
Beyond Sustainability –Towards Restorative Interior Spaces through Biophilic Design

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Abstract

According to biology, humans are inherently interested in connecting with the natural environment physically, psychologically, and spiritually, which is known as the “biophilia hypothesis”. However, with the increasing of urban constructions, they not only caused severely environmental impact, but also isolated us from the nature.

Although the current sustainable design and development movement has confessed the need for change in building and design, it mainly emphasizes a green building standards and low environmental impact approach as well as it has made progress towards avoiding our damage impact and achieve a balance between built and natural environment, but this does not guarantee that the building environment is enjoyable and satisfactory. However, when sustainable design is execute independently,

it discards generally the significance of realizing long-term sustainability and fails to achieve the goal of restoring the human relationship with nature and establishing place-attachment within the built environment in a mutually beneficial manner.

Therefore, a new concept of sustainability was needed to include the reciprocal relationship between man and the environment, which is known as Restorative Environmental Design (RED). RED is a building design paradigm combining sustainable building practices with building practices that benefit occupant health and helping to re-establish the human- nature connection. It is a further step than just sustainable construction through: Biophilic design for the occupants, green building methods for the building. Biophilic design as a new movement, has recently obtained much momentum within the building field, which provide restoring valuable contacts between people and natural environment. While the green movement has often focused on the means, biophilic design tends to emphasize the end results, promotion natural-based habitats for humans to live and work. It considers that true sustainability must contain quality of life case cover human physiological & psychological- health and well-being and incorporates green building ideas, so biophilic design combines elements derived from nature in order to maximize human functioning and health. Recognizing the need for restorative environments in urban settings where nature has been severely withdrawn from interiors and architecture, this paper underlines the limits of Sustainable concept and looks at Biophilic and Restorative Design, two emerging concepts that appear to have a more appropriate solutions to the environmental & humanity problems that we face today and in the future. This paper will give an overview of each concept and design framework, trying to interpret the way they operate and how to use them in the formulation of internal spaces.

Keywords

Sustainability -Restorative Environmental Design – Biophilia -
Biophilic Design - Design Framework

Introduction

Several researches in the areas of interior design provide evidence that contact with nature can have positive effects on human biologically and psychologically. Integrating nature or representations of nature, in the design of interior space can play a key role in creating environments that not only support their designed purpose, but enhance the mental and physical wellbeing of their occupants (Kaplan, R. 1993), where the design possesses have the ability to promote this relationship through built environment solutions that encourage interdependency between people and natural elements.

The benefits of human–nature connections present protection from the reverse impacts of daily living and allow for personal restoration and supporting living within the earth’s systems (Hartig,T. , Bringslimark,T. & Patil,G. 2008). From this point, Stephen Kellert proposed restorative environmental design (RED) to include both of: low impact, sustainable building practices and biophilia that enhance the human–nature relationship to reach holistic sustainable approach.

The restoration theory depends on the assuming that directed attention, an essential component of day-to-day functioning and human performance can be restored through connect to nature directly or indirectly (Kaplan, R. 1995). Similarly, biophilic design is an understanding that “the positive experience of natural systems and processes in our interior environment remains important to human performance and wellbeing” (Kellert, S., Heerwagen, J & Mador, M. 2008).

These principles create a framework for the designing and implementation of restorative design in interior spaces and consider as a new concept of sustainability.

1- Restorative Environmental Design Influencing Sustainability in sustainable design we ask, “What is our impact on nature?” but, we should ask, “What impact does nature have on us?” Although the adoption of green building technology can reduce some of the adverse environmental impact, seldom can it help to re-establish the human-nature connection.

Lately ensuring contact with nature becomes challenging because of the global population grows (Beatley, T. 2011), so the modern urban built environment has supported the regression of natural systems and expanded the void between humans and nature. Urban habitant often forgets the reciprocal nature of the link between humans and the environment (McHarg, I. 2006).

Wherefore without the positive benefits and linked attachment to buildings, people rarely have a sense of responsibility to maintain them for an extended period of time (Kellert, S. 2008) and less responsibility to care for the environment long term. According to Timothy Beatley, professor of sustainable communities, said, " We live in disconnected times. Indeed, we are profoundly separated from the people around us and from the places and environments that nurture and sustain us". Connecting humans to natural elements in place strengthens the bond and people's responsibility to care for their environments. Human social processes and the natural environments are interdependent as lighted by human ecosystem models, as that there is more of a chance for them to work together rather than compete if the bond between the social and natural components of the ecosystem is strong.

Kellert advocates a new standard, which he calls "restorative environmental design (RED), "that combines LEED metrics and essential biophilic elements to achieve "true and lasting sustainability." He maintains that no matter how energy efficient a building is, "if it's a place that doesn't breed satisfaction, enhance morale, or motivate people (and in fact alienates them). When the cutting-edge technology that made it energy efficient is no longer cutting edge, and people don't want to be there, they won't sustain that environment."

People can be good stewards of the environment by implementing healthy natural systems and foster features of the built environment that allow for human-nature connection by bringing to light their biological dependency on nature. In conjunction with low impact design, this level of responsibility is what is needed to foster long-term sustainability (Kellert, S. 2012). Researches emphasize that environmentally conscious manner designing without the beneficial aspects of enhancing well-being and place-connection could lead to a lack of necessary motivation to maintain sustainable built environments, thus limiting their longevity an overall sustainability. Accordingly, the implementation of biophilic design could be the missing component in existing sustainable concept due to the attention in human well-being and connection to place (Kellert, S. 2008).

RED goes two steps further than just sustainable buildings that should: provide healthful benefits to occupants and reinforce the human connection with nature .The goal of RED is to gather the conservation of long lasting buildings with interior and exterior biophilic features.

These features can support the optimal health and wellness of the occupants. Thus, the biophilic connection extends the sustainability set to seek restoration of nature and to a built environment that lives in harmony with nature.

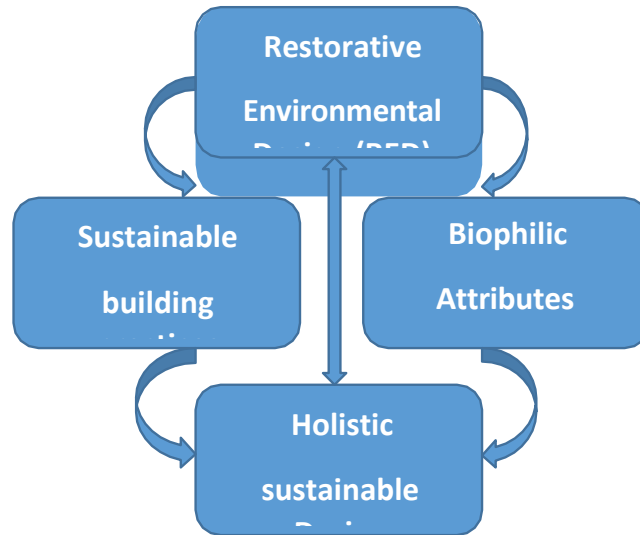


Figure 1. RED as a new concept of sustainability

1-1- Restorative Environmental Design (RED)

The Restorative environmental design as a new concept for sustainability that addresses the issues of human disconnection with the natural environment along with sustainable building practices. It was developed in response to the regression of natural systems such as green spaces and the spread of modern urbanism that restrained the human-nature connection. It also addresses the effects resulting from an increase in human alienation with the natural world, the use of unsustainable energy, and the increase in biodiversity lack (Kellert, S. 2008).

RED this holistic design paradigm is described as an approach that aims at both a low- environmental- impact strategy that minimizes adverse impacts on the natural environment through sustainability and biophilic design approach that enhances beneficial contact between people and nature in modern building and landscapes (Kellert, S. 2008).

Restorative Environmental Design (RED) or Restorative Design considers the using the activities of design and building to restore the ability of local natural systems to healthy state of self-organization (Reed, B. 2007). Low environment impact and organic design are necessary but not enough for achieving restorative environmental design. Without a balance between culture, history and ecology, design and development are unsustainable (Kellert, S. 2008).

Theories connecting human and natural systems	Design Strategies - Linking human and Natural Systems	
Ecosystem Services	Low-Impact Design	Small ecological footprint in construction and operation of the building
Biophilia	Organic Design	Direct, indirect and symbolic experience of nature, using natural materials and ecological engineering.
Sense of Place	Vernacular design	Design in relation of the ecology of place, culture and history. Design to avoid loss of local and regional identities

Table1. The principles of Restorative Environmental Design
Adapted from (Kellert, S 2008)

Many natural environments are restorative, but also interior environments can be as such, if they are designed delicately by the experienced designer who is aware about the impact of nature on us. Usually there is a lack of interest in implementation from stakeholders. It is a challenge to find a fit between all the demands and systems of a constructed interior environment, and also reach an end product that is appropriate to everyone.

The restorative qualities of an environment do often not exist in our priority, the result of which is that our interior environments can even be harmful to our health. So the need for restorative design is born out of this phenomenon, and also from the gap that has been formed between nature and the human being.

The restorative environmental design (RED) helps to explain the responses of humans, in particular, to the sensory information contained in their environment. Since each environment – interior or exterior – can include any number of stimuli to which any or all of our senses can react, understanding the role of environmental impact on human functioning and wellbeing is essential to the successful implementation of any design plan (Kopec, D. 2010).

Humans often seek out nature when stressed. Taking a walk in a park, or targeting a sea trip for a vacation, for example, provide relaxation, and rest, underscoring a premise of RED that periodic, effortless exposure to nature can have a significant impact on lowering levels of stress (Kopec, D. 2010).

The benefits of exposure to nature through the use of photos, artistic picture, colors and sounds also can be recognized in the designed environment. In environmental psychology (Kaplan, R.1995) determined four main aspects must exist in order to be a restorative setting(Herzog,T.&Strevey,S2008).

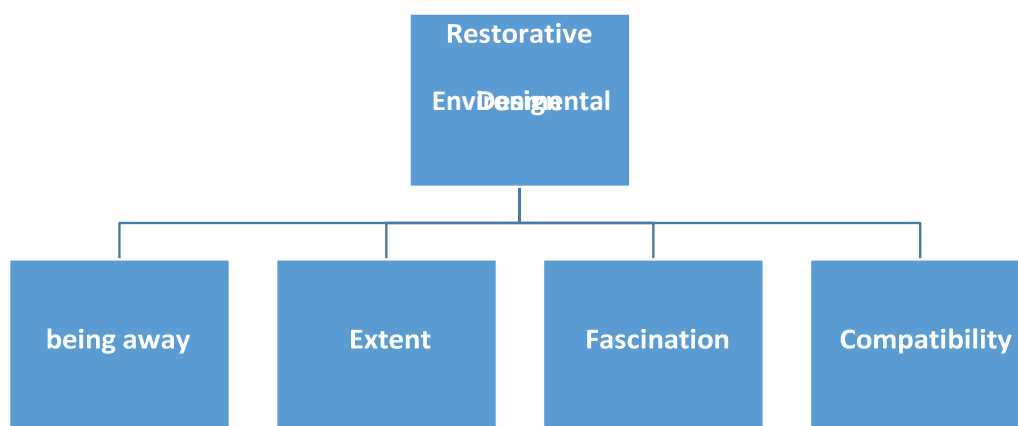


Figure 2. The four aspects of restorative setting.

1-2 Being away

It refers to the ability to escape away from some involved endeavor that is normally present in our urban environment, like references of noise, crowding, chaos, and even the everyday routine of work. This is also an expression of the desire to take a mental and physical rest from seek a certain purpose or task. An ideal restorative environment would incorporate space that allows both means of renewal, rest and escape, to happen without provoking a sense of retention or weariness to the user pursuing restoration (Kaplan, R. & Kaplan, S., 1989).

It provides in interior spaces by a setting that is either physically or conceptually different from an individual's typical setting through: Indoor gardens, views of nature, water features, and any location that is different enough from a typical workstation.



Figure 3. Indoor gardens, views of nature as an application of being away

2-2-2 Connection and Extent

According to Kaplan and Kaplan, the desire to escape comes with a sense of connection to the environment in which it will occur and its domain, which together determines its “extent”. Extent is implicit physically or perceptually and is necessary to represent a sense of being immersed within the environment. Although connection is achieved through the individual's interrelation with the environment as a whole, extent is achieved through the experience that is being presented and the promise of continuation.

It provides by a setting that is complex enough to engage the mind and promote exploration. Open spaces, ceilings with varying height, views of nature all provide a sense of extent.



Figure 4. Fulfill the aspect of connection and extent in interior spaces.

2-1-3- Fascination

Fascination is stimulated by an act of involuntary attention, “attention that does not require effort at all such as an individual looks to discover what is going on when something exciting or interesting happens” (Kaplan, R. & Kaplan, S., 1989). With this aspect, success is dependent on the support of the extent aspect. Without the supportive relationship of fascination and extent, random fascination would only serve as a temporary pleasure produced from its disconnection to the environment’s context as a whole (Kaplan, S., 1989).

This aspect is highly significant in the restorative environment because it promotes interest and prevent an individual from suffer weariness without effort attention.

It achieves through a part of or a whole setting that easily engages attention thereby allowing fatigued attention to rest. Some naturalistic attributes that contain this ability are those that mimic nature directly such as natural lighting, water features, natural patterns, shapes , forms and living greenery allow the mind to effortlessly focus on something (Kellert, S. 2008; Wilson, E. 2008).



Figure 5. Sense of fascination by natural pattern

2-1-4- Action and Compatibility

Humans seem to have a natural affinity for nature. In order to become successful aspect, a restorative environment is required to offer compatibility with the individual's tendencies and actions required by the environment. So while an individual's decisions immersed in the environment, partner with the environment's limitations and demands.

Also, patterns that provided by the environment stimulated psychological activity that guides users' compatibility and actions .A sense of fascination is promoted and compatibility is strengthened when the environment supports the action and compatibility of the individual.

On the other hand if the environment fails to foster compatibility, rise mental effort is required and mental fatigue remains (Kaplan, R. & Kaplan,S., 1989).

Together, the defined aspects of the restorative environment and biophilic design attributes will be integrated to form the proposed restorative healing environment study framework.



Figure 6. Humans seem to have compatibility to nature

2- Biophilia and Biophilic Design

Bio means “life or living things”, philia means “love”. Biophilia can be translated to Love to life. Erich Fromm in 1964 used this term to describe a psychological orientation of being attracted to all that is alive and vital. But when Edward Osborne Wilson wrote the book "Biophilia" in 1984, the term became popular which explained the deep affiliations that humans have with nature and that they are rooted in our biology.

Biophilia is “the inherent human tendency to affiliate with nature” (Kellert & Calabrese, E. 2015). Wilson in 1984 popularized this term in exploring “the need for nature” premise as a hereditary human behavioral feature.

Three decades after Edward O. Wilson hypothesized biophilia as an innate human need to affiliate with nature—thereby benefiting from natural situation that positively impact physical, spiritual, social, and psychological wellbeing.

The interest in biophilia is increasing across different fields of design. But interior designers are still challenged by the identification and application of biophilic features in the interior built environment. Also the design community continues to explore and seek application of this biophilic thinking (Matteson, D. 2013). Biophilia has inspired a movement in design that seeks to incorporate nature into the built environment (Browning, W. 2015). So Research during the second half of the century reveals a rising awareness that designing with nature can have a wide-extend positive impact on human wellbeing (Kellert, S. 2005; Heerwagen, J. 2008). Humans innately seek out colors, designs, patterns, sounds, and smells found in nature, and that some of these effects support mental, emotional, physical, and even spiritual health, is a basic tenet of biophilic design (Kellert, S. 2005).

While biophilia is the theory, biophilic design as advocated by Kellert et al. (2008) and Beatley (2010) internationally is a process that offers a sustainable design strategy that incorporates reconnecting people with the natural environment. Biophilic design is the practice and practical application of the biophilia hypothesis through design forms, Stephen Kellert and Judith Heerwagen define the design aspect of biophilia as follows: Biophilic design is the term of the inherent human need to affiliate with nature in the design of the built environment.

Wherefore, biophilic design has recently obtained much momentum within the building field, which provide further step beyond green to restore valuable contacts between people and natural environment. While the green movement has often focused on the means, biophilic design tends to emphasize the end results, promotion natural-based habitats for humans to live and work. Biophilic Design considers that true sustainability must contain quality of life case cover human physiological & psychological-health and well- being and incorporates green building ideas, so biophilic design combines elements derived from nature within our working environment or habitat in order to maximize human functioning and health.

Biophilic design depends on an inherent connection between humans and their natural environment as an integral component of architecture, interior, and landscape design, therefore it is a valuable resource when creating residential, office and commercial spaces that not only serve their intentional functions, but increase the physical, psychological and emotional health of the occupants (Kellert, S. ,Heerwagen, J. & Mador, M. 2008).

2-1 Defining and Applying Biophilic Design

Biophilic design transforms the spaces into stimulating ones that enhance physical and mental health. Although the goal of biophilic design is clear, but understanding it and its application is needed. Hereafter the explication provides guidance by Stephen Kellert (2008), for how to effectively apply this design paradigm in the modern built environment.

2-1-1 The principals of Biophilic design

To reach a successful application of biophilic design necessitates consistently commitment to certain basic principles. They represent and include fundamental conditions for the effective practice of biophilic design. The principles are:

- 1.** Biophilic design requires consistently and sustained engagement with nature.
- 2.** Biophilic design concentrate on human adaptations to the natural world that advanced people's wellbeing.
- 3.** Biophilic design supports the emotional attachment to specific settings and places.
- 4.** Biophilic design promotes positive integrates between people and nature that encourage an extended sense of responsibility for the human communities and natural.

5. Biophilic design encourages mutual interconnected and integrated architectural solutions (Kellert, S. and Calabrese, E. 2015).

2-1-2 Dimensions of Biophilic Design

According to Kellert, there are two dimensions of biophilic design: First one includes an organic or naturalistic dimension, which has shapes and forms that directly, indirectly, or symbolically address the innate human need for connection to nature in the built environment.

The second dimension is place-based or vernacular, identified by a spirit or feeling of a built environment that allows for a space to become significant and integral to individual and collective identities. Biophilic design seeks through this dimension to transform a built environment into a space to which individuals connect on an emotional or spiritual level and motivates them to take responsibility for they become stewards of their spaces (Kellert,S. 2008, 2015).

Dimensions of Biophilic	
Organic (naturalistic)	Direct experience of nature: describes encounters with self-sustaining elements of nature such as daylight, air, animals, native plantings, natural landscapes and ecosystems, often called “wild nature.”
	Indirect experience with nature: includes interactions with natural elements that require human intervention to survive, such as a potted plant or an aquarium
	Symbolic experiences : representations of nature through natural building materials; images of nature; simulations of light, air, and sound; and other modes of biomimicry

place-based (vernacular)	characterized by a spirit or feeling of a built environment that allows a space to become meaningful to individual and collective identities
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Table 2. Biophilic design dimensions.

2-1-3 Elements and Attributes of Biophilic Design

To provide designers with clarity, Stephen R. Kellert set seventy two nature-based designs attributes fall under six elements within two overarching biophilic dimensions all focus on the essence of natural properties or objectives. Recently he revised and simplified them into twenty- four design attributes-the entirety of the developed list is provided in Table 3- headed by three categories of: direct experience of nature, indirect experience of nature, and experience of space and place, to guide practitioners, architects and developers in the design process. The six elements of Biophilic design are:

1. Environmental features. Characteristics of some attributes of nature that invoke environmental features include but are not limited to color, water, air, plants, and natural materials such as wood and stone.
2. Natural shapes and forms. Include attributes that simulate patterns and shapes found in nature such as botanical and animal motifs, shells, body parts, arches, vaults, and domes; simulation of natural shapes that resist straight lines and right angles.

Natural patterns and processes.

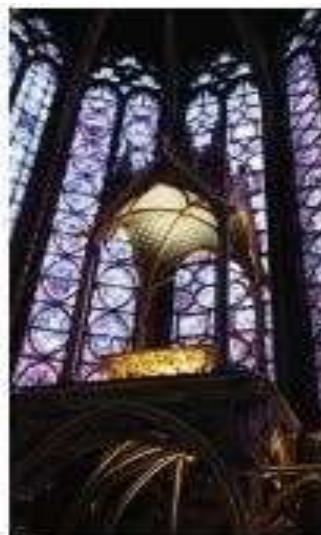
It is a complex element that incorporates attributes that represent properties found in nature. Functions, structures and principles characteristic of the natural world, sensory variability,

information richness, and hierarchically organized ratios and scales are examples of ways natural patterns and properties are integrated into built environments to satisfy the human demand for interactions with nature.

3. Light and space. Spatial and lighting features can evoke the sense of being in a natural setting. These include natural light, filtered and diffused light, light and shadow, reflected light, warm light, openness, spatial variability and harmony, space as shape and form, and inside-out spaces all focus on how space can be manipulated to promote connection to the natural environment.

4. Place-based relationships. Involve attributes that connect culture and ecology in such a way that individuals develop emotional attachments and to and relationships with spaces. This can be achieved through incorporating geological and landscape features, the use of local materials and connections to certain historic and cultural traditions.

5. Evolved human relationships to nature. It includes fundamental features of the inherent human relationship with the natural world such as the feeling of being in a coherent and legible environment, the sense of prospect and refuge, the simulation of living growth and development, order and complexity, curiosity and enticement, mastery and control "are all elements of a more complex relationship between humans and nature that reveal the evolutionary influences (Kellert,S 2008, Ruiz, F. , <http://www.ecobuildingpulse.com/greenbuilding/biophilia-becomes-a-design-standard.aspx>).

DIRECT EXPERIENCE
OF NATUREINDIRECT EXPERIENCE
OF NATUREEXPERIENCE OF
SPACE AND PLACE

- | | | |
|--|---|--|
| <ul style="list-style-type: none"> • Light • Air • Water • Plants • Animals • Weather • Natural landscapes and ecosystems • Fire | <ul style="list-style-type: none"> • Images of nature • Natural materials • Natural colors • Simulating natural light and air • Naturalistic shapes and forms • Evoking nature • Information richness • Age, change, and the patina of time • Natural geometries • Biomimicry | <ul style="list-style-type: none"> • Prospect and refuge • Organized complexity • Integration of parts to wholes • Transitional spaces • Mobility and wayfinding • Cultural and ecological attachment to place |
|--|---|--|

Dimensions	Elements	Attributes
Naturalistic	Environmental features	<ul style="list-style-type: none"> • Water • Air • light • Plants • Animals • Weather • Natural landscapes and ecosystems • Fire
	Natural shapes and forms	<ul style="list-style-type: none"> • Naturalistic shapes and forms • Natural geometries • Natural colors • Natural Material • Evoking nature • Images of nature • Biomimicry
	Natural patterns and processes	<ul style="list-style-type: none"> • Age, change, and the patina of time • Information richness
	Light and space	<ul style="list-style-type: none"> • Simulating natural light and air • Mobility and wayfinding • Transitional spaces • Integration of parts to wholes
Vernac	Place-based relationships	<ul style="list-style-type: none"> • Cultural and ecological

ular		attachment to place
	Evolved human-nature relationships	<ul style="list-style-type: none"> • Prospect and refuge • Organized complexity

Table 3. Biophilic design dimensions, elements, and simplified attributes (Adapted from [Kellert,2008])

2-1-4 Economic benefits with Biophilic design

- Hospitals. Reduce the cost of both patient care and staffing can be achieved by incorporating natural elements into the healthcare industry while improving medical outcomes.

-Work place. Well-designed, spaces can reduce insufficient productivity, frequent absences, Problems with loss of concentration, negative mood, and illness. (Kellert, S. 2008).

-Education – it can be with using biophilic elements in the design of classrooms foster better test scores, optimal health, and increased learning rates. In addition schoolyards with natural elements can trigger mental restoration, better behavior and enhanced the focus of students.

(<http://www.charteredforesters.org/news/item/238-economics-biophiliacollaboration-tpbeii/>)

-Retail Spaces. The attributes and calming effect of nature can attract shoppers into stores with biophilic elements and boost sales compared to those without.

In general the economical biophilic architecture provides us with the opportunity to reach extremely low levels of energy consuming by using high quality, cost-efficient measures to general building components such measures are in turn of advantage to the health, ecology and economy field. But conflict often appears in area of interior design between the economic aspects, on one hand, and the quality of the design and products on the other hand. (Khalil, Z 2001). For marketing, the general trend to wellness and health, high living quality and modernity could be used.

3- Toward Restorative Biophilic Interior Design

Restorative design aims to merge nature, outside & inside building and people In In an integrated system which Bill Reed calls this relationship it “A Whole Living System”, where the final objective is to regenerate the earth ecosystems. To accomplish this we need to work in the level of environment and individuals. In another words, we need sustainable design to relieve our impacts ,but to sustain and improve our life we must engage the restoration of the living systems around us .In this part of paper will approach the “Restorative interior design” framework, consider to be a leading practice to guide the interior designers . There are two principles that a key to my framework: biophilic design, the intersection between nature, interior environments, and human wellbeing, and the restorative design, which highlights the role of nature in attention restoration.

3-1 Restorative Design Framework in interior spaces

In order to achieve the design goals, special consideration was given to each component of the biophilic design and restorative environment framework that is illustrated in table 3. The design of framework incorporates several natural and vernacular biophilic design attributes and restorative aspects from the biophilic design and restorative environment. It is rooted in the overarching attributes of biophilic design which related to the aspects of restorative environment design as it illustrated in figure 7.

The framework operates as an evaluation filter for each of these attributes and aspects and how they are integrated into the interior spaces design.

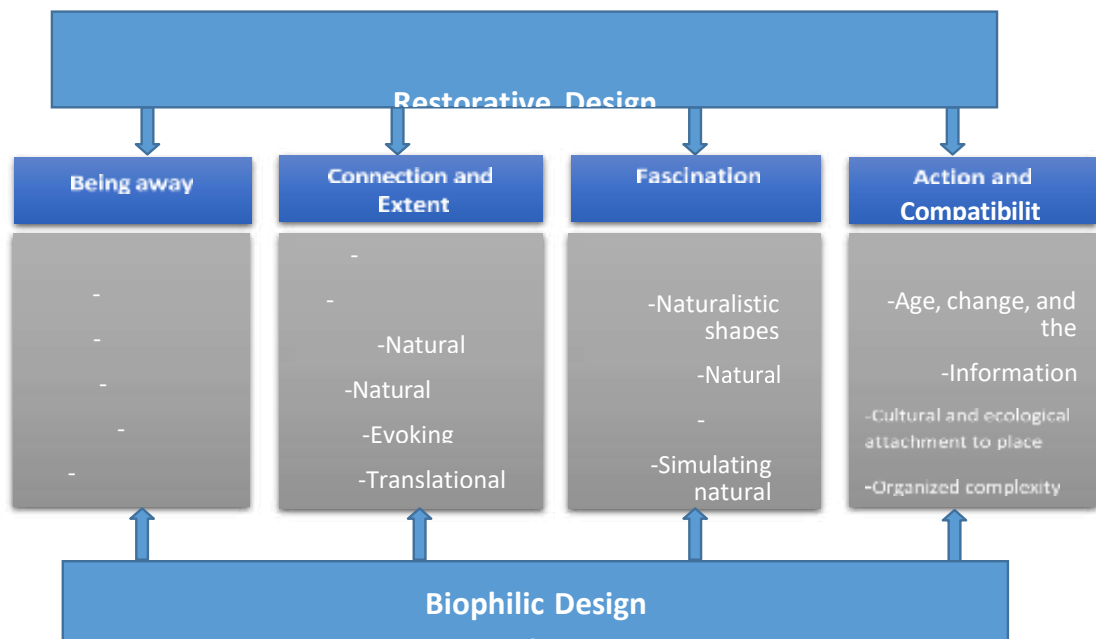


Figure 8. Biophilic design / restorative environment framework.

3-2 Implementing Restorative Design in Interior Spaces

Restorative design often can be implemented quite simply and inexpensively through connecting with nature indirect or indirect way, such as the use of color, fabric patterns and textures that mimic those found in nature, and artistic representations or simulations of nature such as photographs, paintings, and some abstract forms of art.

3-2-1 Being away:

Natural elements like water, plant, animal, weather and fire are essential to life and its positive experience in the interior built environment can relieve stress, promote satisfaction, and enhance health and performance. Varying design strategies can satisfy the desire for contact with them as follows:

Water. It could be present including fountains, water body, aquaria, constructed wetlands.

Plant. Vegetation in interior buildings and constructed landscapes especially flowering plants should be ecologically connected and locally animal. Positive contact with animal life can be achieved through feeders, green roofs, gardens, aquaria, aviaries, and technologies such as web cameras, video. Animal life should include a diversity of species, and local Weather. This may occur through direct exposure to outside conditions, as well as by simulating weather. Also it includes views to the outside through operable windows, decks, balconies, gardens, and more.

Natural landscapes and ecosystems. People prefer natural landscapes with spreading trees, an open understory, the presence of water, forested over artificial and human-dominated. It can be achieved as constructed wetlands, forest glades and grasslands; green roofs; simulated aquatic environments; and other means.

Fire. The satisfying presence of fire in the interior spaces may be achieved through fireplaces, but also simulated by the creative use of light, color, movement, and materials of varying heat conductance.



Figure 9. Respectively examples of Biophilic attributes related to being away aspect.

3-2-2 Connection and Extent

Connection and extent aspect is necessary to represent a sense of being immersed within the environment. Extent is achieved through the experience that is being presented and the promise of continuation, it includes:

Light. Natural light can appealing shapes and forms through the creative interaction of light and shadow, diffuse and variable light, and the integration of light with spatial properties. Natural light can be brought into interior spaces by such means as glass walls, skylight, screen walls and parapet the use of reflecting materials and colors.

It can be enhance the experience of natural ventilation in the interior built environment variations in airflow, temperature, humidity, and barometric pressure. By such simple means as operable windows, wind catcher or by technological and engineering strategies it can achieve it. Natural materials. Include natural environment and decorative materials such as wood, stone, wool, cotton, and leather, used in a wide array of interior and exterior designs products, furnishings and fabrics.

Natural colors. The effective biophilic implementing of color prefer muted “earth” tones characteristic of soil, rock, and plants. In addition emphasize such attractive surrounding environmental forms as flowers, sunsets and sunup, rainbows, and certain plants and animals.

Evoking natural. Through imaginative and fantastic depictions of design principles, it can be representing nature world.

Prospect and refuge. This biophilic effect can be achieved through such design strategies as vistas to the outside, visual connections between interior spaces, and the case of secure and sheltered settings.

Integration of parts to whole. It can often be achieved through the sequential and successional linking of spaces, as well as by clear outlines. This integration of space enhanced by a central focal point that occurs either functionally or thematically

Transitional spaces. It depends on clearly understood connections between spaces facilitated by clear and discernible movement. Transitional spaces include doorways, gateways, hallways, and areas that connect the indoors and outdoors such as courtyards, terraces, patios, colonnades, and more.

Mobility and wayfinding. Through set a freely moving between diverse and complicated spaces, clearly understood pathways and points of entry and egress are especially critical to fostering mobility and feelings of security.



Figure 10. Respectively examples of biophilic attributes related to connection and extent restorative aspect.

3-2-3 Fascination

This aspect is highly significant in the interior spaces because it promotes interest and prevent an individual from suffer weariness without effort attention. It achieved through a certain biophilic attributes allow the mind to effortlessly focus on something as follows:

Naturalistic shapes and forms. Through simulate naturalistic forms to design internal spaces components can transform a static space into one that possesses the dynamic and ambient qualities of a living system. Natural geometries. It include mathematical properties encountered in nature, hierarchically organized scales such as the “Golden Ratio ”and “Fibonacci Sequence.” ,sinuous rather than rigid artificial geometries, self-repeating but varying patterns such as fractals, and more.

Biomimicry. It refers to forms and functions found in nature, whose properties have been adopted or suggest solutions to human needs and problems. Technologically capturing these characteristics of nonhuman nature can provoke human admiration for the creativity of the natural world and performs utilitarian functions.

Simulating natural light and air. By mimicking the spectral and dynamic qualities of natural light, artificial light can be designed. Processed air can also simulate qualities of natural ventilation through variations in airflow, temperature, and humidity.

Images of nature. It can be occur through the use of photographs, paintings, sculpture, murals, video, computer simulations, and other representational means

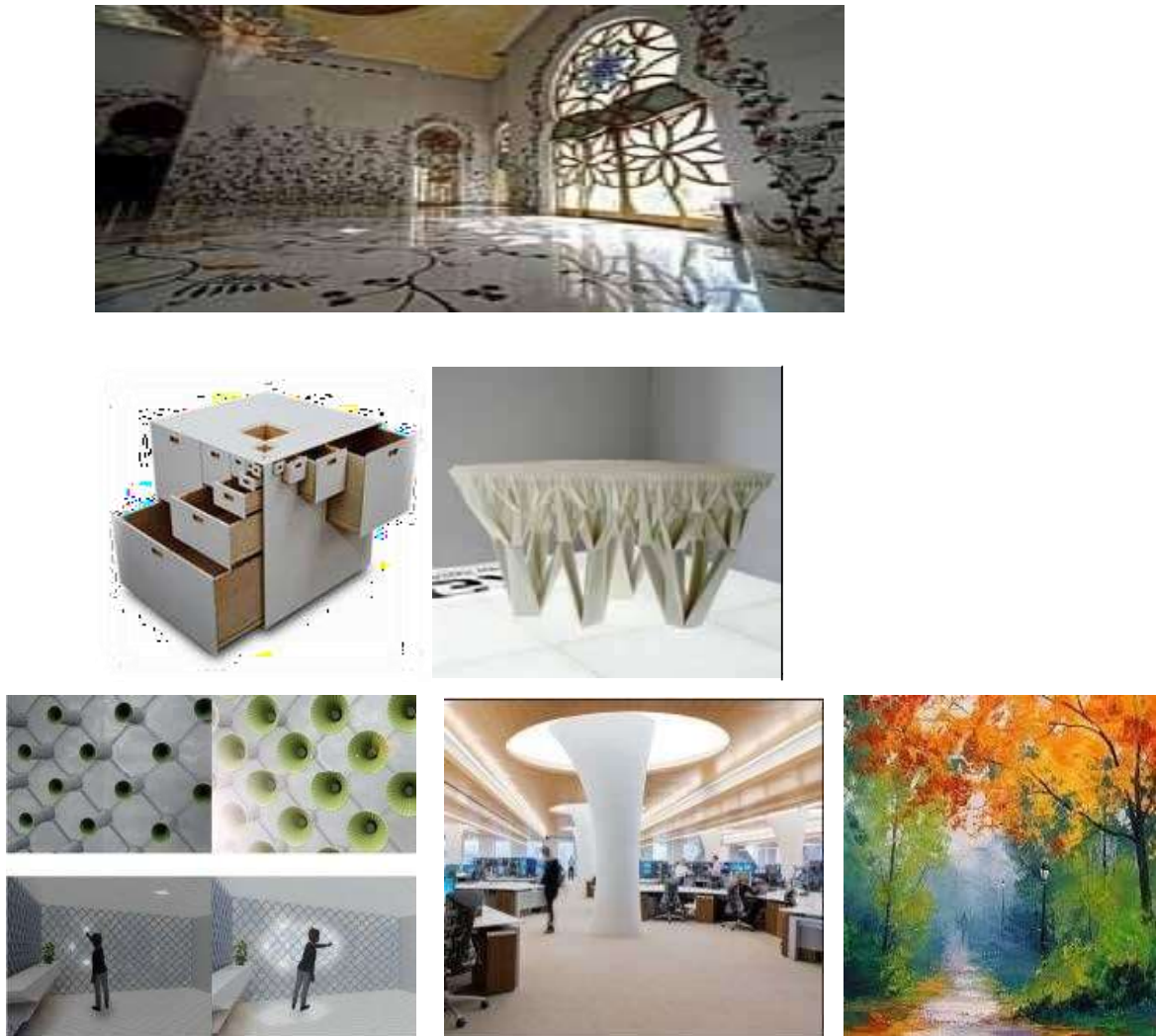


Figure 11. Respectively examples of biophilic attributes related to fascination restorative aspect

3-2-4 Action and Compatibility

Patterns that provided by the environment stimulated psychological activity that guides users' compatibility and actions. A sense of compatibility is strengthened when the environment supports the action and compatibility of the individual. This can be implemented by some design strategies as follows:

Age, change and the patina of time.

Nature and life are always changing reflecting the dynamic forces of growth and aging. Change and a patina of time can be achieved through such design strategies as naturally aging materials, weathering, a sense of the passage of time, and more.

Information richness. People tend to respond positively to information-rich and varied environments that present a wealth of options and opportunities, so long as the complexity is experienced in a clear way.

Organized complexity. People attract to complexity in natural and human settings, which signify places rich in options and opportunities. Complex spaces tend to be variable and diverse, while organized ones possess attributes of linkage and unity.

Cultural and ecological attachment to place. Culturally relevant designs promote a connection to place and the sense that a setting has a special human identity; similarly ecological connections to place can foster an emotional attachment to an area such as the experience of Hassan Fathy in Nuba. They motivate people to conserve and sustain both natural and human built environments.

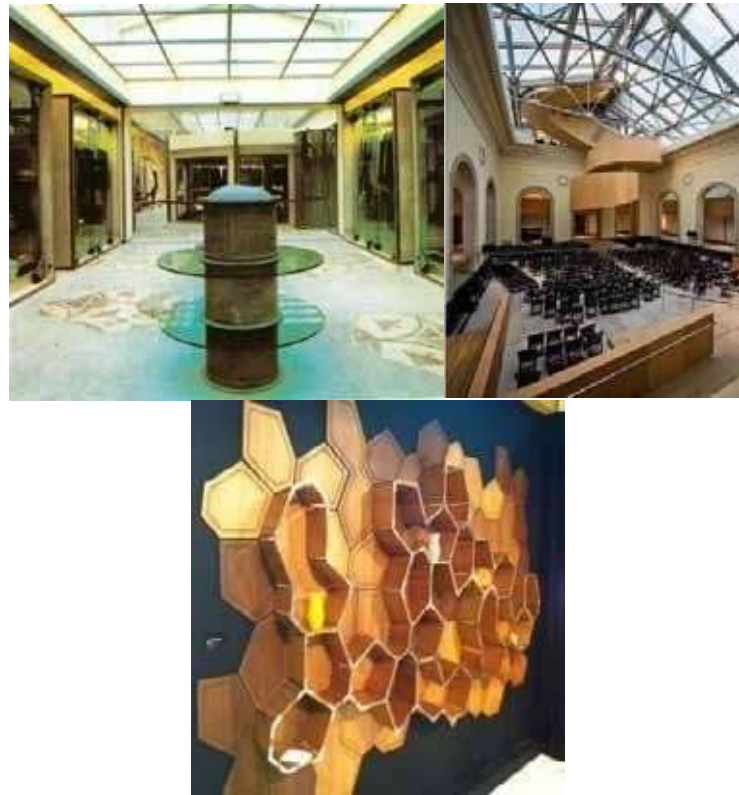


Figure 12. Respectively examples of Biophilic attributes related to the action and compatibility aspect.

Conclusion

The emerging area of biophilic design is rapidly growing. “People's physical and mental well-being remains highly dependence on contact with the natural environment, which is a necessity rather than a luxury for achieving lives of fitness and satisfaction in our modern society” (Kellert, 2008). This research intended to present a design framework that promoted a symbiotic relationship between nature and the interior built environment while addressing humans’ overall psychological, physical, and spiritual well-being and restore the human-nature connection that has been lost in the interior spaces. In the study of the restorative design, it was found that there are many aspects to achieve in the internal build environment using the attributes and characteristics of biophilic design due to their strong connection with the restorative environmental design.

Restorative design is the new concept of sustainability, through its coverage of aspects affecting the environment and human beings. It is concerned with reducing the bad impacts of man on the environment through the application of sustainability practices and green design standers, in addition to the environmental impact on human beings at all psychological and physical levels, and connect people to the environment to keep and interact with it and occurs feel sense of affiliation so achieve the concept of comprehensive or whole sustainability.

The research is supporting the importance of finding greater understanding of restorative design and its application in the interior spaces. The resulting importance of the presented framework is for designers or other experts to have a tool for identifying nature-based features. This knowledge can further influence the design decision-making process to focus on nature-based feature integration in interior spaces. The framework thus offers a valuable tool for designers and those invested in adapting the interior to optimize health and wellness through biophilic design inclusion.

References

- 1- Amanda C. Cleveland (2014). Symbiosis between Biophilic design and Restorative healing environment: The impact of overall well-being of urban dwellers. Florida State University Libraries - <https://diginole.lib.fsu.edu/islandora/object/fsu%3A185368>
- 2- Beatley, T. (2011). Biophilic cities: Integrating nature into urban design and planning. Washington, DC: Island Press
- 3- Browning, W., Ryan, C., Clancy, J. (2014). 14 Patterns of Biophilic Design. Terrapin Bright Green, LLC, New York.

-
- 4- Hartig, T., Bringslimark, T., & Patil, G. (2008). Restorative environmental design: What, when, where, and for whom? In S. R. Kellert, J. Heerwagen, & M. Mador (Eds.), *Biophilic design: The theory, science, and practice of bringing buildings to life* (p. 385). New York, NY: John Wiley.
 - 5- Heerwagen, J. (2008). *Psychosocial value of space: General format*. Retrieved from (http://www.wbdg.org/resources/psychspace_value.php)
 - 6- Herzog, T., & Strevey, S. (2008). Contact with nature, sense of humor, and psychological well-being. *Environment and Behavior*, 40(6), 747
 - 7- Kaplan, R., & Kaplan, S. (1989). *The experience of nature: a psychological perspective*. New York: Cambridge University Press.
 - 8- Kaplan, R. (1993). The role of nature in the context of the workplace. (*Landscape and Urban Planning*), 26G193G201. DOI: 10.10116/0169G2046(93)90016-7
 - 9- Kellert, S. R. (2008). Dimensions, elements, and attributes of biophilic design. In *Biophilic design: the theory, science, and practice of bringing buildings to life*. Hoboken, N.J.: Wiley.
 - 10- Kellert, S. R. (2012). *Birthright: people and nature in the modern world*. New Haven: Yale University Press.
 - 11- Kellert, S., Heerwagen, J., & Mador, M. (2008). *Biophilic design: The theory, science, and practice of bringing buildings to life*. Hoboken: Wiley & Sons.

-
- 12- Kellert, S.R., & Wilson, E.O. (1993). The biophilia hypothesis. Washington, DC: Island Press
- 13- Kellert, S. , Calabrese, E. 2015. The Practice of Biophilic Design. www.biophilic-design.com 16- Kopec, D. (2010). Environmental psychology for design. New York: Fairchild. McColl, S., & Veitch, J. (1983). Full- spectrum fluorescent lighting: A review of its effects on physiology and health. *Psychological Medicine* 31(6), 949-964. DOI:10.1017/S003329170100425.
- 17- A phenomenological study. Retrieved from ProQuest Dissertations and Theses database.
- 18- McHarg, I.L., (2006). The essential Ian McHarg: Writings on design and nature. Steiner, F.R.(Ed.). Washington, DC: Island Press
- 19- Nousiainen, M., Lindroos, H., Heino, P. (2016). Restorative environment design. Kymenlaakso University of Applied Sciences publications. Series A. Nr 76
- 20- Wolf, K. Biofilia Economics, <http://www.charteredforesters.org/news/item/238-biophiliccollaboration-tpbeii/> economics-