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 lumens * 0.85 lifetime average maintenance factor * 0.85 utilisation factor = 2,420 lumens

•(32W lamp + 4W gear loss = 36W) + (36W / 4.0 HVAC energy efficiency ratio) = 45W

- 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 lumens * 0.71 VLT * 0.25 UF = 1,775 lumens

•(1,000 lumens sunlight = 10W) + (9,000 lumens skylight = 45W) * 0.5 SHGC / 4.0 EER = 6.9W

- Resulting system efficacy = **258 lm/W**

No Daylight Scenario:

•Windowless space lit to 320 lux with electric lighting

- 320 lux (i.e. lumens per m^2) / 54 lm/W = **5.9W/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 lux electric @ 54 lm/W * 0.666 controls factor = 2.9 W/m^2) + (500 lux daylight @ 258 lm/W = 1.9 W/m^2)

- Total 4.8 W/m^2 = 19% 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?