Media details
Light Perspectives reference book

What are the intrinsic qualities of light, and how are the techniques and design approaches implemented in architecture? How are abstract lighting concepts conveyed, and how far is our perception of light rooted in the biological and cultural history of human evolution? This book endeavours to identify terms and standards which relate to qualities in architectural lighting. It uses this identification to promote communication and aid dialogue between designers and engineers, building owners and planners, professionals and laymen. The 21 chapters are arranged in three sections covering the actual qualities of light, the relationship between light and space, and, finally, the dimension of light as it relates to culture. In each of the chapters, paired terms explore the respective design dimension of light. Using texts, photos, computer graphics and drawings, the team of authors investigates each pair of terms – beginning with the original cultural and historical context, moving onto didactic material on perception, lighting design and lighting technology and concluding with case studies in virtual architectural situations.
About this book
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Structure of chapters

The 21 chapters of the book all share a uniform structure consisting of introduction, essay, teaching and simulation.

Introduction

A large-format photograph of an actual lighting application illustrates the subject area to be explored by the respective paired terms. The introductory text summarises the most important theses and contents for the twin terminology.

Light and dark

Radiance and illumination

Efficiency and excess
Essay
Using insights gained from the fields of culture, natural science, history or literature, this text approaches the subject area with a journalistic, essay-type style. This provides a variety of starting points and associations, ensuring that the following teaching pages are put in their proper context.
Teaching
The didactic part of a chapter explores the subject area more comprehensively with regards to perception, lighting technology and lighting design. Here, texts, photos, drawings and diagrams combine to optimally put across the facts, giving particular emphasis to visual presentation – as befits the key theme of light. A recurrent device here is the use of charts and series of images to add specific content to all the intermediate stages in-between the paired terms.

20 Light and dark

50 Radiance and illumination

200 Efficiency and excess
Simulation
The facts and theories previously expounded in the chapter are put to the test in an application example in the simulation section. A virtual architectural situation, simulated in photographic quality, is shown with different variations in the lighting commensurate with the theme of the chapter. In some cases, opposite extremes are placed alongside each other in order to vividly illustrate the respective lighting dimension; in other cases, preferences for certain lighting concepts are presented and explained. The simulations are all generated using the photometric data of real ERCO lighting tools.
Warm and cold

The twin terms "warm–cold" convey the perceived temperature of light and colour. Misunderstandings can arise because the scale used for colour temperature contradicts what common sense would suggest. Bluish daylight white has a higher colour temperature than reddish warm white. However, with terms and definitions defined, adding contrasts in colour temperature proves to be a simple design concept in architectural lighting.
Warm and cold

Colour temperature – a subtle design concept

At first glance, transforming the terms of physical temperature, "warm" and "cold" take on a new set of meanings when referring to the phenomenon of light and colour. Colour theorist Johannes Itten, for instance, talks of the warm cold contrast of colour. Thus when there are warm white lamps as opposed to daylight white, his talks of 'colour temperature', but contrasts to common sense. This is higher with "cool" white. Hand photographers refer to "cool" flashlights and the "hot" light of an incandescent lamp. Thus, we can temperate using laboratory technical measures, filters or manual white balance – something which we perform fully automatically in a known as chromatic adaptation. Behind all these are the physically and mentally psychological effects that have been used and are design for sciences – starting with artistic disciplines such as painting and even in architectural lighting.

Cold blue, warm red?

When designers talk of warm and cold colors they usually are referring to the warm-cold contrast – a design concept known about for ages and described by many others, the painter and art theorist Johannes Itten (1888–1967) in his book, "The Art of Colour". Itten states that warm and cool quality to blue colors and call red hues "warm". One can of course speculate as to how the link between these psychological qualities may have occurred – certainly various impression would have played a role in, such as the warm hues of a warm, burning fire and the cool tone of the light of an ice lamp. Whatever the case, it has been empirically shown that warm painted blue are actually perceived to be cooler than those painted red. Even our estimation of distance is influenced by warmer or cooler hues. Warmer colors appear nearer and cooler hues more far away. Romanticism and Rococo periods used this phenomenon in what is called "colour perspective", painting the background in cool gutter tones in distance from the warm hues of the foreground. This trick works because the different wavelengths of red and blue light mean that objects of those colors are actually mapped in different regions of the eye. In the more subtle range of white tones, this warm-cold classification organizing our visual neural system is no longer visible in the form of the known "warm white", and for the color of light from incandescent lamps. It describes a more reddish range of white in contrast to "neutral white" or the even more bluish "daylight white". The color of light in daylight has a certain pure white, as it is relatively free from the influence of other objects in the environment. This is why it is so important to use daylight or daylight-like colors in environments that need to be perceived accurately. It is also why it is so important to use daylight or daylight-like colors in environments that need to be perceived accurately.

Creating atmosphere, adding contrasts

In architectural lighting, these and other effects of perception can be used for design purposes in conjunction with different colour temperatures. In principle, the choice of the dominating color of light can basically dictate the atmosphere of a room, ranging from cool, businesslike and motivational to warm, cozy and relaxing. Therefore, when looking at architectural examples from various regions of the world by browsing through books of interior design, magazines, web pages or even films, you can find the influence of the color of light on the perception of the light. This means that, after a short period of adapting to lighting at different colour temperatures, the eye perceives body colors such as a white shirt or black his attire as a constant. Comparing photographic films – and even digital cameras when the automatic white balance is disabled – will show neutral whether the lighting has different colour temperatures. This is why special emulsions or retractive filters are coated with films to achieve natural-looking colors in the image. Most digital cameras today allow the user to adjust the white point manually, either to categories of light or even to Kelvin values.

The human eye's ability to adapt means that if a lighting design uses a range of different color temperatures to reflect their use – not just as an additional atmospheric component – then exceptionally cool or warm white hues may be tied to comfort or excitement, or even to some extent, the feeling of delight or pleasure.

Carbon lights are one of the most complex, and the most efficient incandescent lights, reaching an efficiency of about 90%.

The dimmed light of incandescent lamps is a cold white light. Incandescent lamps contain an enclosed, carbon-coated filament that will heat to incandescent light simply by passing an electric current through it. The filament eventually melts. When this is shown in the CIE chromaticity diagram, the cold-body radiator can be seen to follow “Planck’s curve” that traces the color of light for any temperature of an ideal blackbody radiator.

The light point is located on the chromaticity diagram within the area in the yellow-red section of the chromaticity diagram is the color of a black body radiator. This color temperature of light is called “black body radiation” and is defined as the color of light of an ideal blackbody radiator at any temperature. The primary advantage of black body radiation is its continuous spectrum. The composition of the luminescent substance determines the color temperature resulting in a mixed white light of incandescent lamps. More about the color temperature of light sources.

The warm white point is based on 3000 K, the color temperature of most incandescent bulbs. The white point is based on 4000 K, the color temperature of most halogen bulbs. The cold white point is based on 6500 K, the color temperature of most fluorescent bulbs.

A problem can occur in our psychological perception of different light sources as they are dimmed. Because we are conditioned by the natural progression of daylight which is characterized by a red shift with the decreasing lengthiness of light. We therefore perceive the analogous effect of red shift when dimming the light. Photographers refer to "cold" flashlight and "warm" tungsten light as opposed to daylight white. One talks of "colour temperature" of light sources which have been used in art and design for centuries – starting with artistic disciplines such as painting and even in architectural lighting.

The lighting concept is the contribution of the architect and the lighting designer to the interior. The lighting designer chooses a light source with a light spectrum that is suitable for the task. The lighting designer must consider the lighting plan and the desired effect, taking into account the needs of the building users. The lighting designer must also take into account the architectural design of the interior, the materials of the interior elements, and the spatial layout of the interior. The lighting designer must also consider the technical aspects of the light source, such as the color temperature and the light intensity. The lighting designer must also consider the aesthetic aspects of the lighting, such as the color of the light and the distribution of the light in the interior. The lighting designer must also consider the psychological aspects of the lighting, such as the mood and atmosphere that the lighting creates. The lighting designer must also consider the economic aspects of the lighting, such as the cost of the lighting system and the energy consumption of the lighting system. The lighting designer must also consider the environmental aspects of the lighting, such as the impact of the lighting on the environment. The lighting designer must also consider the technical aspects of the lighting, such as the reliability and maintenance of the lighting system. The lighting designer must also consider the future aspects of the lighting, such as the potential for future changes in the lighting system. The lighting designer must also consider the cultural aspects of the lighting, such as the impact of the lighting on the culture. The lighting designer must also consider the legal aspects of the lighting, such as the compliance with the building regulations and the electrical safety regulations. The lighting designer must also consider the ethical aspects of the lighting, such as the impact of the lighting on the health and safety of the building users. The lighting designer must also consider the social aspects of the lighting, such as the impact of the lighting on the social behavior of the building users.
Warm-cold contrast

In the colour wheel, the warm colours with red and yellow components are arranged opposite the cool, blue hues. Both the colours of materials and the hues of light can make the observer feel warm or cool and contribute to the atmosphere of a place. Similarly, the hues of light known as warm white, neutral white, or daylight white can be used to establish a warm-cold contrast and set the mood of a room.

Colour effect of materials

The colour effect of materials can be intensified by choosing the right colour of light. The colour impression of warm-toned materials such as sandstone is heightened by lighting them with an appropriately warm white light colour. With cold-coloured objects, using light with a warmer colour temperature would impair the colour impression of the cool material. In everyday settings, the difference is not noticed until compared with a contrast surface under lighting of a different light colour. This is because the way we perceive differences in colours is not absolute but relative. Additionally, we also perform an unconscious adaptation process when interpreting the colour of a white shade. If we look at a warm white or daylight white wall for a long time, then we recalibrate to this as a neutral white.

During the daylight, the warm-coloured tungsten halogen lamps are switched on. The daylight and artificial light appear almost neutral and create a cool background for warm accent lighting.

Daylight and artificial light

Where daylight and artificial light are both present simultaneously, the difference between the colours of light takes on an important role. Warm colours of light, as produced by tungsten halogen lamps, for instance, will produce a warm-cold contrast in the presence of daylight with a much higher colour temperature. After becoming adapted to the daylight of a blue sky and direct sunlight, a cool and diffuse ambient lighting with warm accent light will seem more natural than the other way around. When looking around a room, as the gaze wanders between zones illuminated by daylight and areas illuminated by artificial light, the contrasts of the colour temperatures will reduce the contrast and create a harmonious transition. Lighting designers can determine the scope of the colour contrast by their choice of lamp or by using filters.

Daylight conversion filter

To eliminate a warm white colour of light, while simultaneously making full use of the excellent colour rendition of the thermal radiators, correction filters are available. The effect of the daylight conversion filter is to shift the warm white light to the neutral white range (i.e. to shift from 3,000K to 4,000K). This reduces the difference between daylight and artificial lighting. The colour rendition quality is maintained with the daylight conversion filter.
With thermal radiators such as incandescent lamps or low-voltage halogen lamps, the colour temperature is approximately the same as the actual temperature of the filament. Dimming incandescent lamps reduces their colour temperature, the light is perceived as redder and warmer. To obtain a warmer colour of light for the same illuminance, an incandescent lamp can be replaced by a dimmed lamp of a higher wattage. Since halogen lamps have a higher filament temperature than incandescent lamps, their light appears whiter.

Fluorescent lamps, high-pressure discharge lamps and LEDs are available in different colour temperatures. When making the lamp selection, it is therefore necessary to specify the required colour temperature.

Because the eye does not perceive differences in colour temperature linearly, a difference of 500K in the warm white range will appear to have a greater contrast than in the daylight white range. Lamp manufacturers therefore offer a wider selection of lamps for warm white colours of light than for higher colour temperatures.

To provide easily understandable classification, lamps with white light colours are categorised in three groups: warm white, neutral white and daylight white.

The colour temperature is based on a "black-body radiator", also known as a "Planckian radiator", which emits a specific colour of light depending on its temperature. As the result, the object’s colour temperature is given in Kelvin (K).

When fluorescent lamps are dimmed, their colour temperature remains constant. Compared to thermal radiators that demonstrate a colour shift towards warmer colours of light, this gives the impression that the light becomes greyer when dimmed.

The colour temperature of a clear, blue sky is over 25,000K.

Artificial lighting

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Artificial lighting
The warm and cold colours of light influence the atmosphere of a space and can augment the colour of materials. Incandescent lamps provide a light of a warm colour. Light sources such as fluorescent lamps are available in different colour temperatures, including neutral white or daylight white. This allows lighting concepts to be developed that follow the colour of daylight or that contrast with the lighting.

**Artificial light**
Incandescent lamps typically produce a warm white light, which, when dimmed, changes to an even warmer hue, i.e. comparable with the lighting produced by incandescent lamps.

**Fluorescent**
On the other hand, there are in different coloured fluorescent lamps. The dimmable lighting atmosphere with fluorescent lamps is much friendlier. The colour of light of fluorescent lamps remains constant throughout dimming. Rooms with dimmed fluorescent lamps, for example, remain grey or in a warm range.

**Daylight**
As far as the colour of light from daylight is concerned, there is no light of warm and cold colours. There is a contrast between warm and cold light sources. Daylight with neutral or light colour leads to a homogenous colour impression.

**Material**
Incandescent lamps are particularly suitable for emphasising the colour of warm-toned materials such as wood or leather. This effect can be further increased using dimmed light because the colour temperature decreases with dimmed light. On the other hand, the cool colour of concrete or metallic objects can be drawn into light sources such as neutral white or daylight white lamps.