THE IMPORTANCE OF COLOUR RENDERING IN INTERIOR LIGHTING AND AVAILABLE LAMP SOURCES

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by

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SUMMARY

It is a well known fact that most of our urban life becomes possible because of artificial light. As more and more interior functions are becoming specialized and complex the ‘quality’ light is gaining more and more importance in respect to the quantity of light. Not only in trades where colour plays an important part or the appearance of merchandise is crucial but almost anywhere, every professional designer is becoming conscious of how a particular light can effect the presentation of/ or the product on the whole and the ambiance that houses the product. It is high time for us professionals to list all the available sources of light and classify them in terms of their colour rendering abilities, to work for the awareness of the suppliers who in turn could educate the layman or the contract buyer and market on the basis of quality. Our goal should be not just how much light but what kind of light without loosing on the economics of illumination and energy.

We commute in the city everyday, mostly leaving one interior space and entering another. We may leave our apartment and go to a school, a dental clinic, a super market, an office, a printing press or a textile factory. Obviously the list is endless and every interior demands certain lighting standards, as far as the quantity and quality is concerned. We may not be fully self sufficient in the QUANTITY of light available to us but recently with the developments in our cities, more and more emphasis is being placed on the quality of light.

The three most important factors that determine the quality of light are

A. Freedom from disturbing glare.
B. Directionality of light.
C. The colour of light, colour appearance and its colour rendering characteristics.

Although all three elements are equally important yet the colour of light and its rendering abilities is least understood and least exploited.

The way, in which the colours around us are rendered, exerts a considerable influence on our mood and sense of well being. The subject of colour in general is so vast that it requires a separate session, I often quote an incident in a factory where certain containers with some lousy brown colour had to be hand lifted and the labour had complained for getting breathless and tired etc., some imaginative manager had them painted to some light, bright and cheerful colour and there were no more complaints. But the important question is, does that nice and cheerful colour viewed in the daylight at noon remain the same in the afternoon light or sunset? Or when it is reviewed in artificial lighting!

Colour rendering is of particular importance in a strictly practical sense, especially when objects must be seen in their true colours. Human skin which looks pale and bluish under the commonly available fluorescent changes considerably under the incandescent light which is rich in yellows and reds which renders it more warm and pleasant. The same may not be true in the natural/ daylight, which is equally rich in blues. But we know that even the colour of the natural light changes with the time of the day and the seasons of the year.

Coming back to the Interiors, the light employed generally must be so chosen that the familiar objects that are foodstuff, drinks and above all skin colours appear pleasant. We are able to perceive our products and an interior space with their galaxy of colours and textures, only when light is around. Without light we have no Interiors. The subject of the colour is a rather complicated one, as it involves both the colour characteristics of the light itself and the colour rendering of the illuminated surface. The colour of the light source depends upon the spectral composition of the light emitted by it, apparent colour of a light reflecting surface, on the other hand, is determined by two characteristics: the spectral composition of the light by which it is illuminated and the spectral reflectance characteristics of the surface.

We know that a coloured object is coloured because it reflects light selectively. The spectral reflectance curve of red paint, for example, shows that it reflects a high percentage of the red wavelengths and little or none of the blue end of the spectrum. But an article painted red can only appear red if the light falling on it contains sufficient red radiation, so that this can be reflected.

The two major criterion for the subject of colour characteristics of lamp sources, as specified in recommendations are

COLOUR TEMPERATURE, in Kelvin or (K)

COLOUR RENDERING INDEX OR (Ra)

The colour appearance of light standards are based on a black body radiator which starts to emit visible radiation when heated. This radiation has a relation with the colour specific to the temperature of the body. Different elements will have a different glow on different temperatures. Based on this theory we find that candlelight is 2200 K, a tungsten filament lamp is 2800 K while the colour temperature of the sunlight is 5500 K. A correlated chart has been prepared by the CIE and one can assess the colour (appearance) temperature of any light radiation from any source.

The colour temperature which are less than 3300 K appear warm or rich on the yellow side of the spectrum and are considered warm white. The range of colour temperatures between 3300 and 5000 K is considered as intermediate white. More than 5000 K is rich in the blue end of the spectrum as is taken as cool white.

Although light sources having the same (correlated) colour temperature and also have the same colour appearance does not necessarily mean that colour surfaces will look the same under them. The colour rendering can be different with lights having similar colour temperature, as the spectral distribution or the wavelengths emitted by different matters that are used to produce light is different at different temperatures. This is particularly true with thermal radiators i.e. incandescent lamps, but a selective radiator like a common fluorescent, which is a gas discharge lamp, emits light in a selected number of spectral lines or bands, the other wavelengths being absent.

The colour appearance obtained from such light source can nevertheless be ‘white’ as we know from the ‘additive colour mixing’ theory. Any spectral colour together with its complementary colour will produce white light, and as the complementary colour itself is generally also present in the spectrum, or can be obtained by mixing of two other spectral colours, it is possible to obtain white light by the combination of only two or three single wavelengths. Although the white light thus obtained may be of colour appearance comparable with that of a thermal radiator and therefore can be assigned a correlated colour temperature – true surface colours illuminated by it will often be difficult to distinguish, as most of the colour shades they are composed of are absent in the light falling upon them.

This effect is not restricted to white light. If we compare the monochromatic yellow light from a low pressure sodium lamp with incandescent light with a yellow filter, both of which may have a similar colour appearance and temperature, the colours can be distinguished fairly well under the incandescent lamp whereas every thing turns yellowish with the sodium lamp.

The number, arrangement and relative intensity of the spectral lines or bands present in the visible part of the spectrum of a selective radiator, together determine how far a random selection of surface colours can be faithfully reproduced under this light. This is called the colour rendering capability of the light source.

The CIE has developed a systematic method for the quantitative assessment of colour rendering capability on the basis of eight test colours. First the correlate colour temperature of the light source under the test colour is assessed. Then for each test colour, the colour appearance under the source is calculated as a percentage of that of a black body radiator of the same colour temperature. The average result is called the colour rendering Index, (Ra). This is a number that may vary between “no colour rendering” for mono chromatic light sources, like the sodium lamps and 100 for true black body radiators. For values below 25, the colour rendering index has no practical meaning.

Generally it is considered a mistake to take daylight as a standard because of its chromatic changes of colour (temperature) with the time of the day, but I feel that because of our psychological attunement and historical bondage with the natural light we should not disregard its importance and the part it can play with our psyche, and perhaps our metabolism. It’s all right, for scientific reasons to explore the new technologies to experiment and discover new methods for improving colour rendition in luminaries. It is also correct to assess the colours under the same type of lighting as that existing in the area where they will be finally seen, but I feel that humans will always feel at home with colour of light resembling the natural as much as possible, in fact he will not have any strain whatsoever to identify himself with.

In the west colour rendering lamps are no more a cost burden on the lighting design scheme. It’s an old story when lamps of low Ra i.e. common fluorescent tubes were considered economical. Unfortunately the incandescent lamp, having the highest Ra, consuming the most energy and at the same time giving fewer lumens per wattage, is in full swing mass production in this country which is so poor in the energy sector.

The developments made in the west with their second generation lamps have changed the concept of lighting. The second generation compact fluorescent lamps have made a tremendous improvement as far as lamp efficacy and Ra is considered. In fact the invention of the Tri-phosphor lamps have made a revolution in the fluorescent lighting altogether.

In 1976, Westinghouse introduced the first Tri-phosphor lamps, which had been invented during the 60’s by Dr. William Thornton under the name of Ultralume. The radical difference from standard fluorescent lamps is this: most commercial fluorescent lamps are intended to maximize lumen output without regard to the colour rendition. Tri-phosphor lamps produce energy output in three narrow bands at approximately 440-450 nm, 535-550 nm and at 610-640 nm to which the cone cells of the retina in human eye are most sensitive.

Tests have proven, explains Dr. Alexander Styne of University of Miami, that equal visual satisfaction and performance can be obtained from the light produced by these lamps at lower levels of illuminance than from standard fluorescent sources. Big manufacturers like Philips have achieved amazing results by using rare-earth phosphor rather than halo phosphors as coating for the TL, the only problem is that it may take years when it will be manufactured in Pakistan.

Comparing the international scenario with that of the Pakistan, I would dare say that the local/ conscious designers have been totally frustrated as no development is still in sight as far as colour rendition is concerned. No doubt that the major suppliers have paid a lot of attention to the energy lamps but a total disregard to the colour has wrongly conditioned the buyers.

Even after the demand and pressure only one manufacturer came up with a slightly improved version of the warm white fluorescent tube. This is still not closed to the variety available abroad. It is only after the liberal import policy that we have been flooded by the “CFL’s” and low voltage Halogens, but then the cost factor does not make it as popular as the typical and cheap colour 54.

In the end I would like to conclude with a remark for the lighting research scientists: to consider the natural light, (which is equally rich in the blues as much as it is in the reds and yellows), as a norm rather than Incandescent at 100 Ra which is rich in the yellow end of the spectrum.

Current research led by DR. Sam Berman at Lawrence Berkley Lab have already proved that bluer light means better sight and less work for the human eye.

It is the latest discovery that may well become the decisive factor in the design and manufacturer of future lamps. This is reported by Mr. James R. Benya of Luminae Souter, a San Francisco lighting design firm. It deals with the ‘Photopic’ or the cone vision curve which is based on the fact that the human eye is most sensitive around 550 nm, at the yellow green portion of the spectrum and is relatively insensitive to the red and blue ends of the spectrum.

Now as we know that the eye works just like a camera with the pupil operating like an aperture, the eye operates at its maximum capacity at 550 nm. This can be over burdening for the eye our most important tool. With the fully open aperture even the depth of field diminishes. Under the blue poor light source, like the high-pressure sodium, the pupil opens to full wide. This can cause focusing problems, especially when the tasks are viewed at multiple distances.

The research could drastically change the way we think about lighting. Blue poor sources like the high pressure Sodium lamps and non blue sources, like the low pressure sodium, have traditionally been the big lumen per watt leaders. But both generate about the same number of pupil-lumens per watt as incandescent which has traditionally produced the fewest lumens per watt.

Sources that produce the most blue stands to be the big winners, for example the tri-phosphor fluorescent lamps have a blue peak that corresponds well with the blue sensitivity measured by the researchers. Metal halide lamps also experience higher pupil-lumen per watt than most other light sources.

So let there be a balance between the Blue and yellow to develop a new light colour rendition of purer light.

I would like to take this opportunity to digress slightly from the main course and make an important observation for the professional designers of the built environment, especially the practicing architects.

Before we became totally depends on artificial lighting the quality of architecture, I think was different. Better in many as it provided for the natural light to enter interior spaces quite imaginatively with the help of sky lights and high ventilators and other perforations etc. but since the artificial light has become an ‘easy option’ and an integral part of a building and as it can cheaply be available even in the remotest part of the Interior, the architectural standards have considerably dropped. Although the requirements of our mega city architecture is different from the, say the towns of about fifty years ago, there has been no improvement in the realm of natural light for architecture. We have yet to use natural light to our benefit which is abundantly available and absolutely free. I would highly recommend to the practicing designers to review this situation critically and make an effort to change course. I recommend the use of sky lights and other perforations, also the use of glass blocks to introduce the real light to our, as I call it ‘modern dark age Architecture’. This will result in some relief on the energy sector and yet give us a better ‘quality’ of light that we all strive for.

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