

DAYLIGHTING in the QLD WORKPLACE

- What do we mean by 'daylighting'?
- Why isn't daylighting mainstream practice?
- What energy savings can be obtained?
- What are the other measurable benefits of daylighting?
- How can daylighting be achieved?
- What can go wrong and why?
- Who to ask?
- Questions

What do we mean by ‘Daylighting’?

- ‘Daylighting’ is about bringing USEFUL daylight into a building.
- What is useful or not? Daylight has 3 main components:
 - Direct Sunlight? Problematic in Qld – special measures needed.
 - Refracted skylight? Excellent efficacy.
 - Reflected sun/skylight (ground, buildings etc)? Possible glare problems.
- What is so special (or not) about daylight?
 - Full spectrum light source (*but does not contain magical pixie dust*)
 - Very efficient and cheap light source (*in the right quantity*)
 - Comes with benefits – views, stimulation, information (*circadian rhythm?*)

Why isn't Daylighting mainstream?

- In Europe and North America, it is!
 - Scarce commodity, direct sunlight OK, older buildings, high energy costs, health benefits, clear user desire.
- In Australia (esp Qld) it's harder; and there's less motivation:
 - Daylight is plentiful – too much at times
 - Direct sunlight rarely / never desirable
 - Newer building stock (post-WWII the fluorescent age)
 - Cheap electricity
 - Less health benefit (no SAD, minimal circadian)
 - Users are ambivalent (bad experiences)

(Day)lighting energy savings?

- How efficient is daylight compared to fluorescent light?
 - 15 times as efficient?
 - 3 - 5 times as efficient?
 - Twice as efficient?
 - 25% more efficient?
 - No more efficient?
 - Answer – all of the above! It depends what you're looking at!
- Example space:
 - Electric lighting to 320 lux, no windows = 5.9W/m²
 - Daylight to 500 lux, electric to ~160 lux = 4.8W/m² (including HVAC)
 - Therefore 19% energy savings. Be cautious of claims >25% savings!

(workings provided next slide)

Electric Light System Efficacy (36W troffer installation):

- $3350 \text{ lumens} * 0.85 \text{ lifetime average maintenance factor} * 0.85 \text{ utilisation factor} = 2,420 \text{ lumens}$
- $(32\text{W lamp} + 4\text{W gear loss} = 36\text{W}) + (36\text{W} / 4.0 \text{ HVAC energy efficiency ratio}) = 45\text{W}$
 - Resulting system efficacy = **54 lm/W**

Daylight System Efficacy:

- Direct Sunlight = 100 lm/W; Refracted Skylight = 200 lm/W (generally accepted values)
- Say 10,000 lumens daylight (as 10:90 sunlight:skylight), through a window with 0.71 visible light transmittance and 0.5 solar heat gain coefficient, with an workplane / work hours utilisation factor of 0.25, and HVAC energy efficiency ratio of 4.0:
- $10,000 \text{ lumens} * 0.71 \text{ VLT} * 0.25 \text{ UF} = 1,775 \text{ lumens}$
- $(1,000 \text{ lumens sunlight} = 10\text{W}) + (9,000 \text{ lumens skylight} = 45\text{W}) * 0.5 \text{ SHGC} / 4.0 \text{ EER} = 6.9\text{W}$
 - Resulting system efficacy = **258 lm/W**

No Daylight Scenario:

- Windowless space lit to 320 lux with electric lighting
 - $320 \text{ lux (i.e. lumens per m}^2) / 54 \text{ lm/W} = 5.9\text{W/m}^2$

Daylighting Scenario:

- Electric lighting to 240 lux, with controls reducing annual energy by one third; and daylight to annual average 500 lux:
- $(240 \text{ lux electric @ } 54 \text{ lm/W} * 0.666 \text{ controls factor} = 2.9 \text{ W/m}^2) + (500 \text{ lux daylight @ } 258 \text{ lm/W} = 1.9 \text{ W/m}^2)$
 - Total $4.8 \text{ W/m}^2 = 19\% \text{ energy savings}$

Other measurable benefits?

- Study findings (regression analysis)
 - 10% - 25% increase in office worker cognitive function
 - 6% - 12% increase in call centre call processing speed
 - 15% to 21% **decrease** when glare is a problem
 - CH2 building – 10.9% increase in productivity (not just daylight)
 - 21% increase in primary school learning rates
 - 1% - 6% typical (up to 40% in some cases) retail sales increase
 - Inpatient hospital stays shortened 4 hours per 100 lux daylight (view is less important)
- Other benefits (not quantified for this presentation)
 - Staff retention?
 - Property value?
 - Older workers?

How is Daylighting done?

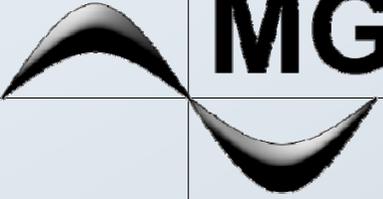
- First, do no harm (i.e. avoid glare and heat):
 - External shading (horiz/vert), Glazing (single/double, transmittance, advanced); Blinds (venetian, vertical, holland), Fixed vs Automatic vs Operable.
- Get the good stuff in (in the right quantity):
 - What is the right quantity?
 - Side lighting vs top lighting
 - Windows, clerestories, skylights, monitors, atria, light shelves, waveguides, light ducts, fibre-optics
 - Internal fitout design (maximise views, daylight penetration and propagation)
- Leverage the daylight (energy savings):
 - Controls – sensors, switching/dimming
 - Reduced general illumination?

What can go wrong and why?

- Glare & Radiant Heat (uncomfortable / unusable workspace)
 - Excess of direct sunlight penetration
 - Excess of total irradiance
 - Excessive reflected glare
 - Poor window and blinds design / selection
 - Real hours of use not considered
- Controls Ineffective or Bypassed (energy savings not realised)
 - Switching vs dimming – user expectations and annoyance
 - Sensor selection and placement – open or closed loop, direct or indirect
- Cave effect (aesthetics, comfort, long-term glare)
 - Poor daylighting design, poor interior design

Who to ask?

- Specialist daylighting consultants
- Senior (by age) architects
- Lighting engineers, ESD consultants
- Younger architects
- Consult design guides
- Software



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Questions?