



Human Centric Lighting

Daylight harvesting and light temperature control:
how to use it to your clients advantage, managed by a
TELETASK integrated system



TELETASK

trendsetter in domotics

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January 2019



TELETASK is ISO9001 certified family owned company, based in Gent/Belgium. Design and manufacturing of smart home products is our core business. Together with a worldwide network of certified distributors and system integrators, we offer high-quality solutions with pre- and aftersales services. TELETASK was founded in 1984 and guarantees high quality and reliable home automation solutions. We are a pioneer in the home automation landscape of residential and professional buildings and became one of the largest manufacturers for it. TELETASK is the company with the longest worldwide experience and offers you high-quality products with a proven track record in thousands of projects who use hundreds of thousands of our products. They are powered 24 hours a day and seven days a week. Made for decades.

The products have a timeless and unique design with a high range of features and a top quality level. TELETASK has become a solid partner with second-to-none experience since more than 30 years, in 40 countries worldwide.

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1 Introduction

Constant light control and light temperature control entail adjusting the light in the workplace to the time of day, to the brightness of the daylight and to the bio rhythm of the human body. The combination of the two ideas is Human-centric lighting.

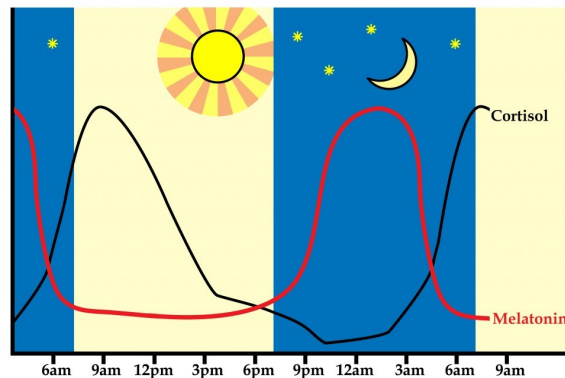


Not only will this reduce energy consumption, there are other advantages of this kind of lighting control. Countless studies from universities across the EU and US mention the relation between the light of the workplace and the performance of the people working there. The workers' mood is generally lower when the lighting is too dark, it improves and reaches its highest level when the lighting is experienced as just right, but when it becomes too bright the mood declines again. Performance and the ability to solve problems follow the same trend. The intensity and the colour of light, depending on the time of day, is proven to have an important impact on a persons mood, concentration level, as well as on the quality of sleep.

Human-centric lighting is therefore important in offices, schools and other large spaces. In this white paper you will discover why the impact of brightness and colour of light is so important. We will then explain how TELETASK applies the theory and puts it into practice.

2 Scientific background

2.1 The impact of light brightness



Countless scientific studies have proven the impact of light colour and light intensity on the human body. Harvard Medical School has published several papers on the subject. One interesting paper (1) states that changing the light-dark regime and therefore changing the brightness of light the human body is exposed to, has an impact on melatonin, core body temperature, cortisol, alertness, performance and sleep. **Melatonin** is the hormone that influences our sleep-wake cycle. In the evening the level of melatonin in our blood increases and makes us feel sleepy. In the morning this level is decreased which wakes us up. **Cortisol** is the hormone that makes us feel awake and alert. The **circadian rhythm** is the biological clock in our body which cycles between sleepiness and alertness during 24 hours. It is our sleep-wake cycle. In normal circumstances our circadian rhythm is synchronized with the cycle of the sun.

Two groups were studied (1): in group one, bright light was used to try to shift the circadian rhythm and in group two moderate bright light was used for the same goal. The subjects sleep-wake cycles were changed so that every day they would sleep for 8 hours but not during the same time of the day. The first day from midnight to 8AM, the second day from 8PM to 4AM etc. Group one showed a significant shift in melatonin secretion timing with a high in the middle of their 8 hours of sleep, not depending on when they were sleeping. Group 2 did not show this change. Alertness and performance showed a significant decline during the testing days in both groups. Sleep quality deteriorated as well.

The study concludes that the circadian rhythm can be adjusted by exposure to bright light but that the quality of sleep and the performance of the subjects is highly impacted (worsened) by this. The study thus shows the negative health outcomes associated with shift-work, jet-lag and exposure to artificial light. It is therefore important to think about the impact of light brightness and to use it to our advantage and rule out these negative effects.

A second study by the Harvard Medical School (2) took a look at the impact of the duration of bright light exposure on the circadian rhythm. The research showed that 12 minutes of bright light exposure had a larger impact on shifting the circadian rhythm compared to 4 hours of bright light exposure. So even a short period can already be damaging.

From both studies we can derive that trying to change the circadian rhythm has a negative impact on alertness, performance, sleep quality, concentration, mood etc.. We can conclude that organizing meetings in bright meeting rooms are not efficient as it impacts the performance of the workforce during that meeting as well as later that day. And it also impacts the sleep quality which impacts the next working day. It is therefore advised to try to follow the natural circadian rhythm. We will come back to this later in the paper. So think twice before setting the lights to the highest level of brightness (100 percent).

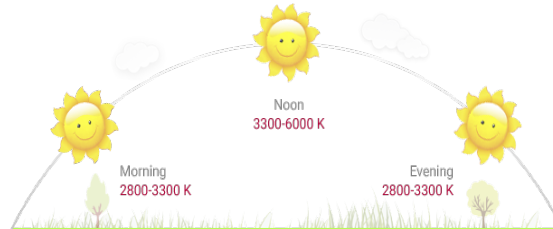
It is important to remark that also in winter the effects of light are significant. Research by The National Center for Biotechnology Information (3) writes about the effects of light brightness on the

2. Scientific background

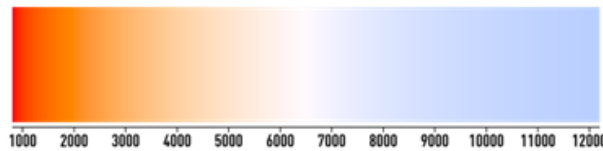
circadian rhythm depending on the time of year. During winter we are exposed to less natural light. During these dark months, brighter light exposure (compared to the outside light, closer to summer light) appears to be effective at improving health, quality of life and at alleviating distress.

2.1.1 The impact of light colour

Following the flow of the chapter above, it is easy to derive that the colour of light impacts our circadian rhythm too. The colour or temperature of the sun changes during the day.



Colour temperature is measured in Kelvin and a higher Kelvin value corresponds with a more blue colour. We see a more reddish white in the morning and evening. At noon the light colour has a larger blue component.



According to research done by Kenan-Flagler business school (4), using natural light in an office will decrease depression and improve mood, energy, alertness and productivity. This means that we need offices with a lot of windows but this is not always an option. By controlling the temperature of the lighting in the office we can also aim at achieving this goal.

A paper published in the Journal of Circadian Rhythms (5) first clarifies that even factors related to colour temperature that are non-visual (biological) can be sensed by a person. So not only seeing the colour but also feeling it has an impact on our circadian rhythm. Secondly, the paper discusses the effect of light temperature in the office on well-being and work performance of the workforce. It shows that colour (and brightness) of light has a large effect on concentration, alertness and energy. This effect is positive when the natural light cycle is followed.

This study goes a bit further and calculates the improvement over the baseline measures (normally observed in a healthy human being). See table below.

Measure	Improvement
Fatigue	27 %
Concentration	37 %
Alertness	28 %
Sleepiness	31 %
Work Performance	19.5 %
Concentration	23 %
Mental Health	14 %

From this research we can conclude that in an office environment, it is important to provide light that follows the colour of sunlight as to mimic natural light. This has positive effects on concentration, alertness, energy, productivity, mood etc

3 Putting theory into practice

The effects of designing the lighting system to follow natural daylight are optimized when a high quality lighting system together with an appropriate management system is used. Different brands use different measures to prove their quality. The choice will depend on the wishes of the customer and the budget. We advise to get familiar with the brands that offer colour temperature lighting and always test the devices in your own lab before installing them with a client. It is also important to know that lights from the same manufacturer with the same specifications can show differences in colour. If you chose to set a light circuit with 20 lights to for example 6000 lux, there will be a deviation in colour between the lights. If the lights are high quality, this difference should be limited.

In this chapter we take a look at different brands and how they interpret the concept of Human-centric Lighting. In the next chapter we will take a look at the application of this concept with the TELETASK home automation system.

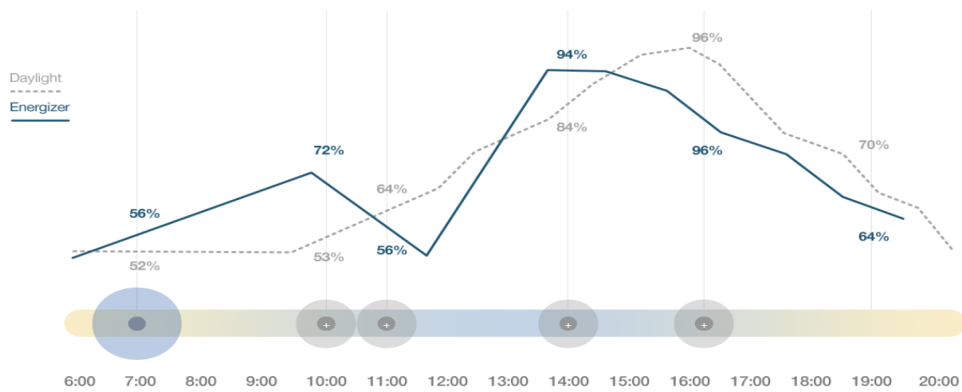
3.1 Lighting companies: advantages and disadvantages



3.1.1 Brand one

The first brand discussed here is a Danish brand (6) Louis Poulsen which proposes a combination of changing the brightness of light and the colour temperature during the day. As you can see from the figure below, the brand proposes two graphs. The grey dotted line shows the Daylight graph. The variation in colour temperature is shown and some points have a percentage of light brightness. As you can see this line kind of follows the natural daylight but with a shifted peak. The peak shows the highest brightness and the highest (most blueish) colour temperature. The brand believes that in the afternoon most people experience a dip in their energy so that explains the shift. The blue line shows the Energizer graph. This is the graph they implement in the lighting systems. The company proposes a peak around 10AM, to wake you up in the morning and a second peak at 2PM to wake you up after lunch. The colour temperature and light brightness decrease towards the end of the day to try to guarantee a good sleep.

3. Putting theory into practice

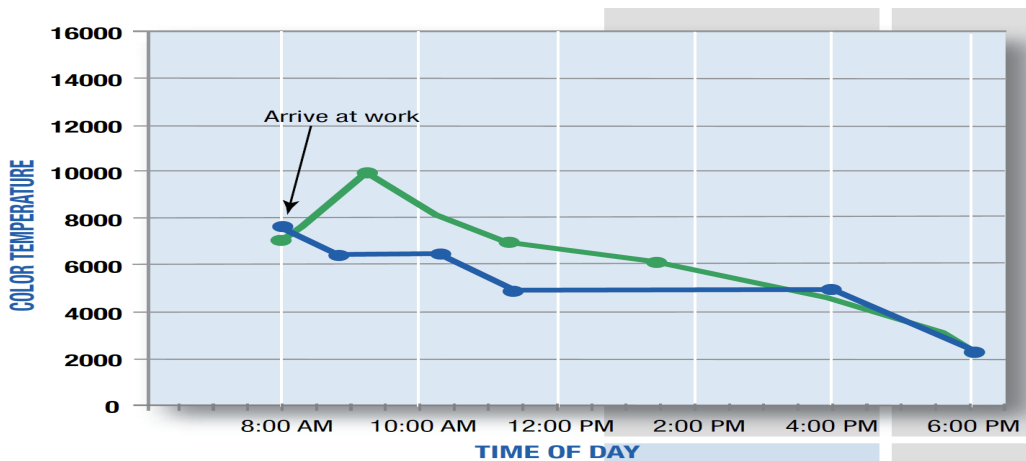


According to the above studies, these curves are too far off from natural daylight with big shifts in values which has a negative impact on health, concentration, work performance, etc. Forcing the light colour (and brightness) to these peak values exposes the work force to the negative effects research suggested. And we need a smoother line (sine function) to connect the points to make sure the transition between values is as close to natural daylight as possible.

3.1.2 Brand two

The second brand is an American LED lighting manufacturer (7) Sigma Luminous. The figure below shows their take on the concept of Human-centric lighting. The green curve shows points taken from the natural daylight curve with a shift in the peak of light colour around 9AM. The company believes that a peak in the morning is necessary to wake up the work force.

The blue points and line in the figure below show the proposal of brand two to implement in offices. It stays away from the high peak in temperature of 10.000 lux. Research shows this a good thing as exposure to high temperature shifts the circadian rhythm with a negative impact on health.



This seems to be a better way of working compared to the first brand. The negative impact of forcing the high light temperature on the workforce, suppressing the melatonin production, happens in the morning. The human body has time during the day to recover. It is important to understand that the negative health impacts are still large in this case, as we explained above.

3.1.3 Brands that get it right

- Lumitech is an Austrian manufacturer of LED lighting (8). The company strictly implements the daylight curve for colour temperature. They believe the best results in working environments, in schools etc. are obtained by creating lighting that is as natural as possible.

3. Putting theory into practice

- Regiolux (9) takes the scientific research seriously. The curve below shows their light temperature and brightness levels during the day. This is as close as possible to natural daylight.



- Osram (10): Natural light is the best light. Our HCL (Human Centric Lighting) artificial light concepts come as close to this proposal as possible. We can conclude that Osram also suggests to use light in the most natural way possible.

3.2 TELETASK: Take advantage



Since light bulbs were invented, the quality of light colour and brightness have greatly improved. Every step we take towards creating more natural light is a step in the right direction. The negative health effects have always been there, we just were never able to do something about it. With the introduction of LED lighting, a whole new world of possibilities is unlocked. The potential is huge now that lighting suppliers can offer high quality LED lighting.

At TELETASK we want to optimize lighting control in a way that, considering the application, natural light is simulated. It makes sense that natural sunlight creates the best environment to work and study in but a surgeon for example still needs bright light with a high Kelvin value to do his job properly. The added value we see in controlling brightness, colour and temperature, besides from the obvious health effects, is energy management. By setting a target lux level and dimming the lighting down when the sun is shining bright or dimming up when clouds appear, there will be a reduction in energy consumption compared to having the light always on at 100 percent. Combined with the other benefits of a smart integrated system, the result will be even better. The light will not be on in the first place when the office or the classroom is empty. With additional information available from the full integration, the TELETASK system behaves different compared to a smart lighting system.

The added value of controlling the light colour temperature is clear from the study above. If the lighting in the office, classroom, shopping mall, etc. follows the natural light, people will be more alert, concentrated and will see an increase in their performance.

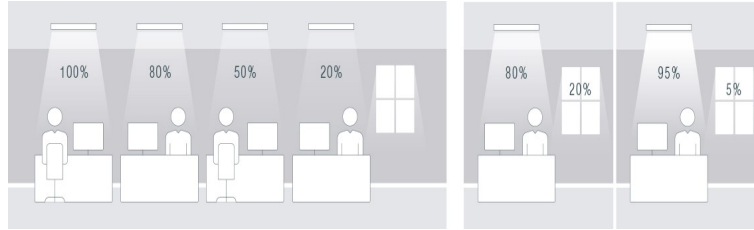
One of the biggest advantages of the TELETASK home automation system is the endless integration possibilities. Implementing Human-centric Lighting in your project will decrease energy consumption and improve the results and health of the workforce. But by using Human-centric Lighting with the TELETASK system, your client will get so much more. For example, within the NZE (Nearly Zero Energy) building concept, the TELETASK system offers you overheating protection and night cooling. Imagine temperature in the office is rising fast as the sun shines through the windows the entire morning. When the temperature has crossed a threshold, the sun blinds will be lowered automatically (avoiding the need to turn on the AC, combined with night cooling). At the same time the lighting in the office will adapt to the new situation. The workforce does not even notice or need to do anything. There are standard built-in algorithms with any DoIP (Domotics over IP) system.

Another big advantage is flexibility. The system integrator can configure any button on a touch panel, touch screen or in the app with specific (manual) settings. For example a certain set colour temperature of 2000 Kelvin on a button or a colour temperature wheel in the app.

4 Takeaways

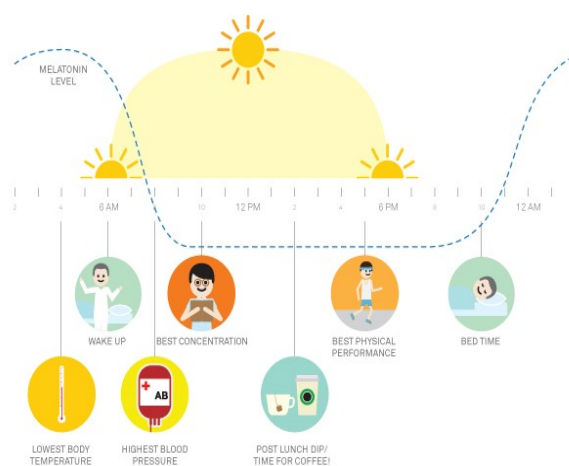
When designing a TELETASK home automation system there are a few important takeaways.

4.1 Constant light control or daylight harvesting



- Energy consumption reduction
- Choose the light brightness target level carefully. The above studies show that 10.000 lux is too high. Using 7000 lux as a maximal value is a lot better but it depends on the application
- Forcing a certain brightness for example in a meeting or during an examination is not good. The negative health effects are known, for example a bad nights sleep after manually overriding the automatic control
- Whatever settings you use, the lighting follows general information such as building architecture, shut-down, emergency status, etc.
- Combine this concept with presence sensors, a sun function (controlling sun blinds when the sun shines bright in summer with a large increase in temperature inside as a result) to prevent over-heating, etc. home automation has an obvious added value
- DALI lamp and gear fault detection for your maintenance team (from any location with the (paid) remote services)
- In winter, adjusting the light to a day in summer, has positive health effects

4.2 Light temperature control



- The function will run in the background and create natural light with the light circuits you selected
- Override of the colour temperature is possible depending on the application, but keep the negative effects in mind
- Trying to shift the circadian rhythm by using a higher temperature of light to improve concentration, during a certain period of time, is not beneficial for health nor productivity

5 References

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If you would like to have more information on how to use the Human-centric Lighting concept with your TELETASK system, please take a look at our website www.teletask.be or contact your local distributor.



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