



Circadian Lighting

Definition and Strategy

Circadian Lighting - Definition and Strategy

CONTEXT

It is acknowledged that light has a significant impact on our physiological condition and wellbeing. However, only recently have biological and medical researchers started to understand the impact of light on people. This new understanding, coupled with advances in lighting technology, has created great interest amongst lighting professionals in how light can impact users of the environments which we design.

The lighting industry is now full of new terms such as “human centric lighting”, “biophilic lighting” and “circadian lighting”. These new terms and knowledge from research have created substantial debate across the industry. This debate is ongoing and agreement is not universal. Two key areas of discussion are 1) how designers can embrace this knowledge within the design process; and 2) what precise non-visual impact light has on people.

Agreement does exist that more research is needed to allow us to fully understand the impact of light, and until agreement is achieved the use of techniques that exploit the non-visual effects of light should be used with caution.

The principle of putting users at the heart of design is not new. As designers we have the responsibility to ensure that we create environments that do not negatively impact people, instead creating comfortable and engaging environments that respond to occupant needs.

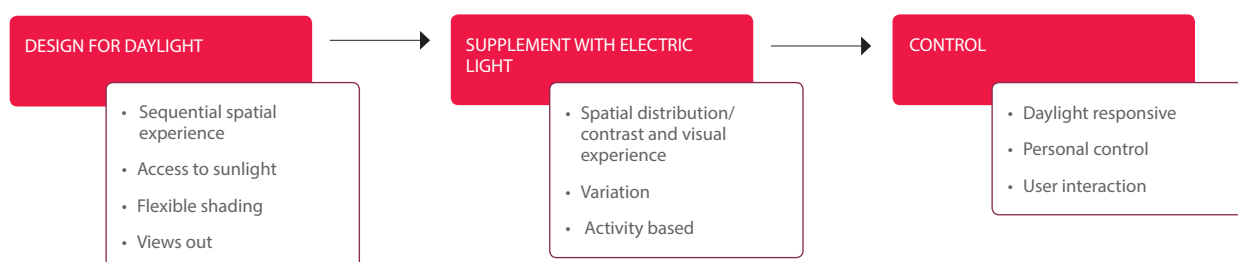
CIRCADIAN LIGHTING - AN ARUP DEFINITION

We have carried out an extensive review of current research and publications over the past 18 months. This confirmed to us that universally agreed guidance from recognised authorities such as the CIE will not be forthcoming in the short term. As such, we have created our own definition, which is informed by our research review and discussions with the industry. The aim of this definition is to inform our own designers of what we believe to be best practice, and to allow us to engage with and inform our clients and collaborators.

“A circadian lighting strategy is one where lighting design supports the human diurnal need for illumination and darkness cycles in tune with their circadian system. This strategy should include both natural and artificial lighting and should take into account the changes in colour spectrum, intensity and directionality over the course of a day.”

It should be noted that our definition for circadian lighting is a strategy – it is not a single lighting system or an off-the-shelf solution. This definition is a strategy for lighting design. In the following section we describe how this strategy can be applied to workplace lighting, through a similar approach can be adopted for other types of building.

A WORKPLACE CIRCADIAN LIGHTING LIGHTING DESIGN STRATEGY



► DESIGN FOR DAYLIGHT

Since its inception, Arup's lighting design philosophy has been to design for daylight first wherever possible. A circadian lighting strategy must start with daylight as it is the form of light naturally suited for circadian entrainment. A successful circadian lighting design within the workplace will provide access to daylight for all occupants. Good daylight within the workplace can include:

- **Access to sunlight** where possible; in particular, areas that do not require protection from glare (such as breakout spaces, informal work areas, circulation etc.).
- **Flexible shading** strategies, either manual or motorised, that are controlled by occupants. This will allow for appropriate access to daylight according to personal preference.
- **Access to a view**, ideally to the exterior or, as a minimum, to an atrium, to create a visual connection to the outdoors and daylight.

► ELECTRIC LIGHTING

The key to successful electric lighting design from a circadian perspective is to consider electric lighting as a source that supports and supplements daylight. Electric lighting design responses are varied due to the almost infinite possibilities presented by architectural and interior design, volume and materials used. There are, however, some common themes that we believe contribute to a successful circadian lighting design:

- Layers of light provide good **spatial variation and contrast**, which results in visual interest for occupants. Dedicated layers of light for key surfaces (e.g. walls or ceilings) can create good spatial variation. Layers of light can also be used to support visual balance and comfort within the occupants field of view.
- **Activity based**. Lighting design should respond to particular activities within the workplace, either concentration, relaxation or stimulation. A single approach to lighting across all workspace areas should be avoided.
- **Variability**. Daylight is inherently a variable light source and its use introduces a dynamic aspect to light which is tuned to our circadian system. When interior daylight availability is inadequate (for example in deep plan workspaces), it is necessary to provide a lit environment that also has variability. This variability can be achieved in a number of ways:
 - by using dimming to change the intensity of illumination. For example varying the intensity of electric lighting in the central and perimeter zones of deep plan areas;
 - by adjusting the balance of lighting layers within the field of view, for example by adjusting wall lighting intensity by dimming, or by adjusting ceiling uplighting if provided;
 - or by adjusting the colour and intensity of illumination by the use of tunable white sources. Tunable white systems are often offered as circadian lighting systems, which we feel is incorrect and confusing to the industry. There is currently no consensus that tunable white systems provide a positive physiological effect on people and their wellbeing. Further scientific research into the effect of colour and spectrum of light on people is needed to understand this relationship, as current research is inconclusive. It also should be noted that simply considering colour temperature (CCT) of the lighting is likely to be insufficient, as it will be the full spectral characteristics that will be important, which goes beyond CCT. Therefore, providing a tunable white lighting solution in isolation does not necessarily translate into a successful circadian lighting strategy.

► CONTROL

It is vital for both layers of light, daylight and electric, to be holistically combined via simple to use control systems. A successful circadian lighting control strategy should consider the following:

- **Daylight responsive**. All layers of electric lighting should be controlled relative to daylight availability within the space. This ensures that the variation of light due to daylight is maximised and not diluted by electric lighting when it is not needed.
- **Personal control**. Fully automated controls that have no possibility of user interaction tend to have a negative impact on user satisfaction. Occupants should be able to control the lighting system as appropriate (for example a certain layer of light localised to their task areas, or lighting within meeting and breakout areas).
- **User interaction**. An intuitive and approachable lighting control strategy not only allows users the flexibility to control the light to meet their needs, but also encourages users to feel empowered to control their environment. This leads to higher occupants satisfaction.



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