Light quality

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Abstract
Beauty is but the revelation of a darkness which has fallen and the light which has come out of it (Alda Merini)

We are immersed in light on a daily basis. Light can be delicate, soft, blinding, warm, limited, blurry, geometrical, diffuse, dark. When we enter a room, or a badly-lit square, we perceive it immediately, and we feel a little uneasy when walking down dark alleyways. Light attracts us. It constantly draws our eye, it can change our way of perceiving and experiencing a space; light is quality of life.

Technological evolution, which has led the lighting sector to throw open the doors to LED light sources, has presented us with a wide array of new possibilities. The LED is commonly known for its results in terms of energy saving, and we recently learned that it can be “smart”, but the truth is that there is so much more to be discovered. The greatest innovation introduced by the LED is customisation. The variety of light sources available on the market is such that one of the main tasks of those who design and build lighting fixtures is knowing how to choose the LEDs with the most suitable characteristics for the different types of application. If we were to light up the façade of a historical building, I would require a light with different characteristics compared to one used to light up a street. This applies both to the colour components and the shape of the photometric solid emitted by the lighting fixture.

But what exactly are the characteristics we are talking about? At least 4 main elements must be identified:

CCT, SDCM, CRI and light distribution.

The CCT (Correlated Colour Temperature) is calculated by determining the chromaticity coordinates x and y of the light source in question by correlating them with the Planck curve through the iso-temperature curves which intersect the Planck curve itself. Lower colour temperatures are associated with warmer colours, and vice versa, higher colour temperatures are associated with cooler colours. Due to how it is defined, the CCT cannot uniquely identify the chromaticity of a light source. To be clearer, two light sources with the same colour temperature will not necessarily also have the same chromatic coordinates, meaning that they could be chromatically different to the eye.

That is why we are not limited to using only CCT, but rather the use of the MacAdam ellipse step has also been introduced, as well as the SDCM (Standard Deviation of Colour Matching), a measurement of chromatic consistency. This value is the method to evaluate the chromatic distance of a light source from its Planckian equivalent. The greater the number of steps that the light source falls into, the higher its chromatic distance will be, with a smaller number of steps corresponding to a shorter distance. Solutions with a number of steps less than or equal to 4 are very good, considering that variations below 3 MacAdam steps are barely perceptible to the human eye.

Light, however, has the purpose of illuminating objects, people, spaces, and we know that the way that these appear depends upon the light that illuminates them. Think back to the streets lit by those old, hot sodium lamps. With a light source such as this, it becomes very difficult to ascertain what the actual colour of the space being illuminated is. We therefore come to add another essential element that describes the quality of a light source, i.e. the way in which it renders the colours of an object when it illuminates it. That is why the CRI (Colour Rendering Index) was introduced, in order to describe a light source's capacity for colour rendering. This is defined by the CIE as "the effect of an illuminant on the colour appearance of objects by conscious or subconscious comparison with their colour appearance under a reference illuminant". To simplify, we can say that the CRI represents a quantitative evaluation of a light source's ability to represent more or less faithfully the colours of an object in comparison to natural light. The higher the CRI value, the more "natural" the rendering of the colour. Nowadays, LED light sources which range from CRI70 up to CRI99 can be found on the market.

However, it is not enough to have such flexible and high-quality light sources available if you are not capable of modelling the light according to your needs. As such, optical design represents the fourth cardinal element which characterises high-quality lighting. We could say: when it is needed, in the shape it is needed in. Since the right shape allows us to design a façade, highlighting certain elements and hiding others, it allows us to have uniformly-lit streets whilst using less energy.

Anyone who producers light fittings must know how to carefully balance all of these elements, ever focused

on their application and knowing that good lighting also leads to a higher quality of life.
To revisit the previous examples, when we wish to illuminate a street, there is no need to have a high colour rendering index - a CRI70 will suffice - just as there are no predetermined constraints on the colour temperature (unless specific legal requirements are in place, for example Regional Laws). Close to an observatory, we can (and must) choose a 3000 K or 2200 K solution; in order to achieve greater energy savings, we can opt for a 4000 K CCT, currently one of the most efficient light sources. The two most important elements, on the other hand, are the SDCMs and the shape of the light; a solution with 4 SDCM steps allows us not to have colour variations within the same street, whilst the use of the appropriate photometric solid for the type of street geometry allows us to optimise the power being consumed and fall in line with the legal requirements.
Conversely, if we wanted to light up the façade of a historical building, all 4 elements must be carefully selected in the most appropriate fashion. The colour temperature should be chosen according to the type of architecture and material, the colour rendering index can be chosen with medium-high values (CRI70 or CRI90), the number of SDCM steps absolutely cannot exceed 4, whilst it is necessary to have a certain number of optical solutions available to be able to design the wall.
Good lighting needs high-quality light, and there can be no high-quality light without a great deal of research and expertise.

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