SC

Conventional Window Treatment

Electric Lighting
- LUMINATING BALLAST
- PHOTOCYCLE

Images:
- Building exterior and interior views
Benefits of LightLouver
Glare control

LightLouver reduces window brightness while increasing room surface brightness
Benefits of LightLouver
Deeper daylight distribution
Benefits of LightLouver Performance

LightLouver units installed in daylight windows; blinds closed 80 percent over vision windows.

Direct Sun Control: Complete
Daylit Zone: 30 feet
Energy Savings: High
Visual Comfort: High
*assuming a 2.5-foot-high LightLouver unit

Interior and exterior light shelves located adjacent to daylight windows; blinds closed 80 percent over vision windows.

Direct Sun Control: Partial
Daylit Zone: 15 feet
Energy Savings: Medium
Visual Comfort: Medium

Conventional windows with blinds closed 80 percent over vision windows.

Direct Sun Control: Partial
Daylit Zone: 10 feet
Energy Savings: Low
Visual Comfort: Medium
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
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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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…
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
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 than 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
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