The World’s Most Advanced Tubular Daylighting Devices (TDD’s)
Everybody Deserves Daylight
Agenda

- Solatube International, Inc.
- Human Performance
- Daylighting Strategies
- The Solatube Advantage
- Solatube Products
- Solatube Design Resources
- ICE Showcase

- Technology Appendix:
  Total System Performance
Solatube International, Inc.

- Established North America HQ in 1992
- Worldwide leader in design, manufacture, and application of Tubular Daylighting Devices for over 20 years
- Creators of the TDD category
- Innovators pioneering advanced optics and photometry in TDD’s
- Most recognized and trusted name in daylighting
Daylighting Drives Human Performance

- Increased staff productivity
- Reduced absenteeism
- Employee retention
- Improved student performance
- Improved quality control
- Increased retail sales
- Improved healing time
- Improved mood
- Greater occupant well-being & satisfaction
Typical classroom with fluorescent lighting.

Same classroom with Solatube Daylighting Systems.
Daylighting Strategies

Traditional Skylights

Benefits:
- Not dependent on building orientation
- Daylight deeper into building

Challenges:
- Up to 10% of roof area
- Can be expensive
- Transient light patterns
- Volatile light levels
- Lack of control
- Top floor limited
- Complex architectural integration
- Historical problems with leaks
- Punishing thermal performance

Windows

Benefits:
- View of the world
- Design feature

Challenges:
- Orientation dependent
- Perimeter limitation
- Punishing thermal performance
- Glare
- Easily obstructed
- Sound control
- Transient light patterns
- Volatile light levels

Optical TDDs

Benefits:
- Highly consistent and controllable daylight
- Daylight any space in nearly any climate
- Minimal roof structure impact (<2%)
- Superior thermal performance
- Endless possibilities with highly flexible, modular system
- Leak-proof design
- Cost-effective

Challenges:
- Only your imagination…
The Solatube Advantage

Capture

Transfer

Deliver+Control

SOLATUBE®
Capture
The Solatube Advantage

Raybender and LightTracker Technologies
- Passive optics
- Maximizes light capture
- Improves low angle light collection
- Controls high angle light
- Minimizes heat gain

Minimize roof area required for daylighting
Impact resistant and UV inhibiting domes
Leak-proof flashings and curb caps
Thermal breaks to minimize heat transfer
Transfer
The Solatube Advantage

Spectralight Infinity Tubing
Light Transfer Efficiency (LTE)
• Highest specular reflectance for visible light 99.7%
• Multi-story installations with minimal light loss
• Extremely long tube runs
• Angular capability: multiple 90 degree turns

Light to Solar Heat Gain (LSG)
• InfraReduction Technology minimizes heat gain

Color Temperature Maintenance (CTM)
• No color shift

Percentage of light delivered after 20 bounces

- Spectralight Infinity 99.7%
  \[0.3\% \times 20 = 94.17\%\]
- Enhanced Silver 97%
  \[3.0\% \times 20 = 54.38\%\]
- Enhanced Aluminum 85%
  \[5.0\% \times 20 = 35.85\%\]
- Anodized Aluminum 84%
  \[16.0\% \times 20 = 3.06\%\]
Deliver+Control
The Solatube Advantage

Diffusers, Decorative Fixtures, Dimmers

• Stylish and functional interior options
• Engineered lens optics for consistent distribution patterns
• Daylight Dimmer for total control
Solatube Products
SkyVault Series
Big tubes for big spaces.

M74 DS Core Unit
M74 DS with Amplifier
M74 DS with Collector
M74 DS with Collector & Amplifier
Trantronics
Irvine, CA
SkyVault: Capture

Core Unit
- Maximizes light collection using large aperture
- Prevents entry of air & moisture
- Exceptional thermal efficiency
- Optional: inner dome and security guard

Collector
- Raybender HD
- LightTracker Technology
SkyVault: Transfer

Spectralight Infinity Tubing

- Patented connection system
  - Tab lock system, tube belts, pre-punched holes for rivets
- 29” diameter tubing
- Maximum recommend tube length of 100’
SkyVault: Deliver+Control

Core Unit
- Increase illumination on high wall and ceiling planes
- Deliver superior diffusion with no light shift
- For floor to diffuser heights of ~18’-26’

Amplifier
- Focus light downward to visual task plane
- Reduce loss of light at ceiling plane and high up on walls
- For floor to diffuser heights of ~26’ and up
“We have been using Solatube products for over a decade and continue to be impressed with the quality and performance, especially the new SkyVault Series. The amount of light delivered is truly incredible, allowing us the opportunity to turn off our electric lights and reduce our peak demand load. More importantly, the natural light creates a better work environment for our most important asset – our people.”

- Kermit Ferrer, VP of Distribution Planning, Capital and Properties
  Macy’s, Inc.
SolaMaster Series
Powered by the sun. Built for versatility.

330 DS & 750 DS
Closed Ceiling

330 DS & 750 DS
Open Ceiling
SolaMaster: Capture

Raybender 3000 (750 DS)
- Redirects low-angle sunlight for maximum capture
- Rejects overpowering summer midday sunlight
- Provides consistent daylighthing throughout the day

LightTracker Reflector (330 DS)
- Redirects low-angle sunlight for maximum capture
- Increases light input for greater light output
- Maximizes midday sunlight
SolaMaster: Transfer

Spectralight Infinity Tubing

- Telescoping system for easy field adjustment
- Angular adjustability for 0-90 degree turns
- 21” diameter tubing
- Maximum recommended tube length of 50’
SolaMaster: Deliver+Control

Diffusers
- Prismatic & OptiView diffuser lens options
- Addresses both ceiling and open ceiling designs

Daylight Dimmer
- Butterfly baffle design provides total control of daylight entering space from 2% to 100%
“Solatube products are more effective, brighter and resilient, but also give the sense of being connected to the outside. In fact, they not only improve the learning environment and morale of the students and staff, they also save significant funds as far as our utility budget, and that money goes back into the classroom.”

- Richard Cosgrove, Director of Planning & Construction
Douglas County School District

Douglas County Schools
Colorado
Brighten Up Series
A big idea for small spaces.

160 DS

290 DS
Brighten Up: Capture

Raybender 3000
- Redirects low-angle sunlight for maximum capture
- Rejects overpowering summer midday sunlight
- Provides consistent daylighting throughout the day

LightTracker Reflector
- Redirects low-angle sunlight for maximum capture
- Increases light input for greater light output
- Maximizes midday sunlight
Brighten Up: Transfer

Spectralight Infinity Tubing
- Telescoping system for easy field adjustment
- Angular adjustability for 0-90 degree turns
- 160 DS: 10” diameter: Max. length 20’
- 290 DS: 14” diameter: Max. length 30’
Brighten Up: Deliver+Control

Decorative Fixtures & Diffusers
- Fixtures with tempered glass offer variety to match any interior
- Diffusers offer durability and simplicity
- Options for closed and open ceiling applications
- Effect lens options to alter light color and/or intensity

Daylight Dimmer
- Butterfly baffle design provides total control of daylight entering space from 2% to 100%

Add-ons
- Light add-on kits - universal and dedicated CFL
- Ventilation add-on kit (160 DS)
“As lighting designers we were especially particular about the quality of light within our own office, and we found that the layout of 45 Solatube Daylighting Systems provided an even, natural light that larger conventional skylights could not provide.”

- Paul Gregory, President
  Focus Lighting

Focus Lighting
New York, NY
Solatube Design Resources

• Specifications
• Cut sheets
• CAD & BIM
• Installation instructions
• Photometry
• LEED information
• CEU courses
• Material safety data sheets

• Codes & approvals
• Case studies
• Daylighting facts & figures
• Product literature
• Product technology
• Solution center
  • Fire rated applications
  • Integrated lighting applications
Solatube Design Calculator

Proprietary software
Creates light studies
Deliver accurate layouts and spacing for Solatube systems
Achieve desired light levels

• Photometry for all Solatube product configurations
• Single point in time and annualized calculations
• Accounts for tube length and 90 degree turns
• Weather data for thousands of sites around the world
• Options for verifying LEED daylighting requirements
Summary

- The worldwide leader in tubular daylighting devices
- Innovation is our differentiator
- Daylight drives human performance
- Designed for both new construction and retrofits
- Variety of models and options to daylight any space
- Tools and resources available to take the guesswork out of daylighting
- Network of certified representatives ready to assist from design to installation
ICE Showcase
Inspired Creative Excellence
“The difference in using Solatube products is dramatic because of the reflectivity rate. We tried fiber optic lighting, but Solatube systems, with their specialized tubing and dome system is the best solution on the market today.”

- Geronimos Dimitrelos, President
  Algae to Omega

Algae to Omega
Oakland Park, FL
“As you can see, that plant has been hanging in my kitchen window for over 10 years. After we installed the Solatube (about 18 months ago) the plant decided that was the place to be. I have actually had to pry the new leaves our from under the trim ring a few times. I think it would grow all the way to the dome if I let it.

- Lynn Hoadley, Design Project Manager
  Group 7 Design
  Franklin, MA
“I chose Solatube systems for the entry of El Monte Sagrado because it was the only company that could meet my specific design requirements. The product arrived exactly when promised, was easy to assemble and has been one of the key focal elements of the resort since opening. I could not be happier with the quality of the product and the splendid service we continue to receive from Solatube International on current projects.”

- David Sargert, Architect

El Monte Sagrado Resort
Taos, NM
Luminous Walls
Solatube International, Inc.
Vista, CA
"The use of Solatube Daylighting Systems is an integral part of our energy management system providing natural light which is very conducive to the learning environment. Solatube products are a cost efficient solution to provide lighting to classroom and office space. The District is currently looking into using Solatube Daylighting Systems in existing buildings."

- Jim Philp, Superintendent
  Lenawee Intermediate School District

Lenawee Intermediate School District Center for a Sustainable Future
LEED Platinum, Net Zero
Adrian, MI
The Vine
Irvine, CA
Hangzhou JNHY Underground Parking
China
Solatube Daylighting Systems
The most visible and effective green feature you can add to any space
Technology Appendix
Total System Performance
Total System Performance
Low Angle Light Collection

• Raybender and LightTracker Technologies both improve input angle of low angle light entering the system
Total System Performance
Specular Reflectance

- Specular Reflectance is the key factor in determining a TDDs optical efficiency in transferring light
- Diffuse Reflectance consists of light scattered in every direction
- Total Reflectance consists of both Specular Reflectance and Diffuse Reflectance and is not a good indicator of a TDDs efficiency in transferring light to interior spaces
- 99.7% specular reflectance for visible wavelengths of light
Total System Performance

Light Transfer Efficiency (LTE)

- Indicates the percentage of light that travels through the tubing daily, seasonally, and between multiple floors
- High LTE is desirable for maximizing light throughput and minimizing daily and seasonal variances in efficiency
- Key factors:
  - Input angle of light rays
  - Specular reflectance of tubing
  - Aspect Ratio (tube diameter/tube length)
Total System Performance
Light Transfer Efficiency (LTE)

- Due to the high specular reflectance of Spectralight Infinity, Solatube products are capable of:
  - Extremely long tube runs
  - Multiple 90 degree turns
  - Multi-story installations

Percentage of light delivered after 20 bounces:

- Spectralight Infinity: 0.3% x 20 = 94.17%
- Enhanced Silver: 3.0% x 20 = 54.38%
- Enhanced Aluminum: 5.0% x 20 = 35.85%
- Anodized Aluminum: 16.0% x 20 = 3.06%
Total System Performance
Light Transfer Efficiency (LTE)

- Enhanced Silver produces a 36% swing in light output between Winter and Summer
Total System Performance
Light Transfer Efficiency (LTE)

- Spectralight Infinity varies by only 11% from Winter to Summer
Total System Performance
Color Temperature Maintenance (CTM)

- A measure of how well a system can deliver reflected light without a color shift
- A high CTM indicates a product that produces minimal color/spectral shift of the light
- L*a*b color model is the best performance parameter for color consistency of light transferred through a TDD
- Spectralight Infinity is spectrally neutral for visible light and produces virtually no color shift.
  - Perfect color rendition - interior colors are truer, brighter
  - No major color shifts over the course of the day or changes in season
  - Color: $a^*$ and $b^*$ (defined by CIE L*a*b* color model) shall not exceed plus 2 or be less than minus 2 as determined in accordance to ASTM E 308
Total System Performance
Light to Solar Heat Gain Ratio (LSG)

- Defined as the ratio between Visible Transmittance (VT) and Solar Heat Gain Coefficient (SHGC)
- Indicates how well a fenestration product transmits useful visible daylight while filtering out unwanted heat
- The higher the LSG value, the more efficient the system is at delivering daylight and minimizing unwanted heat
- Solatube Daylighting Systems minimize heat gain through a combination of:
  - Thermal breaks between the flashing and tubing
  - Raybender 3000 Technology at the top of the dome rejecting high angle sunlight (and heat)
  - Spectralight Infinity with Cool Tube Technology
    - Spectrally selective, focused on delivering the visible spectrum of light
    - Minimizes transfer of Infrared wavelengths (heat) to interior spaces
## Total System Performance

### Light to Solar Heat Gain Ratio (LSG)

<table>
<thead>
<tr>
<th>Fenestration Product</th>
<th>Visible Transmission (Vi)</th>
<th>Solar Heat Gain (SHGC)</th>
<th>Daylighting Energy Performance Ratio (Vi/SHGC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triple Glazed Low-e Window</td>
<td>22%</td>
<td>0.16</td>
<td>1.38</td>
</tr>
<tr>
<td>Clear glass, suspended low-e Heat mirror film</td>
<td>63%</td>
<td>0.38</td>
<td>1.75</td>
</tr>
<tr>
<td>Triple Glazed Window</td>
<td>71%</td>
<td>0.49</td>
<td>1.45</td>
</tr>
<tr>
<td>Clear glass, suspended low-e Heat mirror film, clear glass</td>
<td>71%</td>
<td>0.51</td>
<td>1.39</td>
</tr>
<tr>
<td>Double Glazed Prismatic Skylight</td>
<td>71%</td>
<td>0.51</td>
<td>1.39</td>
</tr>
<tr>
<td>Clear outside, prism inside</td>
<td>60%†</td>
<td>0.20†</td>
<td>3.00</td>
</tr>
</tbody>
</table>

Total System Performance

Ultraviolet Light (UV)

- UV light can have a detrimental effect on interior building materials and occupants
- Solatube Daylighting Systems have UV inhibitors at the dome level to block harmful UV from entering the system