Circadian Lighting

Science-Driven Wellness Design

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Introduction

Evidence demonstrating the impact of light on human biological and behavioral health has been so well-documented in the fields of science and medicine, the American Medical Association has made multiple position statements on the topic. However, much of this has been overlooked in designing lighting in the built environment. How have we been inadvertently influencing occupant health, for better or worse, through lighting? Have we been missing opportunities to support wellness through lighting?

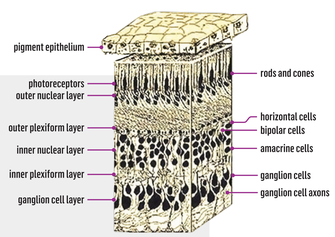
1 Factors affecting circadian system

Quantity | Spectrum | Timing | Duration | Spatial Distribution

2 Physiological or psychological?

Physiological cues create strong circadian entrainment via neurological pathways.

Psychological cues signal changing of time.



The retina is composed of layers:

- Ganglion cell layer
- Major discovery a decade ago: small fraction of RGCs (0.2– 3 %) are intrinsically photosensitive (ipRGCs)
- "ipRGC project directly to the circadian pacemaker, which triggers a cascade of hormones and neurotransmitters that affect and entrain multiple systems in the brain and body."

–White, Ancoli-Israel, Wilson 2013

3 Designing an effective circadian lighting system

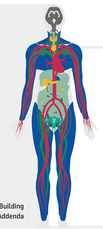
Define the objective

Reduce light above the horizon at night.

Light the Fire.

Daylight is our best ally.

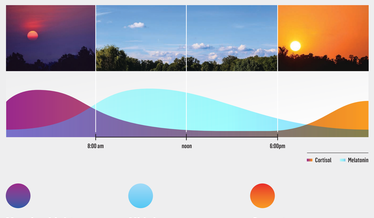
WELL Standard Credits 61, 62, 63



Positively Affects: Cardiovascular, Digestive, Endocrine, Immune, Muscular, Nervous, Reproductive

Illustration Credit: The WELL Building Standard® v1 with Q2 2018 Addenda

Biological darkness at night is as important as circadian stimulus during the day.

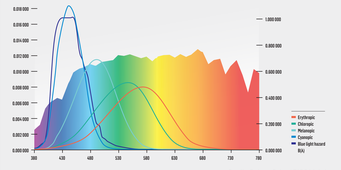


Morning Light: Melatonin suppression, clock reset

Mid-day Overhead Light: Cortisol

Sunset: Cortisol reduction, melatonin production

Spectrum is crucial.



Credit: Robert Soler / BIOS Lighting

Illuminate vertical surfaces during the day.

Light the Sky.

WELL Standard Credit 54

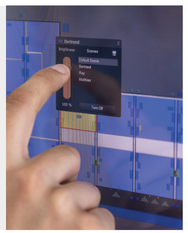
Positively Affects: Cardiovascular, Digestive, Endocrine, Immune, Muscular, Nervous

Illustration Credit: The WELL Building Standard® v1 with Q2 2018 Addenda

Controls are essential.

Circadian lighting varies through the day and night.

WELL Standard Credit 60



Manage glare.

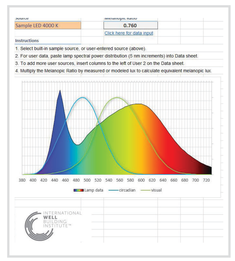
WELL Standard Credits 55 & 56

Positively Affects: Muscular, Nervous, Skeletal

Illustration Credit: The WELL Building Standard® v1 with Q2 2018 Addenda

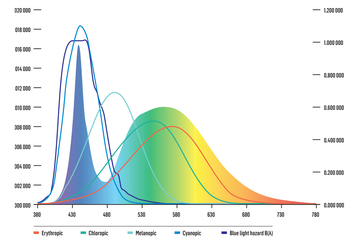
4 Methods

Method A: Melanopic Lux



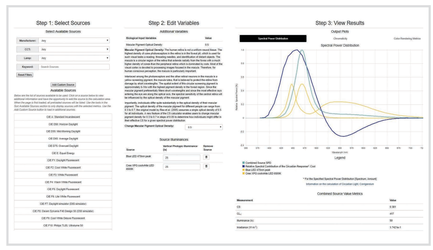
Credit: International WELL Building Institute

Method B: Spectral Optimization



Credit: Robert Soler / BIOS Lighting

Method C: Circadian Stimulus Calculator



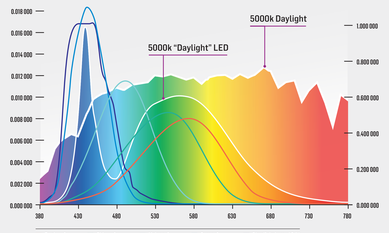
Credit: Lighting Research Center

5 Pitfalls

"Bluewash"

All blue light sources are not created equal.

We used to believe that color temperature was aligned with circadian response. Now we know that we need to look closely at spectrum. Sources with the same CCT typically have drastically different spectral composition.



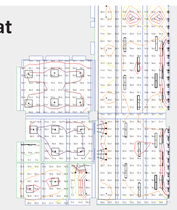
Credit: Robert Soler / BIOS Lighting

"Fake-a-white"

Tunable white does not equal circadian lighting.

Our bodies are adapted to respond to changes in spectrum, which in nature is represented with changes in color of light. Warmer color temperatures and lower intensity, which mimic sunset, are strong psychological cues for relaxation, while cool, bright white light is a strong cue for alertness. Even if the spectra do not align with those found in nature, psychological benefits are still important to consider.

Believing that horizontal illuminance is all that counts.



Forgetting about controls.

> "If light were a drug, I'm not sure the FDA would approve it."
>
> – Charles Czeisler, PhD, MD, FRCP
> Director, Division of Sleep Medicine,
> Harvard Medical School and Brigham and Women's Hospital

Resources

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