



Bulb testing. Photo: courtesy of the Lighting Research Center

## Elements of Lighting – Part Three

by John Copeland

Perhaps no subject is as enmeshed in our ways of speaking about and relating to the world as light. Truth, knowledge, insight – all are understood on the basis of vision and light.

Yet there are dimensions to light with implications for health and performance that we have only recently begun to grasp and that are only now becoming a hot topic for workplace design. In the third and final installment of a series on lighting in workplace design, we'll explore the ways in which lighting is closely wired to our wellbeing.



An Egyptian pharaoh catching rays: this stone block portrays King Akhenaten as a sphinx, and was originally found in the city of Amarna/Akhetaten. The object is now located in the Kestner Museum of Hanover, Germany. Photo: by Hans Ollermann

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**The Light and Health Connection**

In the 1990s, researchers identified cells at the back of the eye with a strictly non-visual function. These exquisitely specialized cells, clumsily referred to as ipRGCs, sense a specific, blue-light portion of the light spectrum (wavelengths of 460 to 480 nanometers in length) and transmit what they “know” to the brain.

The brain takes this information as its cue to release a cascade of chemicals that induce sleep, incite alertness, instigate action, improve our mood and so forth.

The scheduled release of these chemical signals that ready us for the day (pancakes!) and lull us to bed is our circadian clock. This clock is the outcome of our long courtship as a species with the natural cycle of light and darkness. The process of winding the clock is known as entrainment.

**Circadian Disruption**

Increasingly, our clocks are wandering.

Prior to the 1930s, commercial buildings used natural light for interior illumination. Building site orientation was taken into account, narrow floor plates were maintained, ceilings were raised, and windows with high sills stretched up to the ceiling to maximize daylight penetration into the space; New York City’s Flatiron and Woolworth buildings are prominent examples of this.

But with the standardization of electrical infrastructure and the growth of commercial lighting and HVAC systems in buildings, floor plates widened, ceiling heights shrunk, and window design changed – the net effect being a reduction in the overall amount of daylight entering these spaces. Buildings achieved autonomy from daylight.

As result of this evolution and broader economic and cultural changes, a case can be made that people today spend the majority of their time

indoors without maintaining sufficient connection to the daylight cycle.

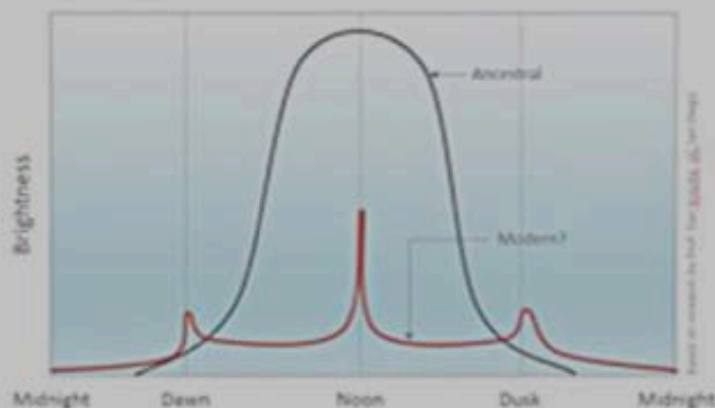
The inefficiencies created by this circadian disruption take a toll on health and performance.

Fortunately, we can do much to improve upon this.

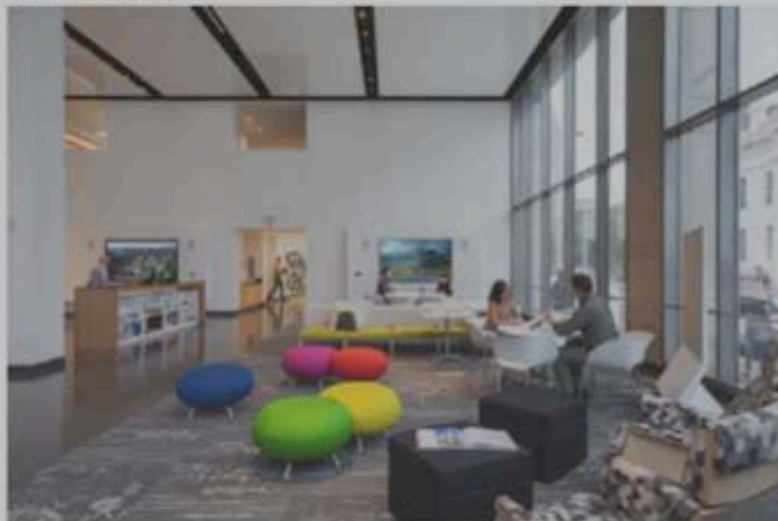
“The work environment is where we have the greatest opportunity to receive the entraining light we need

daily, especially in the winter months, when some of us go to and return from work in darkness,” said Dr. Mariana G. Figueiro, Ph.D., professor and Light & Health Program director at the **Lighting Research Center (LRC)** at Rensselaer Polytechnic Institute.

The workplace is an opportunity for circadian stimulation and for restoring a healthful circadian connection.



*This graph illustrates contemporary daylight exposures versus the ancestral exposure level that is the basis for “standard time,” essentially, on the circadian clock (or the fact that there’s a clock at all). This and other research makes the point that office-bound people are getting nowhere near the daylight exposure the body expects. Illustration: courtesy of Mudit Saxena, principal of Vistar Energy Consulting, based on research by Professor Dan Kripke, University of California, San Diego.*



*The St. Louis offices of HOK: The common gathering area features flexible furniture and seating arrangements to accommodate impromptu work sessions. Photo: by Sam Fentress*

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Designing for daylight (again) is a critical first step, and the open office trend has helped, as open offices typically create access to daylight and views.

Energy codes have also begun to mandate daylight autonomy, meaning that a percentage of a space must be illuminated by daylight a portion of the time. This requires that buildings actually let in daylight and utilize lighting systems that dim in response to detected daylight levels, saving energy.

However, daylight is a dynamic resource that needs to be managed dynamically. Manually operated window-coverings aren't dynamic enough – once lowered, they usually stay lowered – and static louvers and overhangs “tax” the office environment on overcast days by thwarting usable daylight.

But even with a dynamic shading system, supported by light shelves, light-colored floors, low or visually transparent (i.e., glass) workstation walls, light wells, skylights and tubular daylighting devices (TDDs), sky conditions are variable and daylight penetration into the interior remains limited.

#### Circadian Lighting: Adding Layers for Individuals and Groups

Biological research into the effects of specific types of lighting has combined with the near simultaneous development of tunable white light LEDs to make circadian lighting a live option for workplace design.

Tunable LED technology allows the color and intensity of electric light to be adjusted to reproduce the effects of the natural daylight cycle.

“While we may need more watts to accomplish it, it can be an adequate substitute for daylighting, at least when it comes to delivering the same circadian stimulation,” said Dr. Figueiro.

**USAI Lighting's** Color Select product, for example, enables the selection of specific light color temperatures and intensities. With the potential for morn-



*HOK St. Louis: The design studio's work areas foster process, collaboration and community. Photo: by Sam Fentress*



*USAI Lighting Color Select office light settings. Photo: courtesy of USAI Lighting*

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ing and evening scenes for shared, functional, and even individual fixtures, the system is able to provide circadian lighting that helps with entrainment to restore a healthful synchronicity with the wider world.

With task or workstation lighting, there's an opportunity for an even more granular approach to circadian lighting.

"If the individualized lighting is linked to your own cubicle or

deskspace, which can be easily done," said Dr. Figueiro, "then open plan and shared offices are still feasible. This is why the ceiling fixture is not going to be as important."

The benefit of linking lighting to individuals as opposed to groups is that lighting treatments can be tailored to complement personal light exposure levels monitored through a Fitbit-like, wearable device. The idea is to account for the context of one's actual life.

In an effort to achieve this, the Lighting Research Center is working with the Swedish Energy Agency and the U.S. Department of Defense on a phone app that would generate such a "prescription" for circadian lighting based on an individual's recorded light exposure.

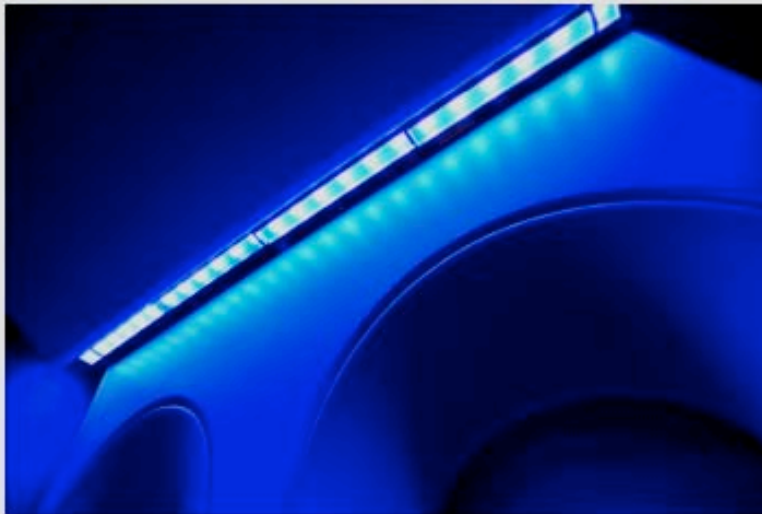
#### Bottom-line Benefits

The benefits of high quality lighting design are difficult to understand, and an increasing amount of research on the topic is making it difficult for clients and designers to ignore.

"It's about employee performance and satisfaction," says Ann Schiffrers, senior vice president for Specifications Sales at USAI Lighting. "It's an investment that will pay itself back." Ms. Schiffrers cited reduced absenteeism and health problems, a reduction in associated healthcare costs, and increased participation and productivity.

Lighting design is also about keeping up. Offices are not only competing with each other for talent, but also with other spaces as a result of connected devices that allow people to work anywhere.

And while people are, in fact, working everywhere – at home, in cafes, at the pub, in the airport, at the pub in the airport, and even on the airplane – untethered, seemingly, to any specific location, a desire to return to a physical space is a common urge. The question is: what kind of place will keep people coming back? ■



Airplane lighting. Photo: courtesy of the Lighting Research Center



Airplane lighting: The Lighting Research Center (LRC) developed innovative and efficient lighting solutions for the Boeing 787 Dreamliner. Today, one of the most remarkable features of the Dreamliner is the interior cabin, illuminated by dramatic overhead lighting that resembles an infinite blue sky. The *New York Times* describes the lighting as "ice bluish-purple for boarding; deep-purple for relaxing; copper during meals; dark, bat-cave blue for sleeping; and a warm blend to help wake passengers for landing. On long flights, the lighting can be used to simulate a full day to help combat jet lag." Photo: courtesy of the Lighting Research Center.