Evaluation of the Luminous Environment in Open-plan Offices with Skylights

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Building 1

- Light pipe
- Window
- Conference room
- Service rooms
- Common area
- Open office space with windows
The role of skylights in the spaces

• Reduce the need for electric lighting

• Bring daylight into a building that otherwise has only electric lighting (building 2)

• Create pleasant and well lit environments for occupants... (general)
Pilot study: general conclusions of qualitative data

- **Incorporate windows** even if they provide little light or are heavily obstructed, ++ positive appraisal of space

- **Ceiling height** is a major factor in glare from skylights low ceilings place skylight apertures in field of view

- **Position of skylight**
  - preferred: skylight behind workstation
  - least comfortable: skylight directly above workstation

- **Control systems** can increase occupant perception of lighting quality where skylights are applied

- **Design of output element**: diffuse light or redirected light to the ceiling are viewed as producing a more pleasing luminous environment
The goals of this work

- Review quantitative data
  - illuminance
  - luminance maps of workstation
- 24 workstations measured,
  11 reported some discomfort glare

address the questions...

- Does the measured data reflect the occupant reports of visual discomfort (discomfort glare)?
- How does the data compare with occupant perception of the space, the lighting and skylights?
Illuminance data

- Average values a poor indication of visual comfort:

<table>
<thead>
<tr>
<th>Average Daily Illuminance at the workstation (Buildings 1 &amp; 2)</th>
<th>No Glare Reported</th>
<th>Glare Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Illuminance (lux)</td>
<td>800 ± 200</td>
<td>800 ± 600</td>
</tr>
<tr>
<td>Vertical Illuminance (lux)</td>
<td>320 ± 90</td>
<td>290 ± 120</td>
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</tbody>
</table>

- Less fluctuation over the day consistent with positive appraisal of the space
  - building 1 variation 3 – 15% over day
  - building 2 variation 8 – 24% (daylight only 34 – 68%)
Comments on illuminance variation and negative appraisal of skylights (Building 2)

“but on a really bright day with few clouds around you do really notice the change in light level. See what I don’t like about this is that your eyes are constantly adjusting backwards and forwards”

“most of the office here people still require the lights to be on during the day simply to have enough reliable sort of lighting because the light coming through the skylights is just too variable”
Luminance Data

Several glare indices tested: DGP, DGI, VCP, CGI, UGR

- **Best agreement**: CIE Glare Index (CGI) \(\rightarrow\) 75% accuracy, correctly identified 73% of reported glare

- **Poorest agreement**: Daylight Glare Probability (DGP) and Daylight Glare Index (DGI) \(\rightarrow\) 54% accurate, both FAILED to indentify any reported glare

- Previous studies show best agreement with DGP, why are these cases different?
DGP in open-plan, skylit spaces

• DGP based on study of glare from windows, uses vertical illuminance, $E_v$, as a weighting factor
• High partitions reduce $E_v$
• Skylights behave more like electric lights than windows
Conclusions

✗ Average illuminances are a poor indicator of discomfort glare and appraisal of skylights

✗ DGP requires further study in open-plan office scenarios, and with skylights

✔ CGI gives best agreement with reports of discomfort glare in these open-plan, skylit offices

✔ Higher variation in workplane illuminance associated with negative appraisal of skylights

→ appropriate electric dimming controls could help resolve this problem