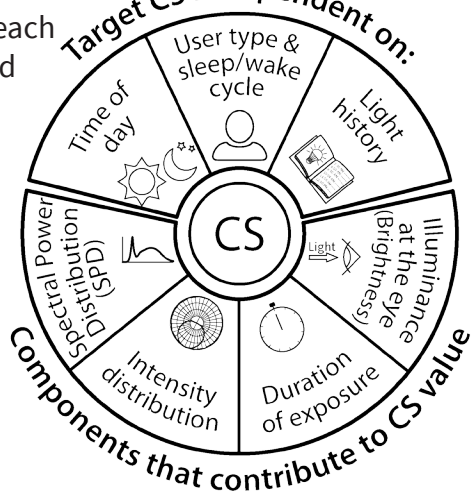
More about CS

Important factors to know about CS:

We know the basics about circadian stimulus (CS), and this section will teach about how to choose a target CS, and what contributes to a CS value.



Target CS is dependent on:

Time of day

What CS you want to target is dependent on the time of day or night. As learned previously, at the right spectrum and brightness, light can delay the onset of the body's hormones, specifically melatonin which is released at night and in dark conditions. If this occurs, the body will not be synchronized with the solar day which can cause negative short-term and long-term effects. Proper circadian designs will provide a CS above 0.3 in the morning and even afternoon hours, and provide a CS below 0.1 at night to not disrupt the circadian system

User type & sleep/wake cycle

Since circadian design can apply to all different types of people, it is important to know the general population you are designing for. People have varying chronotypes, which is what makes people have the tendency to be 'night owls' or 'early birds.' The teenage population undergoes hormonal changes, which causes teens to have a tendency to stay up late and sleep in. Light can be strategically used during the day and reduced at night to encourage a teen's circadian clock to get sleepier early at night. Another thing to consider is sleep/wake cycle, such as one that varies from working night-shifts. Proper lighting should be used in 24-hour facilities especailly to assure circadian disruption does not occur in night-shift workers, as this can have major health impacts on workers who have night-shifts for many years.

Light history

What dosage of light have you previously been exposed to? Traveling to multiple locations that provide different light exposures throughout the day can
When designing for a facility that has occupants coming and going, it can be hard to

Components that contribute to CS value:

Spectral Power Distribution (SPD)

All light is made up of a combination of wavelengths that combine to make white light or saturated colors. With the circadian system being a 'blue sky detector,' light containing a higher power in the short wavelength will activate a cool response, which has a greater impact on the circadian system.
When using the same SPD, CS can change depending on how much of that light is getting to the eye, showing that both play a role in determining the CS value.

Illuminance at the eye, or vertical illuminance (Ev)

Existing lighting practice is concerned about how much light gets to a work plane, also known as horizontal illuminance (EH). Circadian design is concerned about the amount of light that gets to the eye, which is known as vertical illuminance (EV). We are concerned with the light that gets to the eye, and more specifically the back of the eye and into the brain to be perceived. The internal circadian clock in the brain interprets signals from the photoreceptors in the eye to use as cues for determine what time of day it is. Again, the mechanisms in the eye are sensitive to brightness as well as spectrum to determine how it perceives the light cues.

Intensity distribution

Typical lighting fixtures placed in the ceiling direct light downward onto the work plane, but manufacturers should continue to push designs more towards fixtures that get light to the eye as well. This can be done with direct/indirect fixtures, fixtues mounted to vertical planes, or light that washes vertical planes. Since light on the workplane for visibility is still important, designing fixtures with a vertical to horizontal illuminance ratio close to one, or providing layers of light within a space are two great design tactics.

Duration of exposure

How long a person is exposed to a light source of a certain spectrum and brightness determines how the circadian system will be impacted. A minimum of a one-hour exposure is required to have an impact on the circadian system. If light exposure to a high CS is limited for various reasons, a high CS for a shorter amount of time can be equivalent to a CS of 0.3 for a longer duration. However, it is important to remember that CS saturates at 0.7, and white light can become very glary and uncomfortable at high light levels. More research needs to be done to more accurately predict the impact of longer durations of exposure to a high CS. The most important guideline for circadian design is providing a robust light/dark pattern that promotes the discrepency between day and night. On a daily basis, low light exposure that causes circadian darkness in the day, or bright conditions at night that delay the onset of melatonin release should both be avoided, however strategic use or avoidance of light at specific times can aid in synchronization to different time zones.

Facts about CS:

CS is not addative

The power in each wavelength of a light source can be translated to a CL_A value (circadian light) which is then weighted by one of two spectral sensitivity functions of the circadian system. With the circadian system having more of a response to light containing shorter wavelengths, an SPD with more contribution from shorter wavelengths will create a cool response from the circadian system, and CL_A will be weighted by the cool response curve. If the accumulation of wavelengths has more contribution from longer wavelengths, a warm response is activated, and CL_A will be weighted by the warm response curve. Using these two functions, CS can be found, which is predicted based on acute melatonin suppression after a one-hour exposure to that source. When combining multiple SPDs, note that CS is not additive. For example, getting 150 lux at the eye from an incandescent source and 50 lux from daylight would get a lower CS than just the incandescent produced with 150 lux. Even though more illuminance is getting to the eye, the CL_A for the combined source is lower, resulting in a lower CS. This is due to the fact that by the time light gets to the eye, the sources have mixed and the final combined SPD and total E_V determine what the new CS value is. For this reason, it is imperative to determine how much light each source gets to the eye and the response of the circadian system to their combined spectrum. Use the LRC's CS calculator to determine CS values for single and multiple sources:
https://www.lrc.rpi.edu/cscalculator/