

Designers Lighting Forum

Light and health design:
start with a circadian heat map

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Learning objectives

At the end of this session, participants will be able to:

1. Explain why is it so difficult to design lighting for health.
The complexities of the different models will be explained in a way that makes sense.
2. Understand circadian heat maps as a tool. Whether retrofitting or new construction, we now see the non-visual benefits, design with knowledge, and lay out the space accordingly.
3. Discover how lighting designers, manufacturers, space planners and building owners can work together to ensure that building occupants receive the benefits of lighting for health.
4. Enrich property offerings with a tenant improvement option that distinguishes your properties from the competition.

Why is this important?

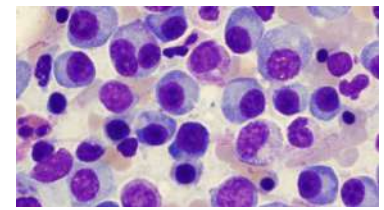
1. The science is conclusive: Our natural biological rhythms require bright lights during the day and dim lights at night for activation of the circadian system.
2. Our sleep “wanders” every day without this signal. Over time, this creates irregular sleep patterns, and can decrease alertness during the day, increase incidents of depression and diabetes, and other maladies.
3. People spend over 90% of their time indoors. With a focus on saving energy, we have dimmed indoor lighting to levels well below the thresholds needed.
4. Building owners are in a position to improve building occupants’ health through better lighting design. Business owners seeking new leases will rate “better employee health” over other location benefits.
5. Lighting designers now have the means to address the lighting requirements. Services are emerging to make it easier. Today, we’ll talk about one of those.



25 Years Accelerating Technology Adoption



Adam Lilien



Cancer Research



Why does innovation take so long to be adopted into markets?



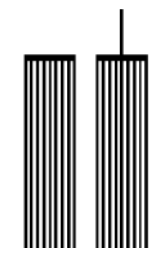
School of Architecture and Planning



Communication Design

7

Marketing and Advertising Firms



9/11



Life Safety Design, Manufacturing



LED Lighting on IoT Controls



UL Business Development, Lighting



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Some basics of light

Humans evolved with sunlight and moonlight
Fire was discovered ~1.5 million years ago
People spend 90% of time indoors
Horizontal light levels have been the focus



Sun: 100,000 lumens



Moon: 400,000 times fainter



Luminaire: ~ 3500 lumen output



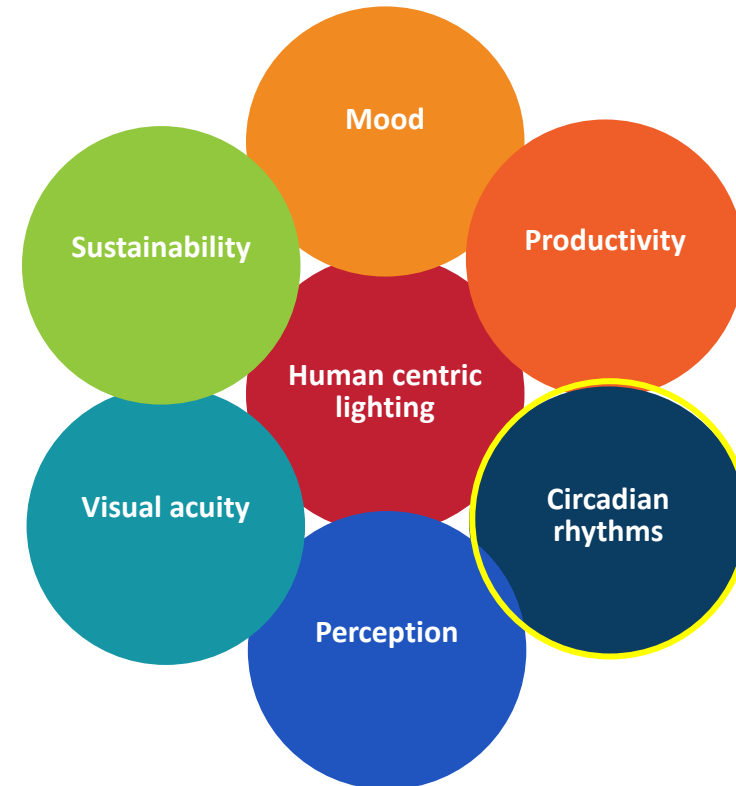
Office: ~ 400 lumens avg.

Terminology is new, inconsistent

“Human Centric Lighting is the concept describing the connection between lighting, health and well-being.

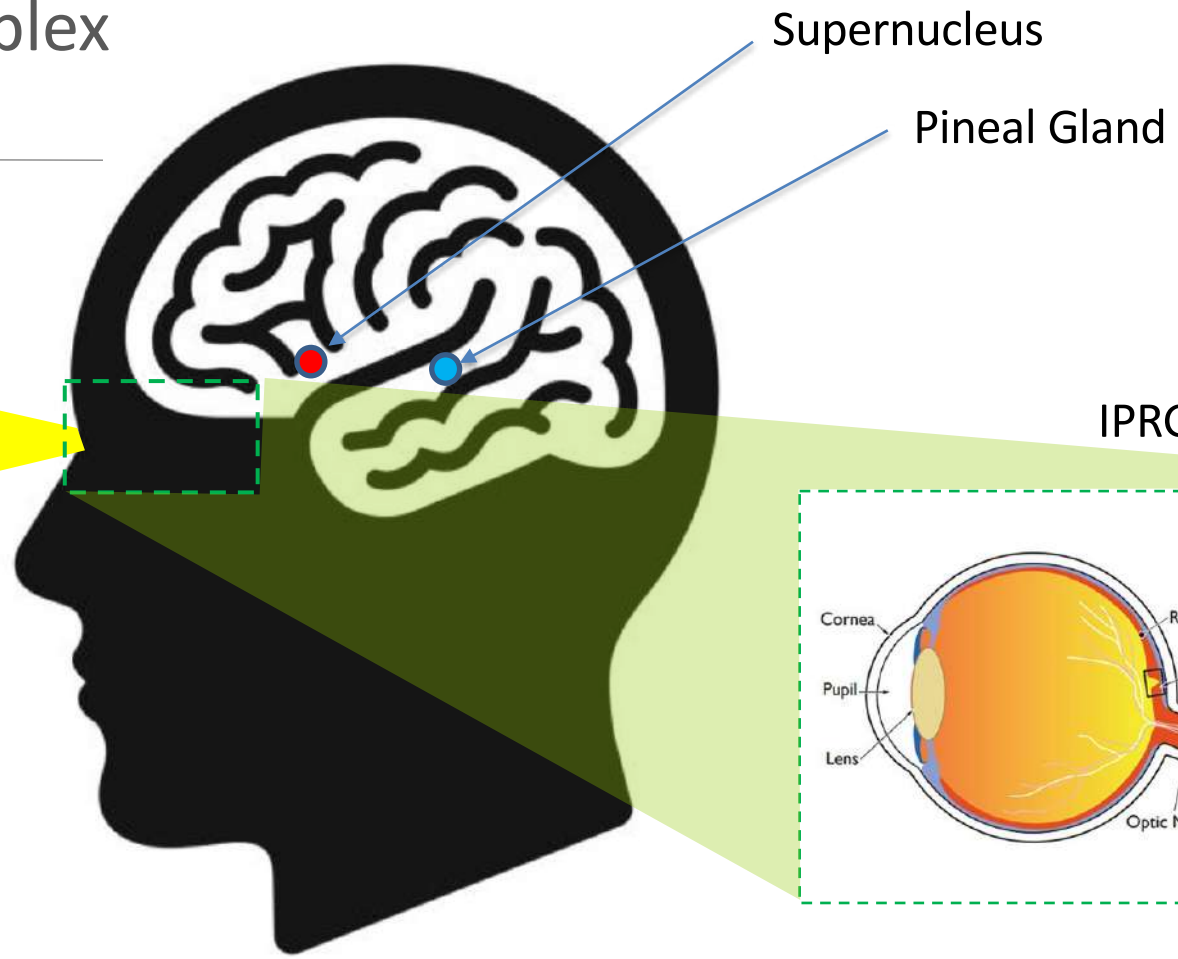
Lighting that focuses on people should balance visual, emotional, and biological benefits of lighting and promote good vision while satisfying the emotional and biological needs of the users.

The latest development and work done in the field in the last 15 years found that lighting, especially Human Centric Lighting, also stimulates non-visual effects on human psychology and physiology.”



Systems are complex

Timing
Duration
Spectrum
Amount
Distribution



IPRGCs

Circadian models

These are some of the most current models that **have been published** or are **being worked on**:

International WELL
Building Institute

DIN SPEC/TS

UL

CIE

IES

Circadian models

These are the most current models that **have been published:**



THE WELL BUILDING STANDARD

33,681 projects encompassing over 3.15 billion square feet are applying WELL across 109 countries.

Explore projects

<https://www.wellcertified.com/>

DIN SPEC/TS

UL



Circadian models

These are some of the most current models that **have been published:**

International WELL
Building Institute



UL



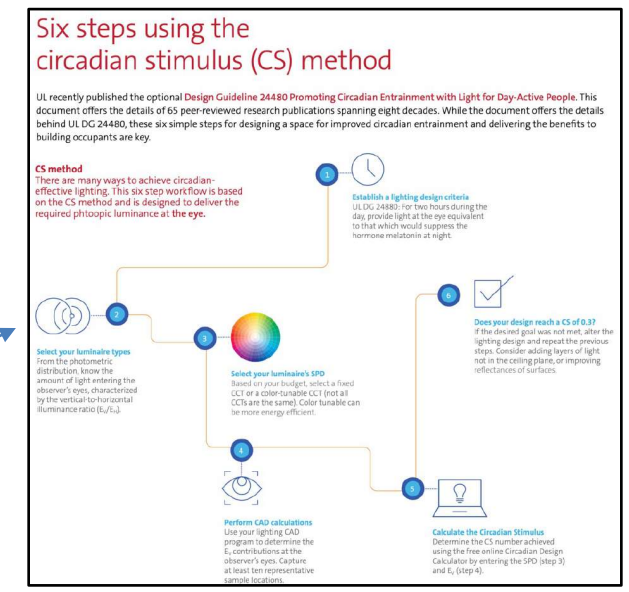
Circadian models

These are some of the most current models that **have been published:**

International WELL
Building Institute

DIN SPEC/TS

SEARCH
UL Circadian



Circadian models

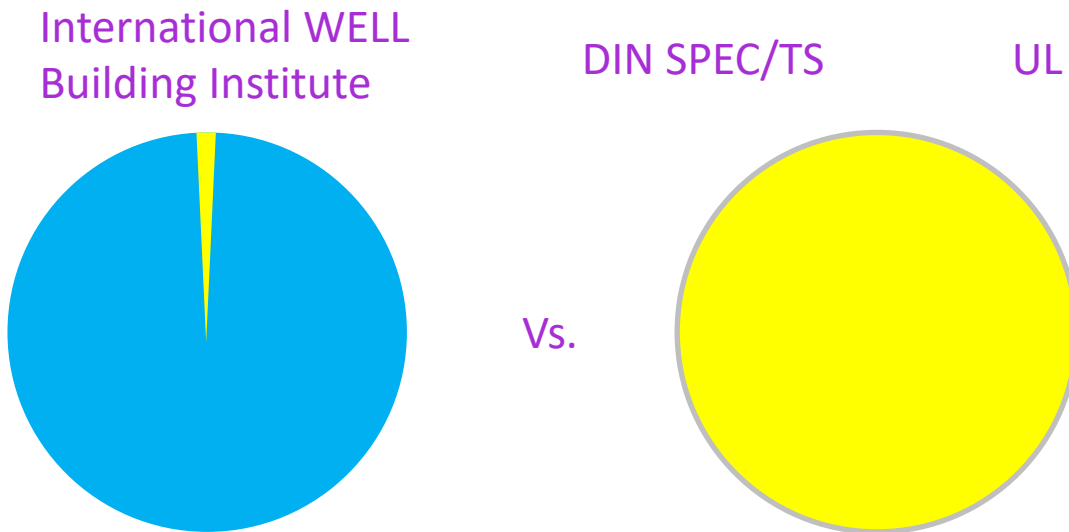
What is consistent among all of these:

Circadian entrainment can only occur when there is a robust 24-hour light-dark cycle. In other words, circadian entrainment depends upon bright light on the retina during the day and dim light at night.

Circadian models: What are the differences?

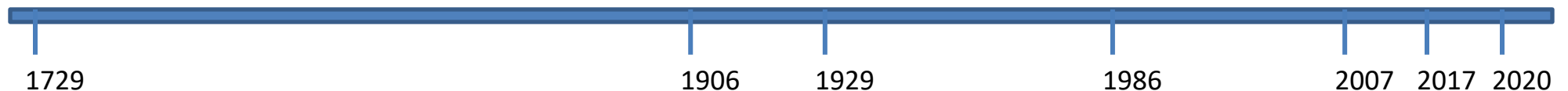
The slight difference is how one defines the requirements

The big difference is the focus: “Building Wellbeing” vs. “Circadian Lighting”



“The science is not yet known.” “It’s too early.”
“What if we get it wrong?”

- As early as **1729**, Carl von Linne constructed a “floral clock,” predicting petal opening and closing times
- **200** years later, Erwin Bunning provided the first evidence of genetic basis of circadian rhythms
- From **1906** through **1986**, observations of endogenously driven rhythms in primates, insects, rodents, birds, single-cell organisms and bacteria
- Cold Spring Harbor brought together the leading scientists to address aspects of biological rhythm, including Symposia on Biological Clocks (**1960**), Clocks and Rhythm (**2007**), and this year, Biological Time Keeping.
- 288 years after that initial observation, the **2017** Nobel Prize in Physiology awarded to three scientists for their discoveries of molecular mechanisms controlling the circadian rhythm
- National Institutes of Health (NIH) has funded millions of dollars in circadian rhythm research.



What we know.

From UL DG 24480

- Bright days and dim nights are essential to entraining our circadian rhythms
- As we spend our days indoors, we can lose the natural signals that we rely on
- Absent these signals, our rhythms tend to wander approximately 20 minutes every day
- Over a period of time, this may lead to less quality sleep and other known maladies, including:
 - Less alertness during the day
 - Greater reliance on stimulants
 - Higher incidents of diabetes and depression
 - Potentially higher incidents of cancer

Circadian models

Point of clarification:

The circadian stimulus sought for greater circadian synchronization is possible with “fixed” or “tunable” lighting, depending on:

- Your project goals
- Your budget
- The lighting designer’s knowledge

Learning objectives

At the end of this session, participants will be able to:

2. Understand circadian heat maps as a tool. Whether retrofitting or new construction, we now “see” the non-visual benefits, design with knowledge, and lay out the space accordingly.

Circadian heat map

A circadian heat map is a tool that expresses the circadian stimulus of the indoor lighting on a floor plan.

A room can be audited with a handheld lighting meter.

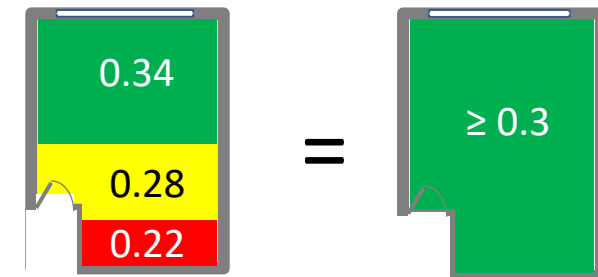
A larger space likely requires thousands of measurements to provide the proper amount of data.

The intent is to provide decision-making insights to lighting designers and space planners so that they can determine where to locate workstations so that lighting-for-health goals are met.

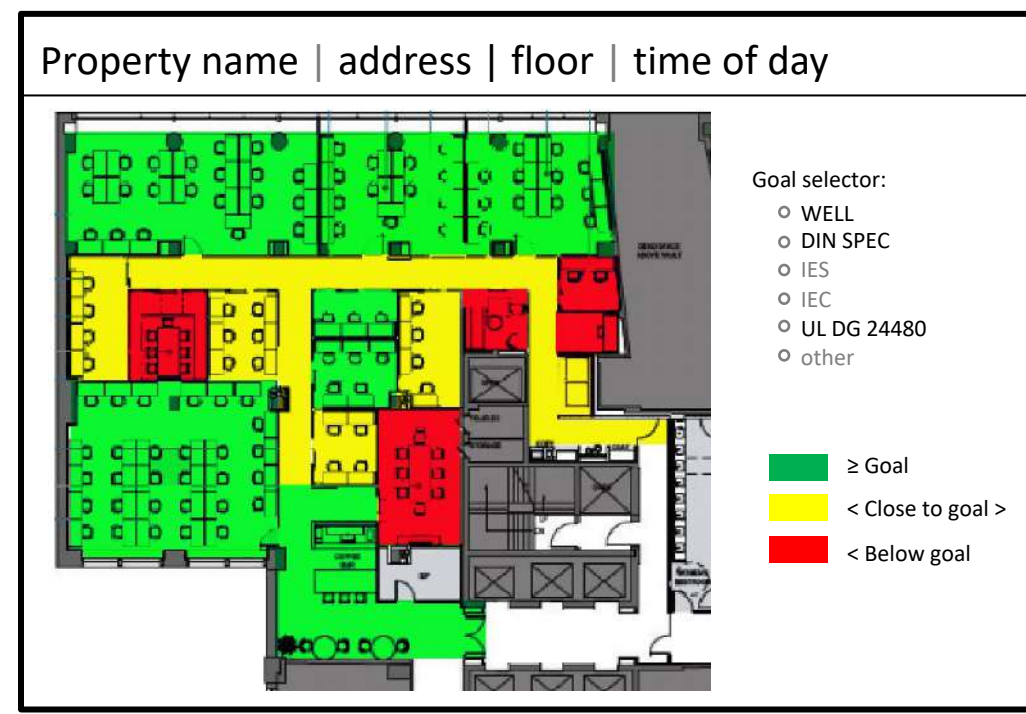
A space that achieves a model's goal = **GREEN**

A space that is close to meeting that goal = **YELLOW**

A space that is well below the goal = **RED**



Circadian heat map: example



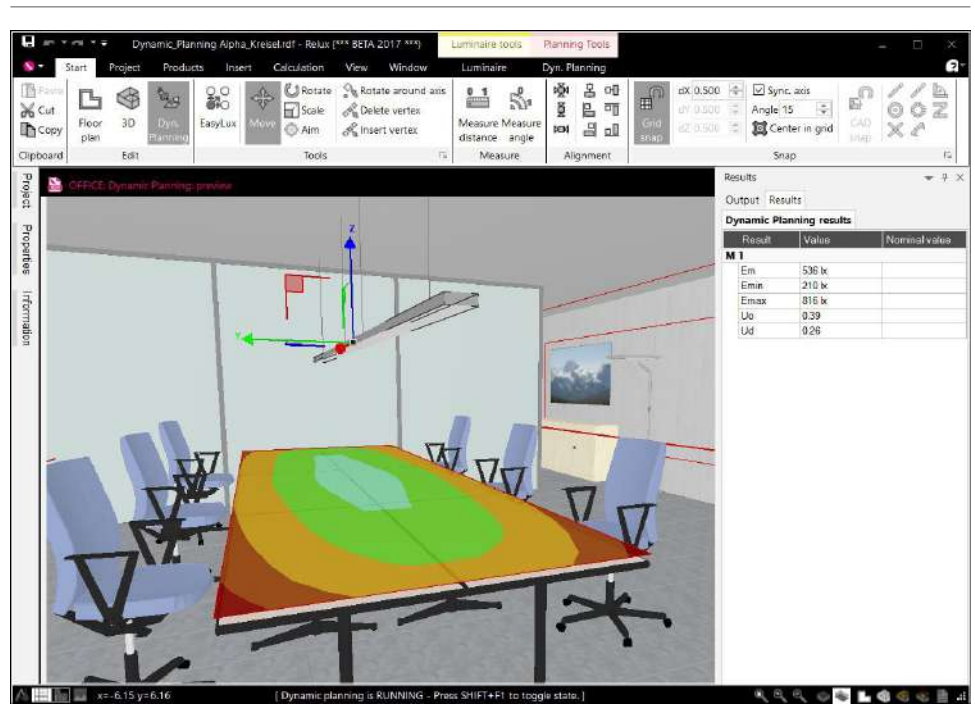
The circadian heat map enables us to “see” the non-visual benefits of lighting.

The heat map is a tool used during the design phase as well as the post-install/commissioning phase.

The heat map works for both retrofits and new construction.

The time of day for recordings should be a decision between the design constituents.

Circadian heat map: Goal

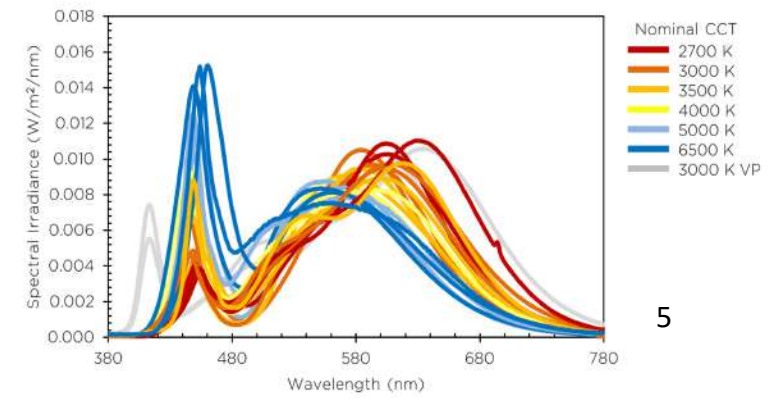


For areas designated for people to work, convert areas that are **below goal** to **≥ goal**

The lighting designer and space planner have options:

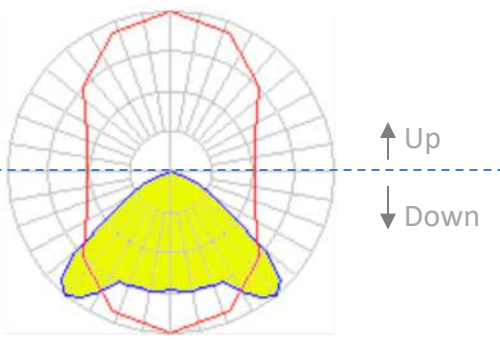
- Change use of space
- Alter controls to increase lighting
- Alter reflectivity (ceiling/walls/floor or furniture)
- Reorient workers toward the light source
- Create “lighting oasis”: break/common areas
- Alter SPD/CCT/H:V ratio...

Circadian heat map: what next?



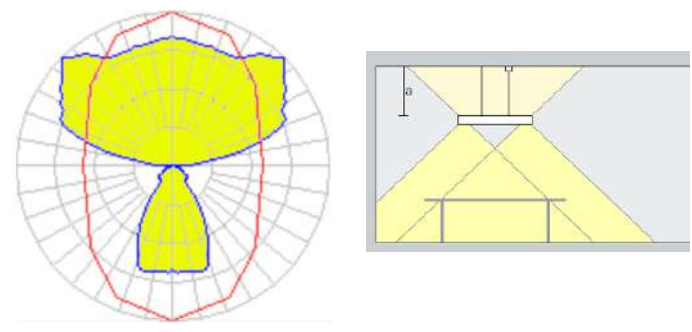
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Direct Recessed Troffer



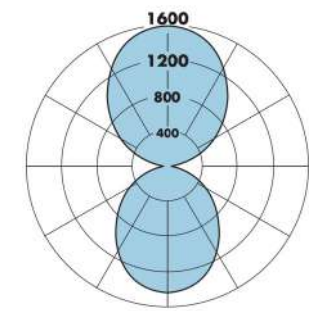
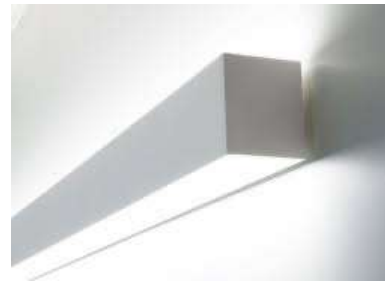
1

Direct/Indirect Linear



2

Wall Wash



3

Desk Lamp



4

1 <https://www.acuitybrands.com/products/detail/47676/lithonia-lighting/rt5>
 2 file:///Users/20545/Downloads/jilly-linear-pendant-17796_2057_1-web.pdf

3 Ref: FINELITE High Performance 4" Aperture (HP-4) - Wall Mount Indirect/Direct
 4 https://bioslighting.com/wp-content/uploads/2021/02/BIOS_SkyView_SpecSheet_v3-1.pdf
 5 Ref: <https://betterbuildingsolutioncenter.energy.gov/sites/default/files/attachments/true-colors.pdf>

Circadian goal

By delivering the right amount of light to the corneas of the eye during the day (volume/quality/duration), applied research has shown that sleep quality and quantity increases at night, sleepiness during the day is reduced, and symptoms of depression are less prevalent.

Learning objectives

At the end of this session, participants will be able to:

3. Discover how lighting designers, manufacturers, space planners and building owners can work together to ensure that building occupants receive the benefits of lighting for health.

Circadian heat map

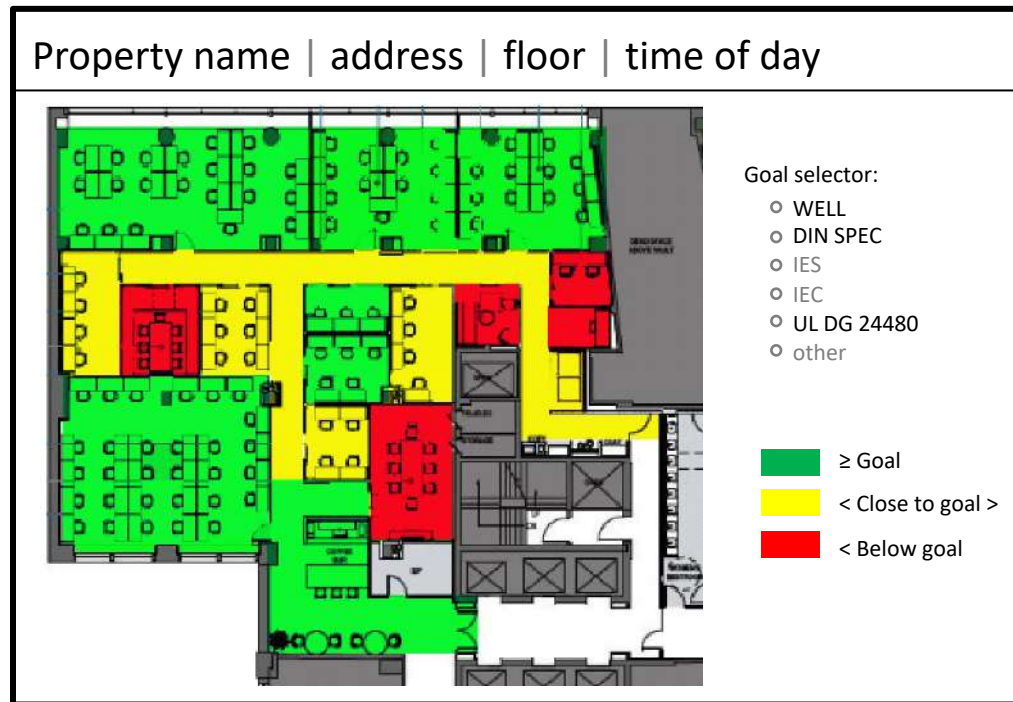
Spaces that provide bright light during the day and dim light at night help entrain the human circadian rhythm.

The best place to locate people is where the space = **GREEN**

The lowest cost spaces for lighting improvements = **YELLOW**

The best non-working spaces = **RED**

Circadian heat map: example

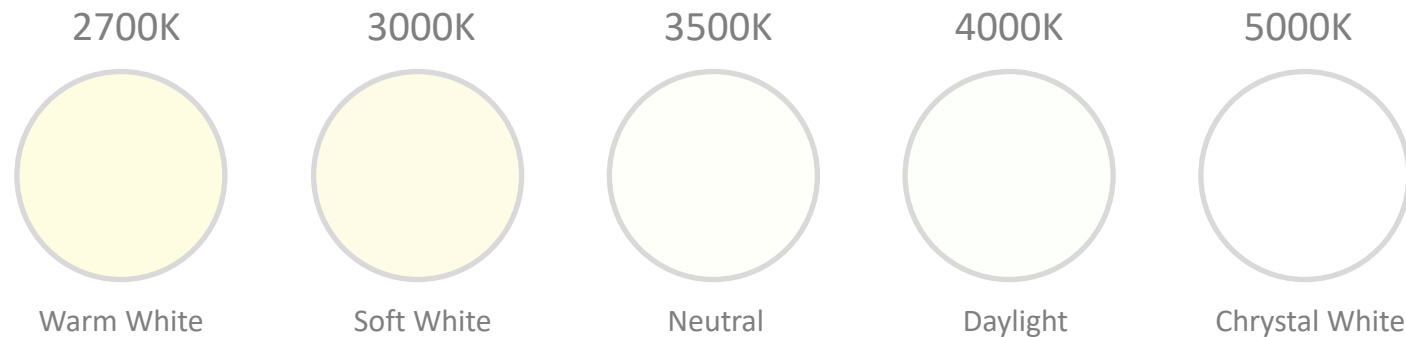


- **Lighting designer** – Determines where to add layers of light to increase circadian effectiveness. Considerations include timing, duration, spectrum, amount, distribution.
- **Space planner** – Determines where to locate people
- **Lighting Manufacturer** – Provides a new way to market and sell luminaires
- **Building owner** – Provides a tool to better value a property
- **Lessee** – Provides an objective tool to select one space over another
- **Lighting rep** – Provides a new level of service

Assumptions

The lighting designer determines the lighting approach based on client needs.

- Either “fixed Correlated Color Temperature (CCT)” or “tunable CCT” is acceptable
- Controls should rely on timing schedules
- Projects may be more energy efficient with tunable systems



Learning objectives

At the end of this session, participants will be able to:

4. Enrich property offerings with a tenant improvement option that distinguishes your properties from the competition.

Property improvements and valuation

Tenant improvements and betterments (TIB): Changes made to the interior of a commercial or industrial property by its owner to accommodate the needs of a tenant such as floor and wall coverings, ceilings, partitions, electrical, lighting, air conditioning, fire protection, and security.

Typically, the landlord pays for tenant improvements as part of the negotiation of a lease.

TIBs become part of the building and the landlord is therefore considered the rightful owner when they're installed. TIBs generally cannot be removed by the tenant without damaging the property.

For example, a TIB budget for Class A office space might be \$70 per square foot; a lease of 10,000 square feet might get a TIB budget of \$700,000. What if improving the lighting to include healthy lighting consumes roughly 8% to 10% of the budget?

Leasing office space: how to

1. Become familiar with the leasing journey
2. Determine if you should hire a broker
3. Assess your space needs
4. Develop a budget
5. Select a location and a building
6. Negotiate with landlords
7. Build out space
8. Pack up and move (if applicable)

What are lesees looking for?

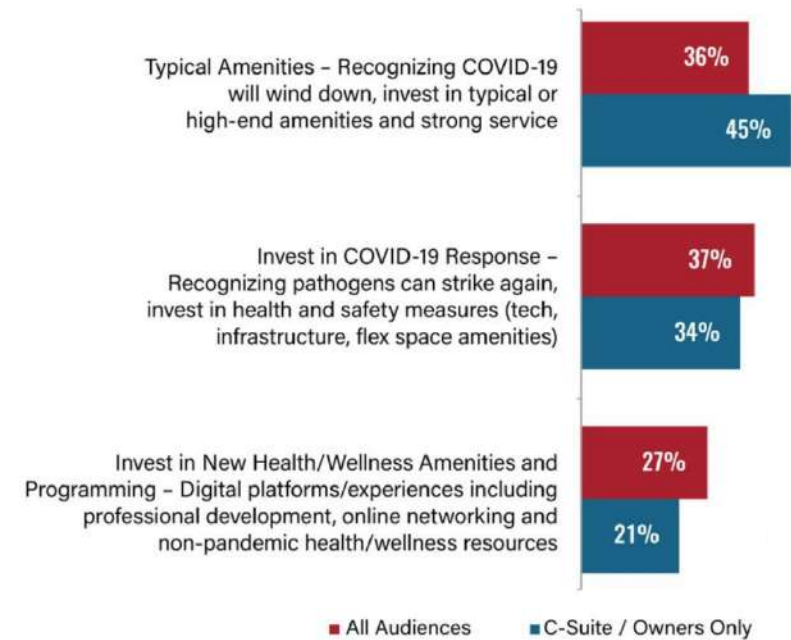
BOMA COVID-19 Commercial Real Estate Impact Study:

64% of respondents want building owners and operators to make additional investments that go above and beyond health and wellness measures put in place during COVID-19.

This includes either infrastructure and technology to mitigate future health emergencies or amenities, programming and platforms that support tenants' efforts to increase organizational culture, connectivity, productivity and well-being.

Key findings:

Investment Priorities – All Tenants vs. C-Suite/Owners Only



Property improvements and valuation

Prospects looking for new office space have an idea of where they want to locate.

They typically know about how many square feet they need, now and in the future.

They typically have a budget in mind.

Let's say that they decide they want 10,000 square feet in ZIP code 10019.

What are their selection parameters?

Property Selection: 10019 ZIP code

In early February, a popular search site listed 47 office spaces available.

Filtering on 9,000 square feet to 11,000 square feet, there were 14 building sites available, with 90+ spaces available.

Lease rates ranged from \$55-\$95 per square foot (of those listed)

Buildings were dated from 1910-2020

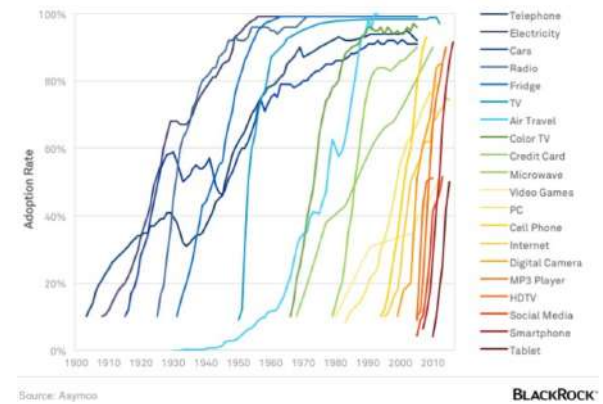
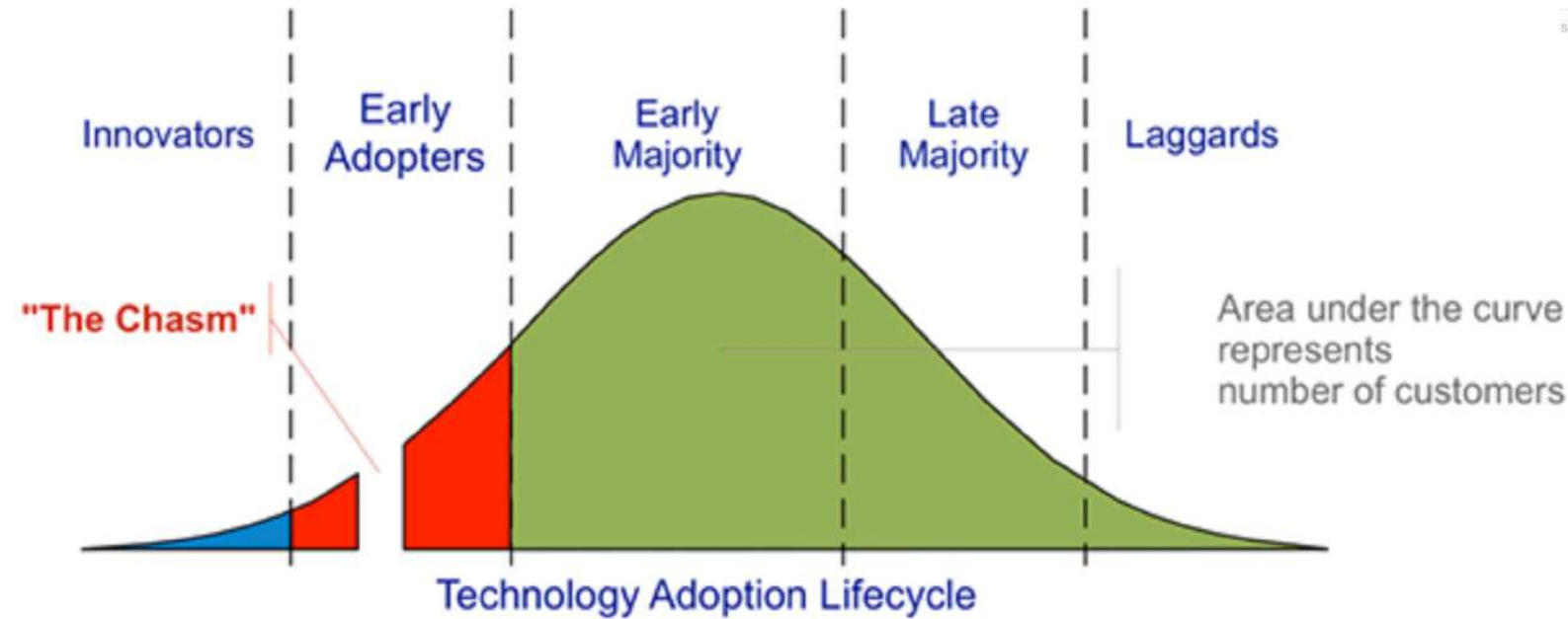
Building options include LEED Certified[®], WELL Building Institute[®], and UL Verified Healthy Building[®] Program.

Amenities included: concierge, food service, raised floors, natural light, Wi-Fi, balcony, etc.

One new building had a WALK SCORE[®] of 98, a TRANSIT SCORE[®] of 100, and a BIKE SCORE[®] of 86



Timing: Adoption of Technology



Adoption: Residential Technology

Ref: Crossing the Chasm, Geoffrey A. Moore



What's missing?

A few building owners seeking a better way to v

What's next?

Technology adoption is accelerated when Innovators win

- A few building owners seek a better way to value their portfolio increase tenancy
- Published case studies convince “Early Adopters”
- “Early Majority” want the benefits
- “Late majority” jumps in
- “Laggards” resist technology advancements

What's missing?

- A few building owners who seek a better way to value their portfolio
 - Select a pilot area to demonstrate circadian-effective lighting
 - Create a 2D Circadian Heat Map and close the illumination gaps
 - Demonstrate to prospects seeking a new lease
- A few lighting designers who seek a better way to serve their clients
 - Learn how to design circadian-effective spaces
 - Design several projects, achieving circadian-effective goals
 - Promote your new skills
- A few businesses seeking a better lease option
 - Sign a lease for a circadian-effective space
 - Promote the company's commitment to employee health
 - Participate in case studies



What's next?

Published case studies stating:

- The goals of the project: Light & Health
- The existing conditions
- The methodology applied
- Design decisions
- Installation and commissioning
- The results: light levels and health outcomes
- Testimonials of the client, designer, installer, end user

This concludes The American Institute of Architects Continuing
Education Systems Course



Thank you!

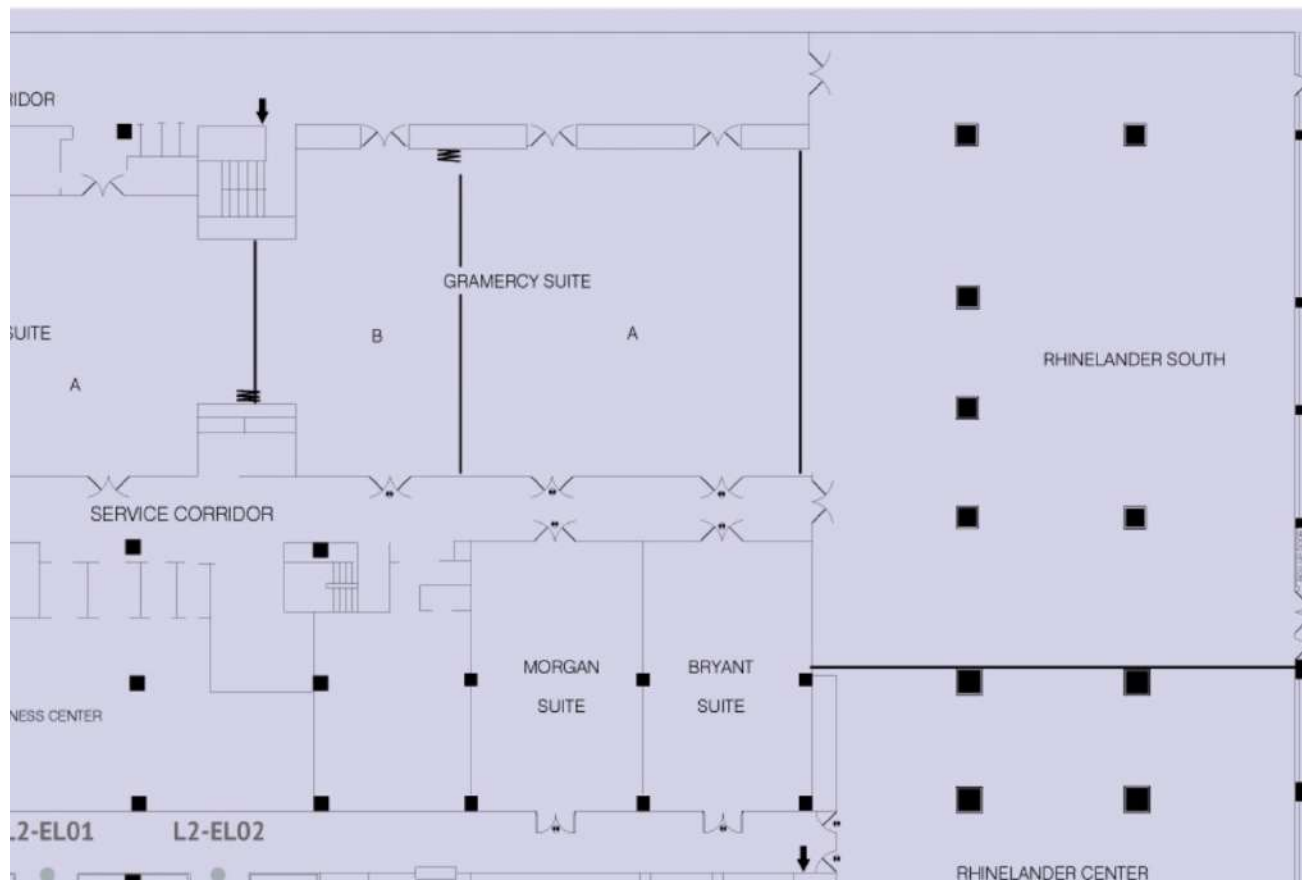
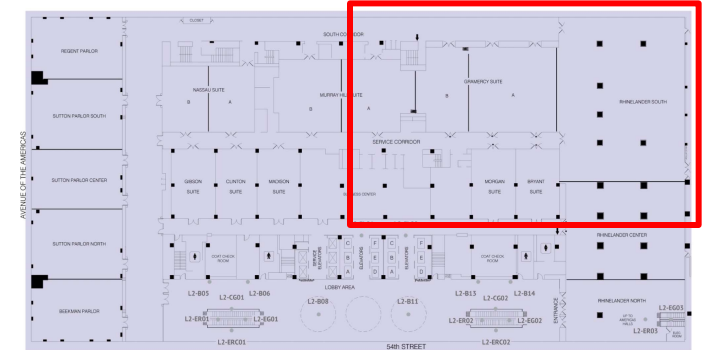
For questions, contact:

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Floor Plan: New York Hilton, 2nd Floor



DG 24480

Underwriters Laboratories, Inc.
**Design Guidelines for
Circadian Entrainment***



***Underwriters Laboratories DG 24480 provides optional design guidelines for promoting circadian entrainment with light for day-active people.**

▶ 2:27



New Option: UL DG 24480 Lighting for Health (also calculates WELL and DIN SPEC/TS)

Building owners looking for a competitive edge can include an option: Lighting for Health.

Based on UL 24480, the Design Guideline for Promoting Circadian Entrainment with Light for Day-Active People, this option delivers enough bright light during the day to entrain (synchronize) the human circadian system.

Requirement: As the primary lighting design goal, a minimum of two hours of circadian-effective light, equivalent to that which would suppress melatonin production at night by at least 30%, should be provided at the observer's eyes during occupied daytime hours (7:00 a.m. to 4:00 p.m.). In the evening (5:00 p.m. to 7:00 p.m.) and during the night (after 8:00 p.m.), levels of circadian-effective light at the occupant's eyes should be limited while still sufficient for performing visual tasks during these times.

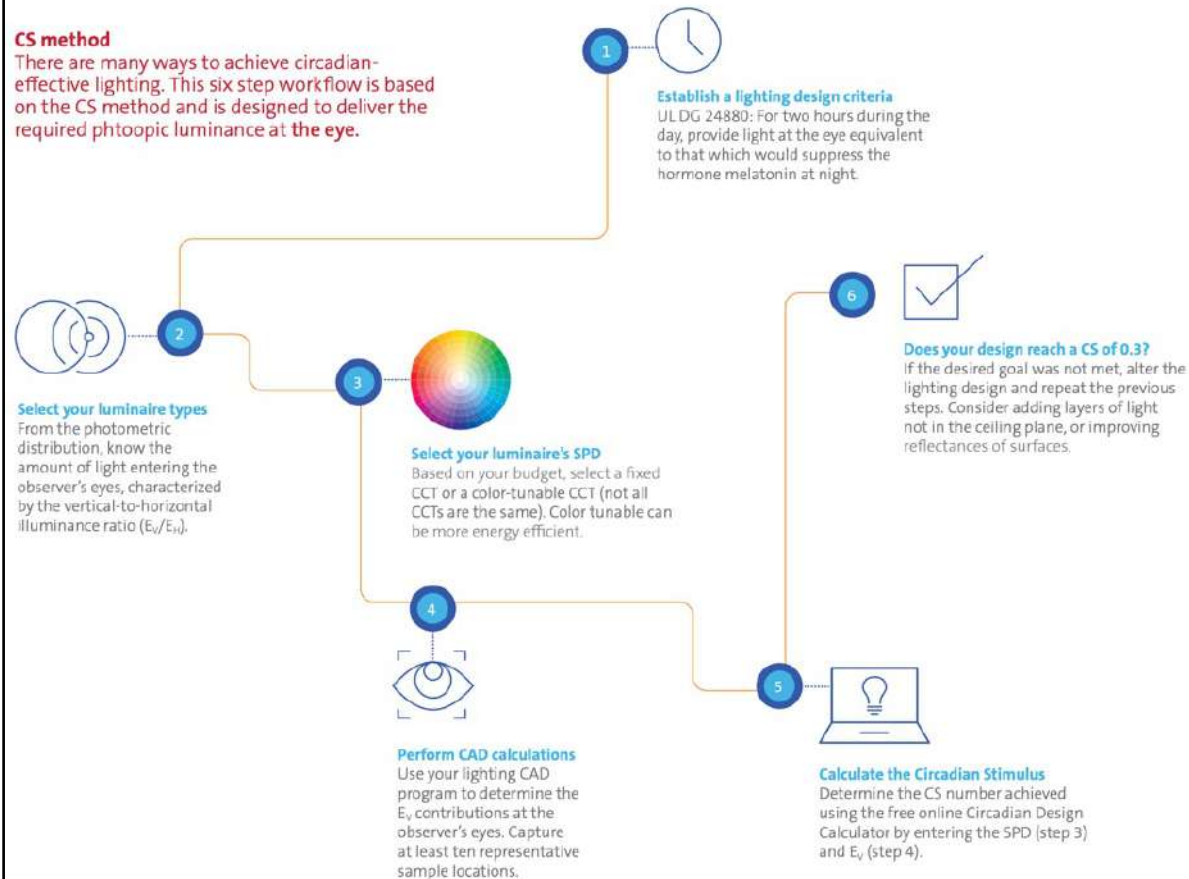
Based upon these design goals, three circadian stimulus (CS) design criteria: CS 0.30 (the primary design criterion), $CS \leq 0.20$ during the evening, and $CS \leq 0.10$ at night.

Six steps using the circadian stimulus (CS) method

UL recently published the optional **Design Guideline 24480 Promoting Circadian Entrainment with Light for Day-Active People**. This document offers the details of 65 peer-reviewed research publications spanning eight decades. While the document offers the details behind UL DG 24480, these six simple steps for designing a space for improved circadian entrainment and delivering the benefits to building occupants are key.

CS method

There are many ways to achieve circadian-effective lighting. This six step workflow is based on the CS method and is designed to deliver the required photopic luminance at the eye.



Six Steps for Lighting Designers

1. Select a circadian-effective design goal.
2. Select the luminaire types
3. Know your luminaire's SPD
4. Perform CAD calculations
5. Use the free CS Calculator.
Are the room's design goals met?
6. Calculate the Circadian Stimulus