



Healthcare and assisted-living facilities are considered solid early adopter opportunities for circadian lighting strategies. From left: 5500K, full 100%; 3800K, dimmed to 75%; and 400K, dimmed to 50%.

The power to heal

Growing evidence of the connection between lighting and health presents an exciting opportunity for the electrical channel. **by Craig DiLouie**

For millions of years, sunrise and sunset set the human body clock, or circadian system. This system produces and regulates bodily functions such as sleep/wake cycles, body temperature, and hormonal release based on 24-hour cycles, or circadian rhythms. These functions in turn are stimulated by light falling on specialized cells in the eye that convert it into neural signals. Today, humans spend the majority of their time exposed to electric lighting systems designed primarily for vision. People also spend large amounts of time with mobile devices. This creates risks of circadian disruption that can affect health and well-being. “Research now tells us that a disrupted circadian system is connected to long-term health, productivity, and behavioral problems such as fatigue, cancer, obesity, diabetes, depression, mood and sleep disorders, reduced physical and mental performance, and irritability,” said Bonnie Littman, president and CEO, USA Lighting (usailighting.com). “In essence, light is powerful and essential and can and should be used for the betterment of health and well-being.”

As scientists advance our understanding of light and health, the lighting industry is beginning to experiment with practices and products that can be used to create more circadian-friendly environments.

“There is currently enough evidence to claim benefits for individual health and happiness,” said John Hollander, director of brand development for Hubbell Healthcare Solutions (hubbelllighting.com). “Where care has to be taken is in claiming healing benefits or patient outcomes.”

The Lighting Research Center has identified four main characteristics that

influence light's impact on circadian health:

1. Intensity: the cumulative amount of light falling on the eye's photoreceptors throughout the day—an issue of vertical, not horizontal, light levels. This may be the chief influence.

2. Spectrum: the wavelength of the light. Visual acuity is most responsive to "green" (medium-wavelength) light, while circadian regulation is most responsive to "blue" (short-wavelength) light. Meanwhile, "red" light can increase daytime and nighttime alertness, making it important as well.

3. Timing: the point in time when light and spectrum are received by the eye's photoreceptors. A high intensity of blue light received in the morning will aid an early bedtime but can delay sleep if received in the evening.

4. Duration: the quantity of time of exposure. The circadian system responds slowly to light received throughout the day.

"We know with certainty that for normal populations, exposure to blue-rich light during the day supports optimal circadian health, and exposure to blue-rich light at night disrupts our circadian rhythms with negative consequences for sleep and health," said Scott Roos, vice president, product design, Juno Lighting Group (junolightinggroup.com), an Acuity Brands company. "The typical lighting scenario of working in a cool, brightly illuminated office during the day and a warmer, more dimly illuminated home environment during the evening is actually spot-on in terms of supporting good circadian health for normal populations."

THE DEVIL IS IN THE DETAILS

Current research doesn't connect health outcomes with specific lighting design strategies. Most research is conducted in laboratory conditions and with average responses. Additionally, nighttime light exposure is as important as daytime exposure, and individual lifestyle trumps all of it.

The lighting industry understands that light and health are connected, and

that lighting, as the application of light, can impact health. Practitioners have the basic understanding and tools they need to make lighting systems more circadian friendly. They're just not sure to what extent and for what percentage of people, and there's currently no best practice.

"The science of illumination is expanding with varying experts' views on applications and outcomes," Littman said.

"Creating new metrics to explain how light impacts our biological systems will be critical in realizing the promise that light has in its impact on health and productivity."

Hollander recognizes that current research suggests some general guidelines but otherwise the industry is still learning. "There isn't a recognized 'prescription' for the optimized spectrum, intensity, timing, and duration," he said. "We will likely see a 'prescription' or template in the future with the equipment to support it."

Ideal early applications include environments in which occupant activity and wake/sleep patterns are predictable, such as healthcare and assisted-living facilities. Roos said research is continuing and, along with the results of early-adopter applications, will reveal recommended practices. He said: "Our knowledge base and ability to provide more concrete information will continue to increase." By the time organizations such as the Illuminating Engineering Society publish a specific recommended practice, he added, the basics of circadian lighting will be widely understood.

"Additional tools will be used to guide us," said Littman. "There are new lighting metrics such as circadian light, circadian stimulus, melanopic lux, and others that are emerging to guide lighting product development and lighting design practice."

GENERAL GUIDELINES

"Research has shown that by providing exposure to natural light throughout the day or electric illumination where the intensity and spectrum are adjusted for the time of day, individuals experience a more typical sleep/wake pattern," said Hollander.

He points to research specifically recommending introduction of blue-rich

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—Scott Roos, Juno Lighting Group

light starting in the morning with an intensity of 30 to 40 vertical footcandles. The light would then transition to a warmer spectrum and lower light levels at late afternoon and into the evening. At home, intensity would then drop to one to two footcandles before total darkness at bedtime.

Looking at a typical commercial building with workers occupying it on a nine-to-five schedule, several elements are needed in the lighting design:

- The lighting must deliver sufficient light on vertical surfaces such as walls. Task lighting can efficiently provide high local vertical light levels.
- The lighting system must be properly controlled to automatically adjust intensity and optimal spectrum during the day on a schedule. Ideally, occupants will be exposed to daylight. If this isn't possible, they should be encouraged to take a 30-minute walk outside in the morning in daylight.
- Occupants should be educated about good nighttime lighting practices.

Circadian lighting and LED sources

products

with intelligent control are ideally matched. "We are starting to characterize the circadian content of various light sources, which is different from the visual amount of light as measured in lumens or footcandles," Roos said. "Understanding this will help us do a better job selecting the most efficient light source in terms of either eliciting a circadian response during the day or preventing it at night. As we continue the migration toward LED technology, we will have more refined ways to optimize the quality and amount of light both during the day and at night. For example, we can now spectrally tune LEDs to insert or remove blue content and can specify warm dimming as an option."

Distributors interested in circadian lighting should get educated about the latest research and principles and identify experts and manufacturers that can be used as a resource. Distributors may also benefit from being able to point out poor approaches, such as a space that operates during the day and night but maintains blue-rich, high-intensity light at night instead of adjusting to warmer, lower-intensity light.

"Like any new field, it will likely take at least a decade to become mainstream, but it creates a great opportunity for distributors to lead their organizations into this emerging field," Roos explained. "It's an opportunity to create a network of experts that allows a distributor to

step into a noncommoditized 'blue ocean' field and differentiate itself in its served markets."

"The convergence of growing research on the connection between lighting and health and the capabilities of solid-state lighting and controls presents an exciting opportunity. We can dramatically change our approaches to lighting spaces and deliver a new level of interaction between occupants and their space," Hollander concluded. ■

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