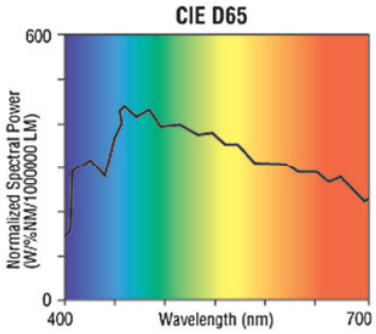
The Basic Building Blocks of Color

Visual color perception is influenced by our individual color preferences depending on our personal experience and memory, varying environmental conditions such as lightness and color, as well as by our inability as humans to communicate and document color. These shortcomings can only be solved by using color instruments with internationally specified color systems.

Standard Illuminant

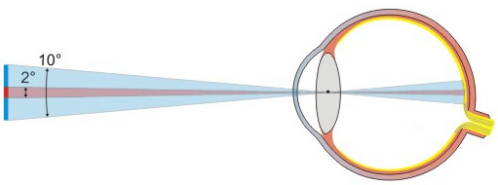


To understand a standard illuminant, it is necessary to first understand how a light source can be described. The spectral power distribution defines the amount of energy that is emitted at each wavelength of the visible spectrum. A standard illuminant is a theoretical light source with a standardized spectral power distribution. It is published in international standards and stored within color instruments. Following are some of the most important standard illuminants defined by the CIE (Commission Internationale de l'Éclairage) are listed:

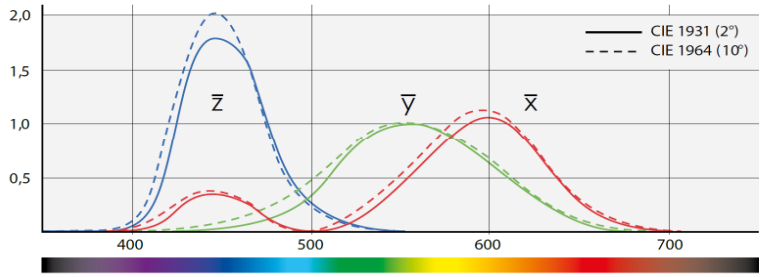
D65: Average daylight (including UV) with a color temperature of 6504K – todays standard daylight
C: Average daylight (not including UV) with a color temperature of 6774K – former standard daylight
A: Incandescent light with a correlated color temperature of 2856K – represent a typical tungsten lamp
F2: Cool White Fluorescent (4230 k) –typical office illumination
F11: Narrow tri-band cool white (also known as TL84, 4000 K) – mostly used for department store lighting

Standard Observer

The human eye with normal vision has two different receptors: cones and rods. The cone cells are responsible for color vision. Three kinds of cone cells exist, each with different spectral sensitivity peaks in short (*S*, 420–440 nm), middle (*M*, 530–540 nm), and long (*L*, 560–580 nm) wavelengths. Additionally rod cells act as receptors for light intensity (lightness vision). Due to the distribution of cones and rods in the eye, the way humans perceive colors depends on the observer's field of view. To quantify the color ability of a standard human observer, color matching experiments using human volunteers were performed in 1931 and 1964.

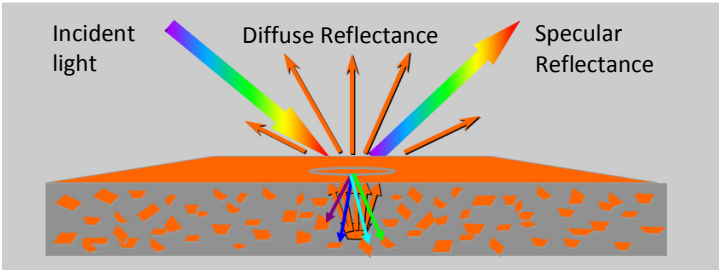


As a result, separate sets of color matching functions are specified by the CIE for the 2° Standard Observer (1931) and 10° Standard Observer (1964). The 2° standard observer represents a field of view when focusing on an object with a diameter of 1.7 cm (0.67 in.). Whereas for the 10° standard observer, the object has an diameter of 8.8 cm (3.5 in.). These standard observers are also published and stored in color instruments. They reflect the human response to the visible spectrum and represent an average human's chromatic response.



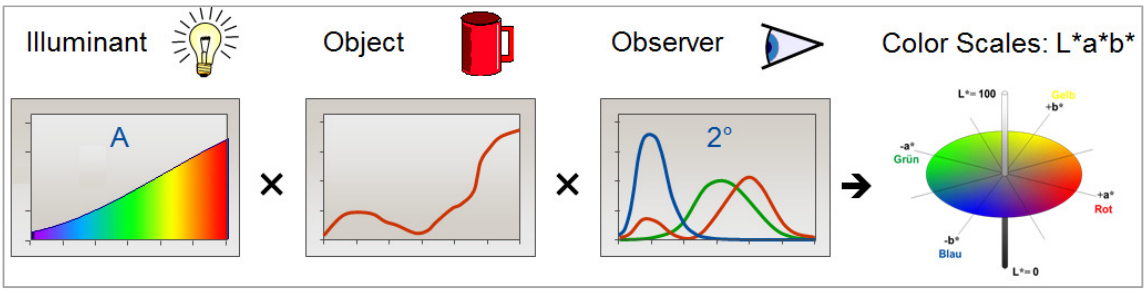
Interaction between Light and Object

When “white” light strikes an opaque sample, part of it is directly reflected on the surface. This is the specular reflectance which is perceived as gloss. The remaining part penetrates the substrate and is selectively absorbed and scattered by the pigments. The scattered light is finally diffusely reflected by the sample and creates the color impression.



Summary

The light source and observer are defined by the CIE and their spectral functions are stored in color instruments. The optical properties of the object itself are the only variables that need to be measured. Color instruments analyze the total amount of reflected light, wavelengths by wavelengths. These spectral data points represent the spectral curve which acts as a “finger print” for the object’s color. All commonly used color systems are calculated based on the spectral data.



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