Light Pipes
Part 1– Introduction to Light-Pipes

Part 2 – Light Pipes within your building
Light Pipes

‘Also known as a “tubular skylight” or “tubular day lighting device”, this is the oldest and most widespread type of light tube used for day lighting’
Light Pipe - Basic principles

Thackley old tunnel was built in 1848 on the Airedale line between Leeds, Bradford and Keighley

Pantheon - Rome

Shaft of Light Vatican Inside Small Dome Rome Italy
Light Pipe - Basic principles

- The first commercial reflector system were patented and marketed by Paul Emile Chappuis in London during 1850s
Light Pipe - Basic principles

- Stephen M Sutton, Oakhurst Australia obtains Patent no. 5,099,622 in 1988

- Patent makes reference to its insulation properties......

“This column of air acts as an insulator which prevents heat entering the room or conversely in winter from escaping from the room’
Light Pipe - Basic principles

The ‘light pipe’ system is designed around 3 basic segments which comprises of:-

• the natural daylight collector
• the transfer pipe
• the diffuser within the space
Light Pipe - Basic principles
Light Pipe - Basic principles

Pipe electroplated with MIRO-SILVER 27/4270 AG

98% reflection (DIN 5036-3/ASTM-E 1651)

MIRO-SILVER 27/4270 AG
- It will not delaminate
- It will not yellow, crack or peel after prolonged UV exposure
- Electrostatically neutral so will not attract airborne dust
Light Pipe - Basic principles

Diffuseness below 6%

Diffuseness below 12%

Diffuseness below 87% +/-
Light Pipe - Basic principles

- Prismatic
- Opal
- Spectrum
Light Pipe - Basic principles
Light Pipe - Basic principles

• The U-Value of some light pipe systems has been calculated at 1.58W/m²K with a G-Value of 0.35 on a typical application of a 1.5m length of pipe.
  
  — Low heat gains in summer & heat loss in winter

• However the actual area utilised by a light pipe is only a small percentage of that utilised by a roof light hence the contribution to heat loss / heat gain from the building is considered significantly lower.
Light Pipe - Basic principles

Light ‘shut off’ damper

Integrated electrical light
Light Pipe - Benefits

- Natural Daylight improves the environment within the space
Light Pipe - Benefits

• Full-spectrum lighting improves visual acuity (VA)
  – Education
  – Design
  – Marketing
  – Retail
  – Advertising
Light Pipe - Benefits

- Research has found that students with the most natural daylight performed between 20% - 25% better in tests (Heschong Mahone Group 1999)
Light Pipe - Benefits

• Natural Daylight improves sales within retail spaces
Integration

- Light pipes can be integrated into the lighting strategy of a building
- Automatic dimming profiles could be employed to ‘take over’ lighting duties
- Full optimisation achieved
Dynamic Modelling
Applications

Retail

Cora Alexandriei
Hypermarket - Romania
Applications

British School Dubai – United Arab Emirates

Education
Applications

Public Buildings

Civil Aviation Department Chek Lap Kok (HK International Airport) – Hong Kong
Applications

National Health Service Hospital Basildon – United Kingdom

Health
Applications

Copper Box London – United Kingdom

Sports Venue
Where to avoid using a light pipe
Where to avoid using a light pipe
Where to avoid using a light pipe

Tall buildings!

‘Light pipes’ are best suited to one or two story buildings
Size ranges

230mm (9”)
300mm (12”)
450mm (18”)
530mm (21”)
750mm (30”)
1000mm (39”)
1500mm (59”)

[Image of domed structures on a rooftop]
Installation & maintenance

- Installation is generally a two person job
- Minimal structural alterations required
- Range of accessories available

Same Deutz, Angouleme - France
Installation & maintenance

- Complexity depends upon
  - Pitch of roof
  - Type of roof
Installation & maintenance

- Length of transfer pipe
Installation & maintenance

• Design life is expected to be 20 year plus
• Most light pipes come with 10 year guarantees
• Limited maintenance required
Part 2 – Light Pipes within your building
Environmental standards

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man 11</td>
<td>Ease of maintenance</td>
<td>1</td>
</tr>
<tr>
<td>Man 8</td>
<td>Security</td>
<td>1</td>
</tr>
<tr>
<td>Hea 1</td>
<td>Daylighting</td>
<td>3</td>
</tr>
<tr>
<td>Hea 5</td>
<td>Internal lighting levels</td>
<td>1</td>
</tr>
</tbody>
</table>

**SS Credit 8: Light Pollution Reduction - 1 Point**

**EA Credit 1: Optimize Energy Performance – 3 Point**

**IE Q Credit 8.1: Daylight and Views—Daylight – 3 Points**

**IE Q Credit 8.2: Daylight and Views—Views - 1 Point**

**ID Credit 3: The School as a Teaching Tool - 1 Point**
## Environmental standards

<table>
<thead>
<tr>
<th><strong>1 ENERGY EFFICIENCY (EE)</strong></th>
<th>Potential points</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE2 Lighting Zones</td>
<td></td>
</tr>
<tr>
<td>Lighting Zoning - Provide auto sensor controlled lighting in conjunction with daylighting strategy for all perimeter zones and daylit areas, if any</td>
<td>1</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>2 INDOOR ENVIRONMENTAL QUALITY (EQ)</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EQ8 Daylighting</td>
<td></td>
</tr>
<tr>
<td>Demonstrate that &gt;50% of the NLA has a daylight factor in the range of 1.0 - 3.5% as measured at the working plane, 800mm from floor level</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EQ 9 Daylight Glare Control</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Reduce discomfort of glare from natural light. Where blind or screens are fitted on all glazing and atriums a base building, incorporate provisions</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>6 INNOVATION (IN)</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IN 1 Innovation in design &amp; environmental design initiatives</td>
<td></td>
</tr>
<tr>
<td>Light pipes</td>
<td>1</td>
</tr>
</tbody>
</table>

Formal certification to be implemented by an independent accredited GBI Certifier
‘Light Pipe’ Performance
Kuala Lumpur - Subang
### Kuala Lumpur - Subang

**Item** | **Project Specific Data**
--- | ---
Weather File | KualaLumpurIWEC.fwt
CIBSE’s Lighting Guide 5: Lighting for Education indicates the following lighting levels that should be achieved within a standard classroom and corridor:

- Classroom  300 lux
- Corridor    100 lux

The model was simulated within IES VE using a CIE Standard Overcast Sky (a standard used for lighting level comparison)
# School Building

### Classroom 2 (area of analysis)

<table>
<thead>
<tr>
<th>Item</th>
<th>Room A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan Area</td>
<td>60 m²</td>
</tr>
<tr>
<td>Average Room Height</td>
<td>3 m</td>
</tr>
<tr>
<td>Working Plane Height*</td>
<td>0.85 m</td>
</tr>
<tr>
<td>Volume</td>
<td>180 m³</td>
</tr>
<tr>
<td>Surface Reflectance*</td>
<td>Ceiling: 70%</td>
</tr>
<tr>
<td></td>
<td>Walls: 50%</td>
</tr>
<tr>
<td></td>
<td>Floor: 20%</td>
</tr>
<tr>
<td>Glazing*</td>
<td>Scenario 1</td>
</tr>
<tr>
<td></td>
<td>6 m² North facing</td>
</tr>
<tr>
<td>Transmittance*</td>
<td>Glazing: 70%</td>
</tr>
</tbody>
</table>
Daylight levels in classroom 2

Classroom 2
(area of analysis)

Radiance IES image taken from the working plane (0.85m above floor level)
Electricity used in classroom 2

Electrical Lighting Gains with Glazing Only within Classroom 2
(Lights on continuously during occupied hours (08:00 until 18:00))
Introduction of Light Pipes
4 x 450mm Light pipe in classroom 2

Classroom 2
(area of analysis)
Daylight levels in classroom 2
Electricity used in classroom 2 post Light Pipe installation

Electrical Lighting Gains with SUNPIPE® systems and Glazing within Classroom 2
(Lights on if lighting levels below 300 lux during occupied hours (08:00 until 18:00))
Before/after comparison – electricity used

Electrical Lighting Gains within Classroom 2

- Glazing only
- SUNPIPE® systems & Glazing
The corridor

Corridor (area of analysis)
Before/after comparison – electricity used

Electrical Lighting Gains within the Corridor

- Without SUNPIPE® systems (Lighting on continuously from 08:00 until 18:00)
- With SUNPIPE® systems (lighting on if daylight level below 100 lux from 08:00 until 18:00)
Total energy saving within classroom 2
Total CO₂ saving within classroom 2

![Total Carbon Dioxide Emissions Savings within Classroom 2](chart.png)
• Any questions?