Daylighting Strategies and Case Studies

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In much of Asia, Fair Skin is Fashionable

EXAMPLE: Sun light / Daylight

Cold climate
“Solar canopy” advertisement

Tropic climate
Skin whitening advert.
In the Tropics, the Sun is the Enemy!

Facekini

for the beach
In the Tropics, ‘modern’ buildings are fully glazed often with floor to ceiling windows.

**Full height glass**

Wonderful design!?

**Grary & hot**

Blinds everywhere

... And in Taiwan

Putting external shading!

Malaysia

Malaysia

Taiwan
So, with this resistance to the Sun, do people really want daylighting?

**YES**

if buildings are designed correctly
Are daylit offices marketable? **YES**

Would a **fully day lit office concept with supplementary electric lighting for heavily overcast days** be marketable to tenants?
Do people prefer daylit offices? **YES**

Suppose daylight can be controlled just like electrical lighting. If this is the case, please indicate how you believe a **typical office worker** would prefer to have his workplace lit:

- Fully lit with electric light
- Fully lit with daylight

*Survey among 46 building professionals in Singapore (by Gregers Reimann)*
Do people prefer daylit offices? YES

“Regarding the balance between electrical and natural light, which do you prefer?”.

Survey among 569 office building occupant in Manila, Philippines
(by Gregers Reimann)
MISCONCEPTION that daylight is "hot"

- Daylight through normal glazing is **2.6 times cooler** than people think

- Daylight through high performance glazing is **4.9 times cooler** than people think

Survey among 46 building professionals in Singapore (by Gregers Reimann)
What do people want from the window? **VIEW** and **DAYLIGHT**

**Survey among 46 building professionals in Singapore**
(by Gregers Reimann)
Daylighting and Productivity

Increase of productivity:

• 7-20% for students exposed to high daylight levels

• Hospital patients with nice view out the window left hospital 10% sooner

• 40% higher sale pr. m² in stores with skylights

Source: Studies in the US
High Availability of Diffuse Soft Daylight throughout the year in Malaysia

Average outdoor Lux (overcast sky)

Average indoor Lux (overcast sky)

D.F.: Daylight Factor
The Case for Daylighting is:

- People want daylighting
- Offices with daylighting are marketable
- Misconception that daylighting is hot, when it is actually the coolest light source
- Daylit spaces increase productivity and well-being of people

But only if buildings are designed correctly
Common Design Mistakes in the Tropics

Everything goes wrong!

overheating & no view out

REMEMBER THE 1st and 2nd PRIORITIES?

MOST IMPORTANT USES OF A WINDOW

<table>
<thead>
<tr>
<th>Purpose</th>
<th>1st priority</th>
<th>2nd priority</th>
<th>3rd priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>View</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventilation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daylight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connection with outside</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection from climate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

view daylight
Example: Ministry of Education

Designed for daylighting, but all the electric lights are still on!

Singapore
Ministry of Education

- ASEAN Award Runner Up in category “Energy Efficient Building”
- Daylight utilisation with split window design with light shelf and slanting ceiling
- Perimeter lighting
- Under-floor air supply
Upper blinds always engaged due to glare, hence, hampering the daylighting system.
Glare can Kill Off any Daylight System

Once the blind is engaged, it is likely to stay in place for months or years

- Glare is experienced when bright light sources appear in a darker environment
- Humans find glare from daylight more acceptable than glare from electric light
- Glare tolerance in the tropics where ‘the sun is the enemy’ is not yet fully understood, but we are working on it!
Main Challenges of Daylit Designs

• Control solar heat gain

• Rely on diffuse daylight, not direct sunlight

• Control glare from direct sun and overcast sky

• Make indoor daylight distribution more uniform

• For offices, a daylight factor of 0.5 – 3.5% is appropriate
Case study no. 1

Daylighting case study

GEO BUILDING
(MALAYSIA. FORMERLY ZEO BUILDING, 2007)
Good Orientation for Daylighting
Step-in Design (Self-Shading)
Daylight Facade with Mirror Lightshelves
MIRROR LIGHTSHELVES:
Direct Sunlight Cut Off, Only Diffuse Light Enters Rooms

Photo taken on 12 June 2007 (North facade)
Split Window Design with Fixed Blind inside Double-Glazed Unit

Blind encapsulated in double glazing, no maintenance needed. Looks as good as new after seven years and counting....!

Semi-specular tannenbaum reflector in the ceiling. Maintains inward light reflection without causing glare to the occupants. Translucent cubicle walls parallel to the façade ensures daylight passage to table top.
Daylight Measurements

- Lighting consumption: 0.56 W/m²
- Code requirement: 15 W/m²

25 times more efficient
Daylight Responsive Lighting

Lighting Control
• Automatic off (light sensor and/or occupancy sensor)
• Manual on (people press the wall switch)
• Use task light (table lamp)
GEO Building Daylight Measurements

Light levels (lux) measured in GEO Building, 9 April 2012, 4:30 pm on rainy and gloomy afternoon. None of the general lighting had been switched on by the staff.

- Office design in Singapore and the US
- Office design code in Malaysia (MS1525:2007)
- GEO Building, desk near window (no lights on)
- GEO Building, desk away from window (no lights on)
- GEO Building, desk with 6.2 Watt LED task light
- GEO Building, library (no lights on)
- GEO Building, 2nd floor meeting room (no lights on)
- GEO Building, atrium

![Graph showing light levels in different locations and times]
Transparent / Transluscent Walls Parallel Not to Block Daylight
+ No Suspended Ceiling with Slab Cooling (high 3.6 m floor to ceiling height)
Roof Lights taking in diffuse soft daylight from the North
Daylight factor in atrium about 1 – 1.5%

Nice light pattern through PV atrium roof

- PV sandwiched in low-e glass
- 13% transparent area
Case study no. 2

Daylighting case study

ST DIAMOND BUILDING
(SURUHANGJAYA TENAGA, 2010)
Interestingly, both buildings reached the same design concept of blocking the sun while allowing diffuse daylight to enter.
Atrium Daylight Design

The atrium has been carefully designed to optimize daylight utilization for each floor employing the combination of the following three strategies:

1. Automated blind with six different configurations to maintain the appropriate daylighting levels at all times. The blinds with 30% light transmittance are adjusted every 15 minutes and follow three different control strategies for morning, mid-day, and evening.

2. The window size becomes larger as one moves deeper into the atrium to cater for lower daylight levels.

3. A band of Tannenbaum reflector panels are applied to the 4th and 5th floor to deflect daylight across the atrium to the 1st and 2nd floor where daylight levels are the lowest. The ‘christmas tree’ profile reflectors have an inclination of 10° and reflect about 85% of the light in a semi-diffuse manner, hence, avoiding visual glare issues for the building occupants.
Façade Daylight Design
The building is 50% daylit. The façade daylighting system consists of a mirror lightshelf and a white painted window sill. Both deflect daylight onto the white ceiling for improved daylight distribution until 5 meters from the façade + 2 additional meters of corridor space. Installed office lighting is 8.4 W/m², but 1-year measurements show consumption of only 0.9 W/m² showing high reliance on daylighting.
Day-Lighting - Office

- Mirror
- Lightshelf
- Fixed blinds for glare control
- Daylight reflected onto ceiling
Daylight Skylight through Roof
Take in diffuse light only
# Lighting Control Strategy

<table>
<thead>
<tr>
<th>No.</th>
<th>Lux sensor</th>
<th>Switch</th>
<th>Electric light</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Above setpoint</td>
<td>Off</td>
<td>Off</td>
<td>If necessary, use task light</td>
</tr>
<tr>
<td>2</td>
<td>Above setpoint</td>
<td>On</td>
<td>Off</td>
<td>If necessary, use task light</td>
</tr>
<tr>
<td>3</td>
<td>Below setpoint</td>
<td>Off</td>
<td>Off</td>
<td>If necessary, use wall switch or task light</td>
</tr>
<tr>
<td>4</td>
<td>Below setpoint</td>
<td>On</td>
<td>On</td>
<td>If nobody around, switch off switch</td>
</tr>
</tbody>
</table>

### Location Setpoint (current) Setpoint (with task lights)

<table>
<thead>
<tr>
<th>Location</th>
<th>Setpoint (current)</th>
<th>Setpoint (with task lights)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>300 lux</td>
<td>120 lux</td>
</tr>
<tr>
<td>Corridors</td>
<td>100 lux</td>
<td>40 lux</td>
</tr>
</tbody>
</table>

Note: Task Lights to be distributed

NB. The same principle applies for first row of lighting for workstations along the atrium.
Case study no. 3

Retrofit daylighting case study

EECCHI OFFICE RETROFIT
(JAKARTA, 2011)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy</strong></td>
<td>170 kWh/m² yr</td>
<td>80 kWh/m² yr</td>
</tr>
<tr>
<td><strong>Comfort</strong></td>
<td>26-31 °C</td>
<td>24-26 °C</td>
</tr>
<tr>
<td><strong>Noise</strong></td>
<td>57 dB</td>
<td>53 dB</td>
</tr>
<tr>
<td><strong>Daylight</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>View out</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
BEFORE RETROFIT
- Vertical blinds blocking most of the daylight
- Suspended ceiling

AFTER RETROFIT
- Mirror lightshelf on external ledge reflecting diffuse daylight onto the high ceiling (suspended ceiling removed)
- Perforate venetian blinds
- Extra window pane
Case studies (ongoing)

Daylighting case studies

INNOVATIVE DESIGNS
(MALAYSIA AND SINGAPORE, 2015)
Light Scoop for ‘Urban Canyon’

For urban streets where the daylight must be harvested from above

Ongoing project in Kuala Lumpur, completion 2016
Horizontal Light Trough

For high rise offices. Daylight above suspended ceiling

Ongoing project in Kuala Lumpur, completion 2016
Window film instead of Lightshelf

This will solve the maintenance issue lightshelf cleaning

Redirected daylight
by window film

Photo from IEN Consultants office (Kuala Lumpur) in preparation for demonstration project in Singapore (2015/2016)
The End

Thank you!

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Build green
- drive clean!

Hope you saw the light!