

Interior Lighting Influences Work Efficiency and Human Behaviour

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Abstract

Effective lighting design goes beyond simply installing electrical fixtures and must consider the specific needs and functions of the space, as well as how light interacts with the building's mechanical systems. A well-designed lighting plan can enhance the interior design of a space and create a feeling of warmth and comfort. Since light is a critical component of vision and our perception of the world around us is largely dependent on our vision, it's easy to see why neglecting proper lighting strategies in the workplace can have a significant negative impact on productivity. The negative impact of lighting on worker productivity is not limited to either harsh or dim lighting. Both types can be equally detrimental. However, by choosing natural lighting or effective lighting systems, you can improve productivity while also saving energy. The lighting in a workplace can have a positive impact on the health of employees, increase efficiency, reduce absenteeism, and ultimately lead to greater productivity.

KEYWORDS: Interior Design, Architecture, Office Design, Lighting.

INTRODUCTION

Lighting is crucial for creating a healthy workplace and has a significant impact on how people feel. Poor lighting can lead to eye strain, fatigue, and reduced performance, especially in jobs that require problem-solving and concentration. In modern commercial buildings, proper lighting design is essential for people to carry out their activities comfortably, efficiently, and effectively.

Light that contains a high amount of blue spectral component enhances performance and concentration. Decreasing the amount of blue light leads to a more relaxed state of the body. White/white control has additional benefits on the human biological rhythm and can boost motivation, concentration, and productivity, particularly for intellectual tasks.

1.1 Relation Between Work Efficiency And Light

Veitch, J. A., & Newsham, G. R. (1998) asserted that Work efficiency i.e., ability to complete a task with high-quality results in a minimal amount of time. It is typically used to describe the capacity for achieving a particular outcome. The factors that contribute to efficiency are diverse, including aspects such as temperature, access to nature, lighting, color, noise control, and indoor air quality. Comfortable thermal conditions, access to natural surroundings, and proper lighting, among other factors, are critical for creating an efficient work environment.

Having good lighting in the workplace is crucial for achieving optimal visual task performance, especially for an ageing population. Studies conducted over the past few decades have indicated that enhancing the quality of lighting from a low or moderate level can significantly improve the speed and accuracy with which objects are detected and recognised.

In addition to visual performance Veitch, J. A., & Newsham, G. R. (1998) also suggested that good-quality lighting can also reduce the risk of workplace accidents by promoting greater awareness of potential hazards and improving the mood, alertness, and health of industrial workers. As low concentration levels and high levels of fatigue can lead to accidents, the importance of good lighting cannot be overstated.

Furthermore, lighting plays a significant role in creating a stimulating working environment, which is why it is given equal importance as layout and interior design. While lighting can highlight the positive elements of a design, it can also detract from them, such as by causing poor colour rendering or glare effects.

1.2 Need Of Adequate Lighting

Adequate lighting is essential in office spaces to promote productivity, reduce eye strain and fatigue, and enhance overall well-being. Bean, R. (2014) concluded that insufficient lighting can lead to a decrease in productivity, as workers may struggle to read documents or see computer screens clearly. Poor lighting can also cause headaches, eye strain, and other health issues that can lead to absenteeism or decreased work performance. As suggested by Bean, R. (2014), need of adequate lighting can be divided into various needs as mentioned below:

Practical Needs: While it may be easy to identify the practical considerations that should guide our choice of lighting in an office, it is not feasible to create optimal lighting conditions for all areas using only one or two ceiling fixtures set at a constant brightness level. This is because there are various spaces within an office that require different types of lighting considerations.

Ease Of Performance: Having the right amount of light is crucial to complete any job effectively. However, the complexity of the task at hand plays a crucial role in determining the lighting requirements. The more complicated the job, the more critical it becomes to understand precisely what needs to be done to provide adequate lighting.

Comfort: Human adaptability and perseverance allow us to carry out visual tasks even with minimal available light.

Safety: Correct lighting is important in areas of special danger to prevent accidents or injuries. The amount of light required to illuminate an area, such as a flight of stairs, can vary depending on whether natural or artificial light is being used.

Economy: To reduce the use of artificial light, maximizing the use of natural daylight is recommended. However, it is important to address any potential issues that may arise from this. Additionally, implementing various controls can help save energy and improve the economic efficiency of lighting.

Decorative Needs: Light is essential in determining how objects are perceived visually. An important principle to note is that colors will only appear if they are present in the light source. Depending on the lighting, objects can either be made to look more attractive or less appealing.

1.3 Qualities Of Light

Light has the ability to create an optical illusion by changing the visual perception of a space, even without physically altering it. Egan, M. D. (1997) guided our focus,

impact our interpretation of a space, and draw attention to specific features. In his research of “Concepts of architectural Lighting” he mentioned that spaces can be defined to create visual connection between the inside and outside with the help of light. The way light is distributed and its level of brightness plays a crucial role in how architecture is perceived. Egan, M. D. (1997) also suggested the following regarding Architectural Lighting:

Forming functional zones: Light can be utilized to highlight specific areas of a space by using zonal lighting. This technique involves creating distinct beams of light to visually separate different functional zones, such as traffic areas, waiting areas, and exhibition areas. Zonal lighting can help to divide up an area and improve orientation. By using narrow beams of light and strong contrasts in brightness, individual zones can be separated from their surroundings. This creates distinct contrasts between the zones and their spatial context.

Defining spatial borders: The use of lighting can emphasize various elements in a space. Floor illumination can draw attention to objects and pedestrian surfaces, while vertical illumination can highlight spatial borders by illuminating wall surfaces. Different types of illumination can also affect the perception of walls - uniform distribution emphasizes the wall as a whole, while accentuating or grazing light can create patterns and give the wall structure. Bright walls can also increase the level of diffuse light in a room. By varying the level of illuminance on different surfaces, their importance and role in the space can be emphasized.

Colour rendering: Objects appear to have a certain color because they reflect only certain wavelengths of light and absorb the rest. For accurate color perception, it is important to have proper color rendering, which ensures that objects are seen in their true colors without any distortion.

Emphasising architectural features: By illuminating architectural details, the focus of attention can be shifted from the entire room to specific components. For example, columns can be highlighted as silhouettes against an illuminated wall. The form of the columns can be emphasized using narrow-beam downlights. Grazing light can accentuate the texture and form of individual elements or areas.

1.4 Need Of Lighting Controls In Offices

Controlling the lighting in modern office design is crucial, particularly in open-plan offices where different departments have varying lighting needs. For example, computer users require sufficient desk lighting without glare on their monitors. The lighting system in a building can be customized to meet the unique requirements of each user, allowing them to adjust the luminaire above their workspace. Mills, P. R., Tomkins, S. C., & Schlangen, L. J. (2007) asserted that level of control empowers users to create a comfortable environment for themselves, which can help reduce stress and fatigue. Moreover, the use of programmed daylight patterns can mimic natural lighting changes throughout the day, which could be particularly beneficial for call centers where employees work varying shifts. Additionally, constant light control can ensure that the interior lighting remains consistent throughout the day.

The practical role: In modern times, the quality of lighting is primarily influenced by the selection and arrangement of luminaires and lamps, as well as the nature of the surfaces that are being illuminated. Nonetheless, there are numerous situations where artificial lighting is utilized under varying conditions, wherein several parameters may

fluctuate, such as the degree to which natural light contributes to the overall illumination, changes in activity levels within the illuminated space, or the necessity for adjustable lighting based on the specific task or activity being performed Mills, P. R., Tomkins, S. C., & Schlangen, L. J. (2007).

The aesthetic role: The lighting control industry has been primarily driven by the aesthetic aspect of lighting control. Although energy management may be given lip service, the appeal of dynamic lighting effects is what truly sells. The main purpose of lighting control is twofold: firstly, it enables the balancing of various light sources to ensure that the overall result is visually pleasing, and secondly, it provides a means of transitioning between different lighting states Fontenelle, C. V. (2008).

The energy management role: Energy consumption is a global issue that affects both cost and the environment. With buildings consuming almost 70% of the electricity in many countries, lighting control can play a significant role in energy conservation. Whenever a lighting scheme incorporates complex lighting control for aesthetic or practical reasons, it is important to program it to operate in the most efficient manner. Incorporating lighting controls is necessary for green building accreditation and for businesses to accumulate carbon credits Stranks, J. W. (2002).

1.5 Problems Of Bad Lighting Design

As rightly suggested by Stranks, J. W. (2002), bad lighting design can have a significant impact on the health and well-being of employees, as well as the productivity and success of a business. It is crucial to prioritize good lighting design to create a safe, comfortable, and productive work environment.

In continuation to research done by Sun, C., Lian, Z., & Lan, L. (2019) and Jones, C. C., & Gordon, K. L. (2004) following problems can be summed up in case of Bad Lighting Design:

Glare: Glare refers to a type of bright light that can interfere with visual perception. Although it may not significantly impair one's ability to perform visual tasks, it can be quite uncomfortable and even painful. While exposure to glare for a few minutes may not cause discomfort, prolonged exposure, such as working for hours in a highly-glared environment, can lead to severe fatigue.

Direct glare occurs when the image of the source of glare falls directly on the workplace, while indirect glare happens when the image of the source falls on the periphery of the visual field.

Veiling Reflection: Reflected glare, sometimes referred to as "effective reduction in contrast," is caused by the reflection of light rays and can result in a significant reduction of contrast between a task and its background. This type of glare is commonly observed as the reflection of bright light sources on glossy surfaces, such as printed pages, which can impede good vision by reducing the necessary contrast.

Shadows: Shadowing occurs when an obstacle, such as a physical object or equipment, obstructs the light source and creates a shadow on the working area. This can cause discomfort and reduce productivity, as the shadowed area may not be adequately illuminated for the task at hand.

Light Trespass: Light trespass is the unintentional and unwanted illumination of an area where light is not needed or desired. This can be subjective, as it can be difficult

to determine when, where, and how much light is considered unwanted. An example of light trespass is when spill light from a street light or flood light enters a window and illuminates an indoor area, which can be disruptive or distracting for those inside.

Insufficient Light: Insufficient light occurs when the amount of light available for performing a task is not adequate. This can reduce productivity, as individuals may have difficulty seeing and performing their tasks effectively in dimly lit areas.

Choice Of The Light Source Is Incorrect: Selecting the incorrect light source for a particular space can lead to significant problems in terms of both function and aesthetics. Different lighting sources are designed to meet specific purposes, such as drafting, reading, writing, or enhancing the visibility of textures in a space. It is up to the designer to choose the appropriate lighting source to meet the function and aesthetic requirements of the space.

Non Integration Of Daylight And Artificial Light: Even if a building is designed to be fully day lit, an electric lighting system is still needed for stormy weather and night time use. Integrating daylight and artificial light sources is important to meet the function and aesthetic requirements of the space. If there is no integration between daylight and artificial light sources, problems such as high energy consumption, unwanted shadows, and visual discomfort can occur. Therefore, it is important to carefully balance the use of both daylight and artificial light sources to create a comfortable and efficient lighting environment in the space.

Lack Of Maintainence: Failure to maintain light sources can lead to inadequate lighting that hinders task productivity. Two key factors to keep in mind when maintaining a lighting system include regular upkeep and cleaning of fixtures and components, as well as following recommended maintenance schedules and procedures to ensure optimal performance and address issues promptly.

Ageing: Accumulation of dirt on the lamp and fixture. When a lamp ages, its lumen output decreases until it eventually stops working. Accumulated dirt is another issue that can result in light loss. This is affected by both the cleanliness of the area and the luminaries' design. For instance, indirect fixtures would not be suitable in a woodworking shop since dirt mainly accumulates on the top side of lamps and fixtures. Therefore, easy access for cleaning and replacing lamps is a crucial aspect of the design.

2. RESEARCH SOLUTION

Make sure that the openings for solar heat are covered with internal shading devices like blinds or louvers to prevent diffuse solar radiation from entering the space.

To achieve efficient lighting in a space, top lighting strategies such as skylights, domes, or pyramid-shaped designs with baffles to control glare should be employed. The area of glazing should be between 3% to 9% of the floor area to provide adequate lighting levels.

Install clearstories and monitors that have glazing facing north and south.

Install high-level windows or light shelves that can reflect light onto the ceiling, with a cut-off angle of around 15 degrees in both upward and downward directions.

An even distribution of light is crucial for effective daylighting, and evenly distributed apertures are beneficial in achieving this. Continuous-strip apertures are

even better, and apertures on multiple sides are often the best solution to avoid "hotspots" in terms of temperature and brightness. Horizontal bands of windows that are positioned high in the space (to prevent glare and reflect off the ceiling) or evenly spaced, vertically oriented windows that extend to the full height of the room are often used to achieve this.

Side Light: Windows on the sides of buildings only allow daylight to penetrate so far into a building, which is why skylights are often recommended for multi-story buildings. A general rule of thumb for most latitudes is that daylight can penetrate a room approximately 2.5 times the height of the top of the window.

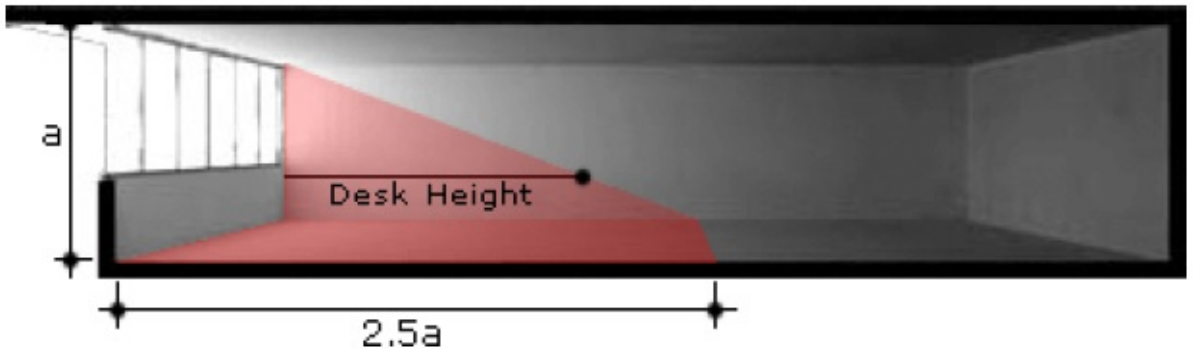
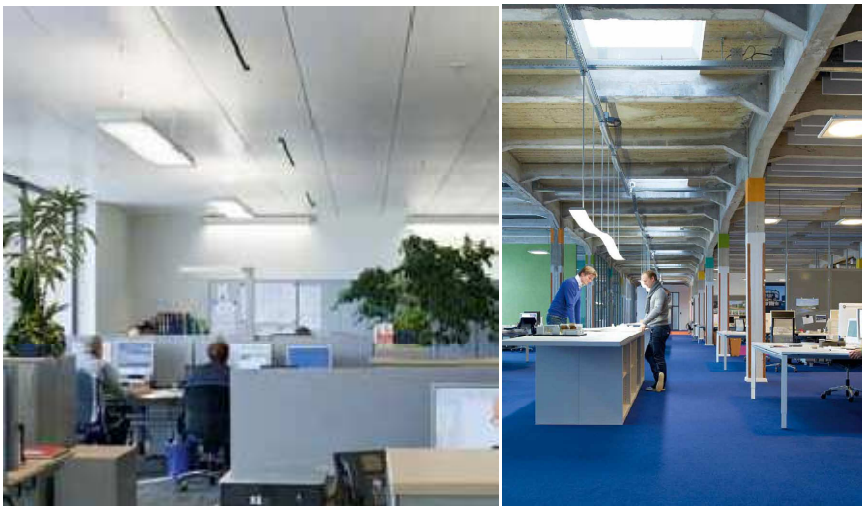


Figure 1: Optimum light travel from a window

Open plan office: Providing appropriate lighting that is customized to specific tasks can increase work efficiency and create a comfortable work environment. This includes controlling glare, ensuring color consistency, and promoting visual comfort. By creating a comfortable work environment, employees are more likely to feel good and perform better.



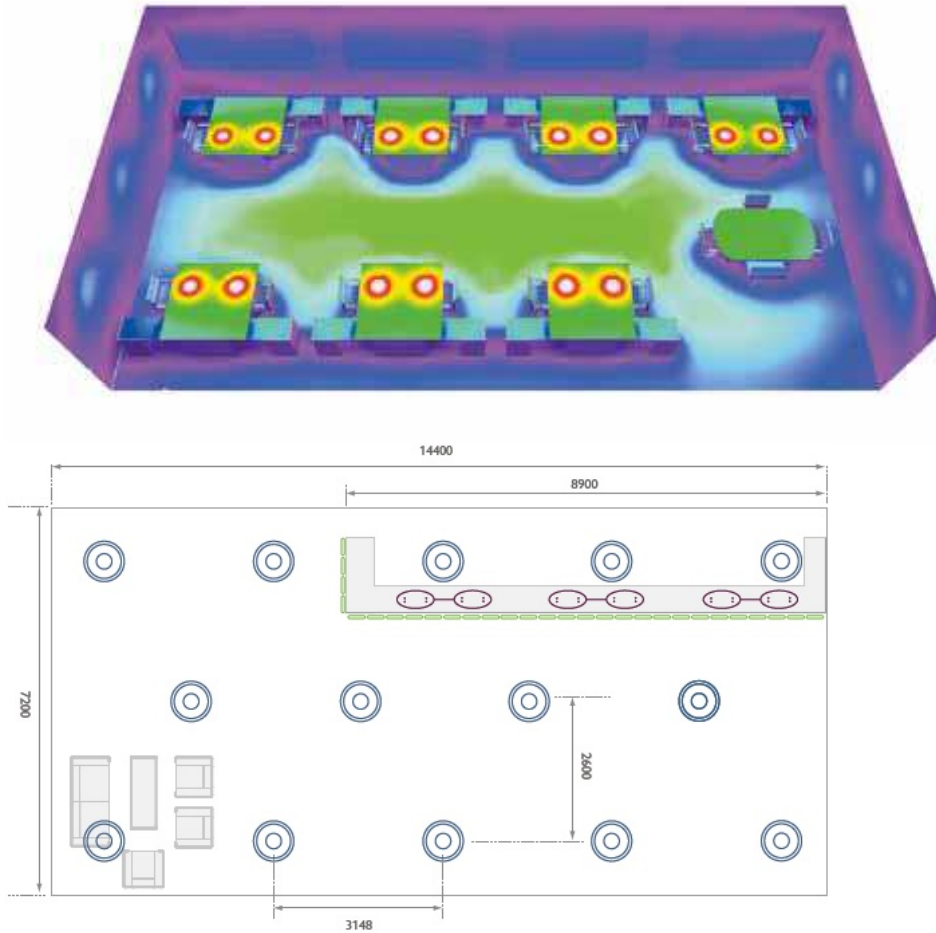
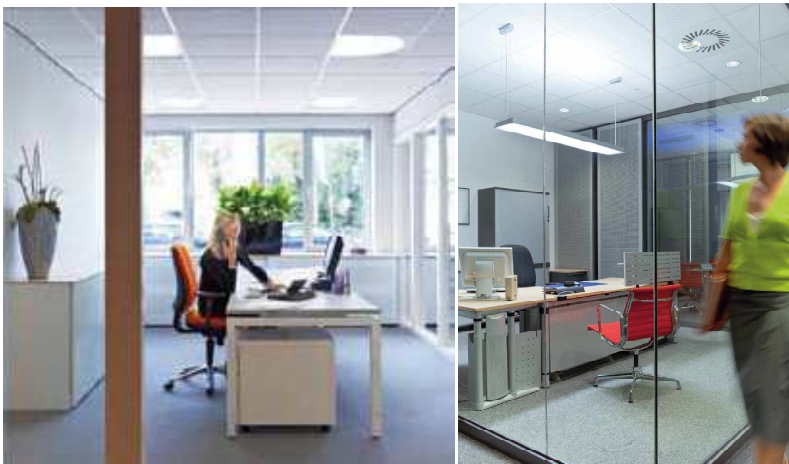


Figure 2: Suggested light placement for open plan office

Cell office: Private offices and interior spaces typically require more artificial lighting to achieve the same brightness as naturally lit rooms. However, this doesn't mean that the lighting solution has to be harsh or unnatural. Many lighting designs offer high levels of visual comfort and the ability to dim, creating a more calming atmosphere. In fact, some of the most innovative luminaire designs are specifically designed to provide optimal lighting while maintaining a comfortable and aesthetically pleasing environment.



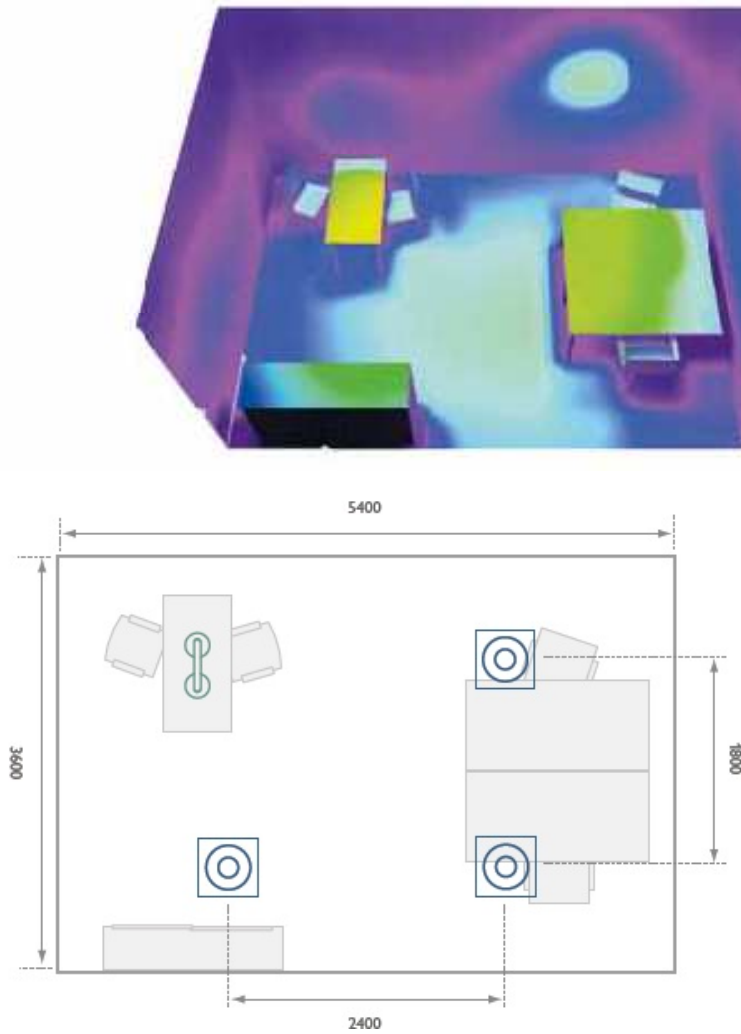
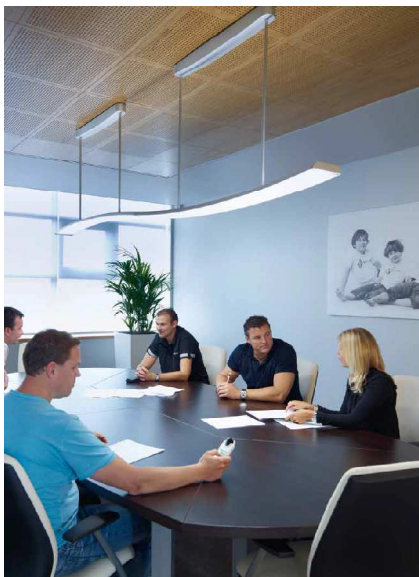


Figure 2: Suggested light placement for cell office

Meeting room: Each meeting is unique, and therefore, it is essential to have lighting that can be adjusted for flexibility and visual comfort in your client's meeting rooms. For collaborative sessions that require maximum productivity, high output lighting without glare is recommended.



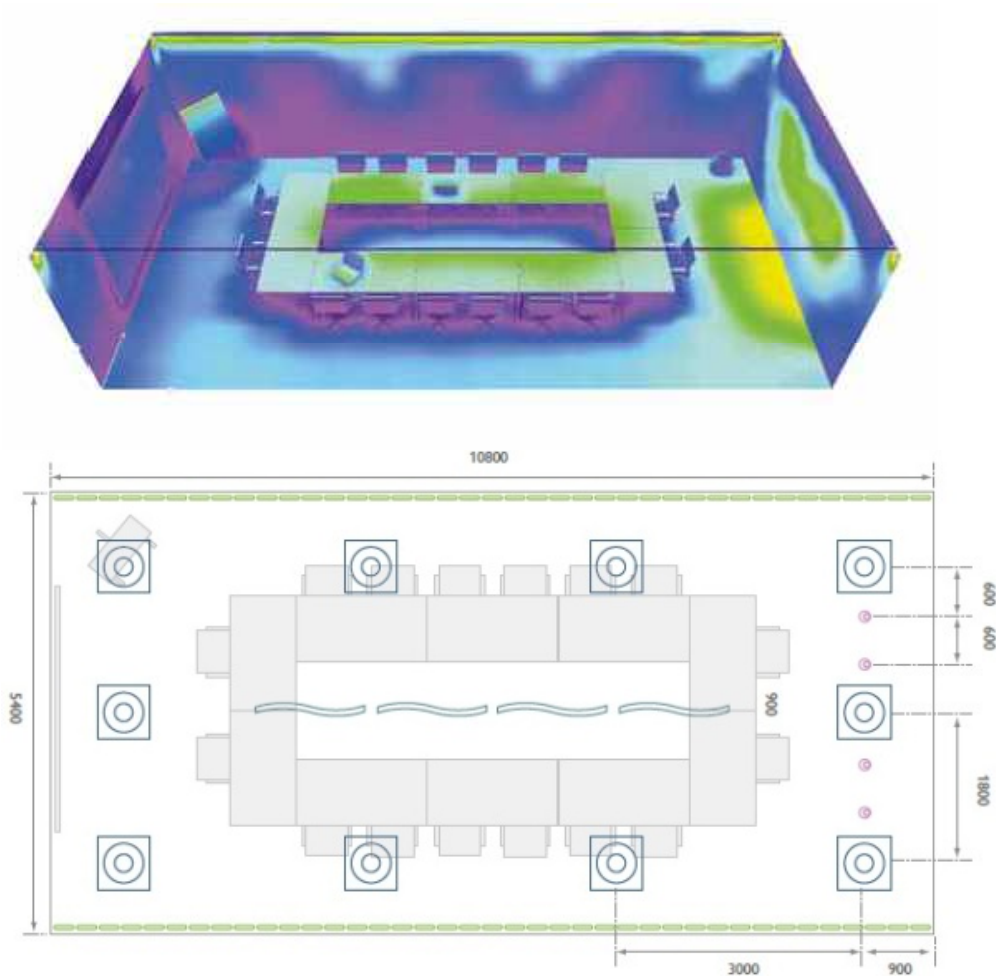


Figure 3: Suggested light placement for conference room

S.No.	Type of Interior, task or activity	Illuminance	Glare Restrictions
1	Filing, Copying, etc.	240	19
2	Writing, typing, reading, data processing	320	19
3	Technical Drawing	600	19
4	CAD Workstations	160 (240)	19
5	Conference and Meeting Rooms	240	19
6	Reception Desk	320	19

Table 1: Suggestive Optimum light levels in an office

3. CONCLUSION

Considering that light is a critical element of vision, and that vision is responsible for 80-85% of our perception of the world, it is easy to understand why neglecting appropriate lighting strategies in the workplace could have a substantial adverse effect on productivity.

Both harsh and dim lighting can have negative effects on worker productivity, and choosing a lighting system that provides sufficient, proven-effective lighting -

whether natural or artificial - can lead to both increased productivity and energy savings.

In conclusion, it can be said that proper lighting in a workplace has a positive impact on the health of office employees, enhances efficiency, and leads to increased productivity.

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