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# Comparative Energy Analysis of Luminous Ambience in a Conventional and Energy-Efficient I.T. Company at Nagpur, India

**Aditi Mahajan[1], Harshal Ganorkar[2]**

[1]IDEAS-Institute of Design Education & Architectural Studies, Nagpur (MS), India

[2]Professor, IDEAS-Institute of Design Education & Architectural Studies, Nagpur (MS), India

**Abstract:** ***This paper deals with the electrical energy consumption for a stipulated office space to achieve desired luminous ambience for effective user performance. Luminous ambience is the role of light in a way that an environment influences the subject, but to attain that level within a conventional I.T. space with the help of artificial lighting and in an energy-efficient I.T. space aided by daylight and artificial light a discrete amount of energy is required. The paper delineates the comparative study of electrical energy consumption which can be analyzed assisted by simulation.***

**Keywords:** Energy, Luminous Ambience, Conventional I.T. space, Energy-Efficient I.T. space

## 1. Introduction

The evolution of office space has gone through many different changes through the past century.During the 1920s, Frederick Taylor heavily influenced office culture by making it his goal to maximize the efficiency of the workplace with a wide-open floor plan. The Primary function of lighting in the office space is to support work.

A comparative study was done to analyze the discrete amount of electrical energy required to attain desired luminous ambience in a workspace which only employs artificial lighting and one which employs a blend of natural and artificial lighting in an I.T. (Information Technology) company.

The offices are located in Nagpur lying in the state Maharashtra in India. The geographic coordinates of Nagpur are Latitude: 21.15,Longitude:79.08.The city of Nagpur lies in the time zone of India Standard Time(IST),offset UTC/GMT +5:30 hours. The selected I.T. office works in the field of software development, testing and maintenance on computers. The working pattern of the employees is of 45hrs for working in a week. The selected workspace is having a standard layout with open plan office consisting of cubicles with partition of 1.35 meter height and 1724 sq. floor area and the same case has been considered for both lighting genre.

## 2. Methodology

Quantitative information from measurements or simulations of interior luminous ambience yields in data that is very useful to analyze the performance and comfort of a luminous ambience in design. The comparative study helps in understanding and promoting the controlled use of daylighting instead of artificial light. The qualitative and quantitative data comprising of ambient light levels, desktop light levels are considered with reference to specified standards and literature reviewed papers.

## 3. Focus of the Paper

The paper focuses on comparison between electrical energy consumed to achieve stipulated luminance levels recommended by Standards and Literature reviewed papers. The study of quantitative parameters like lighting type and light levels and the qualitative parameters like energy requirements to cater a specific luminous ambience. The focus is to formulate a scientific basis to improve the understanding and design of luminous ambience that are comfortable, pleasant and economical by efficient use of natural light.

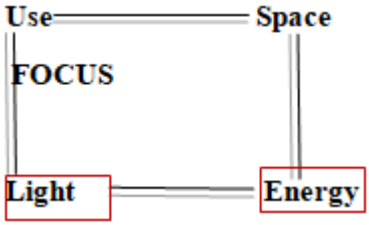


**Figure 1**

## 4. Lighting

Lighting quality is much more than just providing an appropriate quantity of light, it is governed by illuminance uniformity, luminance distributions, light color characteristics and glare. Though there is a broad range of acceptable light levels (illuminance) that provide adequate quantity of illumination, the quality of it has an effect on visual performance which utilizes considerable amount of energy.

The factors for Indoor Lighting include-Size and shape of space, Types of finishes on ceiling, walls and floors, the type of activity to be carried out, economic consideration for initial and operating costs.

In mixed lighting, user's switch on electric light in spaces for two reasons; that is either to have more light and to have

a more pleasant ambience. In that respect, a better design of luminous ambience in daylighting is an important factor to reduce artificial light consumption. On the other hand, for the quantity of light, one may delay the use of artificial light during the day. Hence, immense amount of energy is consumed to create a more pleasant ambience. Hence, being able to control the design of luminous ambience allows creating in daylighting that are more efficient, morecomfortable and pleasant, what leads to a reduction in electric light usage.

Luminous Ambience is defined as the way the luminous environment influences a subject. This definition covers the notion of luminous environment with all its characteristics like energy and the subjective response. In the design of luminous ambience, the designer's approach is usually qualitative. They express intentions and compare them with the results.

## 5. Application Case

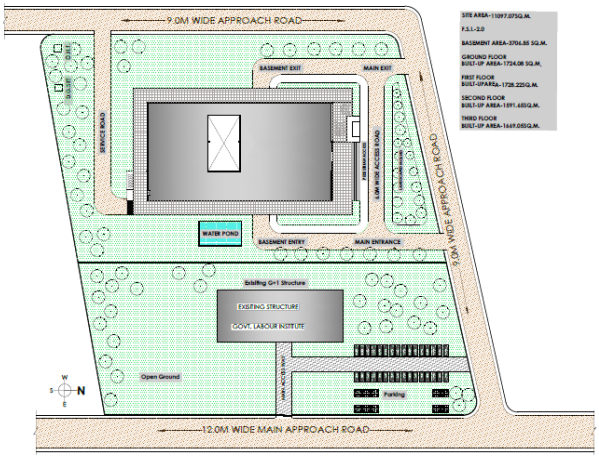


**Figure 1**

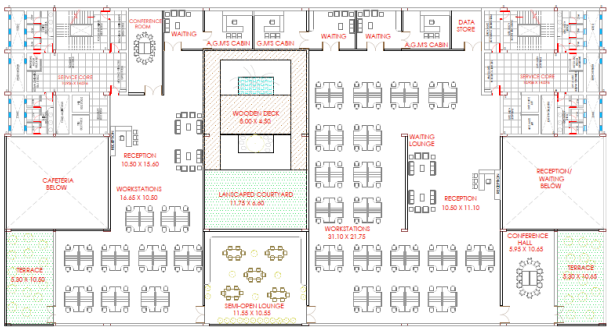

**Figure 2**

As stated above, the offices are located in Nagpur lying in the state Maharashtra in India.The selected workspace is having a standard layout with open plan office consisting of cubicles with partition of 1.35 meter height and 1724 sq. floor area and the same case has been considered for both lighting genre.

## 6. Luminance Levels Recommended by Standards and Literature Reviewed Papers

As per Indian Standards, IS 3646(Part I):1992,code of practice for interior illumination, given by BIS Bureau of Indian Standards, the range of service illumination in lux for type of interior or activity of computer work stations is 300-500-750 lux.IES(Illuminating Engineering Society of North America)has recommended illumination level of 500 Lux for computer rooms of offices and shops whereas the MS 1525 recommendation for the same is 300-400Lux.As per BEE(Bureau of Energy Efficiency),the minimum service illuminance on the task of general lighting for interiors should be 200Lux.Uniformity of luminance (minimum/ average) over any task area and immediate surrounding should not be less than 0.8.

*'Acceptable Illumination Levels for Office occupants'* examinedthe acceptable horizontal illumination levels in an office environment by interviewing occupants about the visual environment perceived in all classes of office buildings in Hong Kong. The subjective evaluation of the office visual environment was correlated to the measured horizontal illumination level and mathematical expressions were proposed for the overall acceptability of the illumination level. The acceptable illumination level Φ as determined from equation was 518 lux.

The study of *'The Effect of Adaptation Levels and Daylight Glare on Office Workers' Perception of Lighting Quality in Open Plan Offices'* stressed on the adaptation levels to isolate causes ofdissatisfaction within the large open plan office environment. It was hypothesized that the adaptation level would be a significantinfluence on peoples' perceptions of their visual environment. Field study was done for offices in Sydney. Meanadaptation luminance was found to be of 131 lux. Boyce (1973) carried out a study in to the effect of age on visual performance and showed that significant improvement in performance is seen to perform a visual task, when luminance is raised from 500lux to 700lux for subjects in the age of 46 to 60 years.

## 7. Daylight Design Considerations

The two factors that govern the interior illumination aided by daylight include-Space Geometry and Light Reflecting features like light shelves and internal surfaces.Light shelves help better day light distribution while also providing shading.Shallow floor-plates provide daylight access to greater floor area. Daylight penetrates into a room roughly 2.5 times the height of the top of the window from the ground.Higher the window, deeper the daylight penetration in the room. Usually, daylight penetration in the room is between 6m to 8m from the fenestration. The base case considerations were made with use of daylight and light shelves for generating the desired output.

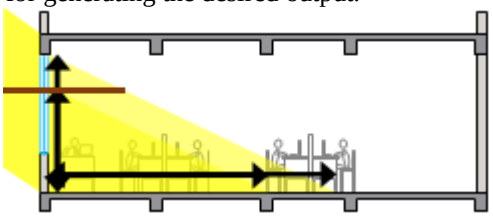

**Figure 3**

## 8. Simulation Software

The software used for conducting simulations in order to access lighting on the energy parameter was design

builder.The Application of Design Builder includes Building Energy Simulation,Visualization,Internal Heat Gains,Solar Shading, Natural Ventilation, Hourly Weather Data,Heating and Cooling, Equipment Sizing and Daylight Simulation. It operates on self-simulation engine.

## 9. Base Case Simulation

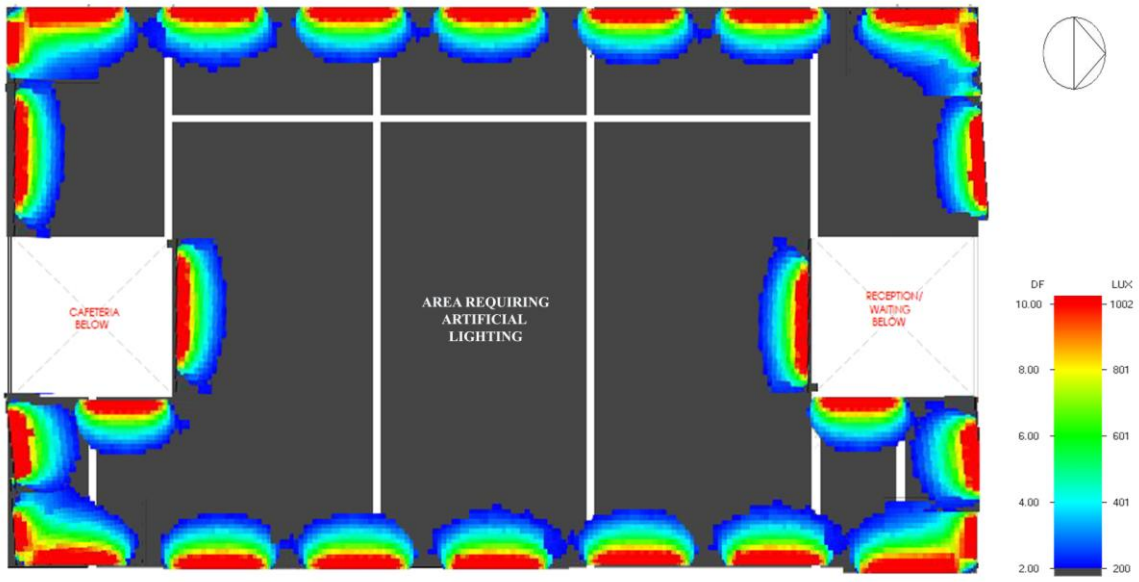


**Figure 4:** Base Case Simulation without Daylighting

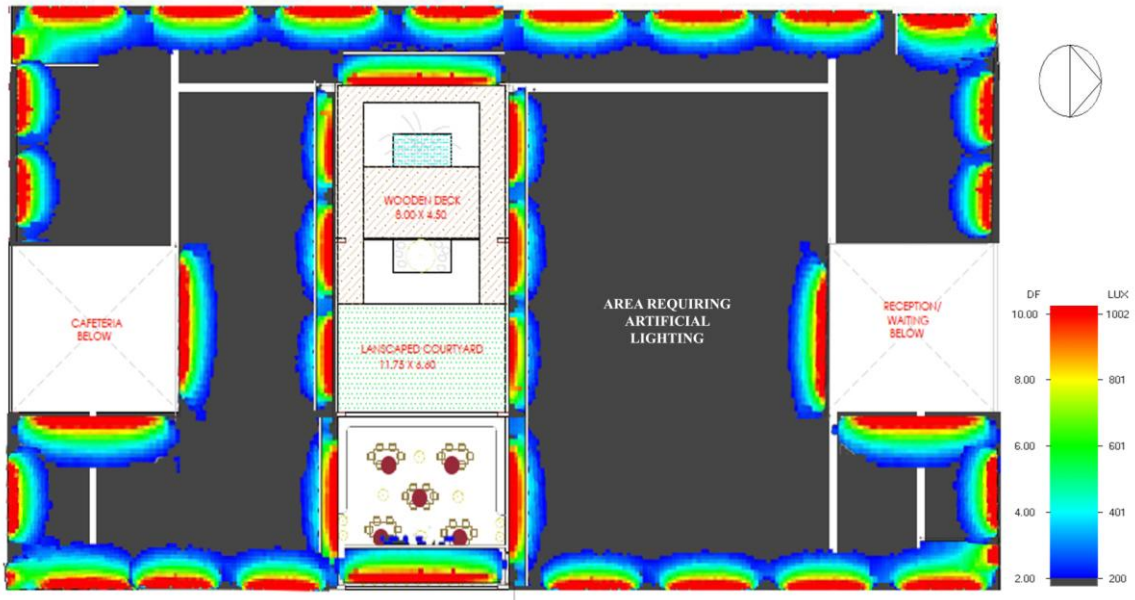


**Figure 5:** Base Case Simulation with Daylighting

## 10. Simulation Analysis

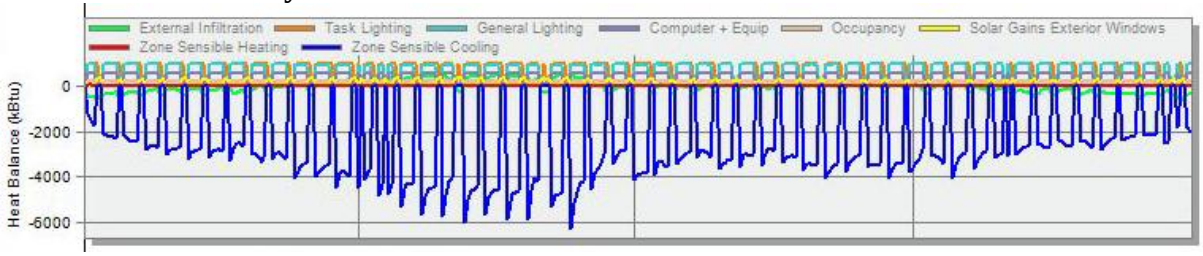


**Figure 6:** Simulation Analysis for Artificial Lighting

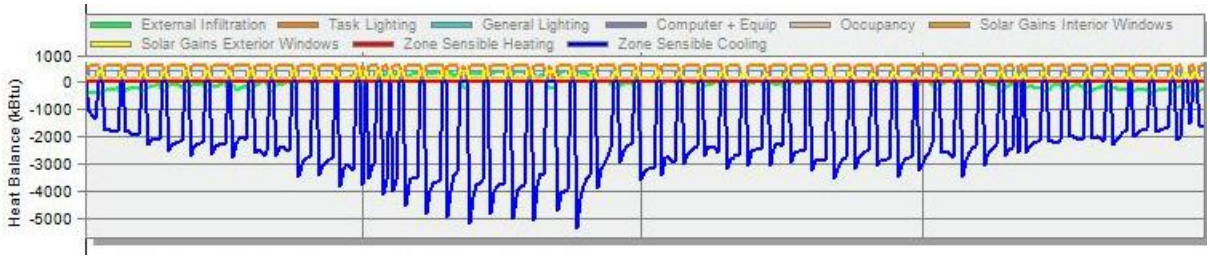


**Figure 7:** Simulation Analysis for Composite Lighting

In Fig.6.Simulation Analysis for Artificial Lighting, The light-blue band depicts the general lighting requirement for the office space. The orange band depicts the task lighting requirement. The purple band depicts the electrical energy consumption for computers and other equipment's.Hence, it can be seen that there is extensive electrical energy consumption to achieve desired luminous ambience within the office space.

In Fig.7.Simulation Analysis for Composite Lighting,The general lighting consumption is drastically reduced. The task lighting requirement becomes optimum and the electrical energy consumption for computers and other equipment's remains the same in both the cases.Hence, it can be seen that the electrical energy consumption is reduced by 30% in composite lighting layout, in order to achieve the desired luminous ambience.

## 11. Conclusion

The work presented in this paper aimed at contributing to improve the links between qualitative and quantitative approaches on luminous ambience with major focus on energy requirements.The nature of the light source has a lot of impact on perception as well. A daylight and an artificial light situation will not have the same effects on people.

People are more likely to tolerate a higher level of glare in a day lit environment. It has been found that a strong correlation exists between the preferred luminance ratios and the visual interest of a scene, which tends to prove that when we are sitting next to a window, we would rather tolerate a high amount of daylight and enjoy the view outside than drawn the blinds down and use artificial lighting. The simulation results depict that there is extensive electrical energy consumption to achieve desired luminous ambience within the office space using artificial lighting, while the requirements are drastically reduced with the application of composite lighting.

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