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ARCHITECTURAL LIGHTING

Tunable white light and its benefits become more accessible

New technologies and products offer lighting designers, architects, and building owners customizable solutions to improve occupant productivity, health, and well-being.

Gregory Kay ▪ June 28, 2023 ▪ 7 min read





Tunable white technology enables the independent control of color temperature and light intensity within a given application. The color temperature of the light can change from warm to neutral to cool in appearance over time, based on the needs of the occupants or space.

The pandemic has changed how we think about offices, remote working, and employee workplace needs. While many office positions have allowed for remote work since 2020, many workers are being asked to return on-site today.

To entice employees back to the office, building owners and company facility managers have implemented strategies to improve indoor air quality and overall interior environments. Lighting is also critical as it affects people's productivity, health, and overall well-being.

In 2017, the American Society of Interior Designers in partnership with Cornell University, Delos, and the Innovative Workplace Institute researched the impact of workplace design on behavior and performance; the impact of spatial design on organizational goals; and the impact of design on human, organizational, and environmental sustainability. The study, discussed [here](#) and [here](#), found that 68% of employees were dissatisfied with the lighting situation in their offices. In other

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Today, tunable white lights are a reliable technology that can support alertness and productivity in an environment by helping workers maintain their natural circadian rhythm.

Advancements in tunable white light technology

Tunable white or Kelvin-changing LED lighting allows for the adjustment of correlated color temperature (CCT) and/or the brightness of a light source. Tunable white LED lighting combines the output of multiple diodes—typically a warm white LED and a cool white LED with a linear cross-fade or blend between them forming the basis for the light source's tunable white color spectrum. CCT spectrums might range from 2000K to 4000K or 2000K to 6500K.

Naturally occurring white light from the sun promotes alertness and focus; it also follows the blackbody curve. Although conventional two-channel, linear tunable white allows for color temperatures that mimic natural sunlight, it does not follow this curve, which would enable a wider spectrum of tunable white tones. Instead, it can only produce accurate white light at the base points—or color temperatures—at the ends of the given spectrum because no other light sources (RGB) influence the spectrum. The behavior of the color profile is linear rather than a parabolic curve as is seen in this blackbody curve diagram.

Forward-thinking luminaire manufacturers are taking tunable white lighting to a higher level of quality and consistency. One product line, for example, adds three LEDs—red, green, and blue (RGB)—to the two existing tunable white channels. The RGB diodes, combined with warm white and cool white diodes, bend the light source's linear color profile, allowing it to follow the blackbody curve across the entire spectrum. The product's spectrum of possible CCTs ranges from 1500K to 6500K, producing a palette from warm amber—think candlelight and sunset—to the bright white light of the midday sun. With these color profiles programmed into the available five-channel controls for RGB+TW, these color temperatures are reproduced efficiently, allowing users to harness the beauty and benefits of natural light.

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more white light exposure during work hours and slept an average of 46 minutes more per night than those working in windowless environments. This suggests that illumination that mimics the sun—something electric light once could not accomplish—delivers better-quality light.

Benefits of human-centric lighting

A [2013 study of human-centric lighting](#) in five government office buildings by the Rensselaer Polytechnic Institute's Lighting Research Center (LRC) **found** that employees working under human-centric tunable lighting had better sleep and lower levels of depression and stress than those who did not. Additional studies have shown the impact of light's spectral content and intensity on circadian rhythm. For example, too much blue light at night can undermine sleep.

In 2016, property company CBRE Netherlands along with the University of Twente and Vrije Universiteit Amsterdam installed time-controlled, Kelvin-changing lighting at CBRE's Amsterdam offices. High illuminance levels and cool, indirect white light were used in the morning and early afternoon; warmer, lower levels were used at midday and in the late afternoon. Approximately 120 employees were surveyed over a seven-month period via questionnaires, biological data, and interviews. The employees working under the new, modern light settings experienced notable benefits, as noted in [this paper](#):

- Increase in productivity of 18%.
- Improvement in work accuracy of 12%.
- Increase in employee happiness by 76%.
- 71% of employees felt they had more energy.
- 50% of employees felt healthier.

At the study's completion, the office returned to its original lighting conditions. One of the first things the participants requested? Resuming the new lighting settings.

Lighting effects

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significant company savings when multiplied by an entire workforce. The link between natural light and employee happiness has led to many design requests to maximize natural light and outside views.

But not every facility can accommodate more windows, nor are all building owners able to afford this retrofit. A more attainable solution is tunable lighting. Lighting companies are partnering with manufacturers of smart control systems to bring dynamic color-changing lamps, architectural fixtures, and smart wall controls to make tunable lighting available to more people. Smart control systems can offer user-friendly installation, easy-to-program schedules, and customizable scenes.

Out-of-office tunable white applications

Tunable white light has many applications outside the office. It is used in nursing homes to treat dementia and psychiatric hospitals to curb aggressive behaviors. Adjusting lighting from warm white to cool white can evoke calm to alert behaviors, providing a holistic method for supporting the treatment of mental illness.

In classrooms, tunable white lighting can increase attentiveness and improve the sleep cycles of students (especially teenagers) by reinforcing natural daylighting cycles of intensity and coloration. Warm lighting can help calm students before they begin a test while cool lighting can enliven their attention during a lecture.

In the retail, restaurant, and hospitality industries, varying light output and coloration during the day can enhance the ambience of a space, potentially boosting sales. For example, a restaurant may dial in higher light levels and cooler color temperatures for breakfast and lunch, but select lower light levels and warmer coloration for dinner time.

Tunable white lighting metrics

Two specifications currently exist for circadian lighting, one promoted by UL and the LRC and the other by the WELL Building Standard. Both institutions use metrics that aim to quantify the impact of lighting on melatonin suppression based on lighting in the vertical illumination plane, or the amount of light entering the eye.

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effective lighting design that is based on a metric the LRC developed called Circadian Stimulus. The WELL Building Standard uses a metric it developed called Equivalent Melanopic Lux.

Since its introduction more than a decade ago, tunable white lighting has become more cost-effective. Tunable white LED light sources and the control platforms continue to improve while their cost premium over standard LEDs and controls decreases. App-based platforms that communicate over Wi-Fi have replaced complex, hardwired, RDM- or DMX 512-based systems used in tunable lighting's early years, offering both labor and material savings while providing the same features and benefits.

Tunable white light can have profound effects on both the physical and mental health of building occupants in myriad verticals. The latest improvements to the technology can help designers, building owners, and managers to provide a positive experience for everyone.

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Gregory Kay is president and founder of PureEdge Lighting. He has worked in the lighting industry for more than 30 years as an...

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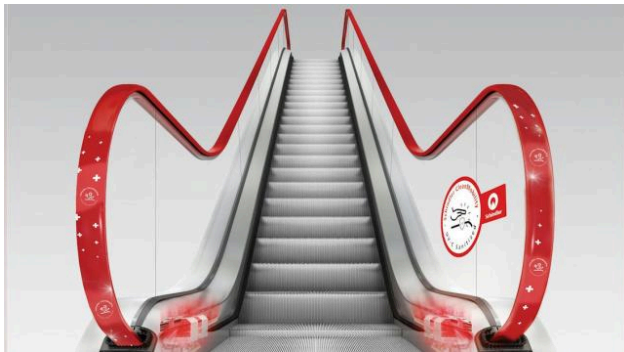
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