NRC·CNRC

The Future of Lighting Lies in Understanding Human Factors

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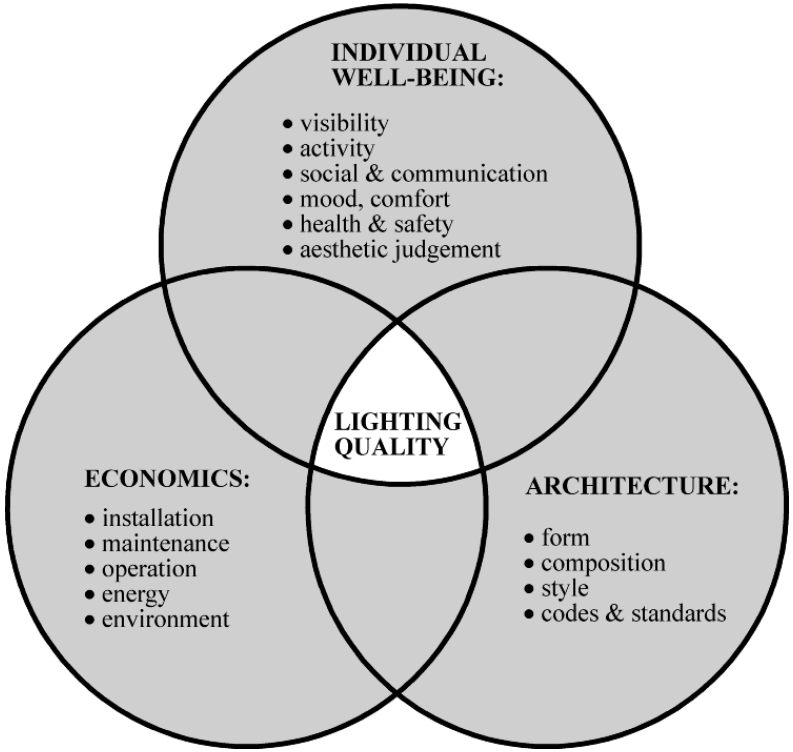
Imagining the future – smart, sustainable lighting

"The difficulty with writing about dramatic change in the midst of it occurring is that the very drama of the effects unleashed by the change will be mistaken for what the future will become."

(Spreckelmeyer, 1999, p. 262)

One future vision...

- When all the electric lighting is solid-state and controllable, energy efficiency takes care of itself and the designer can focus on the effects of the light on the occupants.



NRC Lighting Quality model.

Evidence-based…

- …medicine: "an approach to medical practice intended to optimize decision-making by emphasizing the use of evidence from well-designed and well-conducted research."
- **Evidence-based lighting: an approach to lighting practice intended to optimize decision-making by emphasizing the use of evidence from well-designed and well-conducted research.**

Demonstrating the value

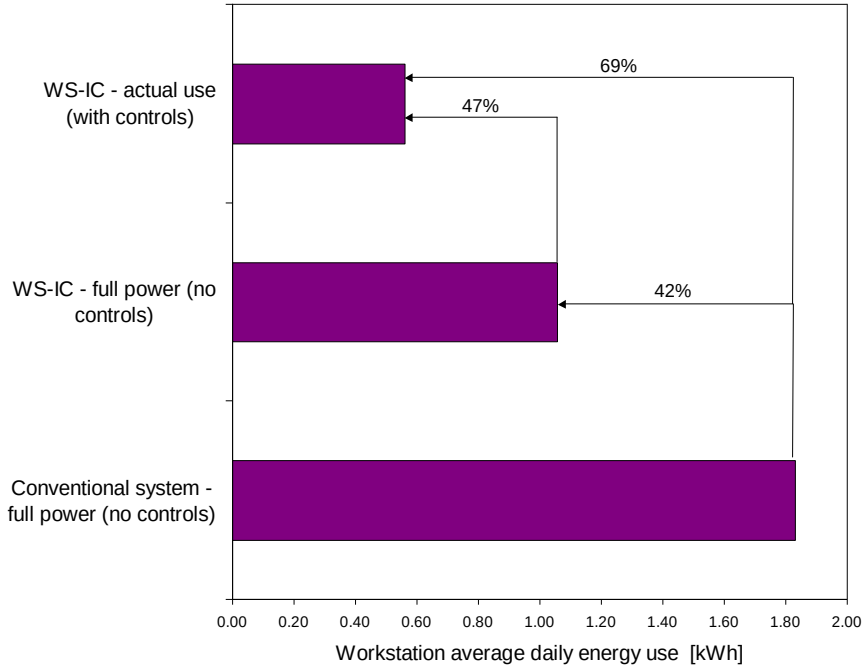
- Can office lighting go beyond providing adequate conditions for seeing?
  - Can it be smart and sustainable?

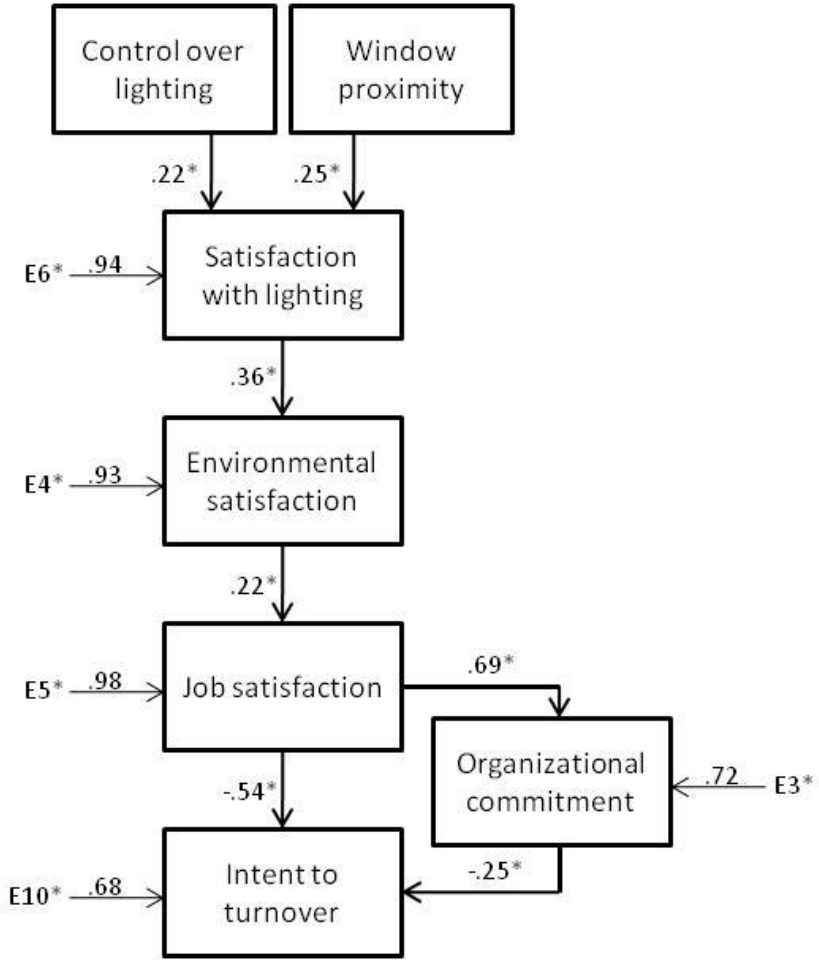
15 yrs **Realism**

- Evidence for individual dimming and direct/indirect light distribution:
  - Highly-controlled lab studies
  - Quasi-realistic lab study
  - Field studies

→ ***Yes.***

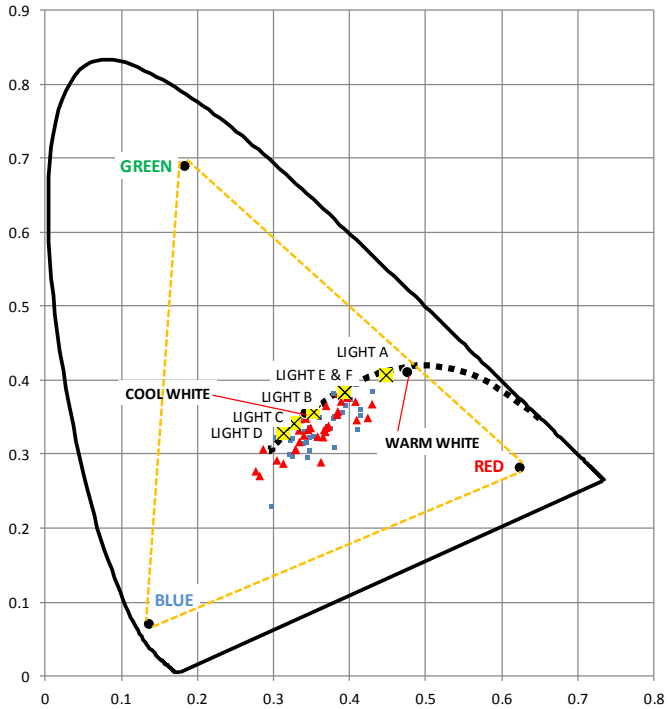
Example: Workstation-specific controls field study

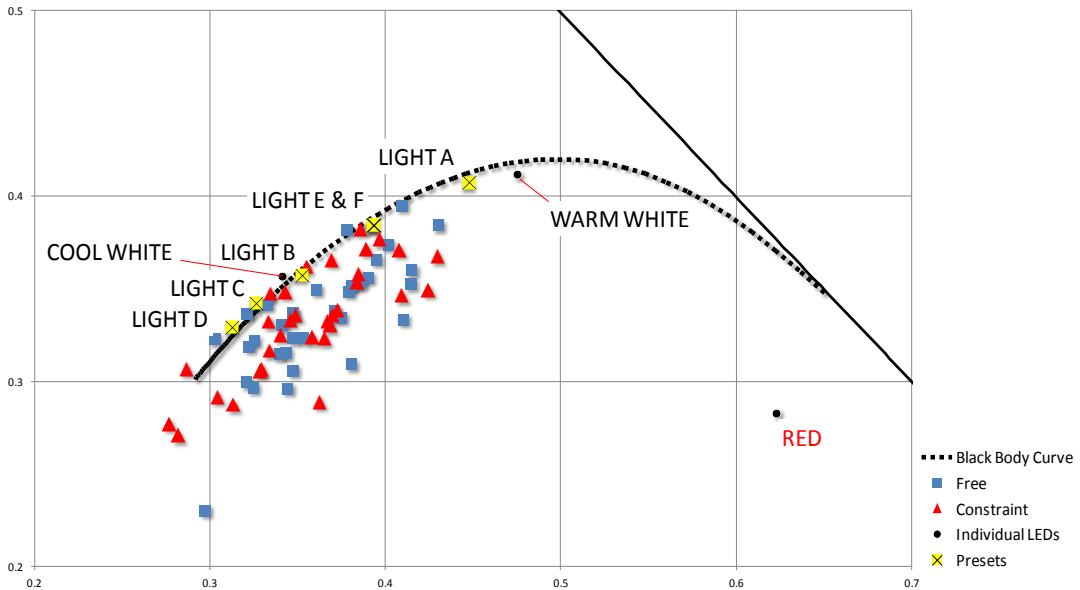




Source: Galasiu, A. D., Newsham, G. R., Suvagau, C., & Sander, D. M. (2007). Energy saving lighting control systems for open-plan offices: a field study. *Leukos, 4*(1), 7-29 Available at: http://nparc.cisti-icist.nrc-cnrc.gc.ca/npsi/ctrl?action=shwart&index=an&req=20377469&lang=en.

Working on…tunable colour and preference

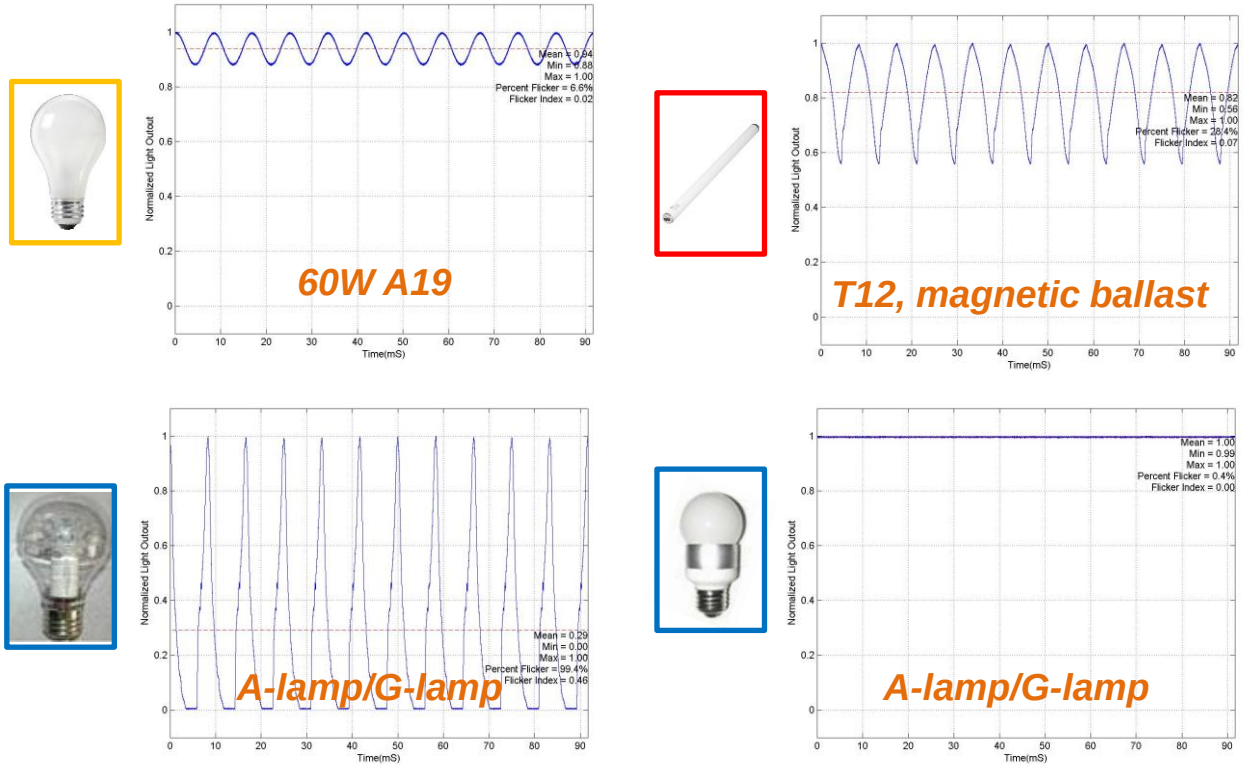




Measure	Condition	Median	Mean	SD	Min	Max
Ave E (lx)	Free	1042	992	391	109	1578
Ave E (lx)	Const.	540	517	50	320	553
CCT (K)	Free	4470	4747	2027	2832	14016
CCT (K)	Const.	4280	5013	2091	2726	11321
CRI	Free	87	82	16	29	95
CRI	Const.	83	82	11	55	96
CQS	Free	91	89	6	70	96
CQS	Const.	91	89	5	76	96
Δuv	Free	-0.0135	-0.0145	0.0109	-0.047	0.005
Δuv	Const.	-0.012	-0.0121	0.0094	-0.042	0.006

Dikel, E. E., Burns, G. J., Veitch, J. A., Mancini, S., & Newsham, G. R. (2014). Preferred chromaticity of color-tunable LED lighting. *Leukos, 10(2), 101-115.*

Working on… flicker, health, and performance

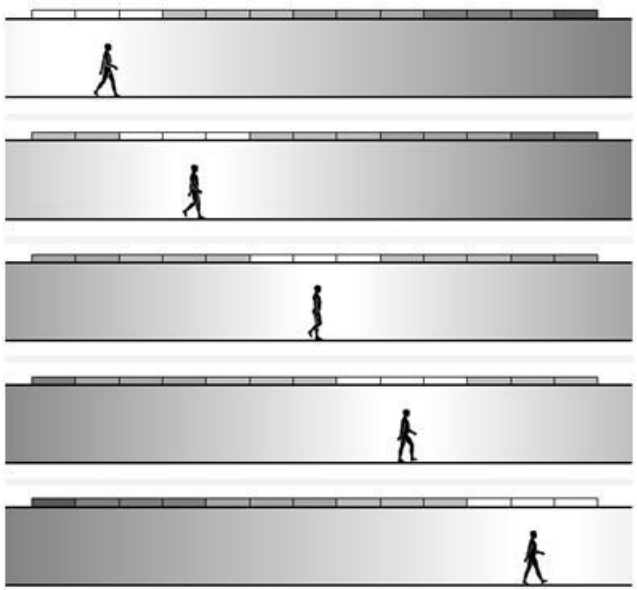


Source: M. Poplawski, PNNL

- LEDs vary widely, depending on driver & system design
- Even when not visible, flicker has neural and behavioural effects
- IEEE S1789-2015

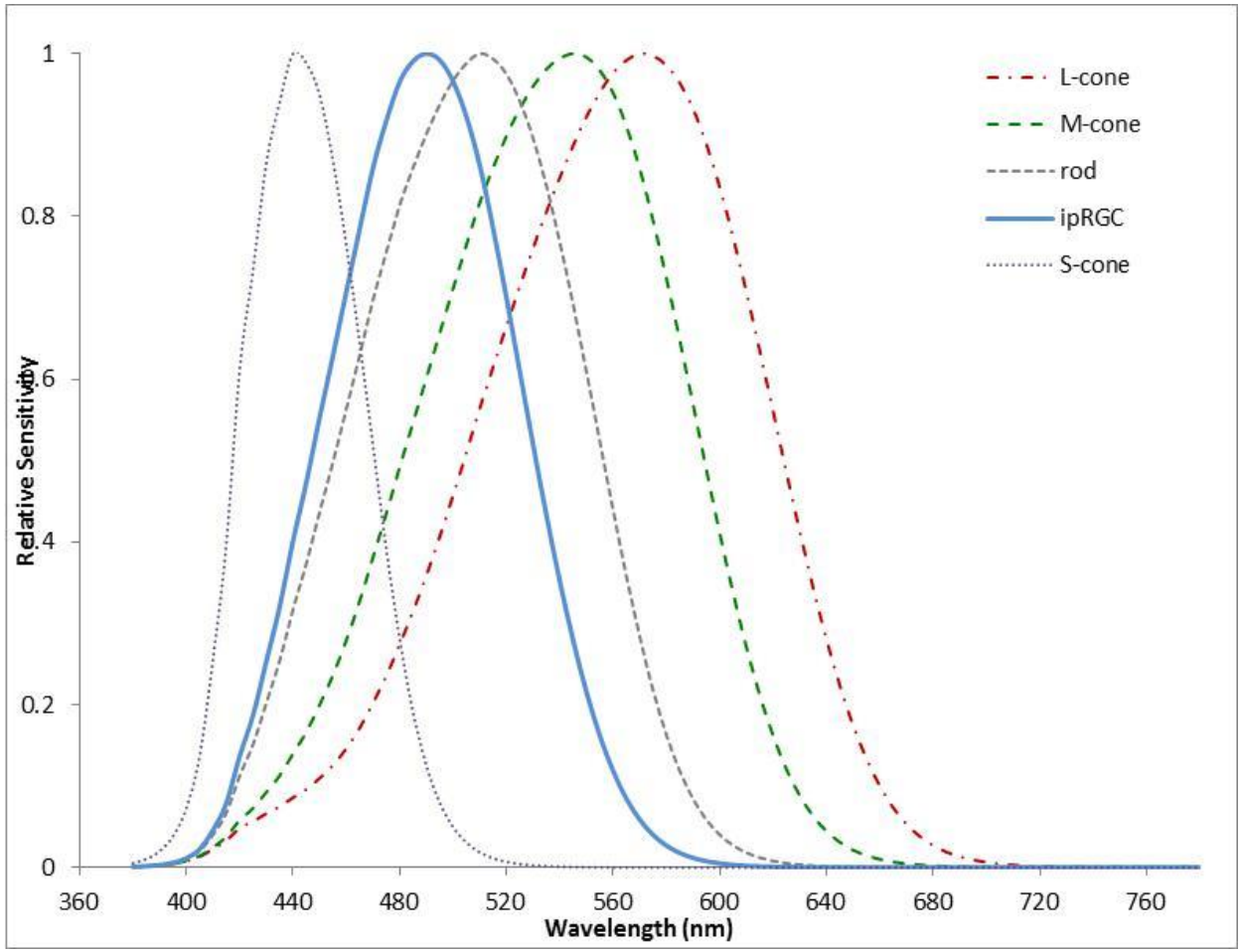
Working on … high-resolution controls

- Controls are absolutely part of smart lighting
- The best ones will take advantange of new form factors and source capabilities
- Usability, from commissioning to operating settings, is key



Non-visual effects: More than only circadian …

- Circadian:
  - Spectrum
  - Intensity
  - Duration
  - Pattern
  - Timing
- Alertness
- Mood
- Social behavior



Source: CIE TN 003:2015.

More information, please…

International Commission on Illumination
Commission Internationale de l'Eclairage
Internationale Beleuchtungskommission

CIE Statement on Non-Visual Effects of Light

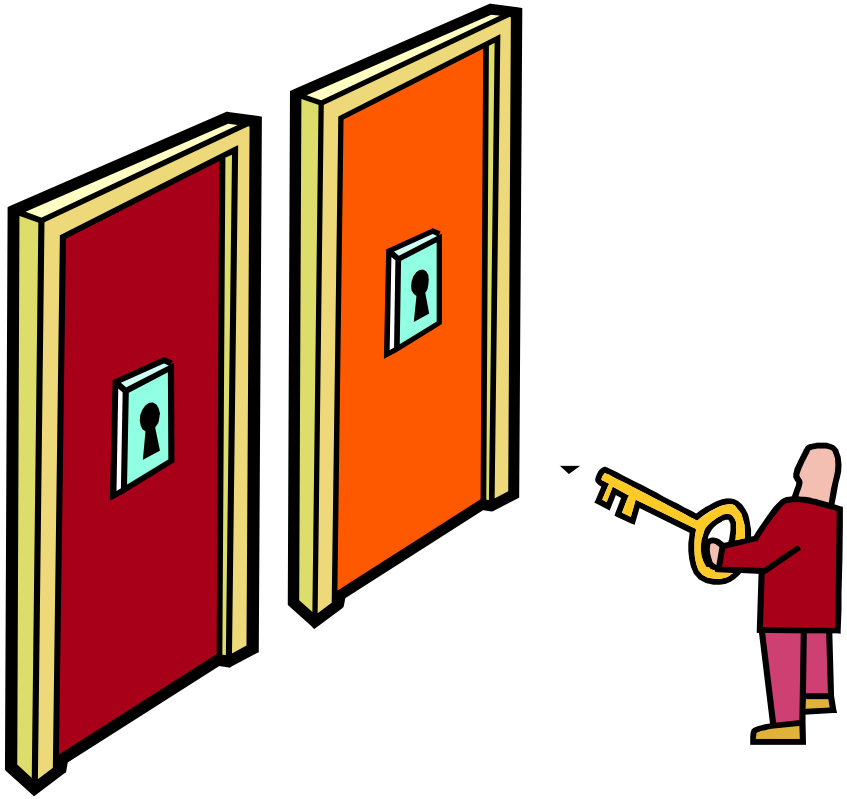
RECOMMENDING PROPER LIGHT AT THE PROPER TIME

Background

The definition of light identifies it as the electromagnetic radiation that stimulates vision. However, we now know conclusively that photoreception in the eye leads not only to vision but also to effects on human physiology, mood and behavior, often summarized as non-visual effects of light. Research on such effects intensified at the beginning of this millennium. It was fueled by the revolutionary detection of a new class of photoreceptors in the human eye that detect optical radiation but do not contribute to image formation. These

CIE Position Statement, June 28, 2015

Conclusion



Human factors research can unlock the best lighting solutions

Thank you

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