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Study of Lighting Design for Interior Spaces

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Abstract: Due to the continuous progress of lighting fixture technology, people's requirements for commercial space design are also rising, and the comfortable, convenient, artistic, and technological combination of space is more and more emphasized by designers. The author has collected a large amount of visual subjective evaluation data through actual investigation and experimentation and conducted extensive and in-depth research on the light source's low radiation, luminous flux, luminous intensity, illuminance, luminance, color temperature, color deviation, color tolerance, beam angle, and maintenance coefficient. This paper takes the lighting quality parameters as the benchmark, analyzes the formal aesthetic relationship between commercial space and lighting design, and has a certain reference value for both lighting workers and academic research.

Keywords: Lamps; Color Temperature; Lighting Design; Lighting Data.

1. Introduction

Light has regional, in northern Europe, the land belongs to the high latitude cold zone, the night is long and the day is short, so a need for a large area of light; in the Middle East, belongs to the low latitude hot zone, the day is long and the night is short, the need for a small area of light windows, the use of reflective light for lighting. Light also has a cultural nature, in the West, people like uniform lighting to achieve the brightness of the space, while in the East is like hidden and not hair, through and through the effect of light. Light in the design of space, through the brightness and darkness as well as the difference in light color, naturally divided into different spaces, through the natural light and artificial lighting intensity changes, can create a rich sense of spatial hierarchy, any object can only be visually perceived under the action of light, the correct design, the use of light, to strengthen the three-dimensional sense of architectural modeling, to enhance the spatial artistic effect. In the items or display lighting design, if there is no artistic sense of lighting design, it will appear very bland, the designer makes the product can cause people's interest, usually to use the space light and dark contrast to strengthen the artistic image or details, stronger contrast can make the space to produce dramatic artistic effect, through the combination of light and shadow and a variety of materials and the light produced by the reaction, you can create a dynamic light, to Create a more rhythmic dynamic change, to accentuate the artistic atmosphere. In 1941, Germany Kludov first put forward the concept of illumination, low illuminance low color temperature or high illuminance high color temperature, the light source makes people feel happy and comfortable, and low illuminance high color temperature makes people feel gloomy, dim, cold, therefore, low illuminance when using the use of warm-colored light, close to the dusk mood, in the interior to create a friendly and relaxed atmosphere, in the high illuminance is appropriate to use cold light, give people a lively, relaxed atmosphere. A large number of experiments have shown that the color temperature in 3000 ~ 4000K, the human visual degree is more comfortable, projected to the commodity picture more comfortable and bright. Usually in the museum lighting design, to ensure the color rendering effect of paintings, the most appropriate parameters for the color temperature of 5500 K, illuminance 200 lx. A scientific research team on the relationship between commodities and lighting experiments found that the lighting effect of different commodities on the color temperature requirements are not the same, such as lighting samples of fruits and vegetables in the 4500 K to 5500 K or so, it will show the freshness of the vegetables and thus cause the desire to buy. The desire to buy. Affected by cultural and regional influences, the East and the West the color temperature preferences there are clear differences, Asians are more inclined to warm color temperature, while Europe and the United States are the opposite. A large amount of practical data proves that the subjective evaluation of the lighting data value is very important, it can be used as a reference method for evaluation of lighting quality and effect, the comfort of the light source in a certain color temperature range there is a peak, too high or too low a color temperature reduces the comfort or quality of the light source lighting. In addition to the brightness of the light source and color other factors, the space of the material and the size of the area, the visual preference will also affect the lighting effect of the space.

2. A Few Concepts About Lighting Design and the Selection and Arrangement of Luminaires

2.1. Difference between Illuminance and Luminance

Illumination is the unit of light flux received on the illuminated surface, different functional areas on the demand for illumination are not the same, brightness is the luminous surface of the luminous intensity of physical quantities, the human eye from a direction to observes the light source, the light intensity in this direction and the human eye "see" the ratio of the area of the source, the greater the intensity of the light, the smaller the projected area, then it also feels The greater the light intensity, the smaller the projected area, then also feel the brighter, that is, the greater the brightness. Illumination and the illuminated object are irrelevant, under the same conditions, the light is the same, that is, the illumination is the same, just as the human hand and the back of the hand, under the same illumination, will always feel that

the heart of the hand than the back of the hand is a little brighter. Different materials, in the same illumination, the brightness is not the same, the same kind of material is not the same color, the color of the brightness of the light than the color of the deep high. The human eye can intuitively feel the brightness, why is it necessary to use illuminance to assess the lighting design? Very often, the designer of the color of indoor materials and space brightness makes it difficult to grasp the impact of each other, in the "Architectural Lighting Design Standards" do not accurately illustrate, such as classroom tables and chairs in dark or light color, the brightness should be how much. At present, the national standard is only more general to stipulate the illumination, meaning that probably such a functional area, how much light can be obtained, and then based on a large amount of data for statistics, such as the configuration of school classroom surface desks, textbooks, the relationship between the eyes of the students to get the 300lx light to meet the needs of the students to read, which requires designers to fully consider the ambient light, interior materials, the nature of use, etc. to accurately design the light. This requires the designer in the lighting design, to give full consideration to the ambient light, indoor materials, and the use of nature to accurately design the illumination to meet the user's comfort and psychological needs.

2.2. Illumination Calculation Methods and Problems

In calculating spatial illuminance, we sometimes utilize the formula:

$$\text{Luminous flux of a single luminaire} = \frac{\text{Number of lamps} \times \text{Space utilization factor} \times \text{Maintenance factor}}{\text{Floor area (length} \times \text{width)}}$$

At present, this calculation method cannot be a very accurate expression of illuminance value, can only ignore a lot of objective factors to estimate, and the expected effect is difficult to achieve, we have to combine it with the light distribution curve to achieve the purpose of lighting design, light distribution curve is in fact to indicate a luminaire or light source emitted by the distribution of light in the space, you can record the luminous flux of the luminaire, the number of light sources, the power, the power factor, the dimensions of the luminaire, Luminaire efficiency including luminaire manufacturer, model number and other information, records the luminous intensity of the luminaire in all directions.

There are generally three ways to represent the light distribution curve, polar coordinates method, right angle coordinates method, and equal light intensity curve. In the polar coordinates light distribution curve, we through the center of the light source on the photometric plane, measured the light intensity value of the lamps at different angles, from a certain direction, the angle as a function of the angle of the light intensity of each angle with a vector labeled out, connected to the top of the vector connection is the lighting fixture polar coordinates light distribution curve. If the lamp has a rotational axis of symmetry, then only through the axis of a photometric plane of light intensity distribution curve can illustrate the distribution of its light intensity in space, if the light distribution of lamps and lanterns in space is asymmetric, it requires several photometric plane of light intensity distribution curve to illustrate the spatial distribution of its light intensity. Experiments have proved that in incandescent lamps, fluorescent lamps, and inflatable lamps, the distribution range is almost close to the 4π space, LED lamps due to the stronger directionality, the light distribution curve is generally used to indicate the polar coordinates, as long as the 0 ° -180 ° polar coordinates are sufficient, that is, only half of the traditional light source and coordinate paper. The beam angle of the lamp is usually divided according to the angle, narrow light distribution below 35°, medium light distribution at 35°-45°, and wide light distribution at more than 45°, if you give the angle value, power and luminous flux, you can calculate the illuminance, the first read out the angular direction of the position of the light intensity value, illuminance = light intensity value Lamp Luminous Flux Φ× Lamp Installation Height×cos the angle value. The illuminance value measured by this formula is relatively accurate. Usually, people imitate the sun's lighting placed in the interior of the geometric center of the lamps and lanterns, generally close to the ceiling point, this arrangement of the actual lighting problem is still lacking. Lighting arrangement should be combined with the function of indoor space as well as display props and product furnishings and other factors to consider, to achieve the basic requirements of lighting design, and enhance the spatial mood. Designers generally must choose the light source and then choose the lamps, in the design of the indoor light environment, we should comprehensively consider the characteristics of the lamp attributes, according to the visual angle, environmental factors, and economic factors to choose the lamps. The arrangement of lamps should be reasonable, first of all, to determine which type of lighting, what kind of light source to choose, the illumination value of the space needs, calculate the required lighting installation power or number of lamps, and then lamps and lanterns arrangement. First of all, to meet the requirements of uniformity of illumination on the work surface, in the lighting design, through the uniformity of the lamps, to serve the requirements of the entire work surface has uniform lighting requirements of the place, the general lighting is mostly used in this way, uniformity of the lamps will usually be of the same type of lamps and lanterns according to the equilibrium of the area arranged into a single geometric figure, such as linear, square, rectangle, rhombus, angle and star-shaped, etc., the arrangement of the form of the eye to see the lamps and lanterns When the eyes see the light fixtures produce the least sense of stimulation as a principle. In the local lighting design, there should be enough brightness-selective lighting. To highlight a certain part to strengthen a local illumination, or to create a certain decorative effect, or environmental atmosphere, you can selective lighting, generally used in local lighting or directional lighting, while considering the light direction should be appropriate, glare is limited to the permissible range, no shadows, we must consider the energy saving, try to improve the utilization factor, the layout of the beautiful, and the architectural, indoor space, and the decorative atmosphere and decorative mood of the coordination. The lighting should be arranged in an appropriate direction. The specific arrangement of lamps and lanterns also needs to consider the lighting place of the building structure form, style, aesthetic requirements, process equipment, piping safety maintenance, and other factors.

We have to choose the light source according to different

spatial characteristics, in the place of high color rendering performance requirements only, to choose the color rendering index greater than 80 light sources; high demand for the light environment, when the illumination is less than 100, to choose a warm light source, when the illumination is greater than 200lx, to use the intermediate color or a cold light source; emergency lighting, frequent switching, the requirements of instantaneous start and continuous dimming of the place and can not interrupt the important places of lighting, it is appropriate to use incandescent lamps and tungsten halogen lamps. Lighting important places, it is appropriate to use incandescent lamps and tungsten halogen lamps, can not choose to start the ignition and re-start the ignition time is longer than the high-pressure gas discharge lamps; high space places, such as factories, gymnasiums, large venues, etc., you can choose high-intensity gas discharge lamps. The choice of lamps and environmental conditions also have a great relationship between the most suitable ambient temperature of fluorescent lamps for about 20-25 ℃, when the low temperature when the start of combustion is difficult, can not be used in the ambient temperature is particularly high or low places, should not be used for high ambient humidity of the environment, generally in the relative humidity of 60% of the following is appropriate, but also should not be used in the place of the switch frequently; incandescent lamps, low luminous efficacy, power consumption, heat, short life, high operating costs, is not suitable for use in the requirements of the light, the power consumption, heat, short service life, operation, the light is not a good choice for the light. High cost, not suitable for use in the requirements of high illumination, long time lighting or high precision requirements of the constant temperature places; metal halide lamps more ultraviolet, can not be used in the lighting distance closer to the place, to avoid ultraviolet radiation on the human body caused by burns, art museums, and other exhibits should not be used in the illumination of ultraviolet radiation of the light source, otherwise, the works will cause damage. We space lighting design, to economically rational choice of light source, such as the selection of efficient light source, to achieve the same illumination colleagues can reduce the number of required light sources, thereby reducing the cost of electrical equipment, materials, installation costs, etc.; Selection of high luminous efficacy, long life of the light source can save operating costs.

3. Artistic Expression of Lighting Design in Commercial Space

3.1. Selection of Lamps and Lighting Forms

In the display space and specialty stores, more commonly used track lighting, through the track a flexible device, so that we can move, swing, place, and along the track to adjust a separate lamp irradiation aiming point to achieve the desired effect, but also to meet the scene changes. If possible, you can also install the lanterns and chandeliers on the track for the design of the lighting scene, easy to move the light position according to the position of the items on display changes. Spotlights are also commonly used lamps in commercial space, can change the angle of projection, and are a kind of local lighting lamps, especially in stores, exhibition halls, museums, and other indoor lighting to increase the attractiveness of goods, exhibits; generally embedded in the floor compartments in the lamps and lanterns (downlights, bull's-eye lamps, bucket lamps), with a better downward light distribution, the light is relatively more centralized, the formation of the environment of the dark and light contrasts are relatively strong, this type of lighting can be obtained. This type of lighting can get a quieter environment atmosphere, the average illumination is uniform. Spotlight-type lamps are generally used for local lighting requirements of the place, such as gold and silver jewelry stores, shopping malls, shelves, etc.; Diffused lamps are mainly used for local lighting outside the auxiliary lighting, such as hotels and cafes, such as aisles.

In the form of lighting, commercial spaces often use directional lighting, to strengthen the sense of three-dimensionality, revealing fresh contours and shadows, and projecting light in a specific direction onto the goods. Museums, exhibition halls, and other indoor spaces are often used in this type of lighting. In decorative lighting you can use light-emitting ceiling, light-emitting wall, in indoor ceiling or wall construction when the choice of light-transmitting materials, such as light-transmitting soft film, organic sheet, frosted glass, light-transmitting stone, etc., in which to set up the light source, to achieve a large area of light-emitting effect. The design of the built-in light source requires orderly arrangement as well as reasonable spacing, thus ensuring uniformity of brightness. In the selection of wall washing lighting, to early wall connected to the ceiling, continuous lighting set up, making the wall both bright and uniform and illuminated, the space irradiated light is softer, more comfortable, generally used in hotels, SPA halls in the channel space.

3.2. Quality Parameters of Display Space Lighting Used in Commercial Space

In commercial space, quality parameters should be combined with the artistry of light to convey conceptual infectiousness, visual comfort, exhibit brightness, and acceptance. Excellent commercial space has strict requirements on exhibit detail expression, exhibit appearance, outline clarity, exhibit brightness, and exhibit texture clarity. Through the experiment, the relationship between subjective evaluation indexes and color quality parameters is calculated, and the correlation between them is explored, and Table 1 is specially produced. brightness visual adaptability, exhibit brightness appropriateness, and visual comfort have a strong correlation with brightness, the higher the brightness, the more uncomfortable it is; exhibit texture clarity, exhibit outline clarity, and exhibit detail expressiveness have a strong positive correlation with brightness uniformity, the higher the brightness uniformity, the higher the brightness, the higher the acceptance level. The greater the brightness uniformity, the clearer the details of the exhibits. As for the artistic expression of light, the infectiousness of light in concept communication, the color preference of light source, and the degree of warmth and coldness, we mainly focus on the study of comfort and pleasure.

After repeated tests and research, in the lighting design of clothing stores, the color temperature of the light should be adapted to the grade and design style of the decoration, the arrangement of lamps and lanterns to meet the requirements of the space illumination, and strive to be simple, the form of lighting can be a variety of ways to cooperate, bake the space of the art of the atmosphere and the theme, to meet the public's aesthetic needs, and to provide a comfortable spatial environment. Different lighting forms and space light illumination designs should be based on the brand positioning

of the store goods combined, otherwise, it will mislead the consumer psychological induction, thus forming the wrong consumer orientation. High-grade fashion store illuminance should be controlled at about 300lx, in the form of lighting mainly using key lighting, lamps, and lanterns selection mainly using LED track lights, so that the space lighting levels of dark and light is rich, to highlight the goods of the noble and luxurious, clothing color rendering should be combined with the lighting environment to be considered together, the general requirements of the color rendering index should be more than 90, the lamps and lanterns can be selected from LED, fluorescent lamps, or a mixture of the two. Mixed as a light source, highlighting the quality of clothing materials, and conveying accurate color, to achieve the purpose of accurate sales. Popular boutique illuminance is generally controlled at about 400lx, the color rendering index should also reach more than 90, the form of lighting using general lighting, lamps and lanterns evenly arranged, weakening the level of space lighting, highlighting the active atmosphere of the space.

Table 1. Lighting values for commercial building spaces (authors' self-measured values)

Name of the premises	Height of reference plane (m)	Illumination value (lx)	Color rendering index	UGR
Museums	0.75 from the ground	200-500	90	0.8
Specialty store	0.75 from the ground	300-500	80	0.8
Exhibition hall	0.75 from the ground	200-500	90	0.6
High-end supermarkets	Ground level	300	80	0.6
Upscale indoor shopping street	Ground level	300	50	0.6

In the shoe store, for the illumination requirements are very high, it is appropriate to use special lighting, more spotlights, and LED lights, spotlights have energy-saving, spotlight, the color is close to natural light, after reflection, will not sting the eyes. In the medium and high-end shoe stores, the space of the local illumination and general illumination of the value of the difference is very large, the local lighting can reach 2500lx-3000lx, the general illumination in 300lx-400lx, due to the shoes show props more display cabinets, usually using the form of cast lighting, the need to appropriately increase the value of the general illumination, to increase the gloss of the shoes and the three-dimensional sense of the key lighting To increase the luster and three-dimensional sense of shoes, key lighting should use LED embedded spotlights. Shoe store grade and focus lighting coefficient are directly proportional to the higher coefficient, the higher the grade, the higher the grade, high-grade brand shoe store focus lighting coefficient should be more than 1:8, ordinary stores in 1:6. In food specialty stores food stores and food stores should mainly consider illumination, brightness and color temperature. This type of specialty store design highlights the visual freshness, to uses lighting to improve the allure of fresh goods products, the goal is to create a fresh environment. Premium food stores require uniform brightness and high illumination throughout the room, merchandise display case illumination should reach 900lx or more, for display cases using fluorescent lighting, you can add LED track lights on the outside, this way the effect is better. The general illumination of the mass store should be 400-850lx, the use of higher illumination is to highlight the rich colors of the goods. This kind of merchandise lighting can be fluorescent lamps and incandescent lamps can be used in parallel. Fresh fish and meat stores and vegetable stores such as commodity stores need higher brightness to increase the freshness of the goods, therefore, it is appropriate to use the color temperature or low color temperature lamps and use high illuminance. This type of store can use high-brightness light source beam projector lighting, such as LED-embedded spotlights.

In the shopping plaza in the luxury goods stores, the sale of goods includes various types of precious metals, jewelry, watches, designer glasses, etc. For such stores, the store decoration and lighting design has a unified brand culture style. For gold, it is appropriate to use 2800K-3500K warm color lamps and lanterns for irradiation, illuminance 2200lx; platinum, the application of 5800K-6000K or so lighting, illuminance in 1800lx or so; for jade amber can be used 4500-6500K, illuminance should not be too high, 600-900lx or so; and diamonds should be used 7000-7800K Cool white light, illuminance 1900lx. In addition to illuminance, the store should avoid glare, but also avoid the harm of artificial light on the goods.

4. Conclusion

Lighting gives people identification, safety, interaction, and other functional roles, while lighting design is to give people emotion, recall, artistic beauty, and other spiritual role; lighting is practical, lighting design is artistic; lighting is rational, lighting design is emotional; lighting is a tool, lighting design is the road, with the tool to use, with the road to pleasure. Lighting design has an increasing impact on our lives, from museums to exhibition halls, from specialty stores to high-level supermarkets, and so on, which prompted lighting designers to constantly explore the quality of lighting parameters and the relationship between the visual art form beauty of goods.

References

[1] Shen J. M., Zhai Q. Y., Luo M. Correlation between quality parameters of LED lighting and visual evaluation of artworks [TM]. Lighting Engineering Journal,2018,10.

[2] Han Bin. Exhibition Design [M]. Harbin: Heilongjiang Fine Arts Publishing House.1996.

[3] Wang Jiansong. Commercial Exhibition and Facility Design [M]. Beijing: China Architecture Industry Publishing House, 1999.

[4] Xin Yifeng. Architectural Interior Environment Design [M]. Beijing: Machinery Industry Press. Beijing: Machinery Industry Press, 2007.

[5] Zheng Zili, Peng Liangdong. Decoration and arrangement of store windows and booths [M]. Shanghai: Shanghai Science and Technology Literature Publishing House, 1993.

[6] Huang Yan, Wu Aili. Lighting design [M]. Beijing: China Youth Publishing House.Beijing: China Youth Publishing House. 2007.

[7] Sun Z, Liu S, Zou NY, Wang ZS. Lighting design based on interdisciplinary theory to improve museum visitors' emotional response [TM]. Lighting Engineering Journal,2018,10.

[8] Luo Hui. Research on indirect lighting method based on LED display spacing optimization on diffuse free-form surface. Master's thesis of East China Jiaotong University,2017,01.

[9] Ai Jie. LED lamps and light distribution curves. Technology and enterprise [N],2015,10.