

## HUMAN CENTRIC LIGHTING

“Following extensive studies, human-centric lighting installations are emerging as a way to meet people’s emotional needs purely through the control of LED’s illuminance levels, colour temperature and direction of light.”

Henri Juslén D.Sc. (Tech.),  
Director, Product portfolio management



## Introduction

Lighting technologies continue to evolve and improve, bringing a range of benefits to commercial building specifiers and end-users.

These include better energy efficiency and greater freedom and flexibility in how lighting is applied and controlled in the workspace.

At the same time, there is a growing body of research and information available on the impact of lighting on human beings, with particular resonance on its effect upon our emotions, our well-being and our workplace productivity.

This white paper explores the connections between these two trends and the potential for a more widespread adoption of human centric lighting in commercial building environments.



## What is Human Centric Lighting?

Human centric lighting is the means by which the emotional wellbeing, comfort, health and, indeed, productivity of individuals can be improved simply through the correct control of the lighting in place.

Our thinking behind human centric lighting is defined by research carried out over the last quarter century.

In the early 1990's, scientists started to study the efficacy of light therapy in the treatment of seasonal affective disorder (SAD). Michael Terman et al (1989) first noted the anti-depressant impact of bright, artificial light on SAD patients. Since this time, many researchers have replicated these findings.

It is clear then that with the reduction in daylight hours during the winter, we are subjected to longer periods of biological darkness for large parts of the day, and with this change in the seasons comes a lack of energy, low mood and irritability.

For example, about 20% of the UK population find themselves suffering from the symptoms of seasonal affective disorder. In 2% of the population, sufferers of SAD can suffer even more debilitating issues, and cannot function normally without appropriate treatment.

To counter the negative effects of SAD, it is important for sufferers to receive as much exposure to daylight as possible.

Studies have found that the natural colour of daylight stimulates the production of melatonin and serotonin which control the physical, mental and behavioural changes that follow a roughly 24-hour cycle, responding primarily to light and darkness in a person, or their circadian rhythm.

Obtaining a sufficient level of light exposure can be difficult during winter. However, without the required amounts of melatonin and serotonin in the human brain, people are much more likely to be affected by fatigue and even depression.

SAD can be effectively treated by light therapy.

Light levels are raised significantly, particularly in the morning, to help alleviate the disruption of the circadian rhythm, caused by the reduced amount of natural light. Michael Terman et al discovered that there was a clear positive treatment effect for early morning bright light exposure and similar results for midday and evening exposure.

More recently, other issues have been raised concerning the human body directly. It was found that in addition to rod and cone cells, the eye also contains other light sensitive receptors and these are linked with mental alertness. Studies showed that the spectral sensitivity of these receptors were different to that of cone cells: the sensitivity curve of cone cells peaks at yellowish light at 555nm, whereas the peak sensitivity of the previously undiscovered receptors seemed to be in the bluer, colder light at about 470nm.

In practice, this means that our alertness responds not only to the intensity of light but also to the colour temperature. From this research, we now know that exposure to light can increase alertness much quicker too. Of course, this makes sense when you consider the variations we experience in natural daylight. It changes in terms of both intensity and colour temperature, not only over the course of the day but also as the seasons change.

Bearing this in mind, it has become apparent that the direction of light, colour temperature and overall illuminance levels in a space can have a notable effect on a person's mood. The natural circadian rhythm of a person can be supported by using warmer (relaxing) light with lower intensity in the morning and evenings, and cooler (energising) light during a typical working day.

In essence, if we can control the lighting in our buildings better, then we can create a human centric lighting solution.

## What is lighting control?

The term lighting control is often used to describe stand-alone control of the lighting within a space.

An automated lighting control system is an intelligent network-based solution that incorporates communication between various inputs and outputs with the use of one or more central computing devices. These devices may include relays, occupancy sensors, switches or touchscreens, and signals from other building systems, such as, heating, ventilation and air-conditioning systems. Adjustment of the system occurs both at device locations and at central computer locations via software programs or other interface devices.

Lighting control systems are widely used on both indoor and outdoor lighting of commercial buildings to provide the right amount of light where and when it is needed. This type of system is often used to maximise energy savings and comply with relevant building regulations in specific countries.

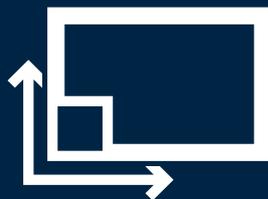
Colour temperature is a fairly new, yet important facet of lighting control solutions within buildings. The colour temperature depicts the temperature of an ideal black-body radiator that radiates light of comparable hue to that of the source.

In other words, it can tell you whether the light emitted is going to be a warm yellowy tone or a cool blue white colour. This can be denoted by the Kelvin scale, lights with a rating of 5000K or lower are typically the warmer tones, whereas those above 5000K are the crisp, cool whites.



### FLEXIBLE

Design lighting just the way you want



### SCALABLE

From small standalone solutions to large lighting networks



### EASY

Easy and cost-efficient set up

# Lighting Control Standards

One of the most popular standards available for lighting control is DALI.

DALI has recently updated its standard to offer support for colour control, covering both RGB and colour temperature. This increased colour control gives architects many more options in how they can control the warmth of the light in each room of a building using DALI fixtures.

By using an effective lighting control system, spaces can be created with multiple uses and properties. Automated dimming and colour control can be used to change the mood of a room and the dynamics of a zone or group of zones according to purpose, time of day, natural daylight, occupancy or other factors. Such controls are also capable of significantly reducing the lighting system's energy consumption.

At the heart of lighting control thinking and practice is DALI. First drafted as a standard in 2000, DALI is a data protocol and transport mechanism that was jointly developed and specified by several manufacturers of lighting equipment.

DALI lamp fixtures are intelligent, 100% dimmable and can all be controlled, monitored and maintained using this two wire global IEC 62386 open standards communication protocol. A wide variety of fixtures are manufactured globally by manufacturers in line with DALI, including LED, fluorescent, HID, halogen, incandescent and emergency lighting, low voltage transformers, PE cells, motion detectors, wall switches and gateways to other protocols.

Up to 64 individually addressed DALI light fixtures may be connected on a single and simple two wire network to be communicated with individually, collectively or in groups. These DALI fixtures can then be instructed, by sending commands along the two wire network, to turn ON, OFF, Dim Up, Dim down. Additional operational status information is available from each DALI fixture, confirming its ability to operate effectively or to confirm a fault condition.

The key thinking behind the DALI standard was interoperability. The common platform of DALI enables equipment from different manufacturers to be connected together, giving designers a 'best of breed' competitive choice in performance and style of lighting solution for their particular building. This gives specifiers considerable flexibility where cost per square metre, functionality and form factor can often be determining factors on equipment selection.

Overall light levels should also be considered – a DALI control system can be programmed to increase or decrease lighting levels according to exterior lighting. As such, a typical system may see illuminance levels needing to be set higher or lower at certain times of the day – during the morning and towards the end of the day, lighting levels may need to be increased, according to ambient lighting conditions.



# Lighting Technology Evolution

Luminaire manufacturers now produce lighting fixtures with adjustable colour temperatures.

At first, these luminaires consisted of multiple fluorescent tubes of different colour temperatures, mixed at a desired ratio. This approach required two controllable ballasts per luminaire.

Now, tunable LED lighting has progressed to almost mainstream technology. By adjusting the relative intensities of warm and cool LEDs, end users can change the colour temperature of the device.

The thickness of the phosphor layer in the LED, together with the wavelength of the blue chip, influence what the colour temperature of the LED will be. The colour temperature of a light source is measured in Kelvins (K). Light with a temperature over 5,000K is typically known as cool colour lighting, with a bluish white appearance. Lower colour temperatures of between 2700K-3000K are warm colours, with a more yellowish white appearance.

Using this technology has allowed for lighting to be programmed at the same warmth as daylight, with natural highs and lows as the day progresses. These advances have meant that the artificial lighting in offices, schools, shopping centres and homes can be as close to natural light as possible, making the effects of human centric lighting highly effective.

**HELVAR'S IC SOLUTION LETS THE SUNSHINE IN.**



## What is Good Human Centric Lighting?

Light is the synchronising pulse generator for our circadian rhythm.

Powerful bluish morning light suppresses the production of Melatonin (natural soporific) thus supporting the production of Cortisol (stress hormone), allowing you to be alert, active and ready for the working day, and Serotonin, which elevates your mood. Warm, cosy light in the evening releases the production of Melatonin (natural soporific), which leaves you feeling relaxed and sleepy.



We can incorporate lighting controls to benefit the occupant of a building, as well as just the property itself. This can be achieved by ensuring that the light levels being controlled are those that will aid productivity when needed, and create a calm entertaining space at other times.

Creating these different atmospheres can also look to aid sleeping patterns in the home by creating the right ambience to fall asleep, and to wake up, making individuals feel more energised and refreshed during the day.

Human centric lighting is used to benefits those in several different applications.

These include Healthcare, Education, Workplaces, Industrial, Retail, Hospitality and Residential.

In healthcare, patients can experience enhanced medicated efficacy, reduced therapy periods and capacity requirements and stimulation by light despite outdoor conditions.

In education, it increases concentration and decreases fatigue. In the work place, it there has been found to be individualised maximisation of concentration and energy, increased employee motivation and commitment, as well as increase in work performance, alertness, and employee satisfaction.



In industrial settings, it helps with biorhythm adjustment for nightshift workers, improved output and error rate of repetitive work steps.

For retail, the increase in awareness levels was most important. Daylight compatible product presentations were possible, as well as staging of Point of Sale products with different colour temperatures and RGB.

Extended daytime in shopping malls was possible, in addition to zoning of shops through different lighting set ups, seasonal lighting stimulation and creating a feel good atmosphere.

These all allow for huge flexibility in changing a retail space's ambiance, without any alterations to the building.

Hospitality buildings saw support for wellbeing of guests, and bedrooms and in dining areas.

This increased value and comfort of these establishments. Similarly to retail, human centric lighting provides flexibility in lighting for different needs, such as transforming a dining room from bright and airy for breakfast, to relaxed for dinner and the use of colour allows for accentuation of architecture and design, and impact for events.



## Summary

The ability to control light colour temperature with predefined rhythms gives interesting and new opportunities to implement lighting designs with high energy efficiency, which can boost the well-being of occupants and also provide many benefits when applied in different environments.

Human centric lighting is an emerging methodology where there are multiple options for implementation, usage and management of the solution. Working with a lighting control specialist, lighting designers, specifiers and end users can be guided accordingly to ensure the selected system meets the needs of the environment in which it will be installed.

By ensuring that lighting is human centric, we can enhance a user's day to day mood, wellbeing, productivity and attention levels. As we have seen, these benefits spread across a wide range of applications, from schools and offices, to retail and industrial applications.

If we implement the concept of human centric lighting across a broad range of applications then we will help to get the best out of people and particularly improve the quality of life for SAD sufferers.

Improved levels of productivity and concentration in education and the workplace can only be a good thing as it will aid development in industry and business for many years to come. Equally, in retail, more focussed and attentive shoppers will lead to more sales and a boost in economy.

## References:

Henri Juslén (2007) Lighting, Productivity and Preferred Illuminances – Field Studies in the Industrial Environment <http://lib.tkk.fi/Diss/2007/isbn9789512289622/>

Juslén HT, Tenner AD. (2005) Mechanisms involved in enhancing human performance by changing the lighting in the industrial workplace. *International Journal of Industrial Ergonomics*. 35, 843-855. © 2005 Elsevier Science. By permission. <http://lib.tkk.fi/Diss/2007/isbn9789512289622/article1.pdf>

Juslén HT, Tenner AD. (2007) The use of task lighting in an industrial work area provided with daylight. *Journal of Light & Visual Environment*. 31, 1, 25-31. © 2007 Illuminating Engineering Institute of Japan (IEIJ). By permission. <http://lib.tkk.fi/Diss/2007/isbn9789512289622/article6.pdf>