RE-LIT - WELLBEING IN EDUCATIONAL SPACES

A STUDY TO REHABILITATE AND ENHANCE THE DESIGN EDUCATION AND ITS SPACES

MEKİN ELÇİOĞLU, PHD.[A] & YEŞİM ÇELİKKOL[B]
[A]KANSAS STATE UNIVERSITY & [B]MIMAR SINAN FINE ARTS UNIVERSITY

PAPER ABSTRACT: In this study, the impacts of lighting design to productivity and motivation in design education's spaces are analyzed and models are tested. Physiological and psychological effects of designing task-specific spaces are examined. Lighting systems are known to have great impacts on users for their visual performance and psychological requirements. In order to create efficient, functional, ergonomic and pleasing working environments, it is crucial to establish balance between daylight and electric lighting. According to space utilization, appropriate light sources should be chosen and arranged correlating with lighting control devices. This study is conducted to gauge the visual requirements of the students and the faculty alike in post-pandemic educational spaces. The emphasis of this study is on well-being of the users via biodynamic lighting integration to recreate spaces and services in design school environment by using light as a structuring element in a space that influences users' perception of the space as well as affecting their well-being, motivation and overall performance. Rehabilitation of the spaces should be established via the right visual conditions that help them to perform visual tasks comfortably, safely and efficiently. This study aims to demonstrate how most design students and their instructors spend the majority of daytime hours inside buildings without much contact to the natural elements such as natural light. It is also intended to validate the sense of well-being and relevant biological processes are affected by types of light source as a serious decision-making criterion in the process of rehabilitating spaces within the design schools.

Keywords: Natural Light and Well-Being, Visual Performance, User Productivity, Circadian Rhythm, Biodynamic Lighting

1. INTRODUCTION

Designing environments for efficient usage for productivity is becoming more crucial for workspaces, thus being a vital component for design education. Design students as well as their faculty spend a lot of their time working in these environments; most of the time without realizing how much exposure they have to daylight to be more productive and healthier. This makes up most of the important portion of well-being in workspaces. Most of these spaces were designed for efficiency spatially but are they really designed for the well-being of the individuals who are utilizing these spaces from a lighting standpoint? It is becoming a more accepted notion that use of natural light is one of the most important aspects of creating healthier spaces not only for energy-efficiency but also to have a better impact on people using those spaces more comfortably. Creativity is also boosted by these types of notions hence making this a priority in redesigning the design spaces in academia due to the fact that students and faculty heavily rely on natural daylight to stay healthy, connected, both physically and mentally. Various studies investigated and proved the importance of the direct effects of daylighting on positive mood, productivity, and overall pleasure. In this paper these will be analyzed.

2. BACKGROUND ANALYSIS & LIT REVIEW OF CRUCIAL CONCEPTS FOR THIS STUDY

2.1 IMPORTANCE OF NATURAL LIGHT FOR HUMANS

The experience of natural lighting is vital to human health, well-being, productivity, motivation, and performance, allowing orientation to the day, night, and seasons in response to the position and cycles of the sun (Kellert et al, 2015).

Because we are dependent on light for perception, it is natural that we should be psychologically affected by it. Light plays a central role in our everyday lives and consciousness through the physiological processes that connect our health to it. Sunlight gives us a sense of time and a connection with the outside world, a connection often needed by our inner biological clock (Boubekri, 2008).

Most design students and faculty spend the majority of working hours inside studio environments without much contact to the natural elements such as natural light. Their sense of well-being and biological processes are affected by the types of light sources, natural day light as well as mimicry of it.

According to Krygiel & Nies, daylighting is the use of natural light for primary interior illumination. Natural light is the highest-quality and most efficient light source available today. Not only does natural daylight help light our interior spaces, but it also supplies us with a connection to the outdoors. Providing occupants with natural light and ties to the outside has been proven in a number of cases to have a positive effect on human health (Krygiel and Nies, 2008). In the workplace, incorporating natural components into the setting promotes mental health advantages such as better focus, less stress, and improved mood (Kaplan, 1995).

Smolder (2013) distinguishes between two different types of image forming effects through which light can influence mental wellbeing, health and performance: one pertaining to visual performance and one pertaining to visual experience. Moreover, it could be distinguished between circadian (phase-shifting) and acute (non- circadian) non-image forming effects of light.

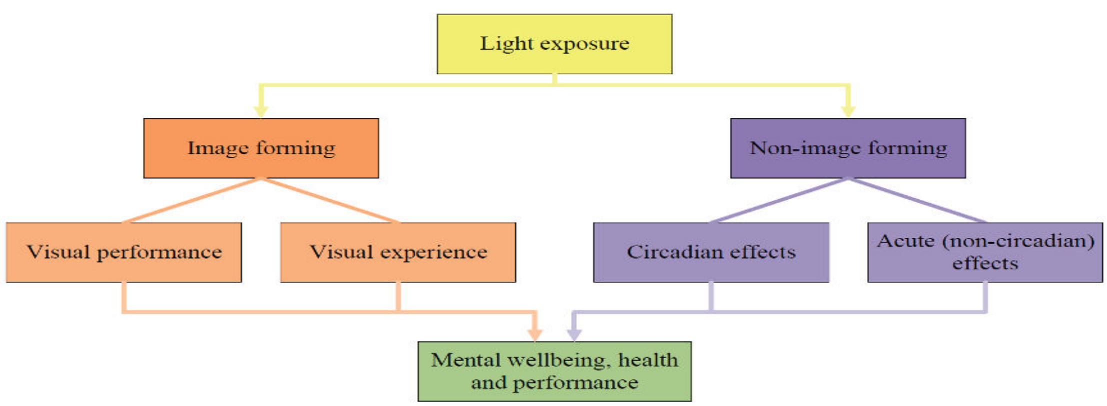

Figure 1. Schematic overview different routes for potential effect of light on human functioning (Smolders, 2013).

2.2 PSYCHOLOGICAL BENEFITS OF DAYLIGHTING IN WELL-BEING

The view through a window, or how we perceive the world outside, is a dynamic experience associated with changes in skylight, sunlight and season. At its lowest level, a view satisfies the physiological need of the eye for a change of focus, and provides an awareness of the environment beyond the building (CIBSE LG 10,1999). There are psychological benefits, not readily quantified, but evident in qualitative human responses:

- Sunshine: The presence of direct sunshine in the interior environment is one of the strongest psychological benefits. The evidence of a desire by most people for some direct sun is strong. Although direct sun on a visual task may produce excessive brightness differences, some direct sun in proper location and quantity is stimulating and desirable. Daylighting design can often include direct sun without destroying visual acuity.
- View: A view to the exterior is another psychological benefit to building occupants. While techniques for admitting daylight are not necessarily directly related to a window with a view, they most often are related. Numerous studies have established that people consider a view to be very important. Any leasing agent of building space will confirm the fact that tenants usually are willing to pay more for office space with windows than for windowless spaces. What constitutes a valuable view is generally related to the information content in the view and the distance between occupant and window. The best views are those that include some sky, horizon, and foreground. More important, however, is a view containing a balance of synthetic and natural things with some element of movement, change, and surprise involved. The closer the occupant is to the window (and, hence, a total view) the more the satisfaction will be. Broad horizontal windows are more satisfying than narrow vertical windows, an optimal size being about 20 to 30 percent of the exterior (window) wall.
- Brightness gradients and color constancy: Daylight generally produces a gradation and color of light on surfaces and objects that biologically is “natural” for humans. Daylight is the “standard” against which the human mind measures all things seen, probably because of a lifetime association with daylight. A gradation of daylight on a wall surface from a window will seem natural, and the wall will look smooth. Colors seen with daylight will appear real and appropriate through something called “color constancy,” even though the color produced by daylight will vary from dawn to noon to dusk, as well as by color reflection from adjacent surfaces (Evans, 1997).

Initial studies exploring lighting and human behavior focused on our preferences in lighting conditions, particularly in the workplace. The common results among these studies suggest that people prefer much higher light levels than those typically recommended by professional organizations such as the Illuminating Engineering Society in North America (IESNA) or the Chartered Institution of Building Services Engineers (CIBSE) in the United Kingdom. To cite only a few examples, American students were found to prefer illuminance levels as much as three times higher than those recommended (Leslie and Hartleb, 1990). Feeling nature in the interior directly, indirectly, and integrated with the space can also be considered a crucial feature of the biophilic design strategy that sustains the human focus (Kellert & Calabrese, 2015).

2.3. PRODUCTIVITY AND MOTIVATION FOR INDIVIDUALS

Lighting should be designed to provide people with the right visual conditions that help them to perform visual tasks efficiently, safely and comfortably. The luminous environment acts through a chain of mechanisms on human physiological and psychological factors, which further influence human performance and productivity (Halonen et al, 2010).

According to Soderlund and Newman (2015) humans are biologically evolved to respond positively to interaction with nature, and this relationship can help them achieve intellectual, emotional, and spiritual fulfillment.

2.4 BIODYNAMIC LIGHTING AS A WELL-BEING FACTOR

Biodynamic lighting is an artificial light source that replicates the dynamic variations of daylight and sunlight through a light management system (Young, 2015). Up until recent times, it was commonly believed that light was only needed for seeing. However, in 2001, an American scientist, G. C. Brainard discovered a circadian photoreceptor in the retina, which receives a specific quality and quantity of light, and sets the biological clock (Brainard, 2001). Young (2015) also analyzes that the exposure to intense light boosts employees' feelings of alertness. At the very least it can counteract feelings of tiredness, although this may depend on the duration and timing of the exposure to light. This leads to the fact that lighting manufacturers and designers are focusing on energy and safety when designing their products, but more and more with the human in mind. It is as important to create energy-efficient lighting to save energy whilst increasing productivity and well-being. Figure 2 shows changing light color temperature depending on the time of day in such indoor working environments.

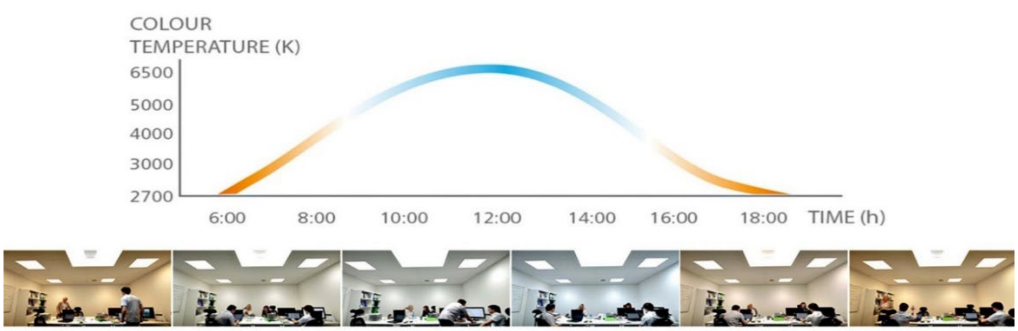

Figure 2: Changing light color temperature depending on the time of day.

Natural lighting awareness may also aid movement and wayfinding and provide comfort and satisfaction. Natural lighting may take on aesthetically pleasing shapes and patterns beyond mere exposure through the creative interplay of light and shadow, diffuse and changeable light, and the integration of light with spatial qualities. Natural lighting may be introduced deep into interior rooms using glass walls and clerestories, reflective colors and materials, and other interior design strategies. Natural lighting contains all hues and positively impacts human productivity and psyche. Light and shadow create an effect that emphasizes or helps differentiate one object from another. Reflected light reduces eye strain by balancing glare and producing a soft impression. Warm light makes people feel protected, and peaceful spatial diversity boosts mental and emotional activity (Karaman et al, 2021).

2.5. NATURAL LIGHTING & BIOPHILLIC DESIGN

According to a 1998 study titled "Benefits of Natural Daylighting," higher student and instructor attendance, greater achievement rates, decreased weariness, improved student health, and enhancement factors of general student development are among the benefits of natural daylighting. Natural lighting in schools has also been linked to physical growth, a good mood throughout the day, and higher levels of alertness and activity in students (McFadden, 2023). According to Kellert et al, (2011) biophilic design identifies two basic dimensions in an indoor environment. The first fundamental dimension of biophilic design is an organic or naturalistic dimension, described as shapes and forms in an indoor environment that directly, indirectly, or symbolically represent the intrinsic human attraction to nature. The second fundamental dimension of biophilic design is a place-based or vernacular dimension, described as structures and landscapes that link to the culture and ecology of a location or geographic area. These two dimensions are followed by six biophilic design elements in an indoor environment: Environmental features, natural shapes and forms, natural patterns, and processes, light and space, place-based relationships, and evolved human-nature relationships.

2.6. REFLECTANCE AND GLARE FACTORS

To create a well-balanced luminance distribution, the luminance values of all surfaces shall be taken into consideration and will be determined by the reflectance and the illuminance on the surfaces. To avoid gloom and to raise adaptation levels and comfort of people in buildings, it is highly desirable to have bright interior surfaces particularly the walls and ceiling. The lighting designer shall consider and select the appropriate reflectance and illuminance values for the interior surfaces based on the guidance below. Recommended reflectance values for the major interior diffusely reflecting surfaces are the ceiling: 0,7 to 0,9; walls: 0,5 to 0,8; floor: 0,2 to 0,4 (EN 12464-1, 2011).

Interior workspaces should have high reflectances to increase interreflections and thus help reduce the undesirable contrast of luminaires against their background. High reflectances also allow the designer to produce an effective lighted environment with fewer watts and fewer luminaires. Dark surfaces, saturated colors, and glossy finishes can maintain visual interest and stimulation, but they should be used to a limited degree (IESNA, 2000). Reflectance of room surfaces strongly affects the perceived atmosphere in the room. Our eyes are drawn to the brightest part of a scene. Within work areas, therefore, higher luminance values usually occur at the task areas, but if this is taken to extremes, brightness constancy may break down. This can be avoided by providing adequate illuminance with good color rendering and glare control. Sharp shadows, sudden large changes in luminance, and excessively bright and frequent highlights should be avoided. Glare occurs whenever one part of an interior is much brighter than the general brightness in the interior. The most common sources of excessive brightness are luminaires and windows, seen directly or by reflection. Glare can have two effects: it can impair vision, in which case it is called disability glare, and it can cause discomfort, in which case it is called discomfort glare. Disability glare and discomfort glare can occur simultaneously or separately (CIBSE, 2002). Glare can be classified in two types according to the way it occurs: direct glare and reflected (veiling) glare. Direct glare is created by a light source which can be from artificial lighting systems or windows. High reflectance or shiny surfaces may cause reflected glare.

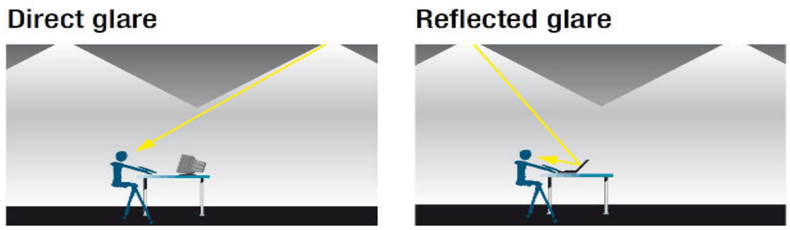

Figure 3: Direct and reflected glare (ZUMTOBEL, 2011).

Direct glare occurs where a very bright point of light, e.g., the lamp of a luminaire, is located in the visual field. Direct glare can be avoided by the use of appropriate luminaires and correct positioning of luminaires and workplaces. Reflected glare is excessive uncontrolled luminance reflected from objects or surfaces in the field of view. This includes the reflected luminance from interior surfaces as well as the luminance of the lighting system (Celikkol, 2012).

3. APPLICABLE METHODS FOR DESIGN EDUCATION

3.1. EVALUATING DAYLIGHTING FOR USERS IN TERMS OF WELL-BEING IN DESIGN EDUCATION

McFadden (2023) defines daylighting as direct sunlight and diffused skylight which are let into a building in a controlled way. It is the practice of designing the placement of windows, skylights, and reflective surfaces to allow sunlight to provide internal lighting. In addition to lowering energy costs significantly, effective daylighting helps create a visually engaging and productive environment for building occupants by connecting them directly to the dynamic and constantly changing patterns of light outside. The placement of windows and doors on the elevations of a building (fenestration) needs to be planned so that direct sunlight doesn't hit work surfaces or people's eyes. Tools that provide dynamic shadings, such as motorized interior and exterior louvers to automated roller shades and blinds, can help with glare and are often used for this purpose.

Designing is defined by Archer (1973) as an area of human experience, skill and knowledge which is concerned with man’s ability to mould his environment to suit his material and spiritual needs. Rapoport’s definition emphasizes that design is any purposeful modification or change to the physical environment by humans (Rapoport, 1990). Hence design education requires an intelligent agent capable of expressing purpose or intention. Design education became more challenging when the conditions changed drastically since moving to online and hybrid modalities which require more interaction time on digital interfaces. Well-being and biological processes of these design spaces with the people using them while adapting to the new norms are affected by natural daylight as well as mimicry of it by the artificial lighting sources and components.

To sense the natural balance and harmony, the inside-outside areas must connect the inside with natural lighting. Natural substances such as natural lighting can help people cope with stress and improve their mood by reducing anxiety (Kellert, 2005). Kellert also argues that nurturing man's intrinsic passion for and connection to the environment, called biophilia, is critical to humans' well-being in the modern world.

3.2. DAYLIGHTING ANALYSIS FOR (RE-)DESIGNING WORKSPACES IN DESIGN EDUCATION

Daylight utilization feasibility of a space can be carried out through daylight analysis which helps to determine the daylight distribution into a space and shows differences of daylight intensity in the same layout. This process shows that daylight availability of spaces for intended times or all year round. Moreover, visualization of the building model as 3D enables building to be seen from any angle when under the sun effect. Evaluation of daylight availability with computer-based simulation programs can give work plane illuminance value, daylight factors, surface luminance, etc. in a scaled model and layout. This provides convenience to designers at decision making process about building interior orientation, windows size, type and location, space organization including room partitions with indoor components such as CMF. Artificial lighting systems with lighting control elements should be integrated carefully into the design spaces. Solar control system could also be included in the modelling if needed (Celikkol, 2012).

Benefiting from daylighting is achieved, according to a study by NCSU (2013), by daylighting design process and its benefits by providing illumination in buildings using natural light as a substitute for electric light is attractive for several reasons including the natural light resource being substantial; during most working hours, the light incident on a building is several times greater than that required to illuminate the building interior, indicating that it should be possible to design solar apertures that provide enough interior illumination to offset most or all of the daytime lighting electricity consumption. The same study also claims Daylighting Concept Generation involves the identification of a lighting need and a method for delivering the daylight to satisfy that need. The physical measurement studies involve the use of photometers, luminance meters, digital photography, high-dynamic range digital photography, and human visual observations to generate information on illuminance levels, luminance distributions, spatial aesthetics, and visual comfort (NCSU Research, 2013).

3.3. SUGGESTED METHODOLOGY FOR WORK & DESIGN SPACES IN DESIGN EDUCATION

For the main wellbeing aspects of this rehabilitation study, the focus areas within work and design spaces are classrooms, studios, workshop environments and offices where ideation, design and development phases take place constantly. Crucial components such as drawing tables, workstations, computer screens and projection areas, modeling stations, workshop equipment and office desks are evaluated and rehabilitated with respective demographics, a spectrum of age-groups for various tasks, abilities, limitations, and opportunities. Necessary adjustments and re-designs are to be administered. As a part of the methodology, a thorough daylight analysis is to be completed for the existing and projected work and design spaces. The window details and interior features of the space should be reviewed as a part of this analysis. Then the daylight analysis of these areas with the determined days and hours should be examined with the required parameters.

One of the key points to be considered at this stage is how much users are exposed to glare during the working hours. If this is to be detected, glare should be prevented with shading elements and other necessary applications suitable for these design spaces. These shading elements could be selected manually or automatically. In prevention of glare, it is also important that users should not be obstructed from seeing outside. Detailed values of glare effects are also referred to in Section 2.6. After glare prevention, lighting dimming could be addressed in zones where natural lighting is sufficient. According to EN 12464-1 (2011) Standard, required illuminance level on the working plane for educational buildings is 500 lux. In areas where natural lighting is not sufficient, the required level of illumination can be provided with artificial lighting and utilizing other components with lighting control systems. Applying all these solutions together will also save energy and create a homogeneous lighting level in the work and design environment for the users' wellbeing.

4. TAKE-AWAYS FOR THIS STUDY

The major aspect of this study is to identify the productivity and motivation of the design students and the faculty in design studios and educational spaces where additional emphasis should be put due to extra work time with a lot of after-hours where mimicing daylighting would be very beneficial. For areas which do not get enough daylight exposure, various applications could be utilized starting with the ceiling features which are of key importance in reflecting daylight coming into the workspaces and extending out to the tasks. Back-wall, side-walls, and the floor would be the secondary focus. Having the ceiling and its added elements with light colors is key while the floor surface deeper tones and colors as referred to in Sections 2.2 and 2.6.

The science of daylighting design involves not only figuring out how to give an occupied room enough light but also knowing how to do so while minimizing the negative side effects. It entails carefully managing heat gain and loss, glare management, and changes in daylight availability, in addition to the placement of windows or skylights in a space. In a successful daylighting design, the use of shade equipment to reduce glare and prevent too much contrast in the workspace should be carefully thought out. Controlling glare is one crucial issue. Direct sunlight entering frequently creates an uncomfortable glare on work surfaces, making it challenging to work or see a computer screen. According to McFadden, the optimal combination of light for a structure can be produced by properly oriented windows and skylights, which also help to reduce glare. Wall openings in rooms should be arranged carefully to avoid blocking the daylight. For instance, components that can block light should be placed as far away from wall openings as feasible if they are high up in the room. In a layout with both open and closed areas, the open areas ought to be near the wall openings. Reflecting light farther into the space amplifies the impact of daylight (McFadden, 2023).

Solar control is also needed to prevent glare caused by direct sunlight and undesirable heat coming through the windows during overheated periods. The direct entry of the sunlight should be obstructed in order to provide both visual and climatic comfort conditions in the rooms. Solar control should be provided by shading devices for most buildings. This may be achieved by integrating into building form or using various solar control materials in different forms. Furthermore, some special glazing coatings could also be used for solar control. Daylight availability may not be uniform in all spaces and each zone in the space would require different illuminance levels. Daylight analysis can be used to determine these illuminance differences (Celikkol, 2012).

The appropriate type, size and positioning of any shading device will depend on climate, building use and the source of the light to be excluded (high or low angle direct sunlight, diffuse sky light or perhaps reflected light from paving on the street outside) (Jones, 2004). Natural Lighting and related supportive systems have great influences on users for their visual performance and psychological requirements. To create functional and ergonomic places with pleasing and efficient experiences, it is important to balance the daylighting and artificial lighting. According to space utilization reqirements, appropriate light sources should be chosen and arranged correlating with lighting control devices. Utilizing AI tools and algorithms to demonstrate and simulate certain scenarios is also another beneficial aspect of the methodology. Some of these solutions could be made more affordable and feasible for design schools by utilizing the resources from their industry collaborators or joint efforts with sponsors. Faculty and students' input would also be a helpful option to accomplish the required goals to make these spaces more in tune with the wellbeing standards.

5. CONCLUSION

Lighting environment has significant impacts on humans physiologically and psychologically. These impacts need to be taken into consideration as crucial decision-making criteria in revitalizing workspaces for design schools which, in some occasions, do not provide enough daylight, mimicry of it or provide proper design elements to mitigate other adverse factors such as glare and reflectance. Light as a structuring element in a room not only influence our perception of that space but also affects our well-being, motivation and performance. In educational institutions such as in design school environments, it has been observed that the design students and faculty exhibit behaviors mostly affected by the utilization of natural light in the studio and working spaces. Thus, the rehabilitation of these work and design spaces should be established for the well-being of everyone, by utilizing the sufficient and healthy visual conditions which are heavily benefiting from daylighting, to perform visual tasks more comfortably, safely, and efficiently. In relationship to this rehabilitation, each technological application or technique requires experimentation and be studied before getting integrated into work and design spaces. New digital applications and solutions could also bring much needed innovation to these spaces. Re-thinking & re-shaping more adaptable working environments while revisiting some behavioral models/habits of students and faculty could be beneficial in order to identify certain potentials in the educational spaces of design schools.

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