Daylighting Strategies and Case Studies

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www.ien.com.my

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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!

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

Full height glass

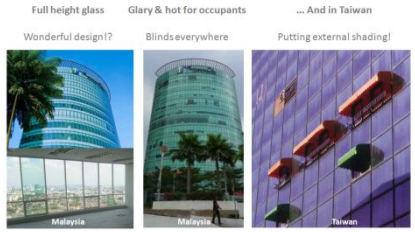
Wonderful design!?

Glary & hot

Blinds everywhere

… And in Taiwan

Putting external shading!



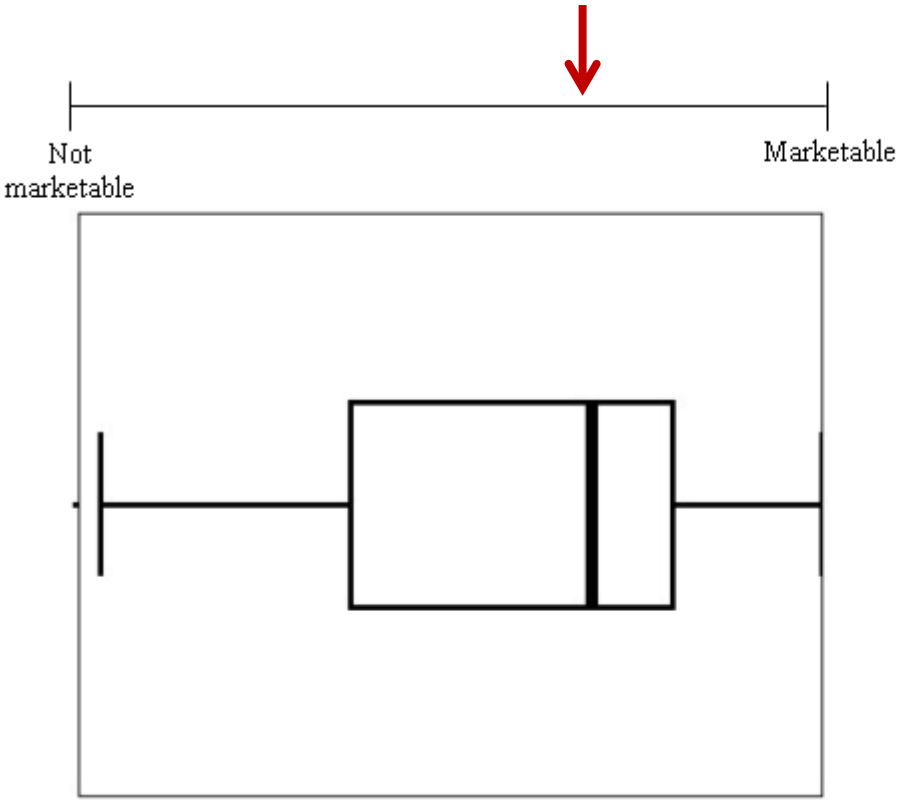
So, with this resistance to the Sun, do people really want daylighting?

YES

if buildings are designed correctly

Are daylit offices marketable? **YES**

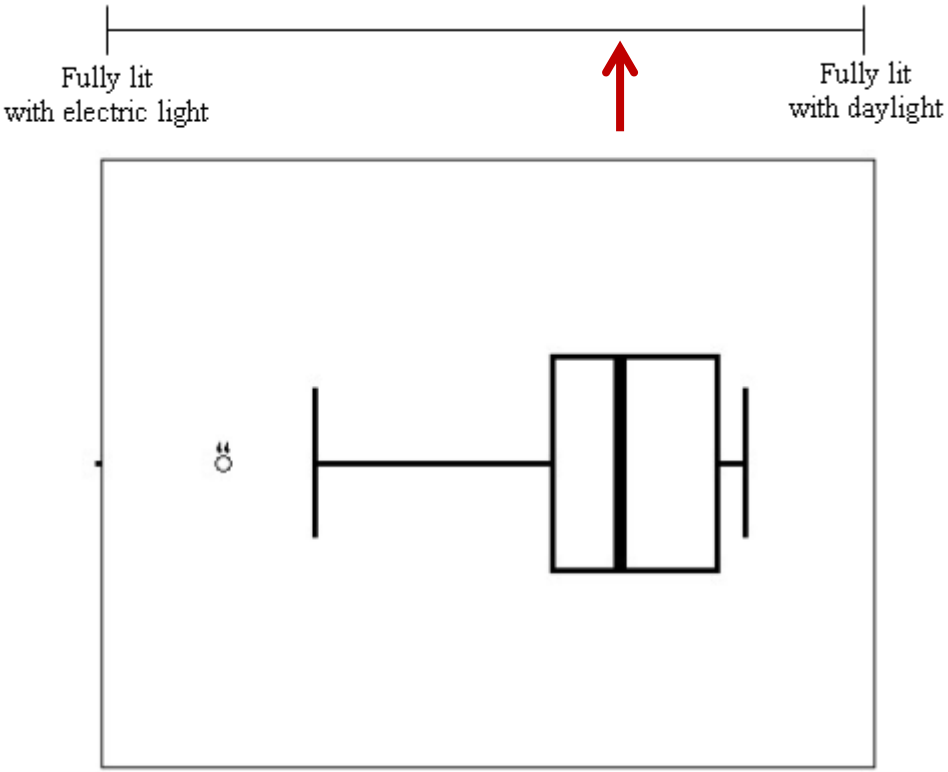
Would a **fully day lit office concept with supplementary electric lighting for heavily overcast days** be marketable to tenants?



Survey among 46 building professionals in Singapore (by Gregers Reimann)

Do people prefer daylit offices? **YES**

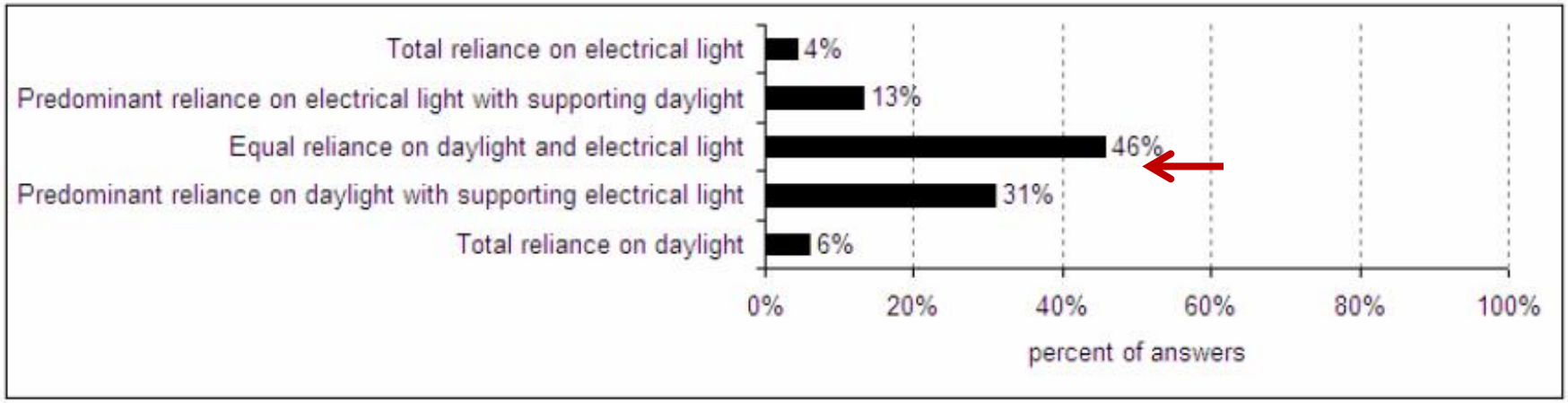
Suppose daylight can be controlled just like electrical lighting. If this is the case, please indicate how you believe **a typical office worker** would prefer to have his work place lit:



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?".



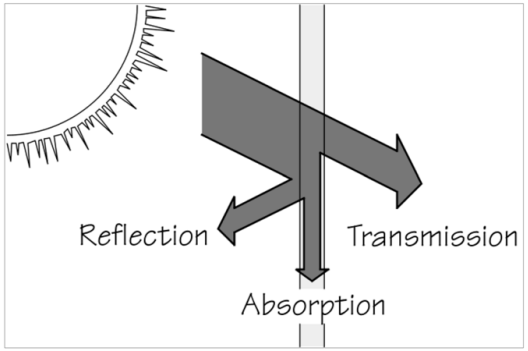
Survey among 569 office building occupant in Manila, Philippines (by Gregers Reimann)

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

Solar Light interacting with Glazing



Reflection(%) + Transmission(%) + Absorption(%) = 100%

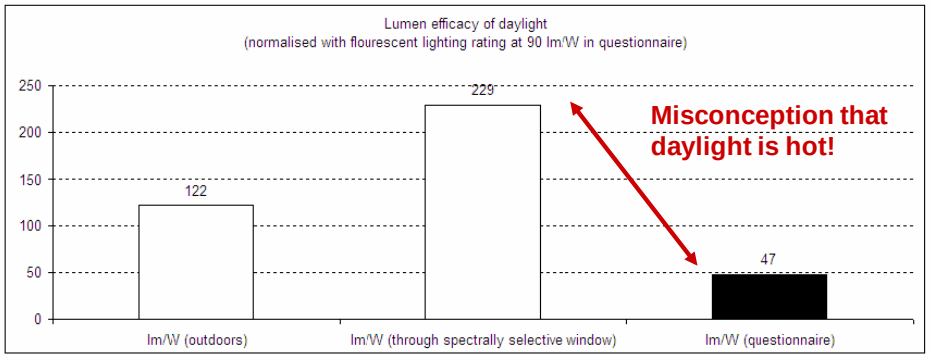
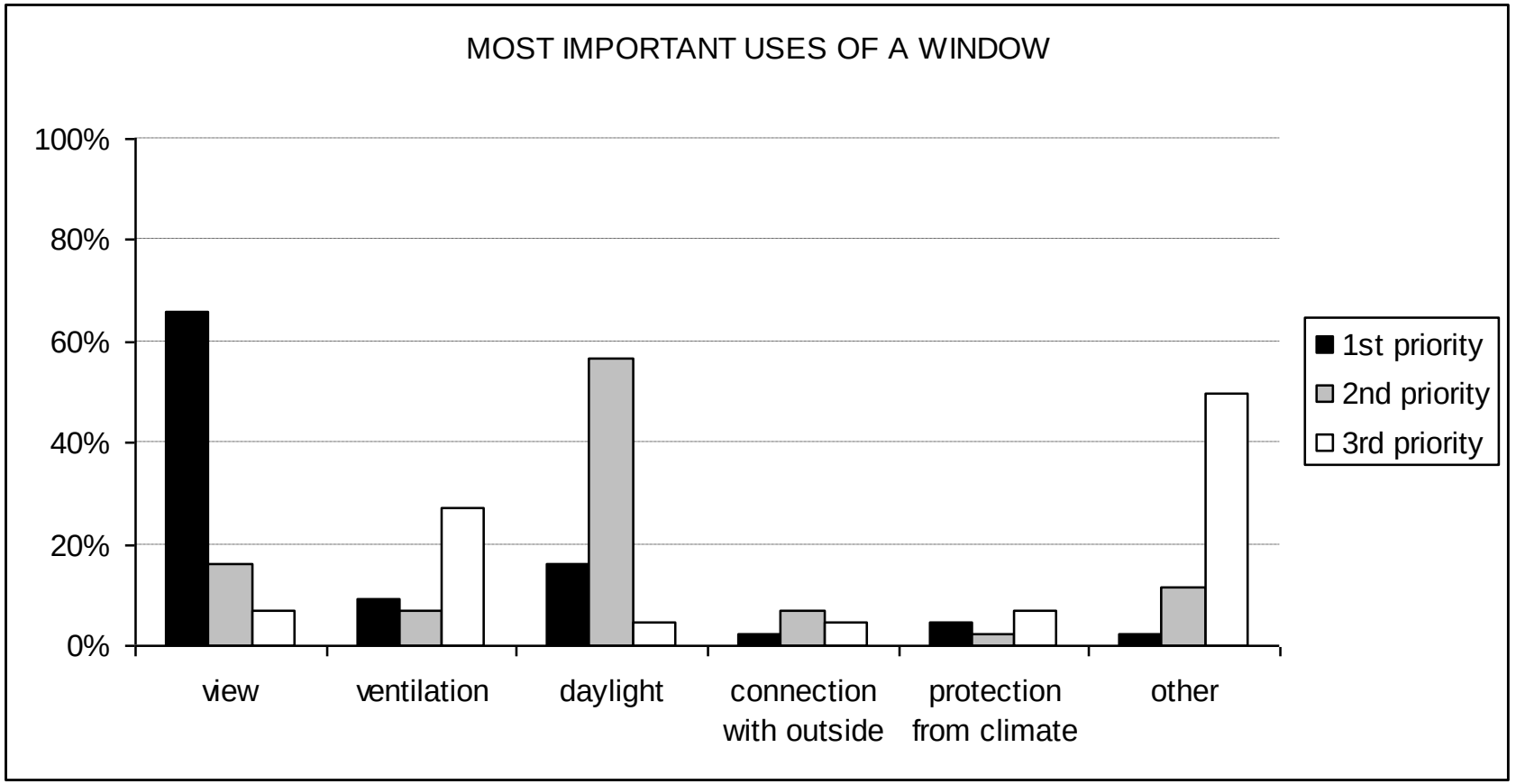


Figure 4.15: Misconception of lumen efficacy of daylight. If fluorescent light is assumed to have a lumen efficacy of 90 lm/W then the lumen efficacy of daylight was set to 47 lm/W, while in reality it is 160% higher at 122 lm/W (outdoors) or almost 400% higher at 229 lm/W when coming through a spectrally selective window.

Survey among 46 building professionals in Singapore (by Gregers Reimann)

What do people want from the window?
VIEW and **DAYLIGHT**

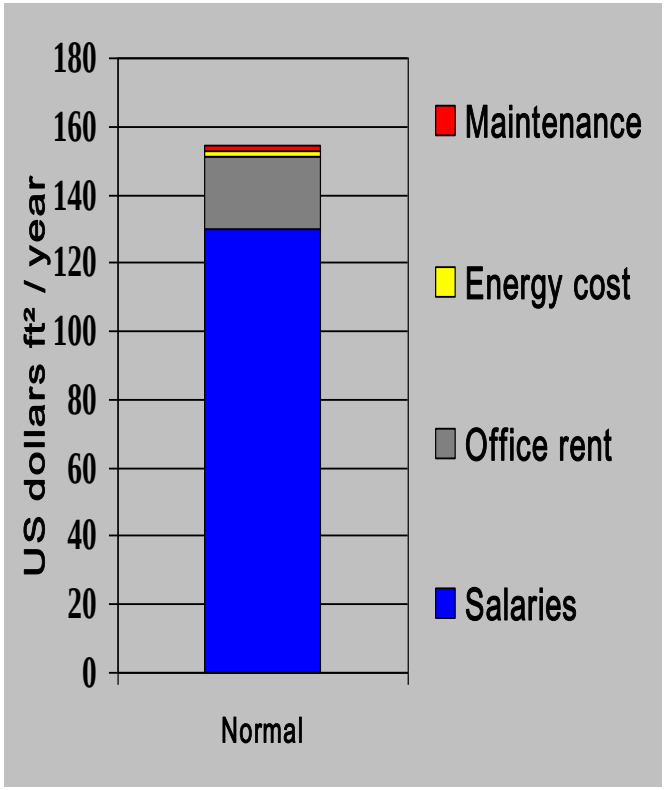


Survey among 46 building professionals in Singapore (by Gregers Reimann)

Daylighting and Productivity

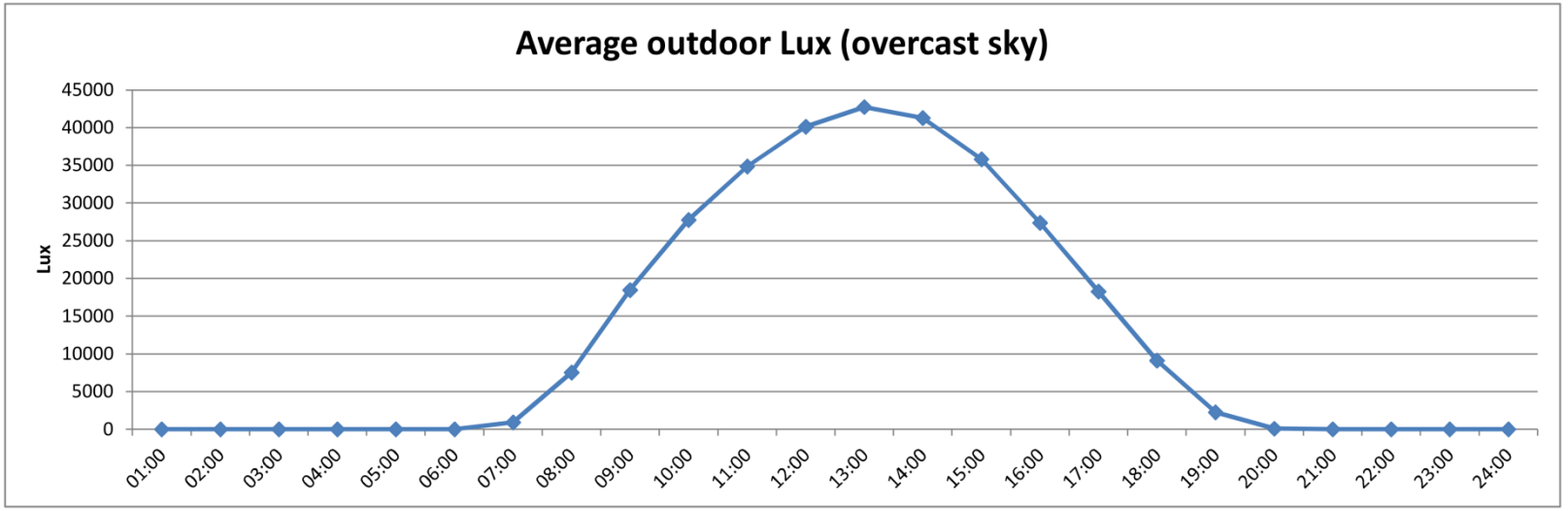
Increase of productivity:

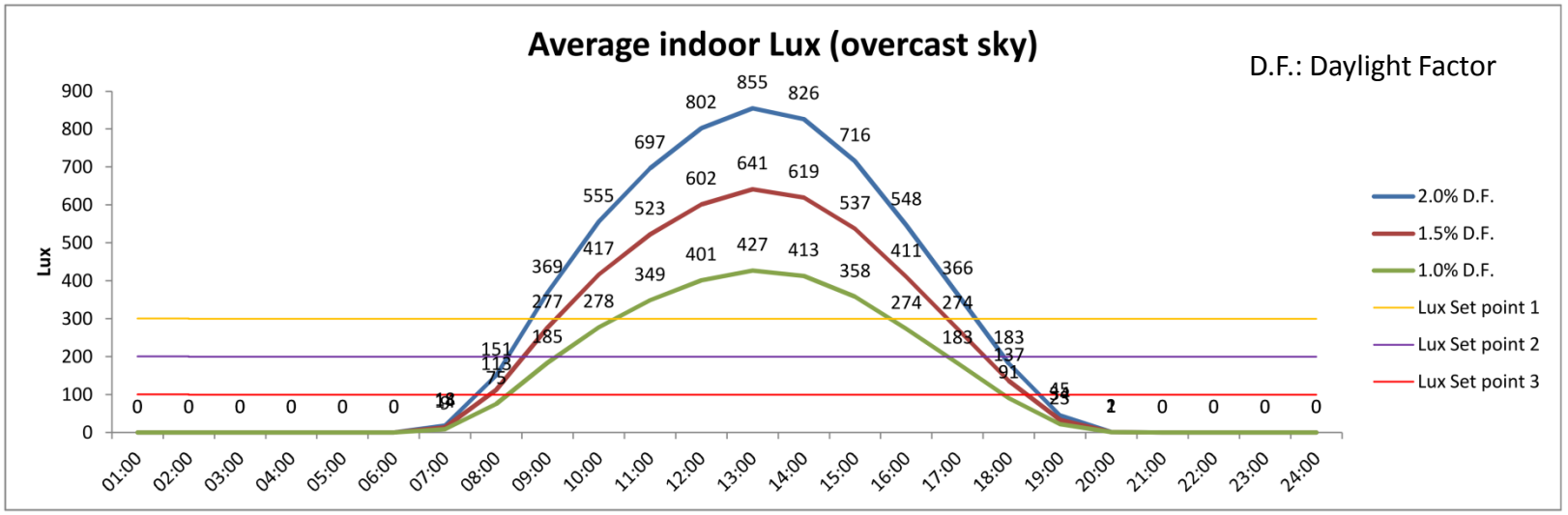
- 7-20% for students exposed to high daylight levels
- Hospital patients with nice view out the window left hospital 10% sooner
- 40% higher sale pr. m² in stores with skylights



Source:
Studies in the US

High Availability of Diffuse Soft Daylight throughout the year in Malaysia





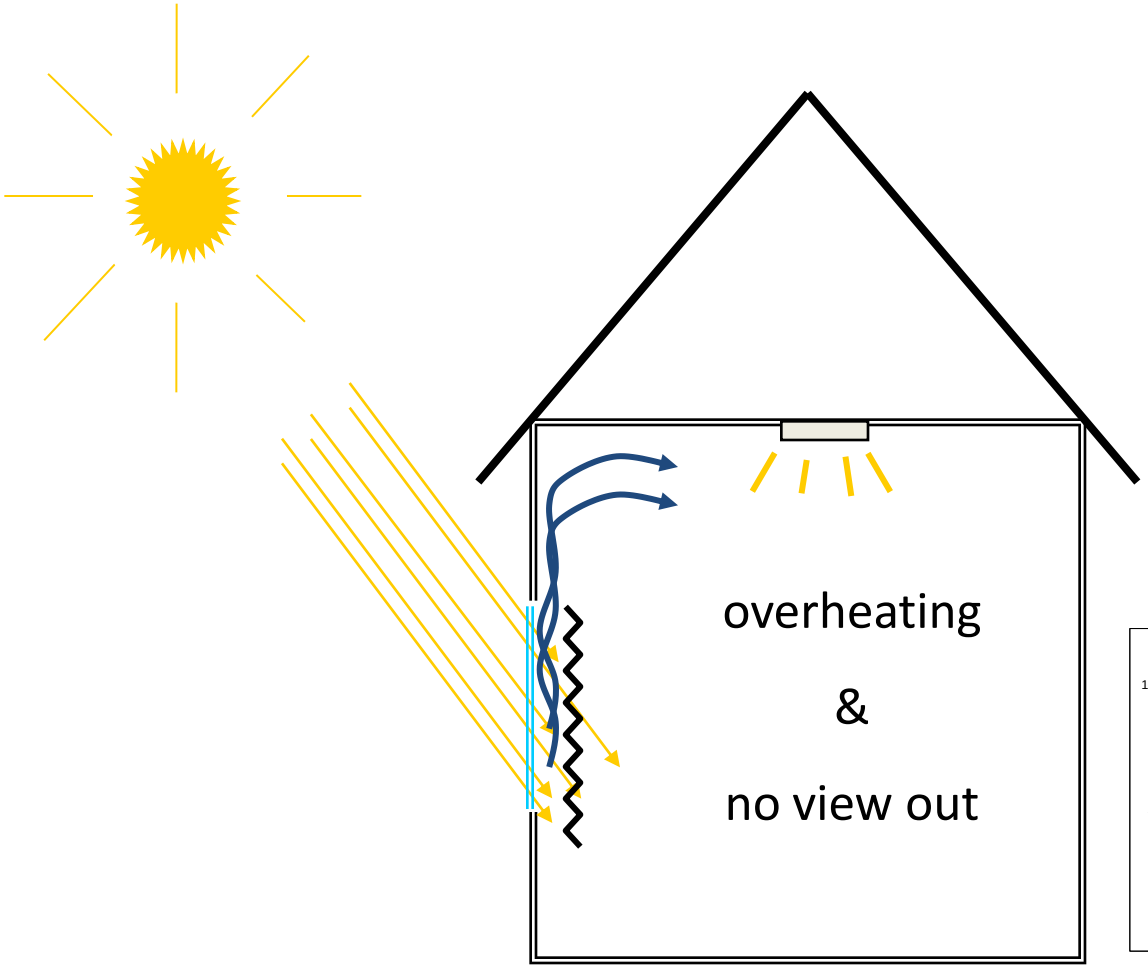
The Case for Daylighting is:

- 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

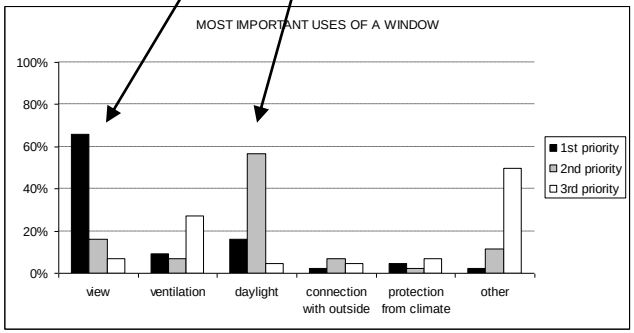
But only if buildings are designed correctly

Common Design Mistakes in the Tropics

Everything goes wrong!



REMEMBER THE 1st and 2nd PRIORITIES?



view daylight

Example: Ministry of Education

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

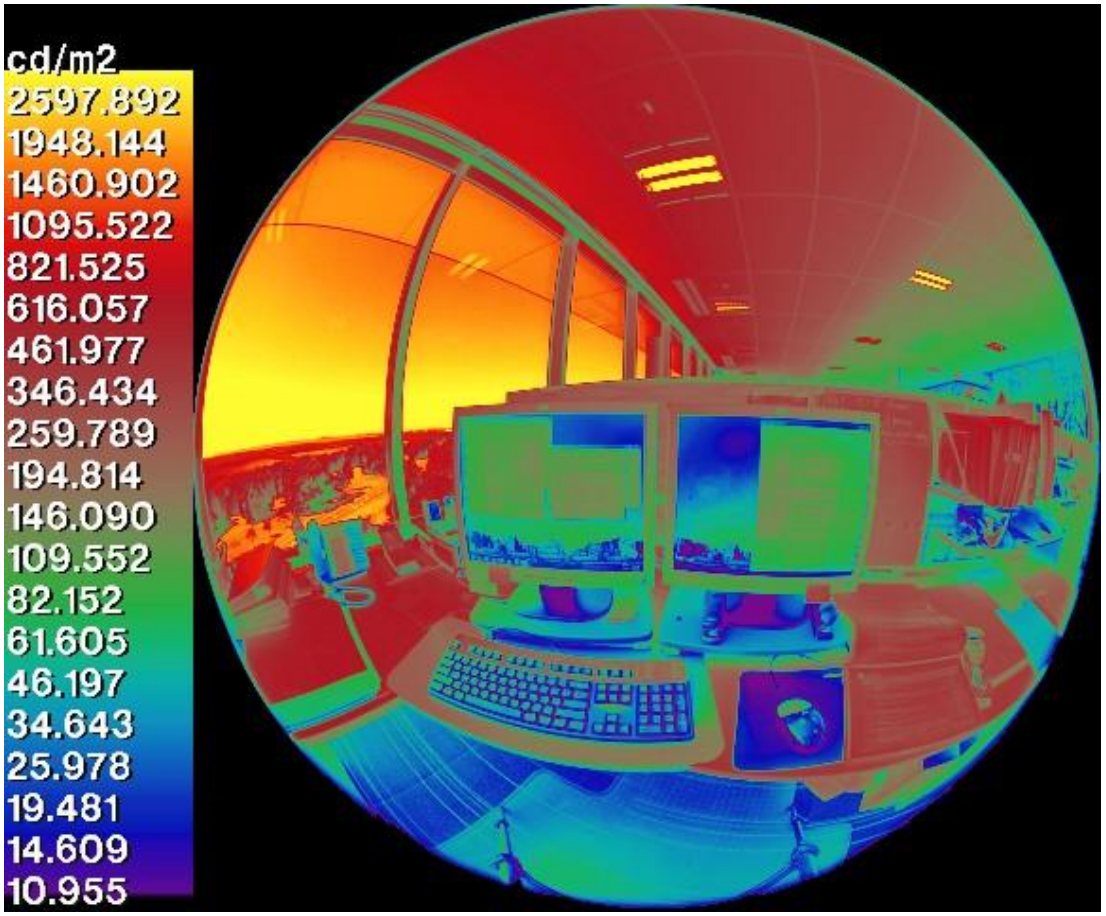
Ministry of Education

- 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

Ministry of Education

Glare can Kill Off any Daylight System

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

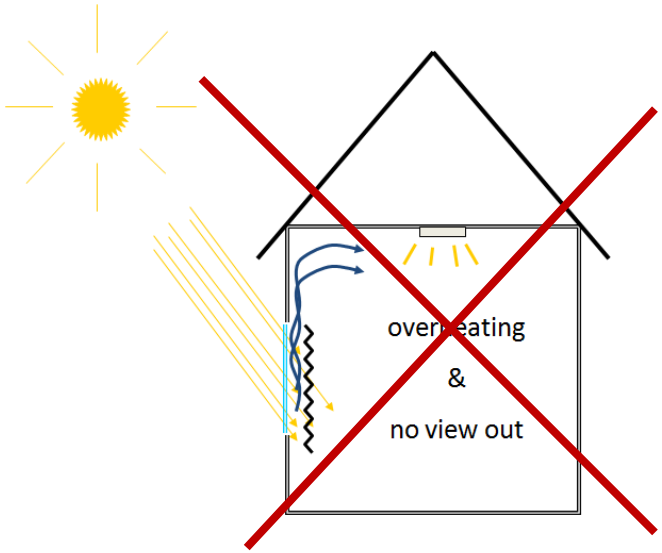


- Glare is experienced when bright light sources appear in a darker environment
- Humans find glare from daylight more acceptable than glare from electric light
- Glare tolerace in the tropics where ‘the sun is the enemy’ is not yet fully understood, but we are working on it!

Luminance image for glare analysis

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

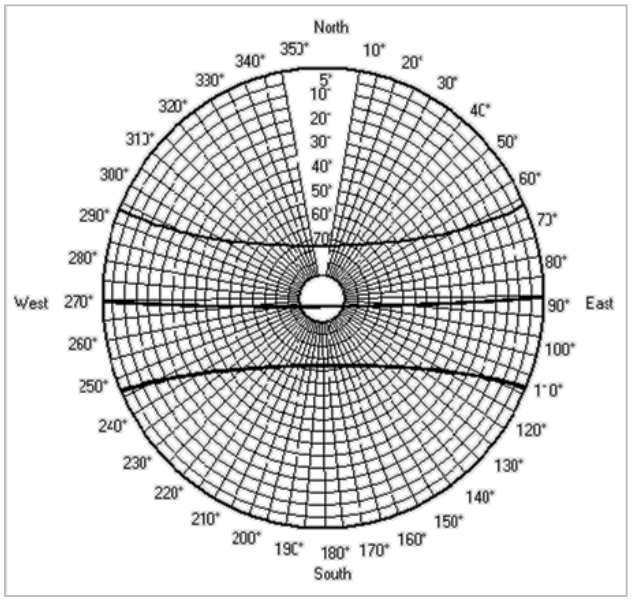
Daylighting case study

GEO BUILDING

(MALAYSIA. FORMERLY ZEO BUILDING, 2007)

Good Orientation for Daylighting

Solar chart for Kuala Lumpur (3.15° North)



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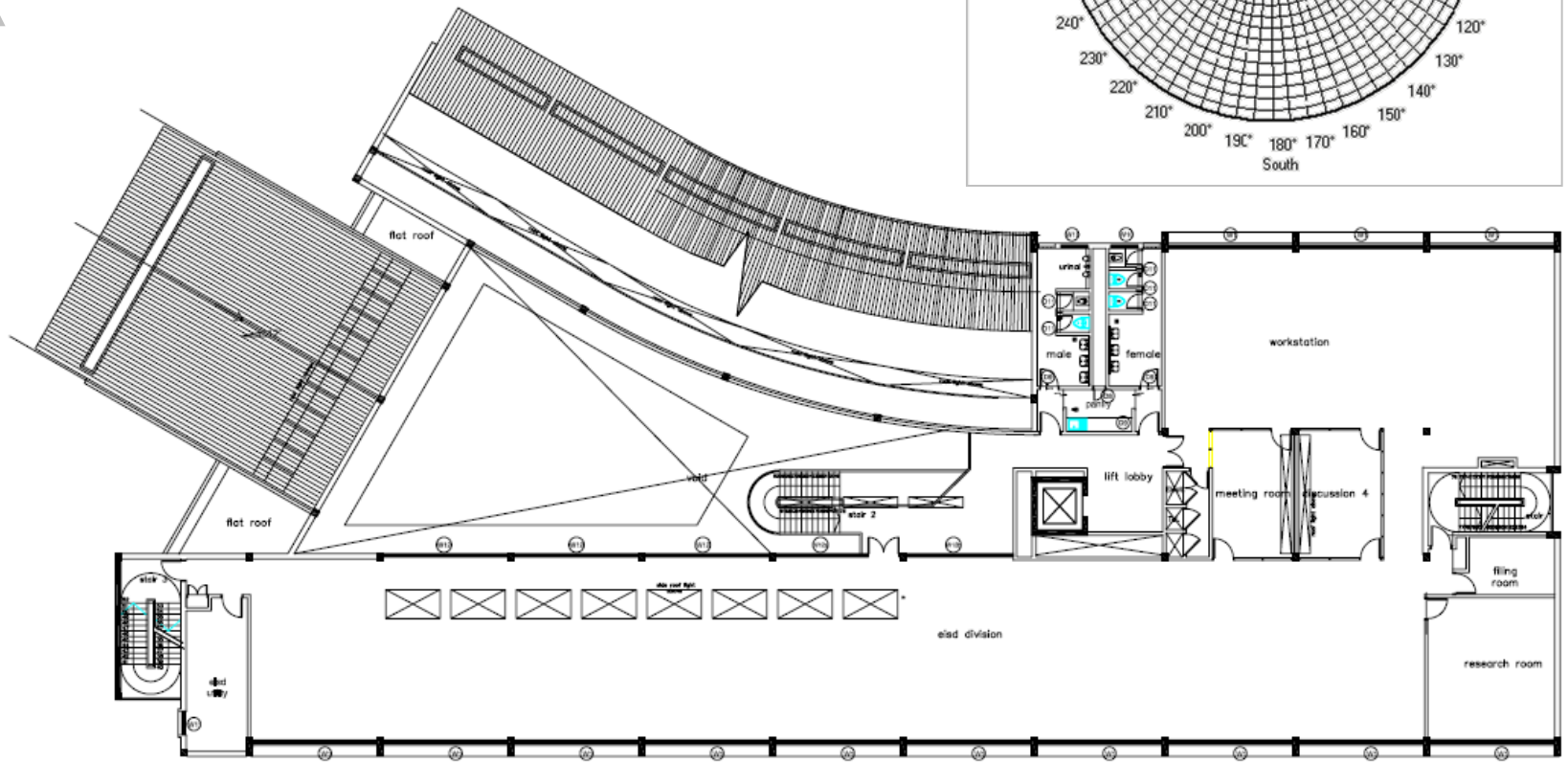
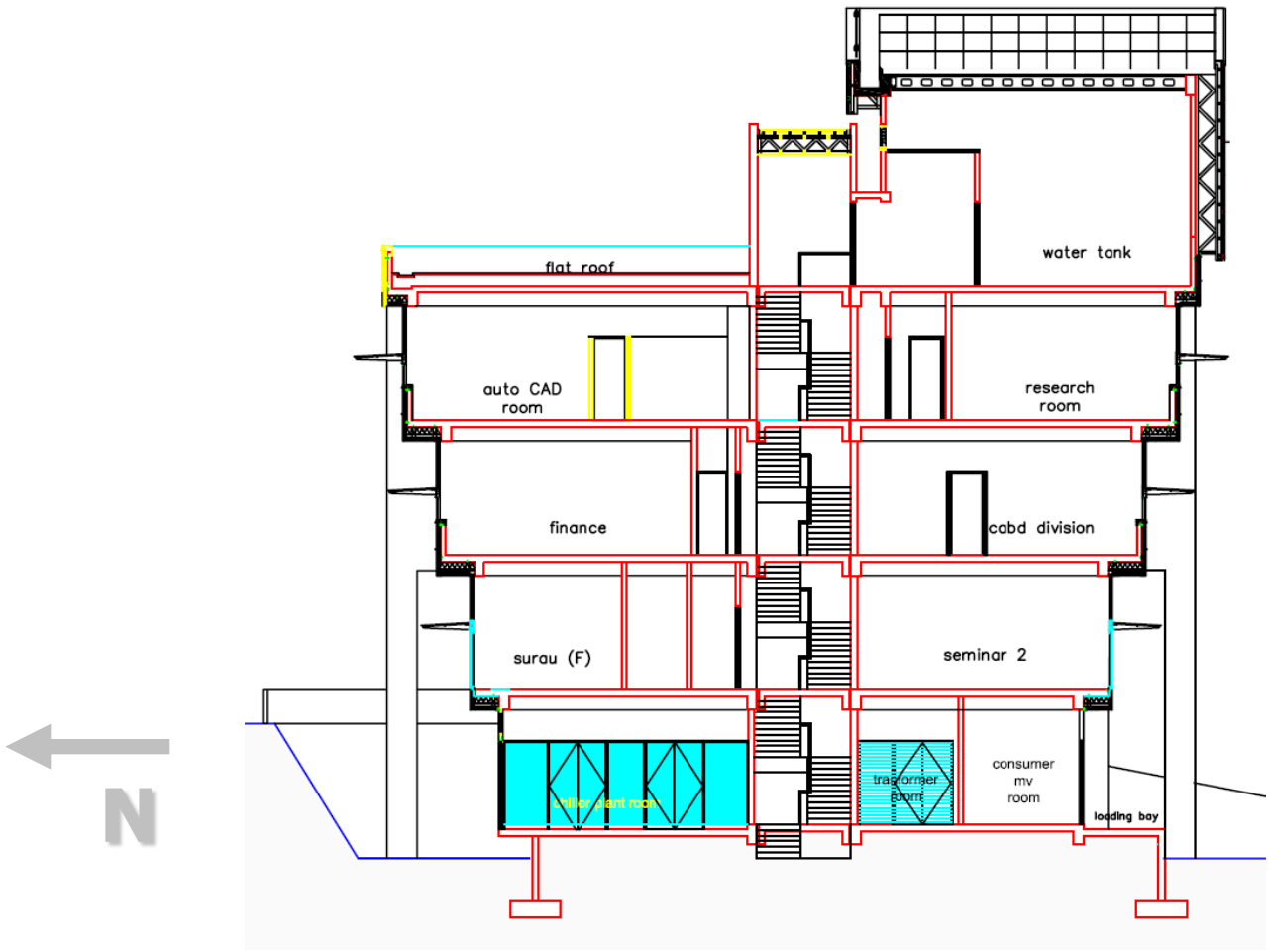


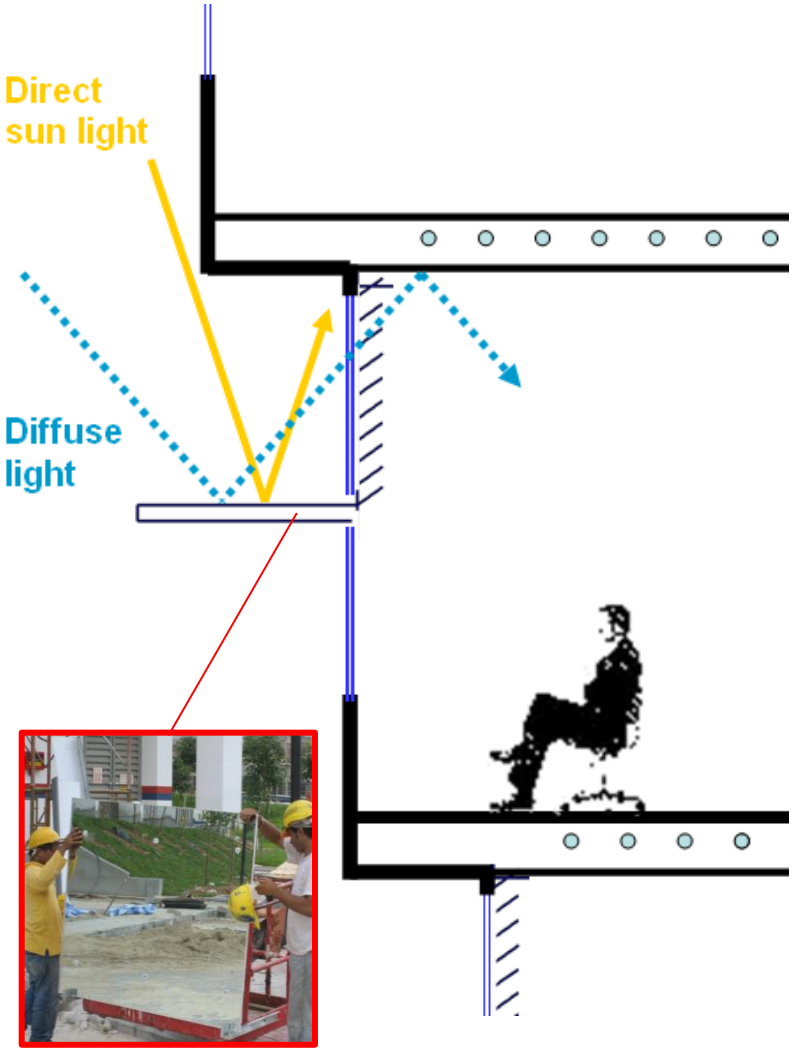
Step-in Design (Self-Shading)



Daylight Facade with Mirror Lightshelves

MIRROR LIGHTSHELVES:

Direct Sunlight Cut Off, Only Diffuse Light Enters Rooms



Mirror lightshelf

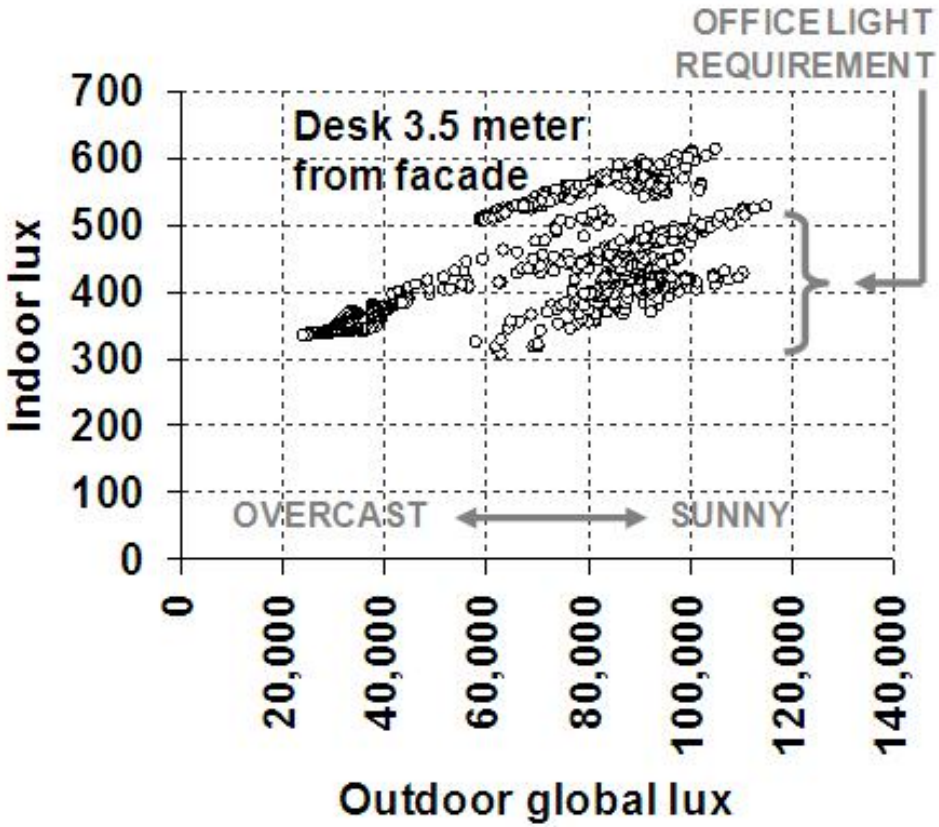
Photo taken on 12 June 2007 (North facade)

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.

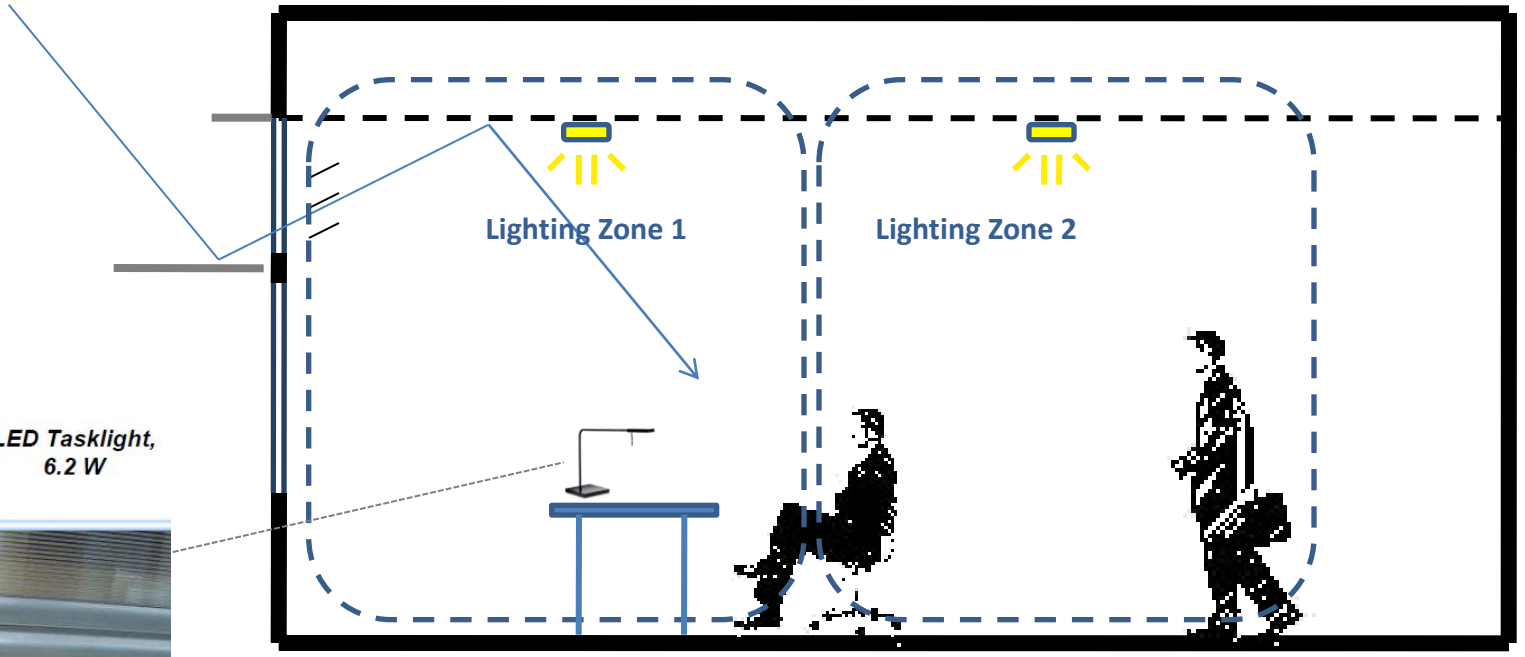
Daylight Measurements



- Lighting consumption: 0.56 W/m^2
- Code requirement: 15 W/m^2

25 times more efficient

Daylight Responsive Lighting

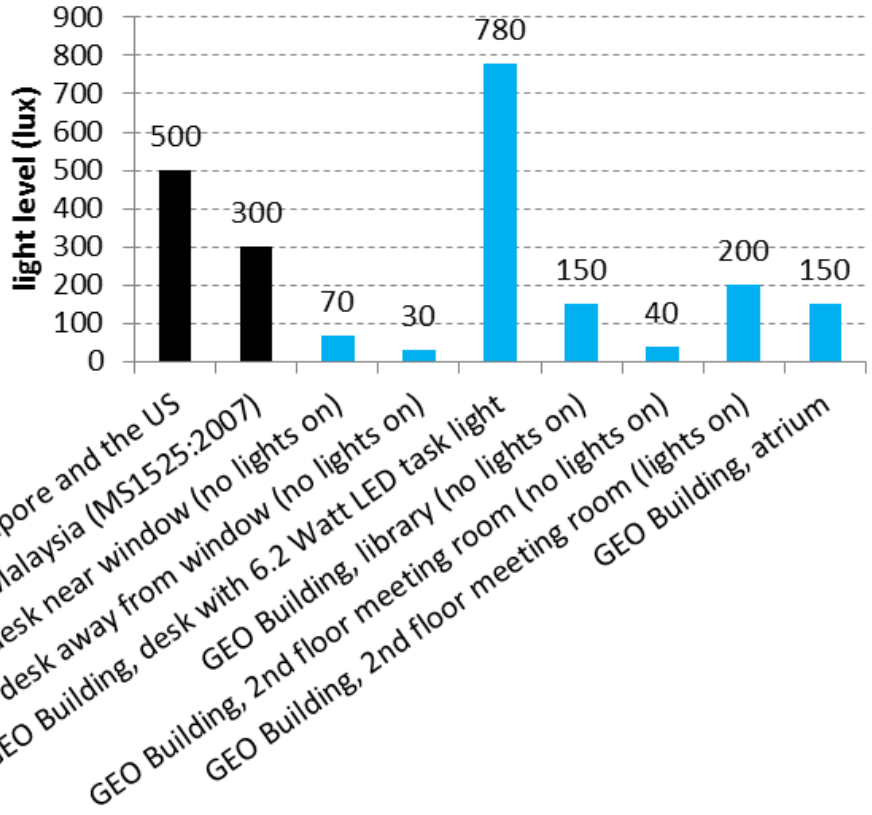


Lighting Control

- 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



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

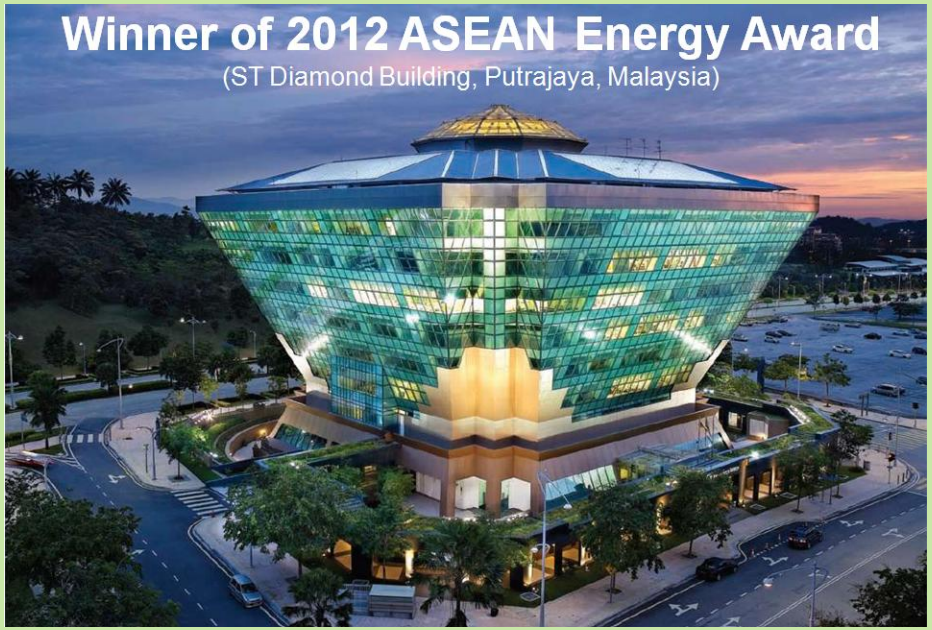
Transparent PV atrium roof

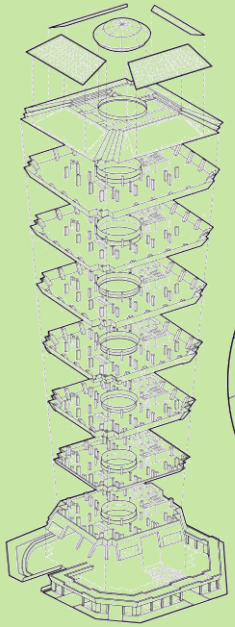
- PV sandwiched in low-e glass
- 13% transparent area

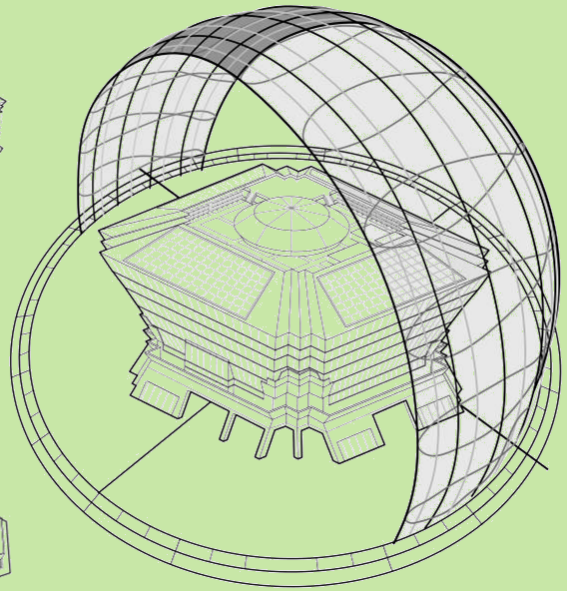
Daylight factor in atrium about 1 – 1.5%

Nice light pattern through PV atrium roof

Case study no. 2







Daylighting case study

ST DIAMOND BUILDING

(SURUHANGJAYA TENAGA, 2010)

ST Diamond juxtaposed with Sarawak Longhouse

(in the book “The Cooperation”, 2012)

Malaysia and Denmark's, commitment to the field of

Green Energy in Architecture

as well as in cooperation and capacity building within the field, can be illustrated by the mutually beneficial involvement of IEN Consultants with the development of this field in Malaysia over the years. IEN Consultants was originally a proprietorship established by a Danish Chief Technical Advisor involved in the identification of energy projects in Malaysia. When the company took on the LEO Building projects it gained recognition in Malaysia and IEN Consultants managed to build up a team of consultants, most of them Malaysian, who with their experience on the LEO Building, became known further afield. This helped gain further commissions on such projects as the Green Tech Building and what has become known as The Diamond Building in Putrajaya.

“Green Buildings” are perceived to be expensive, both because of the costs of employing the expertise necessary to develop and refine the building and system designs, and because of the relatively high capital costs of green technology items. It takes time for reduced operating costs, which come with reduced energy usage, to counterbalance the increased capital investment and this has been a significant brake on development worldwide. However, given that approximately 40% of worldwide carbon emissions come from buildings, it is clear that the there is a need for the “greening” of buildings to make a significant contribution to carbon reductions.

As a result much effort has gone into the dissemination of green ideas to the Malaysian building industry, including the idea that the advantages of reduction of whole life costs of buildings as opposed to just capital costs are worthwhile. The fact that some “green” input to building design in Malaysia has moved from a subsidised base, using for example Danish funding for the LEO Building and European Union funding for the Green tech Office Building, to a fully Malaysia funded base in the case of the so-called “Diamond Building” indicates some success in changing attitudes to operating costs vs capital costs ascribed to “Green Buildings”.

Improved energy efficiency is already recognised by the Malaysian government to be more important than mere certification under the Green Building Index (GBI) scheme. That scheme therefore carries tax and stamp duty benefits to encourage the real application of green ideas in the design and operation of buildings.

Beyond this, IEN Consultants is now involved with a UNDP funded project, with the Ministry of Works, to promote low carbon buildings in Malaysia. It is hoped, amongst other things that it will lead to a building code by 2015 specifying much lower carbon footprints even than the LEO Building or the Diamond Building.

Modern sunshade
Diamond Building in festive season lighting

Traditional sunshade
Rungus Longhouse, Sabah

Another major area of involvement was in

Capacity Building for Malaysian Industry and Academia in EE Building design.

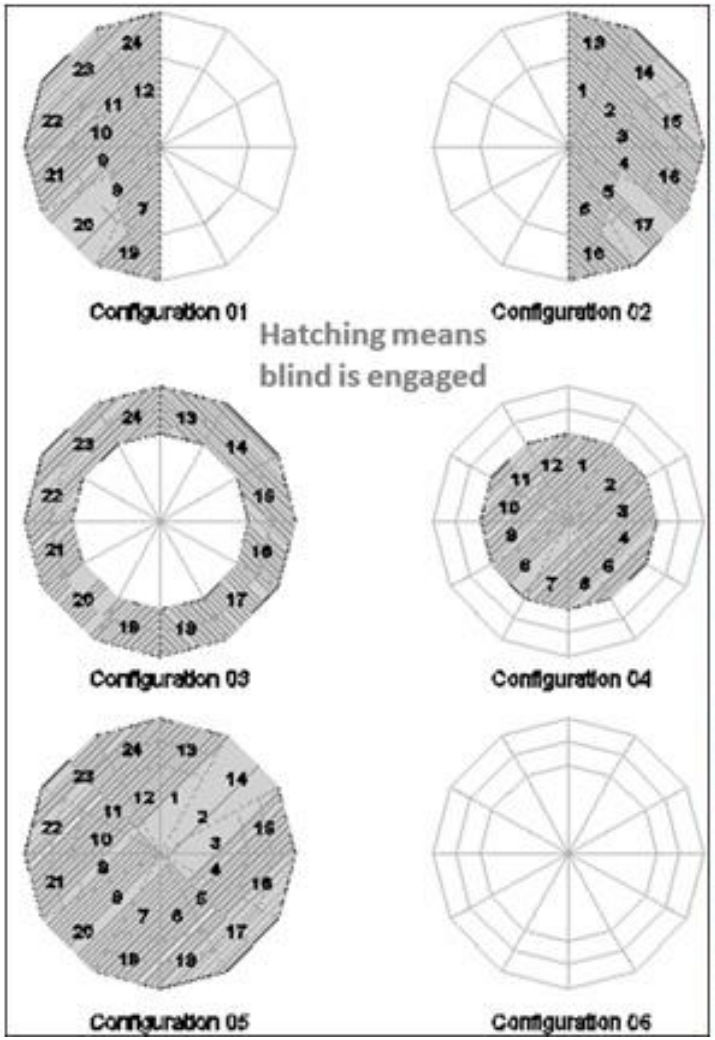
The objective of the scheme, which was implemented by the Ministry of Energy, Communications and Multimedia (now Ministry of Energy, Green Technology and Water), was to develop capacity in the optimisation of energy efficient building design. This was done through training sessions, seminars, specific analysis of existing buildings and design development of new buildings. A key partner in this endeavour was the Public Works Department (JKR) and there was close cooperation with Schools Division and Healthcare Division, so the lessons learned were comprehensive, and the dissemination of the results widespread.

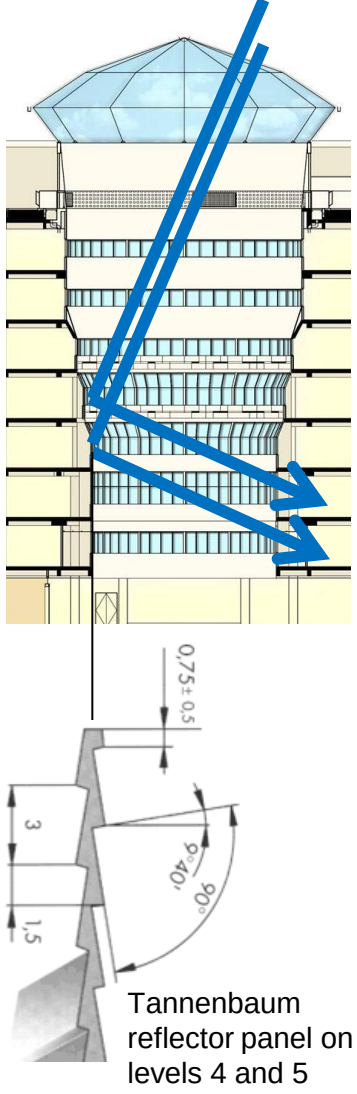
The project produced reports outlining design strategies for new buildings, making lessons learned from the LEO Building described above available to practitioners and academics across Malaysia. The project also produced reports on “Energy Efficiency Promotion: Lessons Learned and Future Activities”, and undertook an evaluation of JKR design standards.

The project certainly raised awareness and improved the country's knowledge base regarding energy efficiency in buildings and made recommendations to Ministry of Energy, Green Technology and Water and JKR to set up demonstration offices, a very successful example of which was in Wisma Damansara.

Interestingly, both buildings reached the same design concept of blocking the sun while allowing diffuse daylight to enter

Book available free online:
http://um.dk/da/~/media/Malaysia/Documents/Other/Book%20Finalist%20LR.ashx





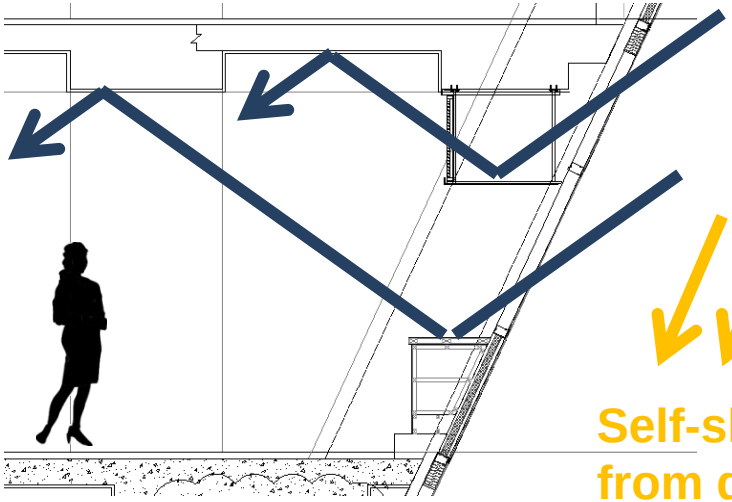
Tannenbaum reflector panel on levels 4 and 5

Atrium Daylight Design

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

1. Automated blind with six different configuration to maintain the appropriate daylighting levels at all times. The blinds with 30% light transmittance are adjusted every 15 minutes and follow a three different control strategies for morning, mid-day and evening
2. The windows size becomes larger deeper into the atrium to cater for lower daylight levels
3. A band of Tannenbaum reflector panels are applied to 4th and 5th floor to deflect daylight across the atrium to 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 semi-diffuse manner, hence, avoiding visual glare issues for the building occupants.

FACADE

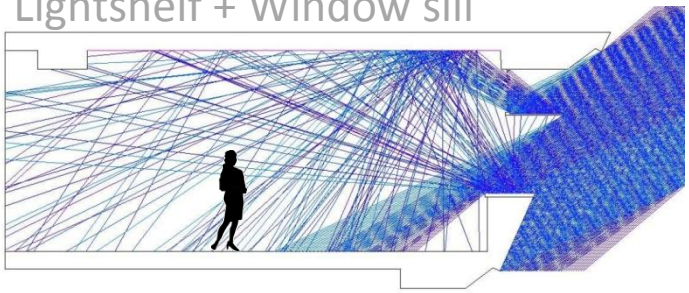


Diffuse light deflected into room by lightshelf and window sill

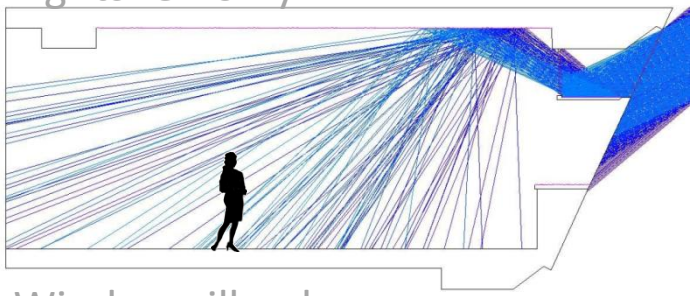
Self-shaded facade from direct sun

LIGHT REFLECTIONS FROM:

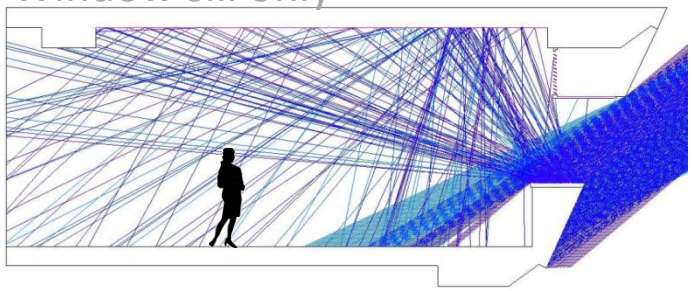
Lightshelf + Window sill



Lightshelf only



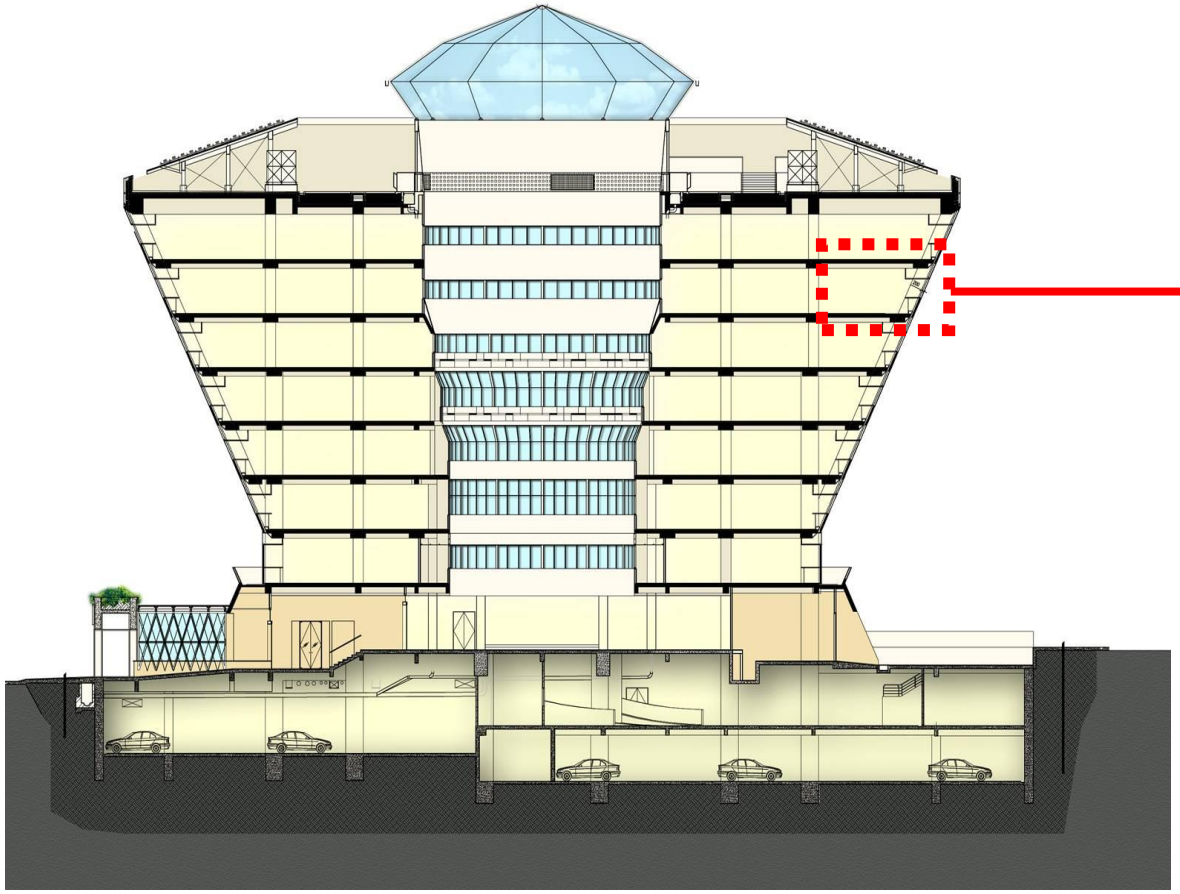
Window sill only



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



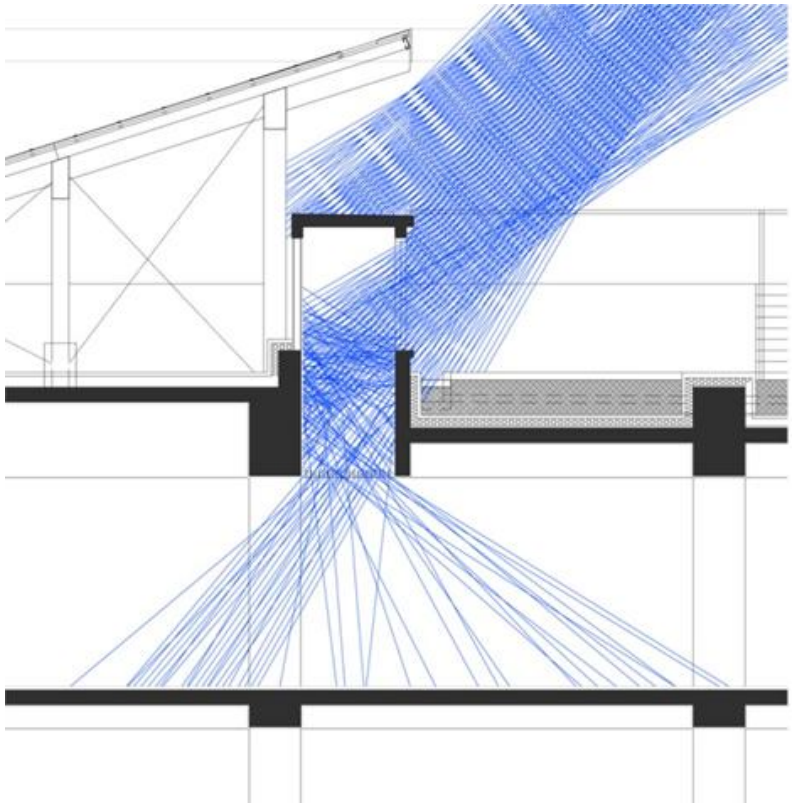
Mirror lightshelf

Fixed blinds for glare control

Daylight reflected onto ceiling

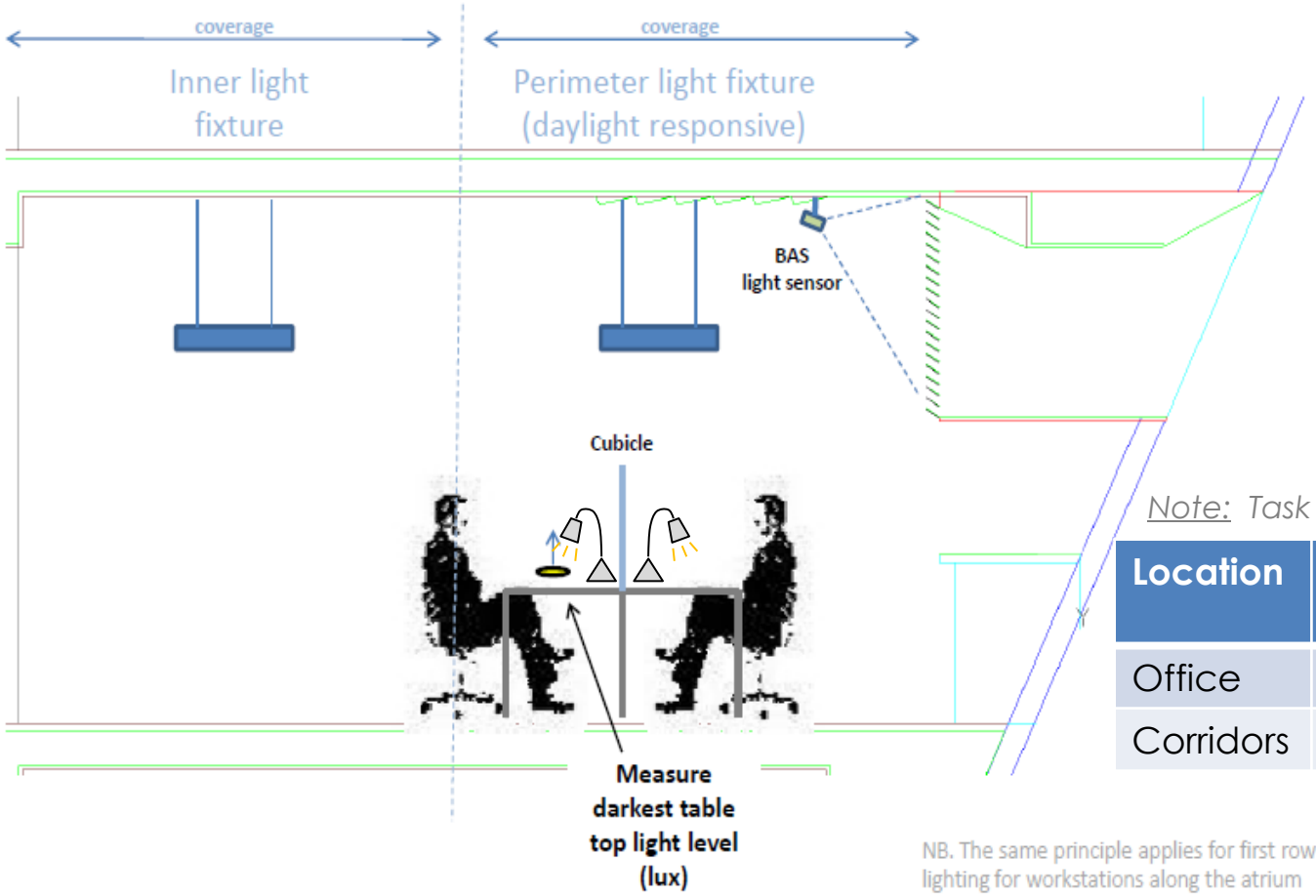
Daylight Skylight through Roof

Take in diffuse light only



Lighting Control Strategy

No.	Lux sensor	Switch	Electric light	Remark
1	Above setpoint	Off	Off	If necessary, use task light
2	Above setpoint	On	Off	If necessary, use task light
3	Below setpoint	Off	Off	If necessary, use wall switch or task light
4	Below setpoint	On	On	If nobody around, switch off switch

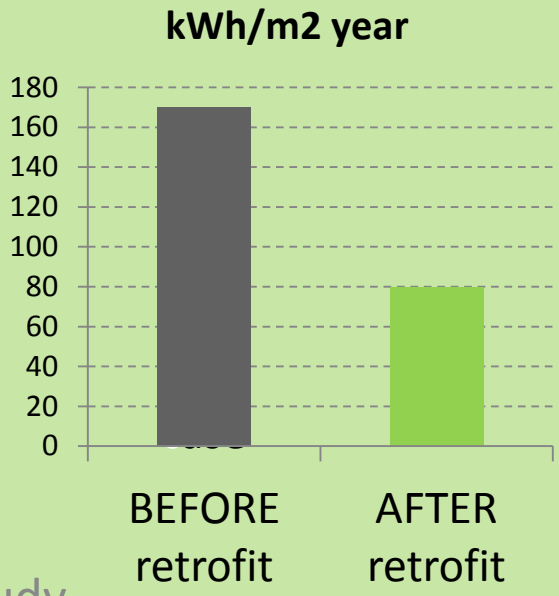


Note: *Task Lights to be distributed*

Location	Setpoint (current)	Setpoint (with task lights)
Office	300 lux	120 lux
Corridors	100 lux	40 lux

NB. The same principle applies for first row of lighting for workstations along the atrium

Case study no. 3



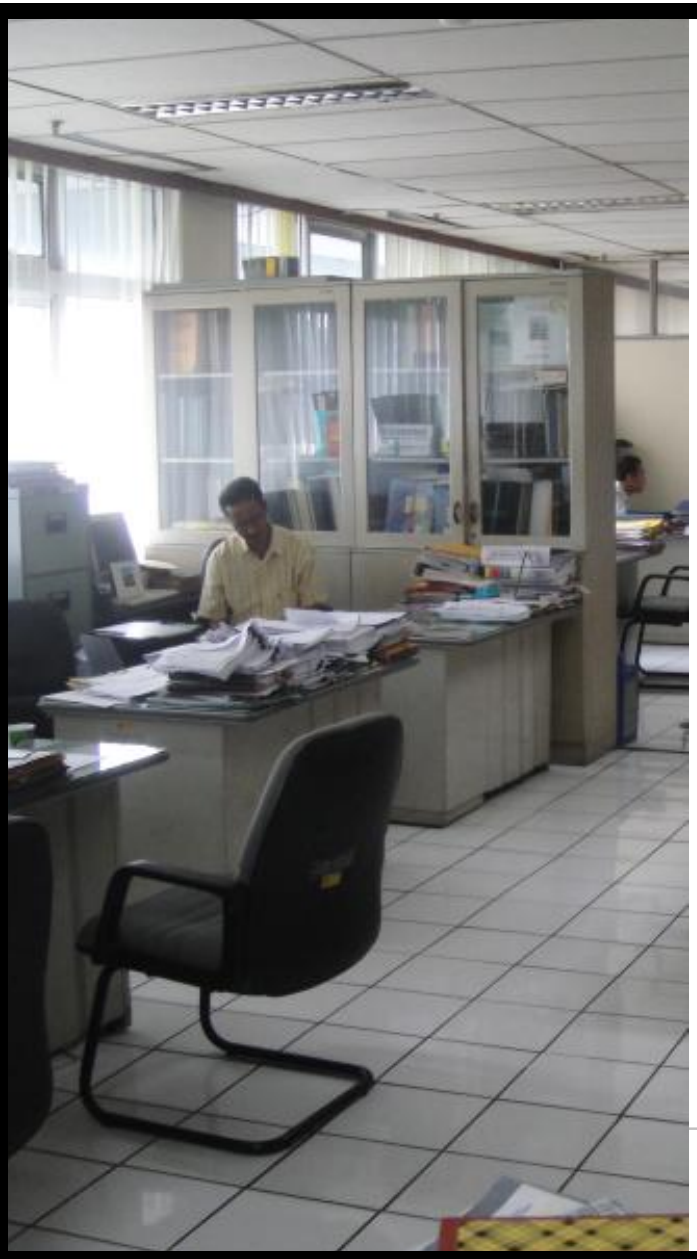
Retrofit daylighting case study

EECCHI OFFICE RETROFIT

(JAKARTA, 2011)

BEFORE

AFTER



Energy

170	80
kWh/m² yr	kWh/m² yr

Comfort

26-31	24-26
temp (°C)	temp (°C)
75	55
RH (%)	RH (%)

Noise

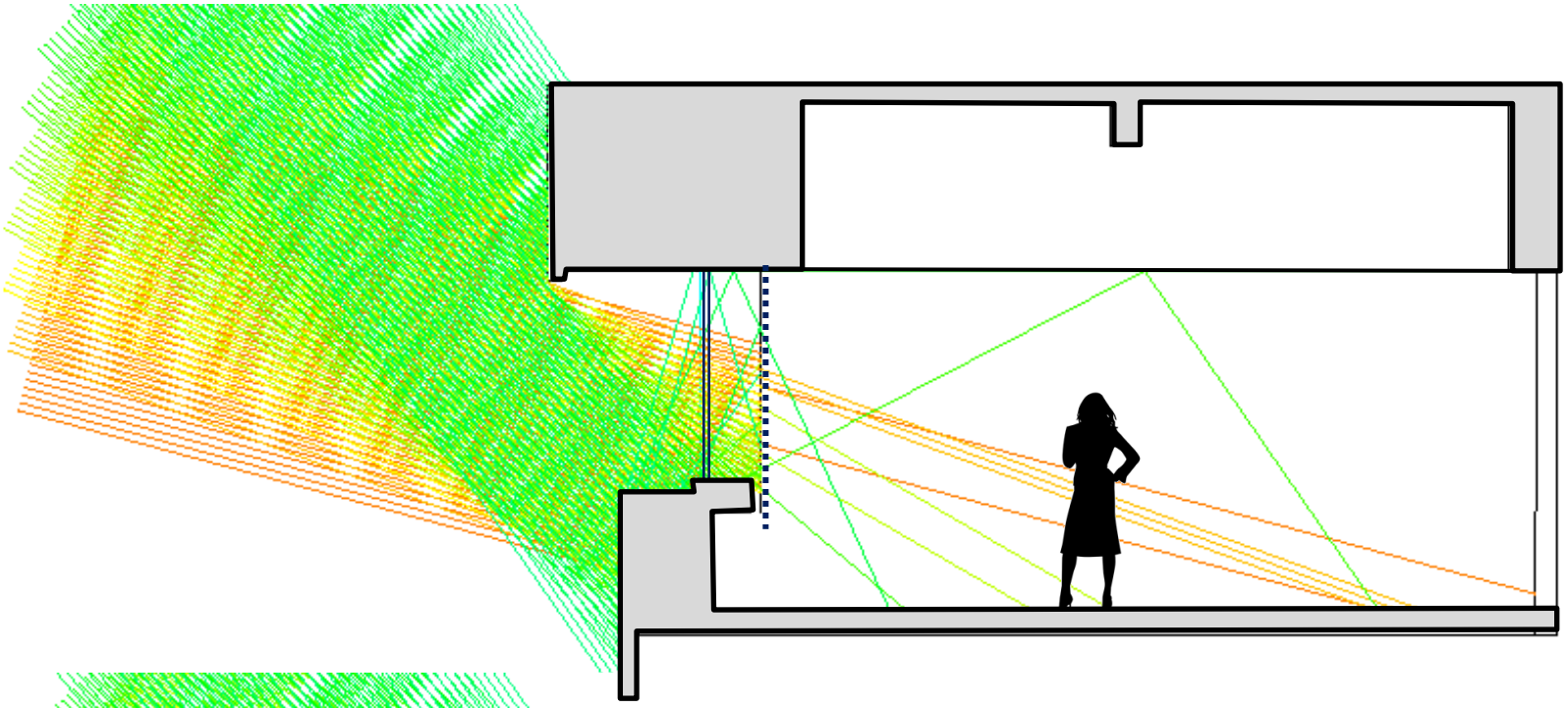
57	53
dB	dB

Daylight

No	Yes

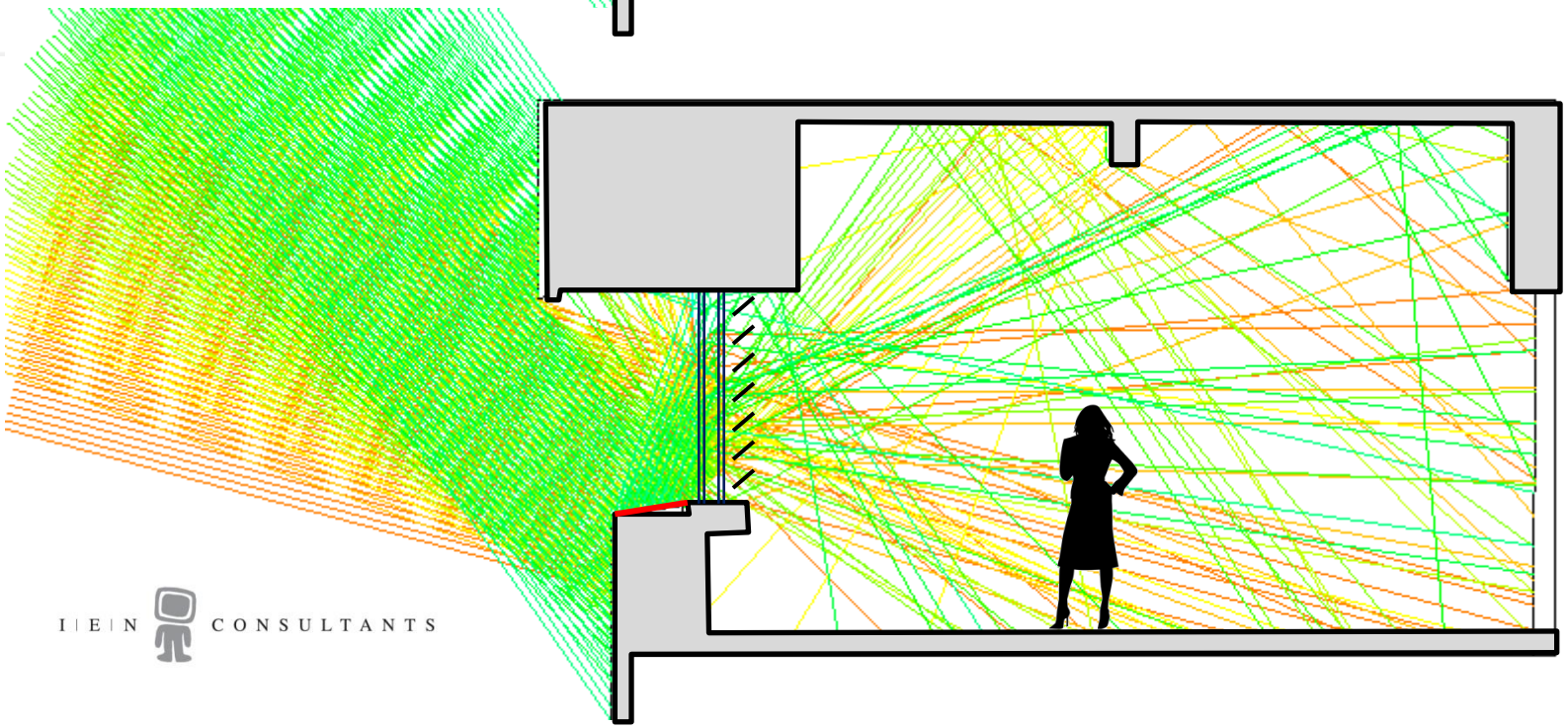
View out

No	Yes



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

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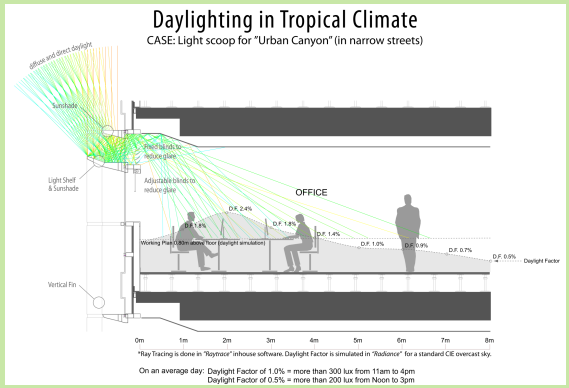
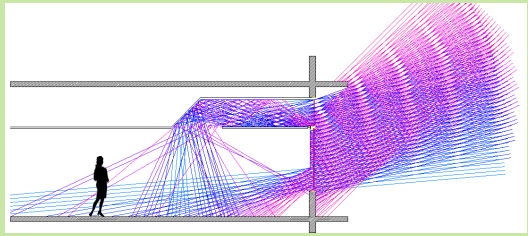
Case studies (ongoing)





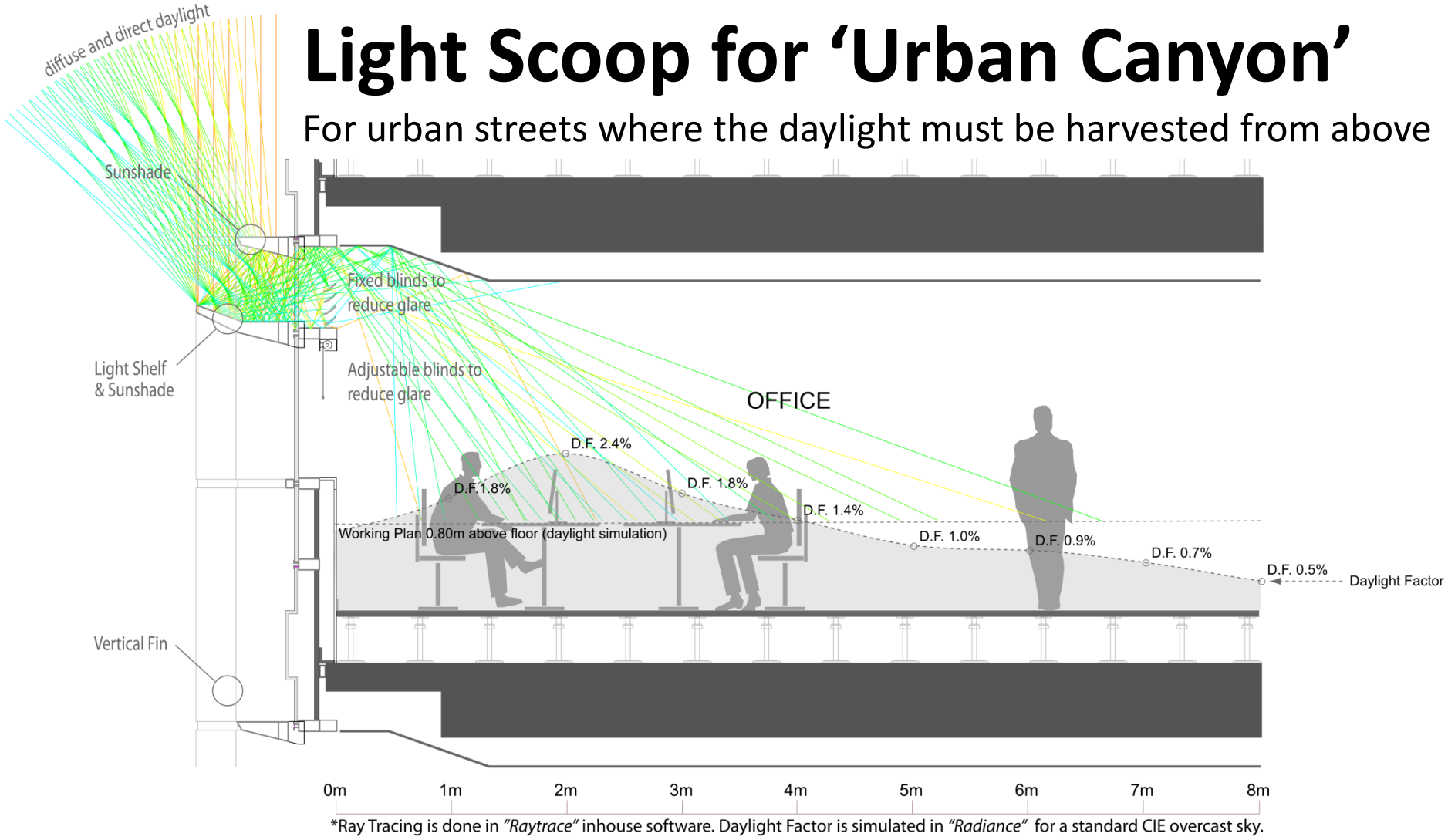
Daylighting case studies

INNOVATIVE DESIGNS

(MALAYSIA AND SINGAPORE, 2015)

Light Scoop for ‘Urban Canyon’

For urban streets where the daylight must be harvested from above



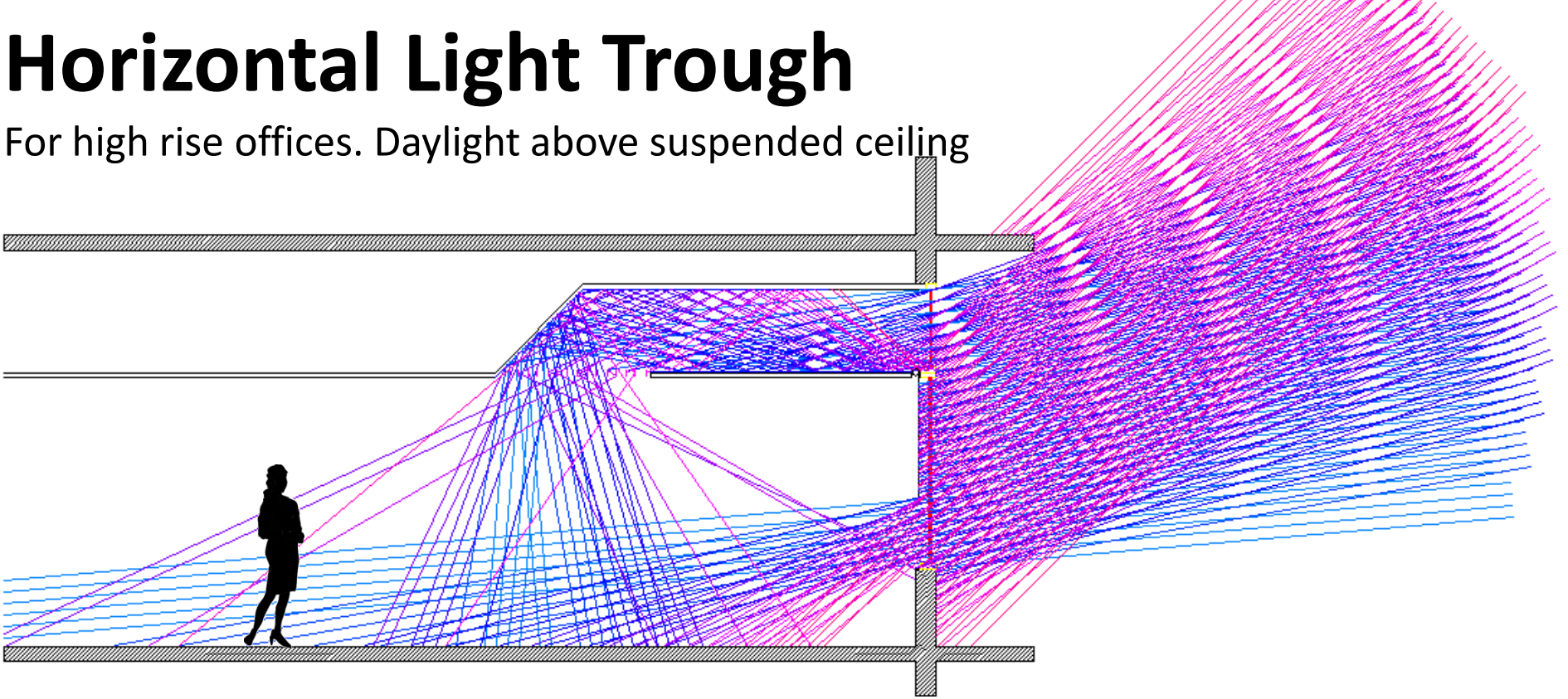
*Ray Tracing is done in *"Raytrace"* inhouse software. Daylight Factor is simulated in *"Radiance"* for a standard CIE overcast sky.

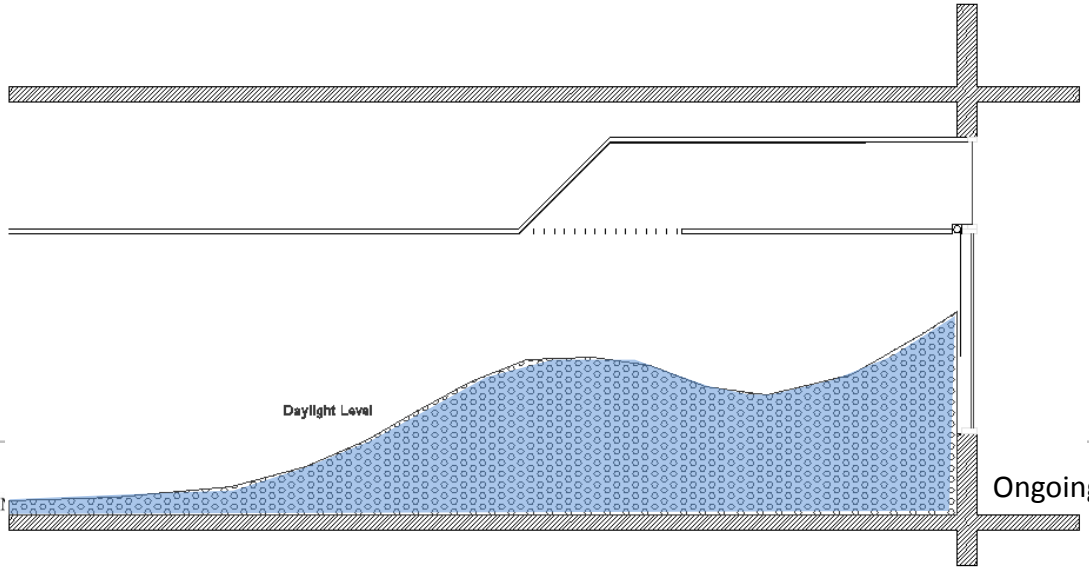
On an average day: Daylight Factor of 1.0% = more than 300 lux from 11am to 4pm
Daylight Factor of 0.5% = more than 200 lux from Noon to 3pm

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

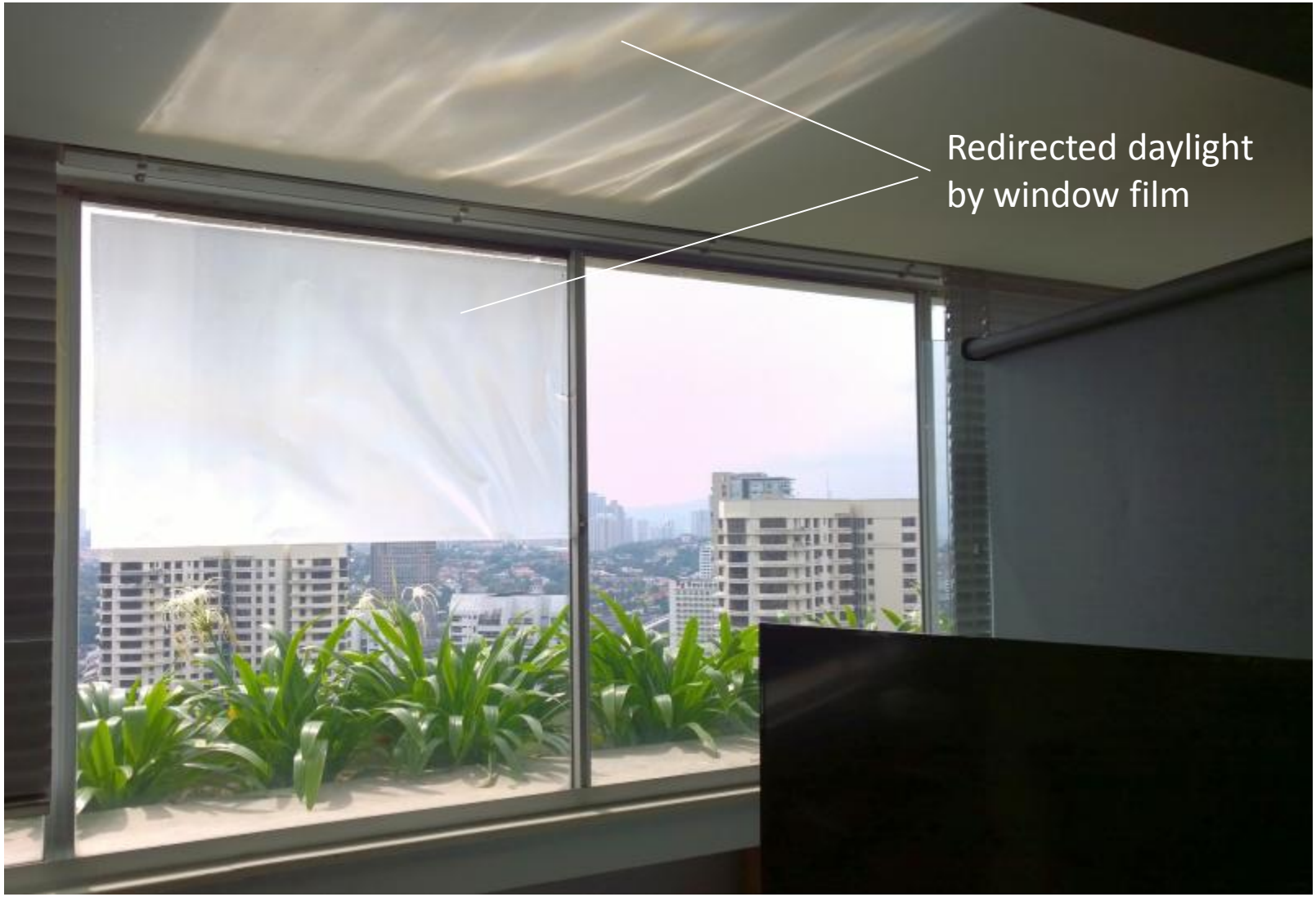


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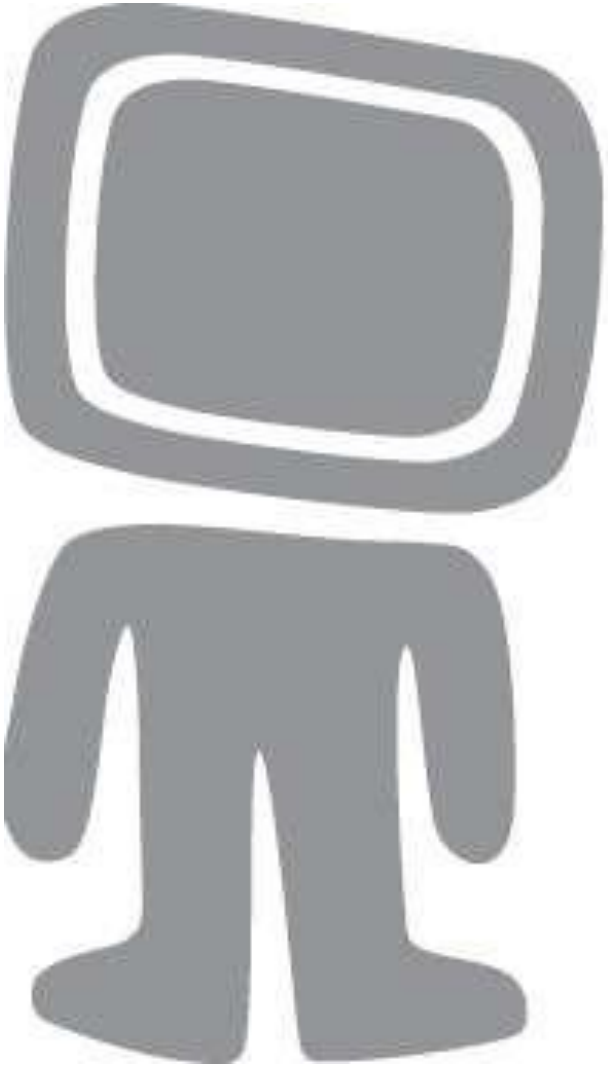
Photo from IEN Consultants office (Kuala Lumpur)
in preparation for demonstration project in Singapore (2015/2016)

The End



Hope you saw the light!

Thank you!

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Build green
- drive clean!