# Human Centric Lighting – Holistic Designs Enhancing Our Environments

With a new Millennium comes a melding of ideas and technologies within the lighting industry. Human Centric Lighting is the belief that your mood can be positively affected by the intensity and color of the light you work under. And that the daily cycle of light is something that regulates our body's chemistry. Moreover, there is a growing volume of tests which confirms this. But the ability to control the color and the quantity of light is a recent improvement that could have only been achieved with solid state lighting (LEDs.)

150 years ago most people spent their days outdoors. We got up with the sun, worked under an open sky and returned to our beds when the sun set. This cycle has existed for thousands, if not tens of thousands of years and it is an intricate part of the human experience. Our bodies come programmed to be in rhythm with this natural cycle. But as a result of today's modern, 24/7 society we have a problem.

Since the invention and adoption of the electric light bulb, human beings have attempted to redefine themselves by extending the amount of "daylight" in their lives. But we have done this without fully understanding our fundamental physiological need for the day/night cycle. This cycle is known as circadian rhythm. And our bodies take their cues from the intensity and quality of the natural lighting around us.

As a direct result of Edison's light bulb, however, we have forever changed how we live and work. Traditionally, we spent 90% of our time outdoors under natural light. But for more than a century, we have spent nearly 90% of our lives indoors under electric light. And while at work, the lighting we use is set to a single intensity and color that never varies throughout the day. This is inconsistent with our natural circadian rhythm. Without regular and direct exposure to these natural and dynamic lighting changes, circadian rhythm can be disrupted, which can lead to health issues.

Specifically, light and darkness control hormone production. During daylight hours within a natural circadian rhythm, dopamine is secreted for pleasure, alertness and muscle coordination; serotonin for impulse control and carbohydrate cravings; and cortisol for stress response. At the night, melatonin is released in our body which allows us to sleep and wake up refreshed.

A recent discovery has been made of photosensitive retinal cells (ipRGC) which have been found to be important in setting your internal clock. These cells are especially responsive to lighting that is rich in blue content similar to the mid-day sky. (Typically sky light can be up to +10,000°K.) The intensity of the blue has been proven to suppress the production of melatonin while encouraging the production of dopamine, serotonin and cortisol. Simply stated this means that greater exposure to blue light during the day can lead people to be more alert and productive at work, or even during night shifts. But exposure at night can disrupt the production of melatonin which can cause sleep issues. Sleep is one of the basic physical requirements (after food and water) for humans to function well. The amount and quality of lighting invariably affect the degree and quality of sleep in humans.

Research in Europe and the U.S. has shown that varying light intensities as well as color throughout the day can have beneficial effects. One study was done by Philips Lighting in a U.S. public elementary school to test the idea. The classroom lighting was set to 12,000°K for the first 30 minutes in the morning to shut down remnants of the children's sleep cycle and "turn on" their day cycle. For "normal" study and learning activity times, color temperatures were set between 5000°K and 6500°K. They also found that the light intensity level could be doubled for classes requiring reading and writing. After recess and during rest time, classrooms were set to 2700°K for a calming effect. Results to date have demonstrated an increase in academic performance that was 33% higher than the performance of a control group which had no changes in lighting intensity or color during their school day.

The Philips study was done using fluorescent fixtures. And there are plans for similar studies to be done using LEDs. The "bright side" of LEDs as opposed to fluorescent is that they can generate more lumens per watt. Another plus is that LEDs are a "Green Technology" because they lack the mercury that is present in fluorescent tubes. Changing fluorescent fixtures with LEDs is easy with either RGB or low and high Kelvin temperature white LEDs, when dimming one more than the other. Why is this important? Imagine coming back from lunch and feeling tired. Instead of drinking coffee or another caffeine stimulant, it may simply be a matter of increasing a fixture's color temperature and intensity level to feel more focused and awake. This type of "tuning" could theoretically be accomplished daily and controlled in an office, school, hospital or home setting to match the color temperature outside the building, which may assist proper internal clock alignment.

The intensity and color temperature from all light producing technology should also be considered. Why? Because there are people who have a difficult time falling asleep at night. What might be a causal factor? One reason may be computers and tablets that are used up to 2-3 hours prior to bed-time. Most of these devices are relatively bright and have a high content of blue light. A lower Kelvin temperature light at night would be better. This is why some hospital ICUs and nurse stations use red or amber light at night. Beyond energy levels in people, lighting is being studied as to how it affects people's moods. It's been shown, for example, that "nature scenes" help reduce human stress in medical settings such as MRI chambers.

Besides the way we may feel or react based on color temperature and intensity, lighting affects visual acuity. Light sources that have higher amounts of blue light stimulate the ipRGC photoreceptors, which in turn make the pupil of the eye smaller. This results in better visual acuity so we see more clearly under otherwise identical lighting conditions. The term used to describe using the spectrum in lighting design to affect visual acuity is "spectrally enhanced lighting." To illustrate this idea consider being able to read one smaller row of letters on your eye doctor's chart. This could be accomplished with a 5000°K fixture compared to 3500°K fluorescent lighting under the same conditions.

Not everyone accepts the idea that changes in color temperature and intensity can positively affect the workplace or education. But, so far, the body of evidence indicates that the benefits of spectrally enhanced lighting are real and significant. Imagine if this lighting methodology were used in factories, office buildings and schools. What improvements could we see? If we see a 5-7% increase in corporate productivity and student comprehension, I would consider that a successful application of an idea. And if these ideas are built around LEDs, the long term energy savings will also be significant.

In the entertainment industry, it has long been known that color, angle and lighting intensity affect human mood. It is nice to know that what artists interpret on an emotional level is being proven correct by using scientific methodology. Lighting plays an important role in evoking emotions. It can be used to make an architectural space more aesthetically pleasing and it can create an appropriate atmosphere within that space; both affecting people's emotions. Using modern human centric lighting designs we will see the world better. And that feels just right!

===== 30 =====