



## Biophilic Design Principles - The Power of Individual Initiative -

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### ABSTRACT

**Purpose:** According to the Environmental Protection Agency (EPA), the average person spends 90% of their life inside buildings. This makes the built environment our primary habitat and therefore one of the most influential factors on our health and well-being. To understand how spaces can positively impact our mental health, improve our performance and overall well-being, this study looks at biophilic design fundamentals - it analyses the principles of mimicking nature in our design to create the most optimal environments for our daily use. The purpose of the study is to understand whether biophilic design principles that are implemented individually by users of a space can be sufficient for improving one's health and wellbeing. **Method:** This study is using surveys as a primary research method. It incorporates both questionnaires and interviews to examine the effects of the built environment on people's health and mental well-being. This study also conducts a series of experiments to develop an understanding of how one's mental state can change with the implementation of 1 to 2 Biophilic design principles in their surrounding environment. **Result:** Based on the research findings, this paper concludes that self-initiated implementation of a few Biophilic Design principles in the indoor environment can positively improve one's health and wellbeing.

### KEYWORD

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## 1. Introduction

### 1.1. Research Background and Objectives

According to the National Human Activity Pattern Survey (NHAPS): A Resource for Assessing Exposure to Environmental Pollutants, people are spending approximately 90% of their time indoors and according to The Global Organization for Stress, our stress levels are also exponentially increasing [4].

There are many factors of stress in our lives, but one of the most predominant in our environment, Human bodies and their biorhythms are susceptible to our surroundings, particularly to the natural course of night and day. While built environments play a crucial role in our society, providing us with security, personal safety, and weather protection, some can also be harmful to our health and mental wellbeing. For example, people that are not exposed to enough daylight throughout the day report higher levels of fatigue, and people who spend a lot of time in noisy environments report feeling more anxious than average [3].

While examining other problems of our built environment, this paper aims to develop a set of principles and design strategies that

can be less harsh on our health. It aims to understand how architects can design places to improve our overall well-being.

Whilst the negative effects of certain built environments have been documented, the clear strategies on how an individual can change his or her surroundings to improve their wellbeing – remain unclear to many.

### 1.2. Sick Building Syndrome

To understand how architecture industry professionals can design better spaces, it is important to identify the key harmful aspects of our built environment. In their work on environmental risks and the built environment, Collaborative on Health and the Environment mentions a building-related illness – a “Sick Building Syndrome”. The term “sick building syndrome” (SBS) refers to instances in which building occupants experience acute health problems that appear to be linked to their time spent in the facility, but no specific diagnosis or cause can be determined. The effects could be confined in a single room or zone or felt throughout the entire building [8].

Some of the key factors that affect people's health after prolonged exposure include bad air quality (lack of ventilation), electromagnetic radiation, humidity and mold, noise, absence of natural light, and lack of ability to control

temperature, which is a huge factor not only on our comfort but our health as well.

Poor air circulation can lead to a build-up of toxic air pollutants which include Radon, Carbon Monoxide, and other site and activity-specific pollutants. Prolonged exposure to such toxins can impact the development of asthma, cardiovascular disease and can even negatively affect unborn babies [9]. Mold exposure can contribute to asthma, skin irritation and produce severe reactions in people with allergies. Some types of mold contain mycotoxins that can lead to inflammation and a possibility of developing a chronic illness [2]. Persistent noise exposure can contribute to the levels of stress and anxiety and lack of exposure to natural light can be a reason for developing chronic fatigue and disrupted circadian rhythms [1].

All the aforementioned factors are critical for maintaining people's health and well-being. But also most of them can be resolved with strategic interior design alterations that are more suitable for maintaining people's mental and physical health.

## 2. LITERATURE REVIEW

### 2.1. The History of Biophilic Design

In 1964, social psychologist Erich Fromm published his essay "The Heart of Man: It's Genius for Good and Evil," where he coined the term biophilia, which is derived from *bio* (life) and *philia* (love) [10]. Later Harvard biologist Edward O. Wilson's published his book in 1984, and the term "biophilia" gained further traction. Wilson's book "Biophilia: The Human Bond with Other Species" explores the depth of human relationship with nature and was one of the first studies to explore human physiological and psychic reactions to various stimuli to determine the framework for people's natural preferences [11].

With Biophilic Design gaining its momentum, Kellert and Calabrese formulated experiences and attributes of Biophilic Design in their work "The Practice of Biophilic Design," basing their classification on 3 pillars: direct experience of nature, the indirect experience of nature, and experience of space and place [12]. Kellers and Calabrese work states that exposure to nature has been shown to reduce stress, provide pain relief, lower blood pressure, improve illness recovery, accelerate healing, and boost performance.

In "Nature Inside", Browning and Ryan take a slightly different approach and address the intimate scale of biophilic architecture, particularly looking at their arts and craftsmanship that can be integrated into the interior. Authors look at the historical context of decor and interior details that have been inspired by nature and

show how the connection between nature and individuals was ever-present throughout history [13].

Similar to Pranjale-Bokankar, who argues that more than adopting a new methodology for designing the built environment, Biophilic Design is about re-establishing our connection to nature—highlighting the possibility of integrating natural elements in already constructed and designed environments [14].

One of the studies that investigated the link between biophilic design principles and people's pro-environmental values and behaviors was made by Simona Totaforti in 2020. The study examines the impact of green spaces and natural patterns created using biophilic principles on people's behavior. Totaforti's focus group findings support the concept of biophilic urbanism as an immediately available planning paradigm that can improve place quality and engage city dwellers in activities that help care for and improve their surroundings [15].

Another study that discusses the importance of access to nature and open space was conducted by M.B Andreucci, A. Loder, M. Brown, and J. Brajkovic. The study points out that nature, in general, has been shown to improve human health, but there are gaps in the application at various scales and a lack of understanding of which research to apply to which situation. Despite biophilic design gaining traction, it still lacks specificity when it comes to research outcomes and variables. The study also concludes that many design circles dismiss biophilic design as "nice to have but not necessary" rather than an effective intervention to improve health and performance. Instead of relying on the abstract ideas of nature, the study highlights the importance of developing evidence-based Biophilic Design strategies through experimentation. [16].

Despite developing practical biophilic design principles, most existing studies primarily focus on the overarching strategies that can be generally implemented at a bigger scale, with a top-down approach – when architects and interior designers are designing buildings. However, it remains unclear how biophilic design principles can be implemented individually by the users of the space and whether those changes can be sufficient for improving one's health and wellbeing.

### 2.2. Biophilic Design Principles

Biophilic design is an architectural approach that aims to bring building occupants closer to nature. Natural lighting and ventilation, natural landscape features, and other components are used in biophilic designed buildings to create a more productive and healthy constructed environment for people [7]. Reduced stress, creative problem-solving, faster recovery from sickness, and even financial benefits have all been related to design that to some extent replicated natural systems [5].

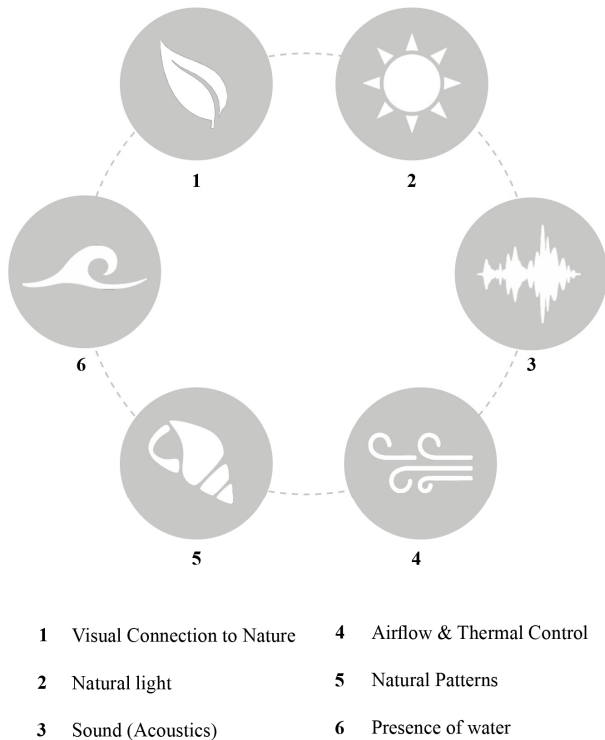


Fig. 1. Key biophilic design principles.

To create healthier environments for our life and work it is important to outline a few design strategies that can be incorporated in almost any building and structure.

One of such strategies to maintain people's circadian rhythms is the integration of appropriate lighting, either natural or artificial. If it is not possible to improve natural lighting in space, it is important to incorporate a lighting system that changes throughout the day to keep us on track with the 24-hour cycle. Currently, several design approaches exist to substitute exposure to the natural light for people who have to work on the basement and lower levels, in laboratories, technical support rooms, and other spaces that either lack or have insufficient natural light. The first design approach is to integrate white light desk lamps that mimic sunlight for individual local solutions. The second approach is about tackling the problem holistically and incorporating circadian electric lighting systems that closely imitate the daylight spectrum with the change of light intensity, color, and stimulus tuning [6]. And the third design solution is about maximizing the amount of white-colored surfaces in the space. White has a high solar reflectivity (albedo) and can amplify the presence of natural light in a space. Having such a system in place can allow individuals to stay connected to the outdoor environment and not disrupt their circadian cycles.

### 3. METHODS

#### 3.1. Participants

For this study, 183 individuals across three different cities (Los Angeles, London, and Hong Kong) were recruited. The study selected various locations to decrease the perceptive bias and consider the vast spectrum of sensory input. The choice of cities was determined by the difference in climatic conditions and the difference in the urban fabric of each location. The participants worked at nine different corporate offices. A random sampling approach was chosen as the recruitment process for this study and individuals were contacted through email.

#### 3.2. Study Design

This study was two-fold. Firstly, all 183 participants were asked to assess their work environments based on the six principles represented in Fig. 1.: light and space, presence of nature (plants or visual proximity to greenery), air quality, natural shapes and forms, materials, and water. Each of these principles was assessed through one or more questions, which had to be answered with either yes or no or had to be evaluated on a scale of 1 to 10. Secondly, 52 out of the 183 participants were asked to document their stress and anxiety levels for seven days in a row. The participants were then split into four equally sized groups of 13 participants each. Group A was the reference group, which did not implement any biophilic design principles in their work environment. Group B implemented one of the biophilic design principles, except natural light, in their work environment. Group C had prolonged exposure to natural light at the workplace. Group D implemented two biophilic design principles in their work environment. Groups B, C, and D were asked to also assess their productivity levels and their feeling of being inspired at the workplace, in addition to their stress and anxiety levels. The assessment was based on two questions with a scale from 1 to 10. Following the implementation of biophilic design principles, groups B, C and D documented again their levels of productivity and inspiration for seven days, using the same questions as prior to the implementation of these principles.

#### 3.3. Statistical Analysis

For the first part of the study where participants were asked to assess biophilic design principles in their workplace, the number of yes (or no) responses was set in relation to the total number of participants. From this, a percentage in the range from 0 to 100 % was obtained. For the second part of the study, where changes at the workplace were implemented, the scales before and after the changes were compared. For this purpose, the scales (in the

range from 1 to 10) were averaged over seven days, for each participant. The resulting values were then averaged across all participants in one group, both before and after the changes. The averaged value obtained before the changes was the reference value, to which the averaged value after the changes was compared. The development of the productivity and inspiration levels is presented as the difference to the reference value, in percent.

## 4. RESULTS

### 4.1. Biophilic Design Principles in the Workplace

Having conducted a survey across 3 cities (Los Angeles, London, and Hong Kong) and 9 different corporate architecture offices, 93% out of 183 surveyed individuals reported reduced stress when working in environments that incorporated biophilic design. 37% agreed that adding a green element on their desks, either a plant, a flower, or another artificial object, improved their mood and focus throughout the day. This means that the integration of greenery is not only about plants. It is about mimicking our natural environment. The Human brain tends to see patterns and makes associations with everything that happens around us. Patterns, spirals, and other elements that can be seen in nature can all be referred to as biophilic design, as they trick the brain into making associations and connections with the outdoor environment. Objects and elements associated with nature can improve our space perception and reduce our stress levels.

Another important component of biophilic design is the presence of natural airflow in space. In the conducted survey, 69% of respondents reported that having slight variations in temperature and airflow improved their alertness, focus, and

performance throughout the day. This finding once again proves that mimicking our natural environment can be highly beneficial to our mental and physical wellbeing.

The last issue that is present in almost any workspace and living environment is noise. Persistent exposure to noise increases stress and anxiety levels. Open office plans do not make it easier on people – such environments force individuals to stay more alert to the surroundings, meanwhile exhausting their energetic resources. 95% of survey respondents reported feeling energetically drained when placed on the open plan set up, particularly near walkways and a big grouping of people. To avoid persistent noise exposure people reported using either earplugs or headphones to create some level of privacy for themselves in those harsh environments. The strategy for tackling this issue can be an incorporation of a diverse space – a space that varies in level of privacy and allows people to accommodate them in the environments that they find the most suitable for a particular activity. Monotonous built environments, even with perfect light and air circulations can become stressful for people who use them, as they do not provide people with a much-needed spatial variety.

### 4.2. Improving Well-being through the Implementation of 1-2 Biophilic Design Principles

Having conducted more than 52 interviews, this paper concluded that despite experiencing sick building syndrome, 85% of respondents did not know the strategies on how to improve their well-being through little changes to their surroundings. That was the reason this study carried out an experiment, asking each participant to implement 1-2 biophilic design principles in their environment. Our suggestions included but were not limited to the incorporation of plants in the visual proximity, relocation of the desk closer to the source of natural light, implementation of specific patterns and organically shaped forms and objects. This study asked each respondent to track their stress and anxiety levels for a week before making changes to the environments and for a week after implementing them. The results of the experiment showed that Group B incorporated 1 biophilic design principle (any other that did not include exposure to the natural light), reported an 11% reduction in their anxiety and stress levels. Participants from Group C, who incorporated 1 change which was prolonged exposure to the natural light reported a 36% reduction in stress levels, and participants who incorporated 2 biophilic design principles (Group D) reported feeling 57% better, with exposure to daylight and proximity to plants/greenery being the biggest contributing factors. The change in data was documented in Fig. 2.

The experiment showed that participants did not have to

Table 1. Key findings on the role of biophilic design principles in the workplace

Statements	Number of respondents	
	Yes	No
I feel energetically drained when placed on the open plan set up, particularly near walkways and in a big grouping of people	174	9
I am less stressed when working in environments that incorporated biophilic design	171	12
Adding green visual stimuli (a plant, a flower, an image of a green landscape, or an object that resembles nature - ex. Sculpture/coral/shell) improves my mood and focus throughout the day	68	115
Having slight variations in temperature and airflow improves my alertness, focus, and performance throughout the day	126	57

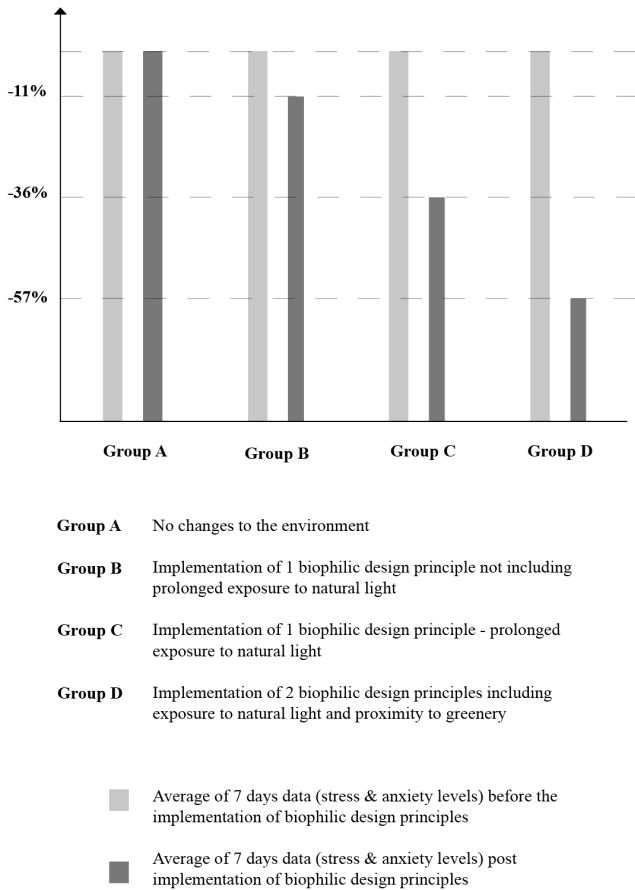


Fig. 2. Improvement in levels of stress and anxiety through the implementation of 1-2 Biophilic design principles

Table 2. Daily levels of productivity and inspiration at the workplace, averaged over seven days before and after implementing biophilic design principles

Questions	Average over 7 days prior to implementing biophilic design principles			Average over 7 days post-implementation of biophilic design principles		
	B	C	D	B	C	D
Assess the level of your productivity today on a scale from 1 to 10	7.3	6.5	7.5	8.8	8.6	8.7
Assess the level of feeling inspired at your workplace today from 1 to 10	5.4	5.2	5.9	7.2	6.5	6.6

change their environments drastically to reduce their stress and anxiety levels. After implementing 1–2 biophilic design principles (without radically changing the design of the space), participants reported not only feeling less stressed but feeling more productive and inspired at their workplace – Table 2. and Fig. 3. The results of the experiment made it possible to argue that by consciously

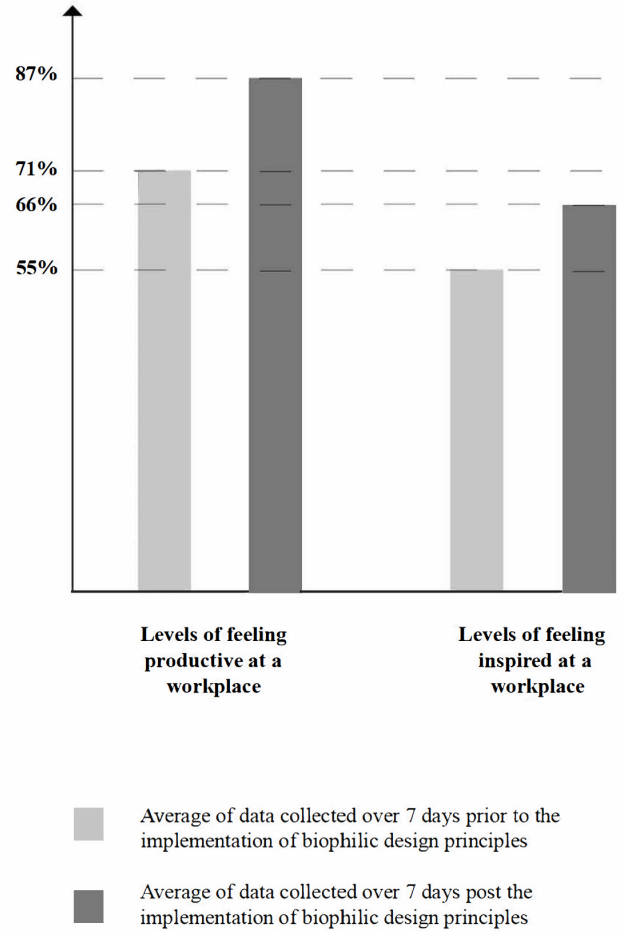


Fig. 3. Improvement in productivity and motivation in an environment with biophilic design principles

selecting and adjusting our environments according to biophilic design principles, we can improve our mental well-being – our mood and general satisfaction with work and life.

## 5. CONCLUSION

Shelter has always played an important role in our society, it has always provided us with a sense of safety, protection from the weather, and other associated health hazards and diseases. Humanity learned to adapt to different climatic conditions and build efficient building structures, but with the exponential growth of time spent indoors, people started to notice the negative effects of staying in the built environment for prolonged periods of time. This paper aimed to understand whether biophilic design principles that are implemented individually by users of a space can be sufficient for improving one's wellbeing.

This study did not only assess the current workplace of 183 participants in light of biophilic design principles, it also examined the impact of these principles on the productivity and inspiration of 52 of the participants. Further, the random

sampling of participants across three continents provides a strong foundation to draw universally valid conclusions from this study. However, having contact to the participants through email only, without being able to visit their workplaces, implies total reliance on the evaluation by the participants. This is especially critical for subjective perception of the environment, such as lighting and noise, which has not been quantified by objective measurements.

Having conducted surveys and research associated with biophilic design, it is possible to conclude that the integration of nature can not only improve our mental and physical wellbeing, but it can also be a driving force of more productive work and happy living. While incorporating real nature in the built environment is the best for human physiology and psychology, design components that resemble nature can also be extremely beneficial in maintaining people's health and normal biorhythms. The biggest benefits of biophilic design can also be observed when it appeals to multiple senses. Incorporating various stimuli in the order and structure of a typical office environment, letting people hear and feel natural elements can create a multi-sensory biophilic experience that can improve people's mental and physical well-being.

Most of the buildings that we live in and work in now, were not designed with biophilic principles in mind. Despite that, this study proved that by leveraging individual power and implementing improvements on a smaller scale, we can elevate our build environments and design spaces for better work, life, and play.

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