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# Task Lighting Effects on Office Worker Satisfaction and Performance, and Energy Efficiency

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# Introduction

- Commonly proposed that energy savings in offices can easily be achieved by reducing ambient lighting levels and compensating with local task lighting of much lower wattage

- Australia's Green Star for Offices (Pilot):
  *"A further credit is available if a two component lighting system (base lighting plus supplementary task lighting) is installed and the base lighting level is no more than 150 lux…"*

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# Introduction

- Studies show that people will tolerate such lighting …
- … But is it what they would prefer?

- Two experiments directly addressed this question for modern office work which is primarily computer-based.

**“Does local task lighting truly compensate for reduced ambient lighting”**

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# Experiment 1

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# Method & Procedure: office laboratory

- 4.9m x 6.1m x 2.7m (16’ x 20’ x 9’) room
- Two 2.4m x 2.4m (8’ x 8’) cubicles

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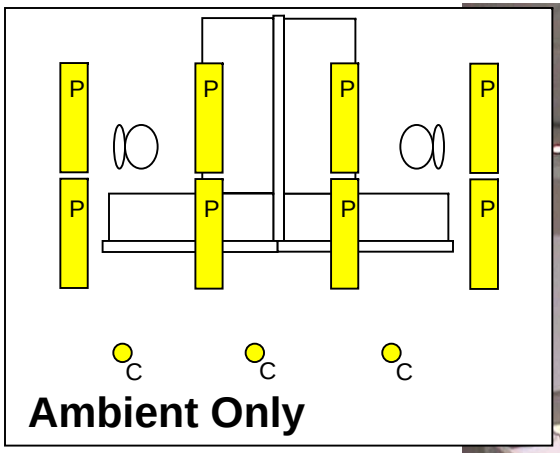
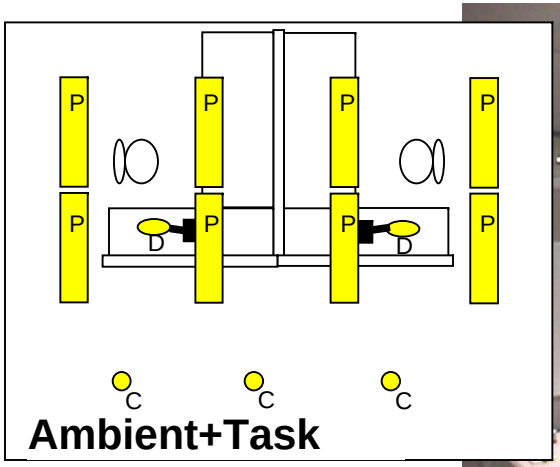
# Method & Procedure: lighting designs

- 1’ x 4’ deep-cell recessed parabolic; 2 x 32 W T8 (3500K, CRI=75); electronic dimming ballast




- Same parabolics + Angle-arm task light; 1 x 18 W quad CFL (4100 K, CRI=82)

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# Method & Procedure: participants

- 58 participants
  - Ambient Only: 30; Ambient+Task: 28
- 2 participants per day
- 1 day exposure
- 1 of 4 initial lighting levels
  - Desktop illuminance ~ 200, 400, 600, 800 lx

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# Method & Procedure: schedule

T1
- **Questionnaires (1) & Task Training**
- ***Morning Break***
- **Tasks (1)**
- ***Lunch***

T2
- **Questionnaires (2) & Tasks (2)**
- ***Afternoon Break***
- **Control Introduced**

T3
- **Questionnaires (3) & Tasks (3)**

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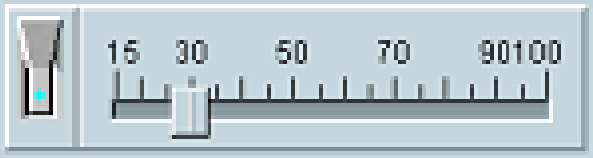
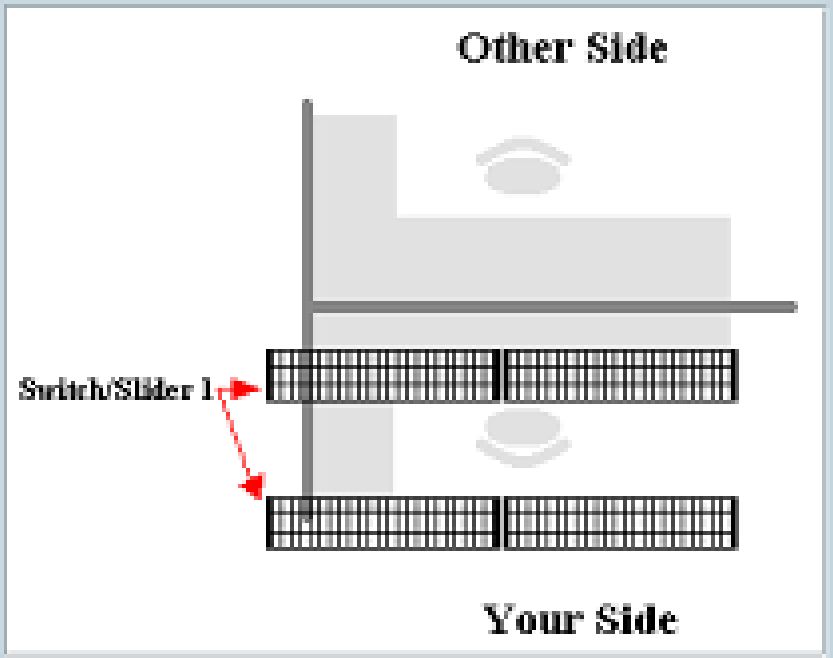
# Method & Procedure: control interface

- Ambient Only: dimming control over parabolics
- Ambient + Task: dimming control over parabolics
  + could move arm of task light



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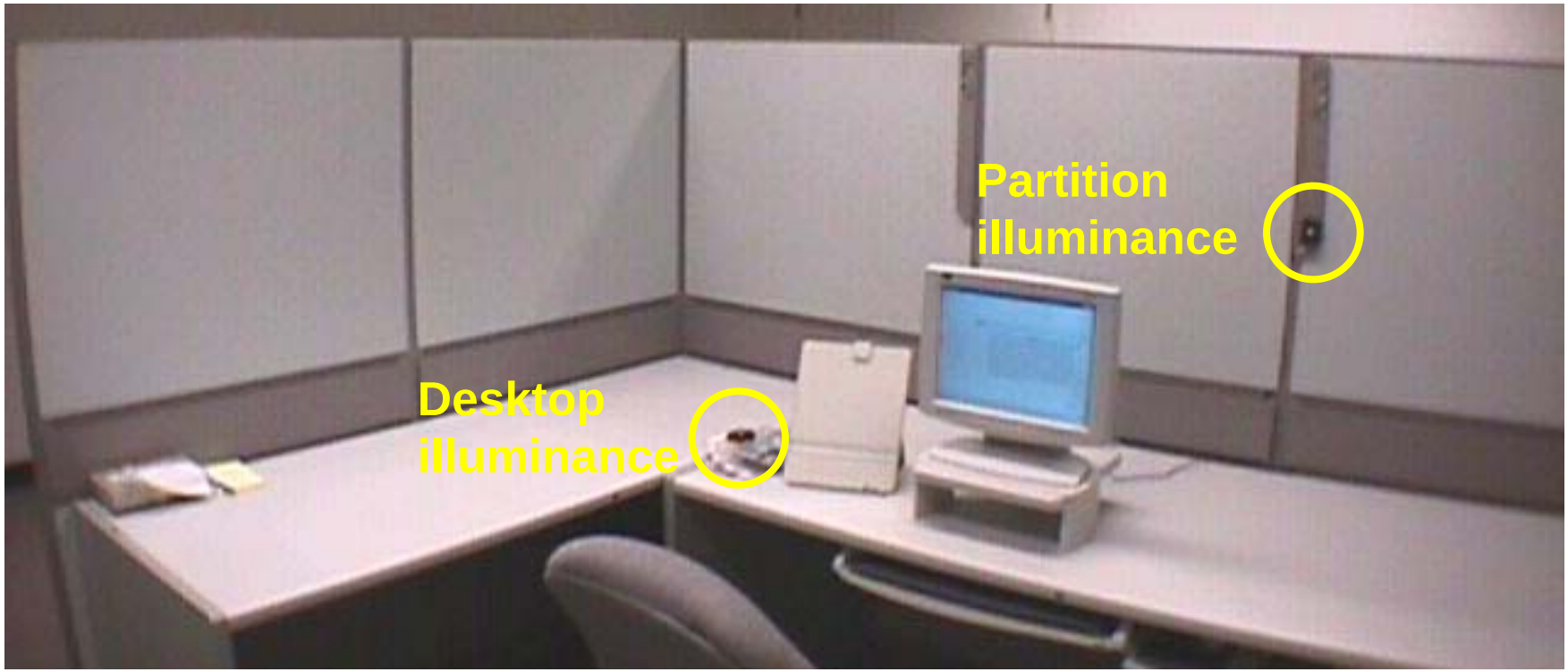
# Photometrics




- Also measured dimmer choices…
- And conducted additional *post-hoc* photometry

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# Results: questionnaires and tasks

- No effect of task light provision on mood, comfort, or satisfaction*
- Effects on task performance were few and mixed, but, on balance, tended to favour the Ambient+Task design
  - Main effect on typing speed: task light was likely helpful in highlighting the paper model text
  - Main effect on vigilance (reaction time to an “e-mail” arriving). Mechanism: arousal?

*There were positive effects associated with acquiring control, see Newsham et al. 2004. IESNA Annual Conference Proceedings, Tampa, Florida, pp. 19-41

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# Results: lighting choices

| | Desktop Illuminance, lx | | Partition Illuminance, lx | | Ambient Dimmer Setting, % | |
|---|---|---|---|---|---|---|
| | Ambient Only | Ambient +Task | Ambient Only | Ambient +Task | Ambient Only | Ambient +Task |
| N | 30 | 28 | 30 | 26 | 30 | 28 |
| Minimum | 33 | 188 | 13 | 33 | 0 | 0 |
| Maximum | 944 | 1478 | 418 | 414 | 99 | 99 |
| Median | 413 | 544 | 169 | 224 | 41.5 | 48.5 |
| Mean | 452 | 582 | 201 | 211 | 46.7 | 47.0 |
| Standard Dev | 241 | 278 | 112 | 102 | 26.1 | 23.4 |

- Chosen desktop illuminance consistent with recommended practice and other studies
- No difference in preferred ambient luminaire output for group with task light

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# Experiment 2

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# Method & Procedure

- Same office laboratory
- Two task light options
- 31 participants
- 6 initial lighting conditions
  - Task light output: 0%, 50% or 95%
  - Initial ambient output: 35% or 70%
- Participants adjusted ambient lighting to preferred level at each task light output level
- Short exposure
- No questionnaires or task performance measures


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# Results

- Effect of task light output on ambient lighting dimmer setting:

| Effect | F (d.f.) | $\eta^2$ | Ambient Dimmer Choice, M (SD) % | |
|---|---|---|---|---|
| type | n.s. | | | |
| initial | 68.5 (1, 30)*** | 0.70 | 35%: 49 (20) | 70%: 61 (23) |
| output: 0% vs. 50% | 23.2 (1, 30)*** | 0.44 | 0%: 60 (22) | 50%: 52 (23) |
| 50% vs. 95% | n.s. | | | |
| type x initial | n.s. | | | |
| type x output | n.s. | | | |
| initial x output | n.s. | | | |
| type x initial x output | 3.6 (2, 60)* | 0.11 | | |

**: p<0.05; **: p<0.01; ***: p<0.001*

- Power reduction of ambient lighting = power for task light

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# Results

| | Desktop Illuminance, lx | | | Partition Illuminance, lx | | |
|---|---|---|---|---|---|---|
| | Task Light Output, % | | | | | |
| | 0 | 50 | 95 | 0 | 50 | 95 |
| N | 31 | 31 | 31 | 31 | 31 | 31 |
| Minimum | 160 | 206 | 231 | 60 | 65 | 68 |
| Maximum | 797 | 1280 | 2016 | 391 | 400 | 420 |
| Median | 503 | 617 | 788 | 238 | 216 | 221 |
| Mean | 501 | 640 | 822 | 238 | 218 | 222 |
| Standard Dev | 171 | 216 | 337 | 80 | 84 | 87 |

- Chosen desktop illuminance consistent with recommended practice, other studies, and Experiment 1
- Control choices result in average partition illuminance maintained constant, rather than desktop illuminance

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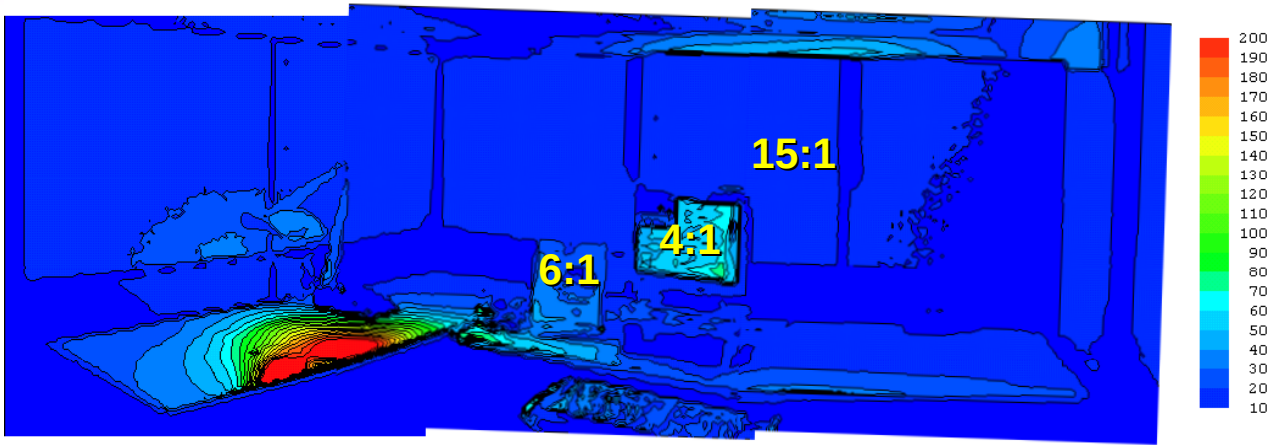
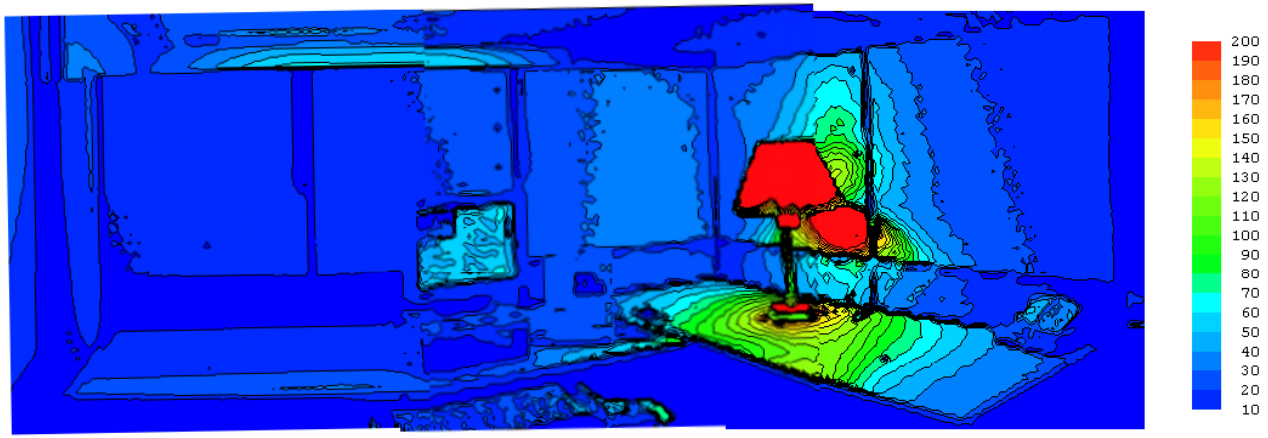
# Luminance Ratios




- Task @ 95%, ambient @15%: 150 lx from ambient
- Excessive luminance ratios

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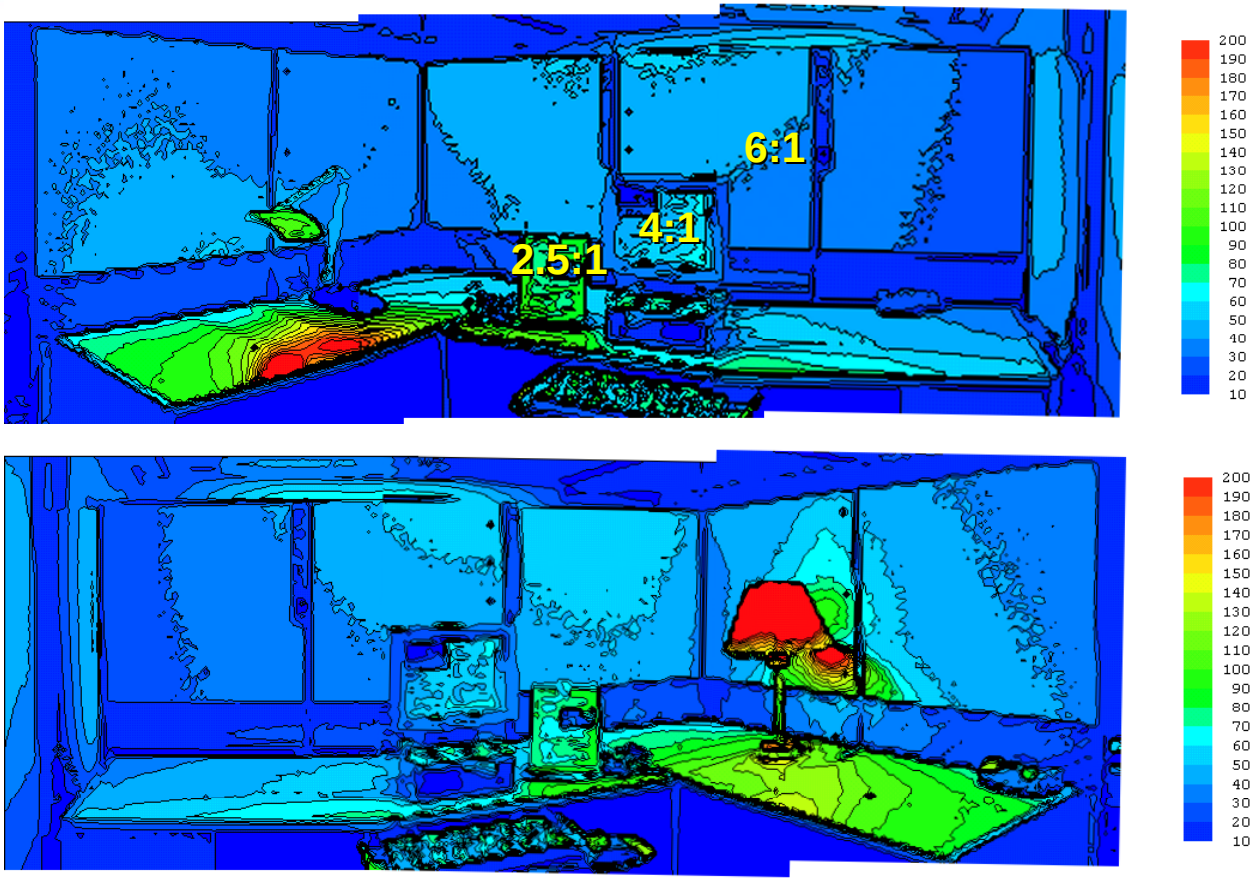
# Luminance Ratios




- Task @ 50%, ambient @50%: 400 lx from ambient
- Reasonable luminance ratios

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# Conclusions

- Preferred ambient lighting:
  - Desktop illuminance: ~450 lx
  - Partition illuminance: ~200 lx
  - Partition luminance 30-40 cd/m$^2$
- Add a flexible task light
  - No energy savings in office
  - But, suggestions of performance benefits
  - Modest savings in circulation areas, and due to task light switching