PDH Academy

AN edcetera CO

Biophilic Design, Biophilic Urbanism and Beyond

AIAPDH254

4 LU/HSW Hours

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PDH Academy

Biophilic Design and Biophilic Urbanism Final Exam

1. **What significant event happened in 1984 with regards to the concept of biophilic design?**
    a. The AT&T building was declared a National historic monument
    b. E.O. Wilson published a book titled "Biophilia"
    c. Central Park in New York celebrated it's 200th anniversary
    d. DNA fingerprinting became the basis for biophilic design

2. **What is the meaning of biophilia?**
    a. Covered with plants
    b. It is a term made up by city planners with no meaning
    c. Love of life
    d. Worship of living things

3. **Which of the following is a benefit derived from a biophilic city?**
    a. Enhanced biodiversity
    b. Segregation of lower income people
    c. More use of soft plastics
    d. Total climate control

4. **Which city changed its description from "Garden City" to "City in a Garden"?**
    a. Portland. OR
    b. Austin, TX
    c. Perth, Australia
    d. Singapore

5. **Which of the following does not affect plant life?**
    a. Insects
    b. Sunlight
    c. Building style
    d. Winds

6. **How many species of plants are used within the Oasia hotel tower?**
    a. 54
    b. 21
    c. 33
    d. 243

7. **According to an RICS publication, "Human costs are ____ times greater than energy costs in the workplace."**
    a. 2
    b. 10
    c. 58
    d. 112

8. **A Harvard-led study in 2015 found that raising these levels impaired the cognitive function of participants by as much as 50%?**
    a. N_2
    b. CO_2
    c. Oxygen
    d. Humidity

9. **The Ford Motor Company's Rouge plant is known for what biophilic feature.**
    a. Recycling
    b. It's donut shape
    c. Living, green roof
    d. Extensive planting around the factory interior

10. **Preserved moss walls are:**
    a. Encapsulated moss in panels
    b. Living moss preserved with low maintenance irrigation
    c. Stabilized dead moss
    d. Any soft textured interior plant covered walls

11. **“zenithal” lighting is used to rain light as a biophilic design element in which project by architect Jean Nouvel?**

    a. La Marseillaise Tower
    b. One Central Park
    c. Longwood Gardens
    d. Louvre Abu Dhabi

12. **The Metropol parasol in Seville Spain is an example of:**

    a. Biophobic architecture
    b. Bioclimatic architecture
    c. Biomorphic architecture
    d. Urban Rewilding

13. **Which of the following is not a design element used biophilic design:**

    a. Air conditioning
    b. Light and Shadow
    c. Color
    d. Views

14. **Which of the following are examples of natural patterns and textures?**

    a. Stone textures
    b. Wood Grain
    c. Leafy patterns
    d. All of the above

15. **According to its definition, a ‘concrete jungle” :**

    a. has a lot of modern buildings without grass or trees, and you think it is ugly or unpleasant to live in.
    b. is an area of paved structures engulfed with artificial trees.
    c. is an urban oasis
    d. is a phrase coined by Le Corbusier

16. **Which term in color theory describes the addition of white?**

    a. Shade
    b. Hue
    c. Tone
    d. Tint

17. What are two problems associated with uniform distribution of light?

a. Energy costs and maintenance
b. Dynamism and diffusion
c. Glare discomfort and a boring space
d. None of the above

18. One of the downsides of using water features in biophilic design is:

a. Biological response from humans
b. Sanitation concerns
c. Attracts people
d. Sound

19. Which building inspired by a desert rose has forms that are highlighted by the interplay of light and shadow?

a. The Portland Building in Portland, OR.
b. The Entex building in Houston, TX.
c. Russian pavilion at Expo 2020 in Dubai
d. Qatar National Museum in Doha

20. What are fractals?

a. Fragments of natural materials like pieces of stone.
b. An industrial process to recreate natural patterns.
c. Patterns in nature created by repeating shapes in different scales where parts resemble the whole.
d. A finite shape with no mathematical relationships.

21. Primary colors are:

a. RAL, Violet, Orange,
b. Red, Green, Blue, White
c. Cyan, Magenta, Yellow, Black
d. Red, Yellow, Blue

22. Greening grayfields and brownfields is what level of implementation in Green Urban design?

a. Neighborhood
b. Community
c. Region
d. Block

23. How many cities are members of the Biophilic Cities network, as referenced in the course material?

a. 18
b. 42
c. 31
d. 65

24. Which of the following buildings mentioned in the course is not mentioned as an example of biophilic design?

a. Fallingwater
b. AT&T (Sony) Tower
c. The Orchard, Hammad International Airport
d. La Sagrada Familia

25. Which of the following is not a challenge with biophilic design implementation?

a. Availability of plants
b. Awareness
c. Funding
d. Space

26. A "Heat island" is:

a. An area of communal gathering with a fireplace or a large heating source at the center, used in cold climates.
b. A localized weather pattern that brings in hot air.
c. Any island where average temperatures exceed 90^0 F for more than 8 months out of the year.
d. Created due to increased temperatures in populated areas.

27. What is a common trait shared by an Eskimo village and a traditional African village?

a. Both use solar energy.
b. They both have a close affinity to their animals and the nature around them.
c. They are both primitive arrangements that offer little value to modern design.
d. They are completely different in all aspects.

28. Which of the following are parts of a structured framework to addressing challenges to implementing biophilic design?

a. Assess your needs and goals.
b. Be creative and flexible.
c. Both a. and b.
d. None of the above.

29. Stone, Wood and Concrete are examples of:

a. Natural materials
b. Pre-engineered materials
c. Materials that are non-biophilic
d. Post-industrial materials

30. What is the premium for a green roof compared to a conventional roof?

a. 25%
b. There is no singular metric for the premium.
c. More than double the cost
d. Ranges from 10% - 19%

Biophilic Design, Biophilic Urbanism and Beyond

Disclaimer Notice:

This course is intended to provide information as an educational benefit for architects and design professionals. The author has attempted to present a summation of the concepts and published data in a manner that intended to clarify these for architects. While the Information contained in this course has been reviewed and presented with all due care, the author does not warrant or represent that the Information is free from errors or omission. The author accepts no liability whatsoever for, or in respect of any use or reliance upon this publication by any party. Author: Muhammad Siddiqui.

Course Summary

Biophilic design is the concept of increasing building occupant connectivity to nature whereas biophilic urbanism is a trend in city planning and urban design to integrate nature into the urban built environment. In recent times, as concepts like green buildings, sustainability and NetZero are gaining momentum, many designers have turned to biophilic design options as another aspect of addressing environmental challenges and the impact of urbanism. The overarching theme with anything emanating from biophilia is the integration of nature into the design. Often this concept is confused with many others like “green buildings”, “green architecture”, “sustainability” or even “biomimicry”. While being different, all these concepts, ideas and philosophies share a common goal of trying to help mitigate some of the negative impacts of human development, particularly in the urban context. It is, however, important for architects, designers, and planners to understand the qualitative and contextual differences to be better able to engage with clients, environmentalists, and agencies. It is also essential to know what is and is not the scope and goal of the various concepts. This understanding will enable proper application within the right context, environment, and project type. No one concept is a comprehensive solution but collectively all can play a positive role if applied with proper knowledge and perspective.

This course is intended to explain the origins, meaning and ideals of biophilic design and biophilic urbanism. It will elaborate on how biophilic design and urbanism seek to engage with nature in ways to influence design and affect the carbon footprint of buildings and public spaces.

There are 4 main goals of the course:

1. Understand biophilic design and biophilic urbanism.
2. Look at the origins of biophilic design and its contemporary manifestation.
3. Examine the main principles of biophilic design and planning.
4. Explore the contexts where biophilic design can provide synergies to further sustainability goals.

Learning Objectives

- Understand what biophilic design and biophilic urbanism are.
- Identify the basic principles of biophilic design and their applications in buildings and in public spaces.

- Understand how biophilic design contributes to the broader sustainability and NetZero framework.
- Create an awareness of significant biophilic design projects and public spaces.

Course Structure

The course on Biophilic Design is a two-part course broken down as follows:

- PART 1 – Introduction to Biophilic Design and Biophilic Urbanism.
- PART 2 – Biophilic Design in Practice.

PART 1

1.1 Introduction to Biophilic Design and Biophilic Urbanism

1984 is a year with many connotations. Aside from its Orwellian infamy, the year witnessed some events that would affect society over the next several decades. Apple introduced the Macintosh computer that sparked a series of developments which have revolutionized human social behavior. DNA "fingerprinting" was introduced and has evolved into a major forensic and commercial science. A tragic chemical leak at a Union Carbide plant in Bhopal, India resulted in immediately killing at least 3,800 people and causing significant morbidity and premature death for many thousands more.[1] This incident essentially rewrote the way industrial buildings and plants are designed and gave birth to a Safety-First culture. In the world of Architecture, Phillip Johnson's AT&T building (now the Sony Tower) was completed at 550 Madison Ave., in New York.

AT&T (now **SONY) Tower (1984);** Philip Johnson Architect; Photo: Courtesy of the author; © Muhammad Siddiqui, 2023

[1] National Institutes of Health (NIH): https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1142333

The Chippendale crested building is considered by many to be the crowning achievement of the Post-Modern architecture era, the building was called possibly "the single most important architectural detail of the last fifty years."[2]

Also in 1984, a lesser-known event – the publication of a book by American biologist E.O. Wilson titled "Biophilia" popularized the term and has been referred to as the "Father of Biophilia". In the book, Mr. Wilson used the term biophilia to describe the traits of evolutionary adaptation that allow us to develop a mental link with the living world and Nature.[3] Literally, the word is a combination of two Greek words: "life" (bio) and "love" (philia); it means "love of life". This meaning has been more broadly interpreted to mean both love for living creatures (life) and love for Nature (Life), understood as the set of living creatures plus the abiotic (*physical rather than biological; not derived from living organisms*) environment in which they thrive.[4] However, the term biophilia had been used in scientific circles dating back to 1960s when Psychologist, Erich Fromm, first used the word biophilia in 1964, when he described it as "the passionate love of life and all that is alive". [5]

Both Fromm and Wilson put forth hypotheses that biophilia has a biological basis and that it is fundamental to develop harmonious relationships between humans and the biosphere.[6] However, it was an American, Stephen R Kellert, who took the theory towards architecture and design. He went on to publish the book titled "The Practice of Biophilic Design" along with co-author, Elizabeth F. Calabrese. The book is a very useful text on the subject and a must for any architect who wishes to indulge in biophilic design. It is also an easy read. The principles articulated by Kellert have earned him the honorific "Father of Biophilic Design", a title that he served well during his lifelong commitment to the ideals of Biophilic design. Below is a short summary of his biophilic framework[7]:

The Direct Experience of Nature
The direct experience of nature are designs that have quantifiable contact with common features of nature such as light, air, water, plants, animals and natural landscapes. Contact with these features usually corresponds with a heightened sense of space and connectivity within the environment.

The Indirect Experience of Nature
The indirect experience of nature speaks of a design coming into contact with representations and images of nature. These may include pure images such as photographs or professional paintings; natural materials or colors placed within the building design; natural air and light simulations; simulations of natural shapes

[2] https://www.archdaily.com/611169/ad-classics-at-and-t-building-philip-johnson-and-john-burgee
[3] National Library of Medicine: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8334556
[4] Ibid
[5] https://www.planteriagroup.com/blog/biophilia
[6] Frontiersin.org: "Biophilia as Evolutionary Adaptation: An Onto- and Phylogenetic Framework for Biophilic Design" by Giuseppe Barbiero and Rita Berto, 20 July 2021.
[7] https://www.auraoffice.ca/blog/what-is-biophilic-design

within the design of a building; "information richness"; biomimicry; natural geometries; invoking natural changes within the Patina of Time and otherwise evoking nature in a project's structural design.

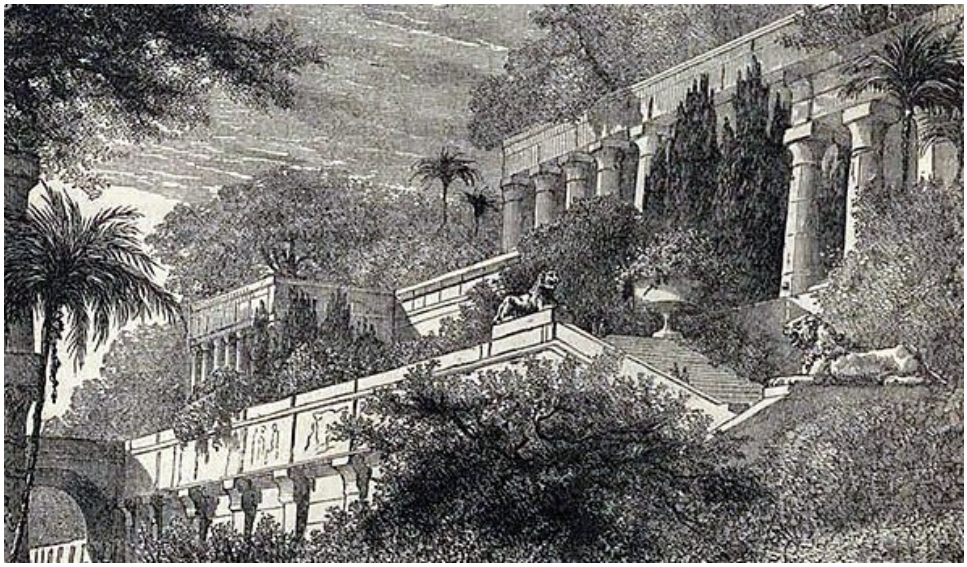
The Experience of Space and Place
Biophilic design can also enhance well-being through the spatial relationships between a design and its surrounding environment. The concepts that are used to flesh out this idea include Cultural and Ecological Attachment to Place; Mobility; Transitional Spaces, Integration of Parts, Organized Complexity and Prospect and Refuge. It is the job of the building architect to understand which of these concepts is the best fit for a project or landscape because each of them is usually meant to be experienced and considered individually.

There are other principles, methodologies, philosophies, and design considerations that will be discussed in subsequent parts of this course.
While Biophilic design generally refers to a building or a singular project or a part of a project, there has also been a parallel movement to extend this concept to the broader environment and create more biophilic communities and even cities. This scaling up of the biophilic design to an urban or municipal scale has been given voice by Timothy Beatley, an internationally recognized municipal planner, and green urbanism author, is an important voice in scaling the idea of biophilic design from buildings to entire cities.[8] In his own words, Mr. Beatley writes: "As we increasingly live in cities, nature delivers a potent remedy to many of the environmental, economic (and emotional) challenges living in cities today presents. To address this, a new approach to urbanism has arisen – a 'biophilic' urbanism – which assumes that contact with nature and the natural world is absolutely essential to modern urban life".[9] This thinking is not new nor are its applications. What is different is the categorization of the concepts in a structured theory with guidelines for integrated and sustainable adoption. This link to sustainability finds congruent timing with the overall prominence of environmental awareness, concern over climate change and the (at least in broad terms) recognition that rapid urbanization and population growth and its attendant need for resources are in desperate need of vigilant management. Combine this with pressure on limited land and there is a perfect storm of congestion, pollution, and human health. It is in response to this emerging "crisis", that the notion of biophilic Urbanism has gained traction as a viable approach to mitigate and temper some of the challenges of mass urbanization. At the same time, it can also serve as a possible planning mechanism to reverse some of the negative effects of urban living and potentially redefine the structure of the urban environment in more productive and humane terms where nature helps restore a degree of tranquility and stress relief and a sense of community that are the defining casualties of urban density.

1.2 Historical Context

[8] Ibid
[9] "Biophilic Urbanism on the Rise": Timothy Beatley, October 2013.

As examined above, one may start to conclude that the idea of biophilia is a mid-20th century concoction and Biophilic Urbanism, an even more recent metamorphosis of that idea. While the coining of the phrases and the formation of guidelines to provide a structured implementation of these ideas in a scientific and planning framework is certainly a few decades old, the intuitive human affinity for these ideas is as old as documented history of the built human civilization. One of the most famous and ancient mentions of the usage of nature integrated with the buildings are the Hanging Gardens of Babylon, considered one of the Seven Wonders of the Ancient World. They were described as a remarkable feat of engineering with an ascending series of tiered gardens containing a wide variety of trees, shrubs, and vines, resembling a large green mountain constructed of mud bricks. It was said to have been built in the ancient city of Babylon, near present-day Hillah, Babil province, in Iraq.[10] While there are no surviving actual visual records of the gardens, many artists over the ages have imagined what these may have looked like based on historical descriptions. The illustration below is one such rendition. What is common to the visualizations is that these were terraced gardens where natural elements like flowing water and a variety of flora and fauna were embedded and fully integrated into the man-made structure. This is classic "biophilic design".



*Source: Wikimedia Commons: **The Hanging Gardens of Ancient Babylo**n.jpg. Cassell's Illustrated Universal History; Early and Greek History. by Ollier, Edmund. (Public Domain)*

In more documented and surviving historical references, the uses of biophilic concepts are evident in various cultures and locations around the world. It is not always in the use of plants but also water and, in some contexts, animals as part of the built environment that biophilic traces are manifest. Some of the examples discussed below may be debatable in the modern sense of biophilic design but they

[10] Wikipedia: Hanging Gardens of Babylon.

do show how the integration and “love of life or nature” has been integral to human communities for centuries. Consider the way traditional villages in Africa or South Asia are clustered close to their animals and have water and trees as essential elements of communal spaces, whether family compounds or village squares. Building materials are local mud bricks and thatching from surrounding forests. On the other extreme, “Eskimo” villages share the same traits with a close affinity to their animals and the nature around them. Again, materials used are local, ice blocks in this case, and animal skins and furs.

African village, The Gambia: Wikimedia[11]

Eskimo Village, Whalen Siberia: Wikimedia Commons [12]

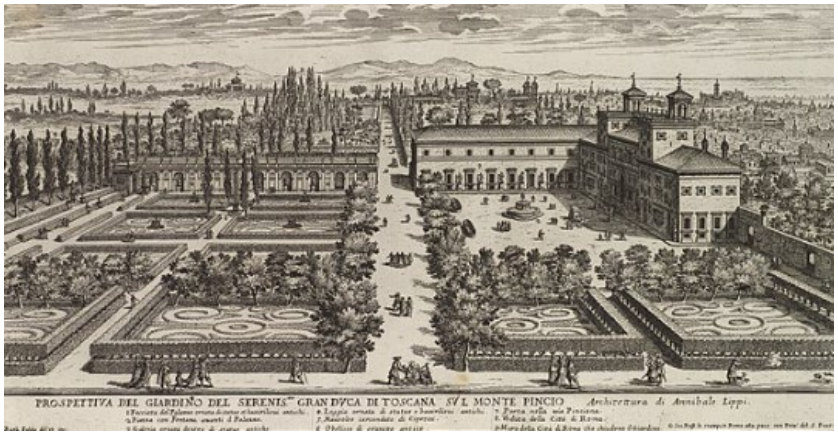
Artist Visualization of Traditional Middle Eastern Courtyard: Wikimedia Commons[13]

Beyond the above examples, most of which are representative of smaller communities or are rural, the most common and impactful historical examples of

[11] Wikimedia Commons: African village - (Find the people!) (28366853149).jpg
[12] Wikimedia Commons: Tourists visiting Eskimo settlement, Whalen, Siberia, ca 1904 (NOWELL 55).jpeg
[13] Wikimedia Commons: Arabian nights 1 by John Frederick Lewis.jpg

incorporating nature into more urban societies have been in the development of gardens and, later, public parks. From the delicacy of Persian gardens, the serenity of Japanese Zen gardens to the Quranic inspired visions of paradise reflected in Islamic gardens or the medieval Medici Gardens in Tuscany, the design of gardens showed the value attached to nature and its role in enhancing the architecture which the gardens complimented.

Zen garden, Japan[14]



Medici Villa and gardens, Tuscany, Italy [15]

[14] Wikimedia Commons: Zen Garden 2023-05-11-2.jpg
[15] Wikimedia Commons: View of the Villa Medici MET DP109548.jpg


Islamic inspired Gardens of The Generlife, Grenada, Spain [16]


Persian inspired Shalimar Gardens, Lahore, Pakistan [17]

Most of the examples above and almost all major historical gardens were developed to serve the aristocracy and were extensions to palaces or estates of the wealthy classes. Gardens are also, almost by definition, creations of art in of themselves. They are products of landscape design, something to be viewed, enjoyed and selectively experienced along designated paths. They do not define or necessarily integrate structurally with the buildings they are attached to but do give the final character to the building, sometimes even pushing the building into the background.

From Gardens to Parks

With the advent of populist revolutions like the French Revolution in Europe and the diminution of the Royalty in Britain, there was a demand for public spaces where an increasingly industrialized and urban society wanted open spaces as a retreat from the smog and pollution of the congested cities. The wealthy classes had always had these

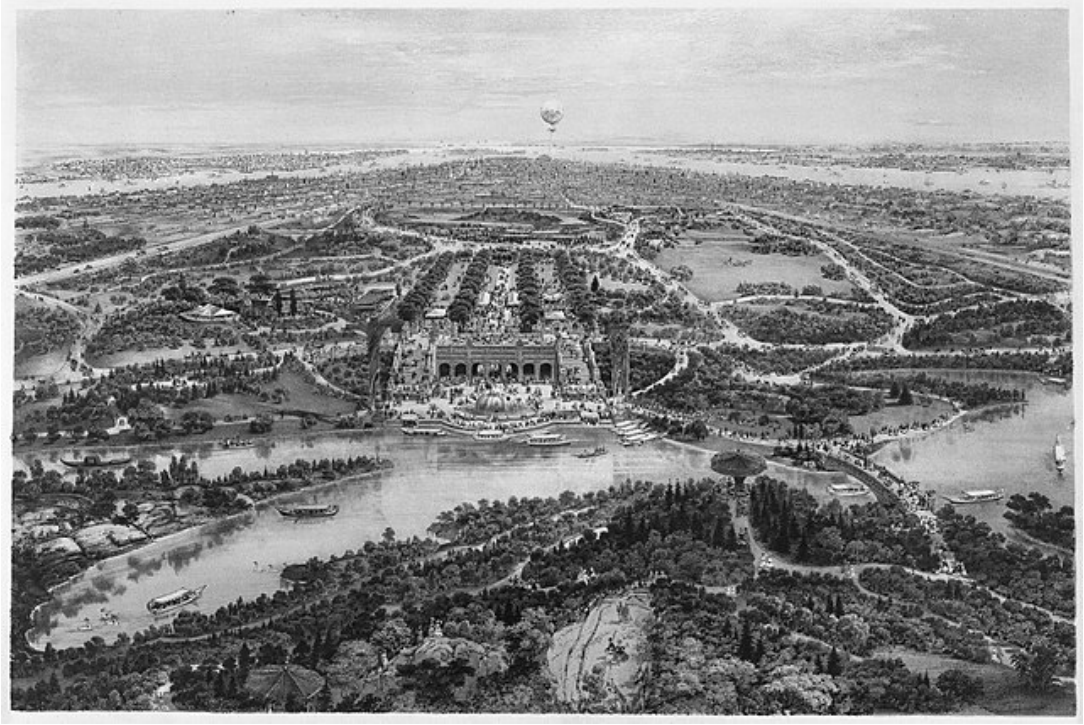
[16] Wikimedia Commons: Generalife Gardens, Granada (28895376608).jpg
[17] Wikimedia Commons: View of Shalimar Gardens, Lahore.jpg

retreats in the form of private gardens and so the concept was extended into the formation of public spaces that introduced nature into the urban fabric by designating areas with grass, trees, flowers, and even water elements and small animals – The Public Park was born.

In the mid-nineteenth century, the urban bourgeoisie sought to respond to challenges of city life through the creation of public urban parks in a wide-scale project that has been termed the "park movement." The park movement involved not only the design and development of parks, but also extensive writings starting in 1840s that depicted the social benefits to be gained by building picturesque *rus in urbe* ("country in the city") spaces.[18]

In 1843, architect Joseph Paxton designed what is considered the first urban park in the world for public use, financed with public funds in Liverpool, England: Birkenhead Park. [It should be noted here that Boston Commons may challenge this as it was the first public park in the United States dating back to 1634. However, this was more akin to a town square, albeit with an element of community and recreation but not purely a dedicated urban park at its onset]. The example set by the English was soon followed by other large capitals. In Paris, Napoleon III ordered the *Bois de Boulogne* and the *Bois de Vicennes* to be opened up to the public. Carlos III had already given public access to the gardens of the *Palacio del Buen Retiro* for recreational purposes, and the park became municipal property in the mid-nineteenth century.[19] Around the same time, across the Atlantic Ocean, in New York City, a strong case was being made to create "an extensive area for shade and recreation" on the island of Manhattan.[20] In 1857 the city gave approval for the Central Park project that would eventually occupy over 840 acres on the between the Upper West Side and Upper East Side neighborhoods of Manhattan in New York City.[21] Designed by Frederick Law Olmsted and Calvert Vaux, the park was completed in 1876 to become the first landscaped park in the United States. Central Park combines all elements of nature, from greens, trees, lakes and wildlife to walking trails and meadows for human communion with nature in what is arguably one of the densest urban settings anywhere. The success of the park is underscored by the fact that it is the most visited city park in the United States with an estimated 42 million visitors in 2022.[22] This success gives credence to the notion that urbanites desire and actively engage with nature. Among the design characteristics of Central Park is the way it seems totally natural, with no seeming human geometry imposed as was apparent in the medieval and oriental gardens. Yet, everything, almost every tree in Central Park is there by design. This demonstrates that a sensitive and immersive knowledge of human needs and nature's elements can be brought together successfully through urban design and planning.

[18] OXFORD Academic: The Park Movement Picturesque rus in urb, John Evelev, April 2021.
[19] Iberdrola.com: Urban parks are far more than the 'lungs' of a city.
[20] Ibid
[21] en.wikipedia.org: Central Park
[22] Statista.com: City parks in with the highest visitation in the United States in 2022



Central Park, Manhattan, New York. circa 1865. Wikimedia.[23]

Central Park, Manhattan, New York. 2010. Source: Author. ©muhammad a siddiqui

[23] Wikimedia:L Central Park (Summer) MET MM22125.jpg

Among some of the more prominent and meaningful historic urban parks that are still in active use today are the following:

- Lincoln Park, Chicago, IL, 1843
- Balboa Park, San Diego, 1868
- Golden Gate Park, San Francisco, 1870s
- Forest Park, St. Louis, 1876
- Griffith Park, Los Angeles, 1896
- Hyde Park, London, 1637
- Park Güell, Barcelona, 1900-1914
- Jardin du Luxembourg, Paris, 1625
- King's Park, Perth, 1895
- Stanley Park, Vancouver BC, 1887
- Englischer Garten, Munich, 1789
- Shinjuku Gyoen Park, Tokyo, 1906 – opened to public 1945
- Chapultepec Park, Ciudad de Mexico, 1895

These parks are perhaps the first formal practical examples of what is now the Biophilic Urbanism movement. The major difference is that while parks are limited, designated areas of nature within but separate from their urban surroundings, biophilic Urbanism seeks to make the park and the urban elements seamless and continuously integrated, transforming the entire community into a living and working environment where nature and man-made become intertwined as a whole. In simpler terms, parks, plazas, and nature themed public spaces are all elements of biophilic urbanism which is the broader, amalgamated urban planning philosophy.

1.3 What is Biophilic Urbanism?

As mentioned in the introductory section, Biophilic Urbanism is a relatively recent term that has grown out of the biophilia and biophilic design philosophy.

Biophilic urbanism, which attempts to reflect the concept of biophilia in urban planning and design, does not mean a return to the age when nature functioned as a shelter. Instead, biophilic urbanism aims to restore the relationship between humans and nature and improve the quality of the relationship by bringing nature into the human living environment. Biophilic urbanism also emphasizes that this relationship is one way to mitigate modern urban problems and is an essential element for achieving sustainable cities (Beatley and Newman, 2013; Newman, 2014; Xue et al., 2019).[24]

At its most simplistic view, any biophilic approach seeks to connect a building and its users/occupants to nature. At an urban level this extends to connecting

[24] Science Direct: A framework of biophilic urbanism for improving climate change adaptability in urban environments; Sunghee Lee & Youngchul Kim, Vol 61, June 2021, 127104

buildings to their surroundings, creating communities bound by natural elements. These can then morph into each other, expanding and contracting as densities demand. The biophilic element is that the threads binding the buildings to the community and the communities to each other are taken from nature.

So, what makes a city biophilic?

A city or urban area that is designed or adapted to create or expand opportunities for its inhabitants to spend time in close vicinity to nature. In this way, built urban spaces reduce their stressful harshness while also contributing to reducing carbon footprints and creating engaged communities that have a sense of belonging and a feeling of safety. Overall, biophilic cities are more sustainable and resilient because they prioritize the health and well-being of both people and the environment. They provide numerous benefits, including increased social cohesion, enhanced biodiversity, and improved air and water quality.[25] The main benefits that are derived include the following[26]:

- **Improved public health**: Biophilic urbanism can improve public health by reducing air and water pollution, providing spaces for physical activity, and promoting mental well-being through exposure to nature.
- **Enhanced biodiversity**: Biophilic urbanism can help preserve and restore natural habitats within cities, such as wetlands, forests, and rivers, which enhances biodiversity and contributes to ecosystem services such as pollination and pest control.
- **Increased social cohesion**: Biophilic urbanism can promote social cohesion and community building by providing spaces for social interaction and shared activities, such as community gardens and parks.
- **Greater resilience to climate change**: Biophilic urbanism can enhance the resilience of cities to climate change by mitigating urban heat island effects, reducing stormwater runoff, and providing shade and cooling through vegetation.
- **Economic benefits**: Biophilic urbanism can provide economic benefits, such as improved property values, increased tourism, and reduced healthcare costs due to improved public health.

[25] PropertyPistol.com: A New Era of Urban Design: The Emergence of Biophilic Urbanism and its Benefits!; February 17, 2023
[26] Ibid

- **Improved aesthetics**: Biophilic urbanism can enhance the aesthetics of urban environments by creating visually appealing and relaxing spaces, such as parks and green roofs.

To better understand Biophilic Urbanism, it is helpful to examine a real-world implementation of this philosophy on a truly large scale. While many cities around the world are stepping up to develop elements of these concepts, Singapore is perhaps at the forefront of biophilic urbanism and is considered by many to be the most biophilic city in the world.[27] This did not happen overnight. Singapore is a small island state of about 700 sq. km. Efforts at fusing population density and nature began back in the 1960s, when the city's motto was "Singapore – Garden City". Recently, the city has put forth a new motto, "Singapore – City in a Garden". Singapore has an impressive network of trails and pathways that connect parks and green spaces to one another. These park connectors allow people to walk, bike, and jog between various green spaces without leaving vegetated areas. The city-state has also made considerable efforts to integrate nature into its vertical spaces. A number of high-rise apartments, office buildings, and hotels have installed green roofs and indoor hanging gardens to help reduce the effects of urban heat island (wherein a metropolitan area is warmer than its surroundings because of escalated human activity). Landsat Images show that while the city grew in population by some 2 million between 1986 and 2007, the percentage of the island in green area actually increased as well, from 36% to 47%. Few dense cities can truly boast being "in a garden" in the way that Singapore can. In many ways, Singapore is the shining example of a biophilic city. [28]

While Singapore is at the vanguard, many cities are joining the movement and have come together to form Biophilic Cities Network (BCN) which, according to its Declaration of Action "supports the implementation of the goals and targets of the Kunming-Montreal Global Biodiversity Framework (GBF) adopted at the December 2022 United nations Biodiversity Conference of the Parties to the UN Convention on Biological Diversity (COP 15)".[29]

[27] BiophilicCities.org: Singapore
[28] Ibid
[29] BiophilicCities.org: bcn-biodiversity-declaration

Tree Garden, Singapore. 2012 by Grant Associates. Photo: Author. ©muhammad a Siddiqui-2016

Singapore Pavilion, Expo2020, Dubai (2022 – WOHA Architects) **& "The Jewel" - Changi Airport** (2016-Moshe Safadie Architects), Singapore. Photo: Author. ©muhammad a Siddiqui 2022.

The biophilic approach to urbanism has a unique quality in that regardless of the political side of the climate change issue, the transformations encouraged by using biophilic concepts create spaces that have universal appeal regardless of politics, gender, race or any other demographics.

1.4 Biophilic Design and its Present Manifestation.

As has been noted, Biophilic design, as currently professed, is a recent concoction and its present manifestations are mainly taking the shape of buildings and developments that are heavily laced with plants and water features as unified parts of the design and its physical expression. The July/August 2023 issue of ARCHITECT magazine, The Journal of the American Institute of Architects (AIA), graced its cover with a photorealistic AI generated rendering by Carlos Banon that paid homage to everything biophilic.

The accompanying article focused on a newly devised process called "Rewilding" which is a practice focused on restoring ecosystems.[30] More on how this relates to the practice of architecture will be discussed later in this course. The point of introducing this at this point is to show the continuing evolution of biophilic design and how this illustration shows that present visions are deliberately blurring the lines of where a building ends and nature starts. The building in the wild or the urban village are all new terms reimagining the concrete jungle of 20th century urbanism into an urban forest for the 21st century. The concepts have not quite reached the visions of the fantasy tree dwellings of the *Avatar* movies but that is a direction where some biophilic inspired designers are channeling their efforts.

ARCHITECT magazine – The Journal of The American Institute of Architects, July/August 2023 Cover.

Over the past two decades, this fusion of nature into buildings has entered mainstream designs, most notably in Singapore, Malaysia, Australia, and some other technologically

[30] ARCHITECT magazine – The Journal of The American Institute of Architects, Madeline D'Angelo; July/August 2023

advanced tropical regions. Unsurprisingly, these regions are prime candidates to experiment with biophilic design as they have the wet, tropical climate and lush vegetation and the technological advancement to merge effective climate control systems for building interiors that can facilitate human comfort seamlessly between interior and exterior spaces.

Two sample projects illustrate how urban projects are assimilating plants into what would otherwise be a typically banal urban high development.

1. **Le Nouvel Vertical Gardens:** Located in Kuala Lumpur, Malaysia, this residential complex brings native greenery to Kuala Lumpur's modern skyline. Le Nouvel KLCC comprises two slender towers–43 and 48 stories–by Ateliers Jean Nouvel that rise above the capital's main business district, Kuala Lumpur City Center (KLCC). To create the vertical gardens, French landscape architect and botanist Patrick Blanc applied a grid of stainless-steel cables across the buildings' glass facades and threaded them with high- and low-climbing varieties of liana vines. Because the range of factors affecting plant life–including insects, sunlight, and intense winds–vary from level to level, Blanc had to use 243 species of the plant to accommodate the disparities. In addition to the veil the vines form, a lily pond next to the swimming pool on the seventh floor, which joins the two towers, is an oasis of serenity within the bustling metropolis.[31]

[31] Architectural Record: Le Nouvel KLCC by Jean Nouvel, Kara Mavros; August 6, 2019.

LeNouvel Vertical Gardens, Kuala Lumpur by Jean Nouvel and Patrick Blanc.

Photo: courtesy of the author © muhammad siddiqui, 2019

Oasia Hotel: Located in Singapore, Oasia Hotel Downtown is a standout example of biophilic design, a new type of tropical skyscraper that seeks to bring flora and fauna into the city. Not only is it an urban retreat for hotel guests, but it's also an oasis that brings comfort and nature to city dwellers. Rising in the midst of concrete and glass, the hotel boasts a distinctive permeable crimson steel façade (25,490 square meters) that encourages biodiversity against an otherwise harsh, concrete backdrop. With butting planters on every story (a total of 1,793 planter boxes on the façade), the aim is to wrap Oasia in a layer of green foliage with a variety of bright flowers. There are 21 species of creepers distributed across the trellis, some producing flowers that will attract birds and insects at different times of the year. To maximize their adaptability, the species have been arranged on an elevation that aligns with their preferred growing conditions (amount of sunlight, resilience to wind and growth speed). The façade extends to the ground, creating possibilities for small animals (such as squirrels) to scale the building and settle in as a habitat—this brings another dimension to the notion of a "living" building. Together with 33 different species of trees, there are a total of 54 species of plants within the tower that is able to support an ecosystem. This vegetated outer skin also seeks to

transform and soften the surrounding landscape by offering visual relief. With the aim of creating a biophilic environment, Oasia's shell visually and psychologically engages guests, staff and the occupants of surrounding buildings. This hotel bucks the trend of a sealed skyscraper—the architecture allows guests to acclimate and experience Singapore's tropical surroundings with internal breezeways and atria, multiple sheltered terraces, sky gardens and vertical greening. It addresses the loss of green spaces in the urban fabric by achieving an overall greenery replacement of more than 10 times the site area. Embracing living systems of lush greenery, the building is eco-friendly, humane and livable.[32]

Oasia Hotel, Singapore by WOHA Architects. 2016

Photos: Wikimedia Commons (Oasia Hotel Downtown, Singapore.jpg and OasiaDowntown.jpg)

[32] Interfcae.com: Biophilic Design in Urban Architecture: The Oasia Hotel in Singapore; Nirmal Kishnani; June 22, 2018.

An interesting observation is that as the visons for biophilic design become more mainstream, they evoke the past memories of structures like the Hanging Gardens of Babylon.

Hanging Gardens of Babylon, Rendering by Ferdinand Knab 1886.

Photos: Wikimedia Commons (Hanging Gardens of Babylon by Ferdinand Knab (1886).png)

This only reinforces the notion that the desire for blending nature into living spaces and the pleasure gained from it is an aspiration as old as human civilization. However, what was previously only reserved for royalty is now aiming to extend to the masses. That goal is not yet a reality at the start of 2024. Most biophilic projects are still on the high end of the price spectrum whether it is commercial rental space or residential developments. A major reason for this is that incorporating natural elements and systems into the built environment often requires a higher upfront investment.[33] However, as increased social awareness about productivity, well being of occupants, environmental impact and long term sustainability and energy cost begin to be considered as part of a building's return on investment, biophilic design, relative to its added initial costs and upkeep, yields superior results. Building practices traditionally focus on costs of energy, water, and materials – all important topics. Yet, sometimes these design criteria neglect the most important factor: us. Human costs are 112 times greater than energy costs in the workplace. Statistics like this are encouraging occupiers, landlords and developers to demand buildings that support health and improve occupant experience. Biophilia – the innate human attraction to nature – offers a framework for creating spaces that improve productivity and wellbeing, reduce stress, and therefore boost the bottom line.[34]

The above reasoning is a challenging argument as it assigns an economic value to human well-being and resultant productivity. These are all somewhat esoteric and seemingly

[33] Ugreen.io: Nature in the Modern World: A Guide to Biophilic Design
[34] RICS.org: The Economics of Biophilia; Bill Browning; 23 August, 2018.

intangible metrics, while the upfront capital costs for biophilic design are very tangible, hard currency costs that are a premium over the basic "functional" requirements of the building or space. For any property developer, higher upfront costs, by simple logic, must result in higher selling or renting costs. In this case the buyers or renters have to be savvy enough and willing to recognize that the "intangible" gains from the biophilic or green design will provide returns that will outweigh the higher purchase or rental cost. This hypothesis has recently gained the support and benefit of a variety of academic and other studies that are lending scientific credibility to the real gains that result from sustainable design, including biophilic contributions. See examples below as reported by the Royal Institution of Chartered Surveyors (RICS) in a 2018 publication[35]:

- *Researchers at the University of Oregon found in 2011 that 10% of employee absences could be attributed to architectural elements that did not connect with nature, and that the quality of a person's view was the primary predictor of absenteeism.*
- *A 2015 Harvard-led study, meanwhile, found that as CO_2 levels in office environments increased, cognitive function of participants was impaired by as much as 50%. These results point to the need for natural ventilation and increased airflow similar to outside conditions, in line with the principles of biophilia.*
- *An experiment conducted in a public authority building in Sacramento found that a biophilic intervention saved three times the cost of its installation. The office occupies an upper floor and, while it has large windows that look out on to trees, the desks were arranged perpendicular to them. Since the workers needed to focus on their computer monitors, seeing the view out the windows required them to turn their bodies. By rotating the desks a few degrees toward the windows, any movement in the trees outside became perceptible in the occupants' peripheral vision. This caused them to occasionally glance out of the windows, relaxing their eyes and providing them with brief mental pauses that restored cognitive focus. Moving the desks cost about $1,000 per occupant, but their call handling capabilities increased by more than 6%, resulting in savings of around $3,000 per occupant.*

On its own merit, it can be argued that biophilic design will take some time to gain widespread traction due to the timing lag of investment vs return. But, as the chorus for more sustainable buildings, energy conservation and delivery of NetZero targets gets louder, all viable design options are under expedited consideration. In this atmosphere, biophilic design is emerging from the periphery as not just an energy saving, productivity enhancing solution but one that truly elevates the human experience of the space and the areas around the community as it is extended beyond a building's property.

Biophilia is increasingly recognized as an important element in building design for creating spaces that support health and wellbeing. Luckily, biophilic design does not require extensive or expensive interventions to have an impact. Simply ensuring offices have views to the outside, contain plants, receive adequate daylight or have decorative nature-inspired

[35] Ibid

art all help create a more inviting, healthy and desirable environment. Biophilic design is not a luxury, it is sound economic investment in our health and wellbeing.[36]

1.5 Main Principles of Biophilic Design and Urbanism in the Context of Architecture.

Having explored the overall background, history, and expressions of biophilic design and biophilic urbanism, this section will examine the biophilic design principles that have emerged based on the founding theories previously discussed. The application of these principles in the context of architecture will be highlighted.

As noted at the beginning, the theoretical framework of contemporary biophilic design was put forward by Stephen Kellert. These have been interpreted in multiple permutations and with varying actionable specifics. Many of these elaborations are stylistic while others focus on building types, materials, locations, efficiency, or carbon influence. Within these variations, there are some principles that are common and those are the ones that will be noted here.

At the simplest, most biophilic design rests on three pillars.[37]

These pillars or categories are:[38]

1. ***Nature IN the Space****: Nature in the Space addresses the direct, physical and ephemeral presence of nature in a space or place. This includes plant life, water and animals, as well as breezes, sounds, scents and other natural elements. Common examples include potted plants, flowerbeds, bird feeders, butterfly gardens, water features, fountains, aquariums, courtyard gardens and green walls or vegetated roofs. The strongest Nature in the Space experiences are achieved through the creation of meaningful, direct connections with these natural elements, particularly through diversity, movement and multi-sensory interactions.*

   Nature in the Space encompasses seven biophilic design patterns:

   a. *Visual Connection with Nature. A view to elements of nature, living systems and natural processes.*

   b. *Non-Visual Connection with Nature. Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.*

   c. *Non-Rhythmic Sensory Stimuli. Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.*

[36] Ibid
[37] Caragreen.com/About us.
[38] Terrapin Bright Green: 14 PATTERNS OF BIOPHILIC DESIGN; William Browning, Catherine Ryan, Joseph Clancy.

d. *Thermal & Airflow Variability. Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.*

e. *Presence of Water. A condition that enhances the experience of a place through seeing, hearing or touching water.*

f. *Dynamic & Diffuse Light. Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature.*

g. *Connection with Natural Systems. Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem.*

2. ***Natural Analogues:*** *Natural Analogues address organic, non-living and indirect evocations of nature. Objects, materials, colors, shapes, sequences and patterns found in nature, manifest as artwork, ornamentation, furniture, décor, and textiles in the built environment. Mimicry of shells and leaves, furniture with organic shapes, and natural materials that have been processed or extensively altered (e.g., wood planks, granite tabletops), each provide an indirect connection with nature: while they are real, they are only analogous of the items in their 'natural' state. The strongest Natural Analogue experiences are achieved by providing information richness in an organized and sometimes evolving manner.*

   Natural Analogues encompasses three patterns of biophilic design:

   a. *Biomorphic Forms & Patterns. Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.*

   b. *Material Connection with Nature. Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.*

   c. *Complexity & Order. Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature.*

3. ***Nature OF the Space:*** *Nature of the Space addresses spatial configurations in nature. This includes our innate and learned desire to be able to see beyond our immediate surroundings, our fascination with the slightly dangerous or unknown; obscured views and revelatory moments; and sometimes even phobia-inducing properties when they include a trusted element of safety. The strongest Nature of the Space experiences are achieved through the creation of deliberate and engaging spatial configurations commingled with patterns of Nature in the Space and Natural Analogues.*

   Nature of the Space encompasses four biophilic design patterns:

   a. *Prospect. An unimpeded view over a distance, for surveillance and planning.*

b. *Refuge. A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.*

c. *Mystery. The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.*

d. *Risk/Peril. An identifiable threat coupled with a reliable safeguard.*

Translating these categories and their design philosophies, or "patterns" into implementable elements of design in the context of architecture, the following principles[39] can be applied to building design to the degree that the project permits:

- **Natural Elements**: This principle involves incorporating natural elements into the built environment, such as plants, water features, and natural materials like wood and stone.
- **Natural Shapes and Forms**: This principle involves using natural shapes and forms in design, such as curves, arches, and irregular shapes.
- **Natural Patterns and Textures**: This principle involves using natural patterns and textures in design, such as wood grain, stone textures, and leaf patterns.
- **Light and Shadow**: This principle involves using natural light and shadow to create a sense of depth and dimension in a space.
- **Color:** This principle involves using colors found in nature, such as greens, blues, and earth tones, to create a calming and soothing environment.
- **Views**: This principle involves incorporating views of nature, such as landscapes and gardens, into the design of a space.
- **Connection to Nature**: This principle involves creating a connection to nature through the use of materials, textures, and elements that evoke a sense of the natural world.

In implementing these (which will be discussed more fully in Part 2 of the course), one of the more favorable and appealing characteristics of biophilic design is that it is flexible, with fluid interpretation and application within a very broad framework. This allows implementation in architecture to be adapted to fit a project's limitations, functions, geography, and climate. This is evidenced by the variety of buildings that have used biophilic principles in their designs, even before the term was formally coined. Application of these principles have ranged from immersion of the entire project into nature to minimal applications of biophilia such as living walls, natural hues for interior finishes or orienting

[39] Render4tomorrow.com: What is Biophilic Architecture? Seven Main Principles; Pedro J. Lopez; Apr 24, 2023

windows to natural views. Below are some examples of buildings that illustrate varying degrees of biophilic principles in the pre-modern and modern eras.

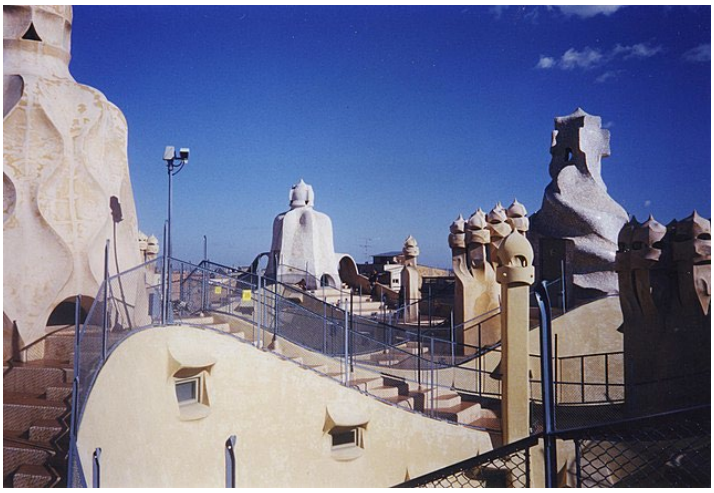
- One of the most unique architects to have employed biophilic principles was the Catalan architect, Antonio Gaudi (1852-1926), whose works in Barcelona literally evolved from natural forms and continued to morph as they were built. Gaudí's work was influenced by his passions in life: architecture, nature, and religion. He considered every detail of his creations which he integrated into his architecture crafts such as ceramics, stained glass, wrought ironwork forging, and carpentry. He also introduced new techniques in the treatment of materials, such as *trencadís* which used waste ceramic pieces.[40] [*author's note:* This represents one of the earliest modern uses of recycled material as centerpieces of design]

  Under the influence of neo-Gothic art and Oriental techniques, Gaudí became part of the *Modernista* movement which was reaching its peak in the late 19th and early 20th centuries. His work transcended mainstream *Modernisme*, culminating in an organic style inspired by natural forms. Gaudí rarely drew detailed plans of his works, instead preferring to create them as three-dimensional scale models and molding the details as he conceived them.[41]

  Among Gaudi's most famous works are Casa Battló, Casa Milà, and the most remarkable work: La Sagrada Familia (which is still under construction and evolving). In addition to buildings, Gaudi also was a pioneer in biophilic urbanism with his Parc Güell public park. The works of Gaudi have had such lasting impact that many have been declared UNESCO World Heritage sites.

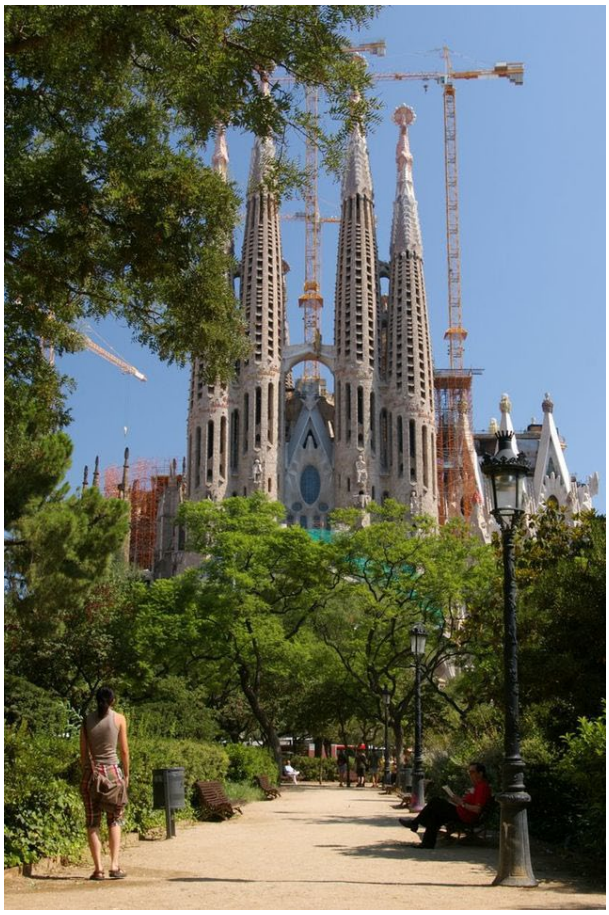
[40] https://en.wikipedia.org/wiki/Antoni_Gaud
[41] Ibid

Casa Battló (1904-1912); Wikimedia Commons: Casa Batllo Overview Barcelona Spain cut.jpg



Casa Milà (1906-1912); Wikimedia Commons: Roof of Casa Mila, Barcelona.jpg

Parc Güell (1900-1914); Wikimedia Commons: Barcelona - Parc Güell - Panorama View on Main square (Parc Güell) 1900-14 by Antoni Gaudí 01.jpg



La Sagrada Familia (1882-ongoing); Wikimedia Commons: ES - Temple Expiatori de la Sagrada Família 1.jpg

- In America, the reputedly most famous architect of the 20th century, Frank Lloyd Wright, developed his design philosophy around what he termed “Organic

Architecture", which for him was an interpretation of nature's principles manifested in buildings that were in harmony with the world around them.[42] In this way, this philosophy is a fit for what is now referred to as biophilic architecture. Wright was a prolific designer, having designed around 800 buildings with 380 actually built. Among these are many that were true to the organic theory and thus included many biophilic design principles. The best example is perhaps the greatest work of Wright's career and the most iconic house of the 20th century – Fallingwater, the house for Edgar Kaufmann in Bear Run, Pennsylvania, which seems to grow out of its surroundings. Its interior spaces all look out into the natural surroundings and, by means of terraces, balconies and spacious light giving windows, engage the occupant in seamless harmony with the surroundings. Another of Wright's projects, Taliesin West, the architect's own residence and studio in Scottsdale, Arizona, achieves the same marriage of form, materials and balance with its desert surroundings.

Fallingwater (1936-38); Frank Lloyd Wright, Architect. Photo: Courtesy of the author; © Muhammad Siddiqui, 2022

42

Taliesin West (1937) Frank Lloyd Wright Architect; Photo: Courtesy of the author; © Muhammad Siddiqui, 2012

- The next two examples feature designs by Mies Van Der Rohe and Philip Johnson, masters of corporate, urban, International Style and Post Modernism respectively. One would hardly associate these names with anything resembling biophilic design. But, in the two Glass Houses – Farnsworth House by Mies van Der Rohe and the Glass House by Philip Johnson, these architects created a design that, for its occupant, was to make the house disappear into its natural surroundings and from the inside the occupant would feel as if outdoors. These scions of industrial materials stayed true to the "Less is More" philosophy by creating the simplest of forms and replacing the exterior walls entirely with floor to ceiling glass panels. The result is a merging of the interior space into its natural surroundings. While both glass houses have competed for the title of being the first or being the "best", they are both uniquely suited to their surroundings and, while neither incorporates interior plants or "earthy" materials, both succeed in being one with nature while maintaining their industrial design roots.

Edith Farnsworth House (1946-51); Mies Van Der Rohe; Photo: Wikimedia Commons: Farnsworth House Interior.jpg

Philip Johnson Glass House (1949); Philip Johnson; Photo: Courtesy of the author; © Muhammad Siddiqui, 2021

Moving into the 21st century, and emphasis shifting to sustainability and more eco-friendly development, biophilic design principles are seeing greater visibility in mainstream, large architecture projects that are paving the way for greater exposure and awareness of the longer-term benefits. Among the global brands, this commitment is reflected in their choice of designs for their landmark signature buildings.

- **Apple Park, California**: Apple's new campus is widely regarded as one of the leading examples of biophilic design. The doughnut-shaped structure copies the natural curves found in nature and brings light into the offices from every angle. A new, 9,000-tree woodland also surrounds the campus.[43]

[43] https://www.planradar.com/gb/biophilic-design-10-great-examples/

Apple Park (2013-17); Norman Foster Architect; Photo: Wikimedia Commons: Aerial view of Apple Park.jpg

- **Ford Rouge Plant Revitalization, Dearborn, Michigan**: This new truck assembly plant represents Ford Motor Company's bold efforts to rethink the ecological footprint of a large manufacturing facility. With its grass-covered roof and pollution-eating plants and energy-recycling infrastructure, the Ford Rouge plant is built to the highest environmental standards of any industrial facility in the world. The design synthesizes an emphasis on a safe and healthy workplace with an approach that optimizes the impact of industrial activity on the external environment. With the sound of nesting songbirds chirping over factory workers' heads, the new Dearborn Truck Plant offers a glimpse of the transformative possibilities suggested by this new model for sustaining industry.[44]

  The keystone of the Ford Rouge stormwater management system is the plant's 10-acre (454,000 sf) "living" roof --- the largest in the world. This green roof is expected to retain half the annual rainfall that falls on its surface. The roof will also provide habitat, decrease the building's energy costs, and protect the roof membrane from thermal shock and UV degradation, thereby extending its life. An innovative and inexpensive hanging trellis with deciduous climbing vines envelops many areas of the plant's exterior, creating both shade and additional habitat.[45]

[44] The Index Project: Ford Plant Green Roof; 2005
[45] Ibid

Ford Rouge Plant (2000); William P. McDonough + Partners Architects; Photo: Courtesy of the author; © Muhammad Siddiqui, 2016

- **The Orchard, Hammad International Airport, Doha, Qatar**: Located at the heart of the recently expanded terminal, The Orchard is a 6,000 square meter indoor tropical garden. The 575 square meter water feature, which is an aquatic plant installed in a sustainable bio pond, will serve as one of the airport's main attractions. Over 300 trees and more than 25,000 plants from sustainable forests all over the world are displayed in The Orchard.[46]

  In some ways this has been compared to Singapore's "Jewel" at Changi airport. Both have the same biophilic concepts employed. The main difference is that The Jewel at Changi airport is on the "landside", meaning it is open to local visitors and only passengers who have exited the airport terminal. The Orchard, on the other hand is "airside", meaning it is exclusively a transit area, making it a haven for travelers with layovers.

[46] DOHA News: "Orchard: Hamad Airport's stunning new 'jungle-like' expansion…"; Hazar Kilani; November 10, 2022

The Orchard, Hammad International Airport, Doha, Qatar (2022); HOK Architects; Photo: Courtesy of the author; © Muhammad Siddiqui, 2023

Not all projects using biophilic principles need to be large or as elaborate as the examples shown. In some cases, the applications in architecture are much more subtle. These can be as simple as adding living green plant walls or preserved moss walls in existing spaces or articulating design features to maximize natural light flow to the deeper parts of a space.

- **Longwood Gardens' Living Wall, Kennett Square, Pennsylvania**: The green wall in the institution's new East Conservatory Plaza, designed by British landscape architect Kim Wilkie in association with Philadelphia's Wells Appel, is the largest in North America, at more than 4,000 square feet. The biggest challenges in a green-wall project are water and light, both essential to plants' survival. Water can accumulate at the bottom of a system ..... inundating some plants while leaving those in higher sections dry. Detailed light studies are needed early in the design phase, says Eichmann. The information ensures that appropriate plants are specified, and that the irrigation system delivers the right amount of water to keep them thriving.[47]

[47] ARCHITECT magazine: "Longwood gardens" Living Wall", Linda McIntyre; November 09, 2010.

Longwood Gardens (2010); Kim Wilkie Associates; Photo: Wikimedia Commons: Green wall - Longwood Gardens - DSC01042.JPG.

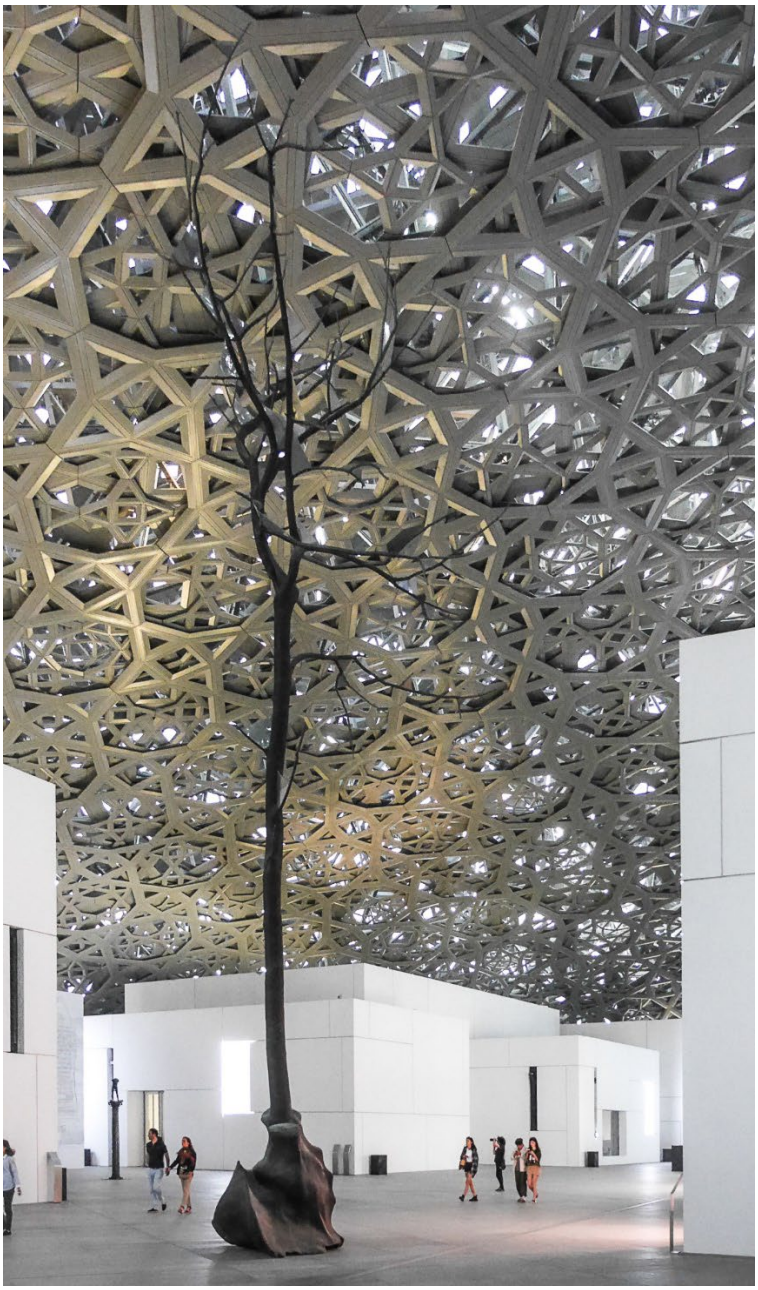
- **Preserved Moss Walls:** Preserved moss walls are green walls constructed using stabilized dead moss. These are not living plants but preserved moss plants that retain their natural greenery and texture due to the preservation process. Therefore, unlike living walls, preserved moss walls do not require water or sunlight. They are low-maintenance green walls that only need the occasional dusting. Plus, moss wall panels can be molded into various shapes and forms if you are looking for creative green décor ideas.[48]

Preserved Moss Wall: Photo: Courtesy of the author; © Muhammad Siddiqui, 2022

[48] Ecobrooklyn.com: Living Walls vs Preserved Moss Walls.

- **Louvre Abu Dhabi:** Architect Jean Nouvel wanted the Louvre Abu Dhabi to rain light. The geometric dome was inspired by the cupola, a distinctive feature in Arabic architecture. Woven metalwork and a mix of surfaces provide a mesmerizing experience as you explore the various buildings surrounded by water. Filtered natural light is present in all the galleries, from lateral windows or through 'zenithal' lighting, which uses glass mirrors to capture and direct sunlight into the spaces while also scattering rays to reduce glare.[49]

[49] Architezer.com: "7 Iconic Architecture Firms Harnessing the Power of Light — Inside and Out", Samantha Frew



Louvre Abu Dhabi Interior (2017); Ateliers Jean Nouvel; Photo: Courtesy of the author; © Muhammad Siddiqui, 2018

1.6 Biophilic vs Biomimicry, Biomorphic, Bio phobia and Bioclimatic.

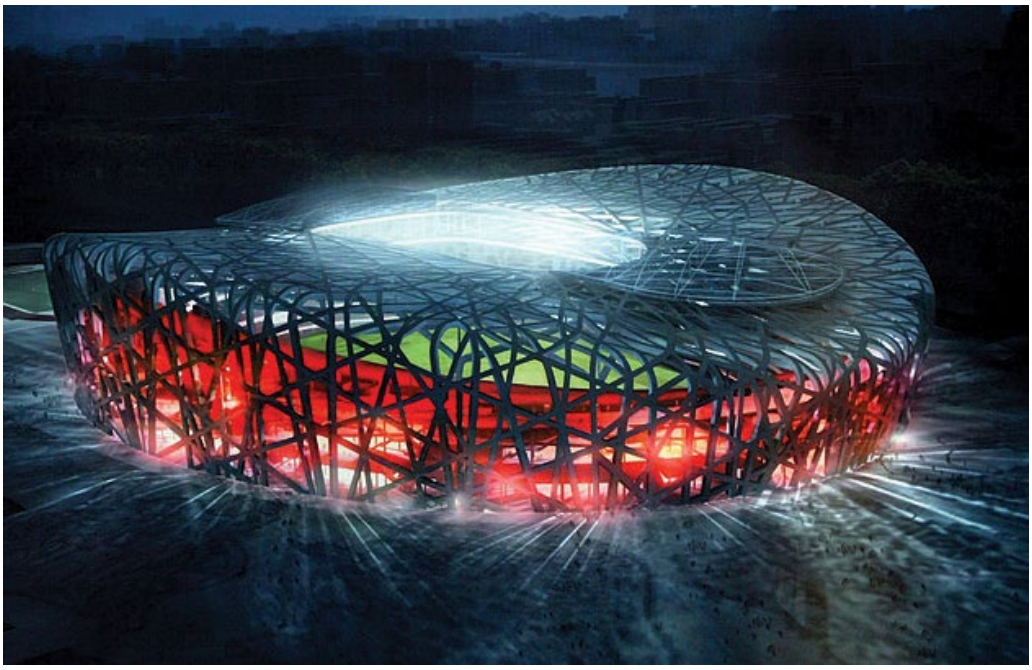
Biophilic design covers a wide range of areas as has been demonstrated in the foregoing sections. There are, however, some other terms and phrases that sometimes get confused or conflated with biophilia. Some are closely related while others are quite different. In this section some of the more common of these will be discussed.

- **Biophilic vs Biophelia:** These terms are frequently used interchangeably and this has been the case in some instances during this course as well. However, it is to be

noted that they are different, despite sharing the same roots and general principles. ***Biophilia*** is the innate connection between human beings and other living things, whereas ***Biophilic Design*** is how designers play on this idea and bring natural elements into a space to help make it more attractive and resonant with the senses.[50]

- **Biomimicry**: *Biomimicry*, or *Biomimetics* is the emulation of the models, systems, and elements of nature for the purpose of solving complex human problems. The terms "biomimetics" and "biomimicry" are derived from Ancient Greek: (bios), life, and (mīmēsis), imitation, from (mīmeisthai), to imitate, from (mimos), actor. A closely related field is bionics.[51]. In contrast, biophilia describes humans' connection with nature and biophilic design is replicating experiences of nature in design to reinforce that connection. It's easy to mix up these two terms — biomimicry and biophilia are similar in many ways. They sound similar, they were both born out of the environmental movement and they both relate to nature. However, they define different concepts with different aims. Understanding how they differ and what issues they solve is key to unlocking the breadth of solutions nature has to offer — from sustainable, innovative designs to improved human health and wellbeing. [52] Biomimicry is an innovative method to achieve better performance; biophilic design is an evidence-based design method to improve health and wellbeing. Biomimicry is more heavily used in technology and product development circles; biophilia applies more directly [applied] to interior design, architecture and urban design.[53] However, biomimicry is also used in architecture. The Beijing National Stadium that was built for the 2008 Summer Olympics is considered an excellent example of the use of Biomimetic principles.[54] The structure's form bears a very close resemblance to a bird's nest with the structural elements emulating (mimicking) twigs that would be the supports in a bird nest.

[50] Linkedin.com: What's the Difference Between Biophilia and Biophilic Design?; Percy Smith; Jan 31, 2020.
[51] Wikipedia: Biomimicry
[52] GreeenBiz.com: Biomimicry vs. biophilia: A primer. Allison Bernett; October 27, 2017.
[53] Ibid
[54] Linkedin.com: Biophilia, Biomorphia, Biomimicry – spot the difference!; by Elena Makrak; Oct 21, 2022.

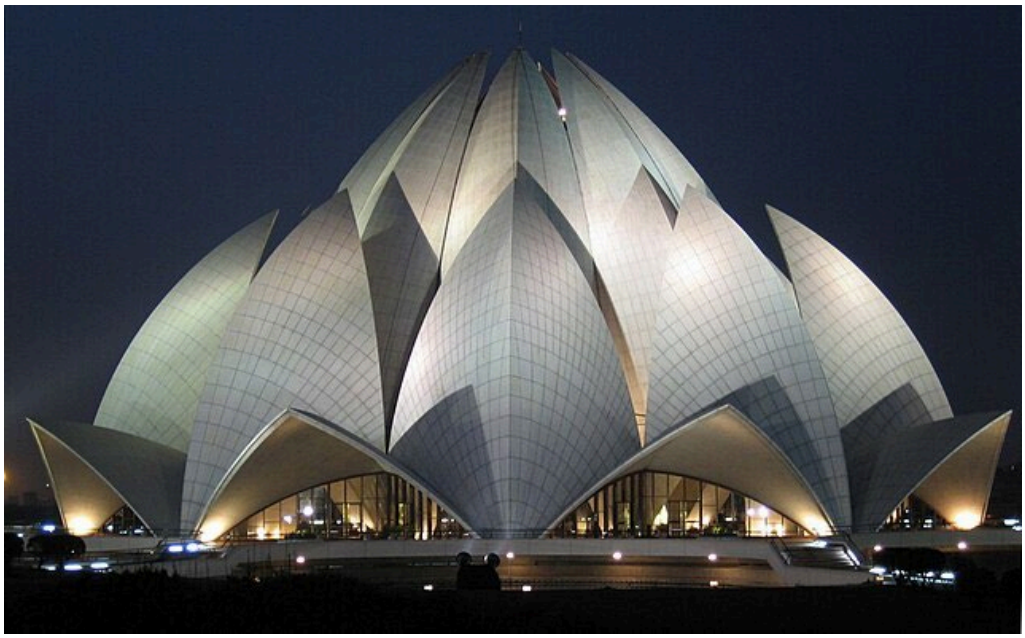


Beijing National Stadium (2006); Herzog & de Meuron Architect; Photo: Wikimedia Commons: Beijing Birdsnest.jpg

- **Biomorphic:** Derived from the Greek words bios (life) and *morphe* (form), the term refers to abstract forms or images that evoke naturally occurring forms such as plants, organisms, and body parts.[55] *Biomorphisim* is used by designers to emulate nature in decorative forms and symbolic associations. This type of design tends to be only surface level, with no underlying natural systems. Frank Lloyd Wright and Le Corbusier were known for their use of *biomorphisim*. Also, *biomorphisim* does not have to take on a literal interpretation; many natural symbols have been abstracted extensively, which can be seen in many of Frank Lloyd Wright's designs.[56] Implementing biomorphic design in built environments can be done by integrating elements or representations of nature in décor as a cosmetic to the function of the space. Built environments with biomorphic forms and patterns feel interesting and comfortable and are known to create a more visually captivating environment that enhances cognitive performance and reduces stress. Biomorphic patterns can be introduced in the form of rugs, wallpaper, fabrics, and more. Free-standing sculptures, woodwork, masonry, and wall decals are other types of designs that fall under the Biomorphic category as well. A biophilic interior design may incorporate *biomorphism* but not all biomorphic designs are necessarily biophilic. Both phenomena are rooted in the common philosophy – we belong with nature.[57] An

[55] MoMA.org: Biomorphic
[56] arch3150.wordpress.com/2012/12/06/biomimicry-biomorphism-biophila/
[57] Commersilk.com: Biohilic vs Biomorphic Design; by Snehal, July 12, 2021.

architectural expression of a biomorphic design is the Lotus Bahai Temple in India which is a stylized form based on the lotus flower.



Lotus Bahai'I Temple, New Delhi, India (1986); Fariborz Sahba Architect; Photo: Wikimedia Commons: LotusDelhi.jpg

- **Bio Phobia (Biophobia):** People can express irrational fears and disgust responses towards certain wild organisms. This so-called *'biophobia'* can be useful and indeed necessary in some circumstances. *Biophobia* can, however, also lead to excessive distress and anxiety which, in turn, can result in people avoiding interactions with nature.[58] This is the opposite of *Biophelia* and elements of biophilic design may have adverse effects on some people who suffer from some aspects of biphobia. For people raised in a post industrial urban environment, it is not uncommon for there to be apprehension, even fear of the "wild" or natural spaces which are strange and almost alien for people who have never experienced them. So, while there is much to support the benefits of biophilic design and a restorative biophilic urbanism, it is also important to recognize that the benefits are not universal to all populations and urban dwellers – people and animals alike. Some studies have shown that "… urban populations have also been found not to engage with these spaces and to display some form of *biophobia* which may hinder them from perceiving any of these benefits. This concept of *biophobia* is thought to entail both our innate physiological responses to the perceived danger from non-human threats such as spiders and snakes and our cultural attachment to material comfort. The word is often used with derogatory connotations, even if it is part of an

[58] NIH, National Library of Medicine; "The vicious cycle of biophobia"; by Masashi Soga, Kevin J Gaston, Yuya Fukano & Maldwyn J Evans; Jan 25, 2023.

evolutionary mechanism honed over thousands of years to keep humans alive."[59] The same study cited above concludes on a positive note: "The existing connection between people and nature could potentially be preserved by encouraging children to engage with the natural environment, but the innate and genetic basis for biophobia might not so easily be tackled. The focus should then be on the creation of mixed environments where nature is present but not threatening and balanced with the presence of restorative built elements."[60] The main take away is that, like most design theories and philosophies, none are universal in their acceptance or even 100% beneficial. It is careful to not become a fanatical disciple of any one singular approach. There should be a balance between the perceived benefits and any counterpoints that exist. By calibrating design approaches with any potential phobic concerns, architects can create a more inclusive and beneficial design.

- **Bioclimatic:** The dictionary meaning of Bioclimatic is "... of, relating to, or concerned with the relations of climate and living matter."[61] In the context of design and architecture, Bioclimatic architecture is a way of designing buildings based on the local climate, with the aim of ensuring thermal comfort using environmental resources. They must also blend into their natural surroundings. This is nothing new, because it is fair to say that traditional architecture is intrinsically bioclimatic.[62] Bioclimatic architecture is a way of designing buildings based on the local climate, with the aim of ensuring thermal comfort using environmental resources. They must also blend into their natural surroundings. This is nothing new because it is fair to say that traditional architecture is intrinsically bioclimatic. All you need to do is look at the shapes of roofs and the sizes of windows in different countries and regions. The main aims of bioclimatic architecture are to create healthy, comfortable spaces for the inhabitants of these buildings, while respecting the environment. To do this, it is essential to avoid using polluting materials, ensure the wellbeing of local biodiversity and make efficient use of energy, building materials, water and other resources.[63] One of the most cited examples of bioclimatic architecture is the Metropol Parasol, a project consisting of six large timber *parasols* shading the Plaza de la Encarnación in Seville, Spain. This is one of the largest timber structures ever built. The parasols, constructed in a mushroom-shaped timber lattice, frame the structure and create shadows that move continuously throughout the day.[64] With nearly zero energy and capable to

[59] MDPI.com: "Biophobia and Urban Restorativeness"; by Agnès Patuano; 25 May 2020.
[60] Ibid
[61] www.merriam-webster.com/dictionary/bioclimatic
[62] Iberdrola.com: "Bioclimatic architecture, buildings that respect the environment";
[63] Ibid
[64] ARUP.com: One of the largest timber structures ever built

guarantee the comfort of the building's users, Metropol Parasol is an example of bioclimatic architecture at [a] high level.[65]

Metropol Parasol, Seville, Spain (2011); Jürgen Mayer Architect and ARUP partners; Photo: Wikimedia Commons: Metropol parasol 02042011 001.jpg

- **Rewilding:** The term rewilding was coined by members of the grassroots network *Earth First!,* first appearing in print in 1990. Rewilding is a form of ecological restoration aimed at increasing biodiversity and restoring natural processes. It differs from other forms of ecological restoration in that rewilding aspires to reduce human influence on ecosystems. It is also distinct from other forms of restoration in that, while it places emphasis on recovering geographically specific sets of ecological interactions and functions that would have maintained ecosystems prior to human influence, rewilding is open to novel or emerging ecosystems which encompass new species and new interactions. A key feature of rewilding is its focus on replacing human interventions with natural processes. The aim is to create resilient, self-regulating and self-sustaining ecosystems. While rewilding initiatives can be controversial, the United Nations has listed rewilding as one of several methods needed to achieve massive scale restoration of natural ecosystems, which they say must be accomplished by 2030 as part of the 30x30 campaign.[66] Ten principles of rewilding were developed[67]:

[65] ARCHITETTURA RESILIENTE: Examples of bioclimatic architecture. Metropol Parasol, Seville; Di Santina Di Salvo; March 20, 2019.
[66] Wikipedia: Rewilding
[67] Carver, Steve; et al. (2021). "Guiding principles for rewilding".

1. Rewilding utilizes wildlife to restore trophic interactions.
2. Rewilding employs landscape-scale planning that considers core areas, connectivity, and co-existence.
3. Rewilding focuses on the recovery of ecological processes, interactions, and conditions based on reference ecosystems.
4. Rewilding recognizes that ecosystems are dynamic and constantly changing.
5. Rewilding should anticipate the effects of climate change and where possible act as a tool to mitigate impacts.
6. Rewilding requires local engagement and support.
7. Rewilding is informed by science, traditional ecological knowledge, and other local knowledge.
8. Rewilding is adaptive and dependent on monitoring and feedback.
9. Rewilding recognizes the intrinsic value of all species and ecosystems.
10. Rewilding requires a paradigm shift in the coexistence of humans and nature.

It is tempting to think of rewilding purely in terms of rural landscapes. But cities are where nearly all of us live. The city landscape is something we have to get right. Nature-based solutions answer almost every serious problem our cities face.[68] Rewilding can create jobs and volunteering and build communities. In Medellin, Colombia, the city's low-income citizens are given training to become gardeners and ecologists to look after their green corridors. Free Town in Sierra Leone pays its citizens to plant trees. In Paris, residents actively participate in the greening of their city. Just as in the countryside, rewilding can regenerate degraded areas, bringing life back in. In Metropolitan Detroit, abandoned, depressed, post-industrial areas along the river have been transformed into a river walk described as a 'beautiful, exciting, safe, accessible, world- class gathering place for all'. Nearly three million visitors now use it every year, strolling between the city and the Great Lakes.[69]

[68] Rewilding.com: "Putting cities at the heart of rewilding"; by Isabella Tree and Charlie Burrell; Sep 26, 2023
[69] Ibid

Detroit East Riverfront Revitalization (2007-17); Skidmore Owings and Medrrill Architects; Photo: Courtesy of the author; © Muhammad Siddiqui, 2016

In this part of the course, the description of biophilic design and biophilic urbanism, their historical context and contemporary applications along with related design concepts have been discussed with illustrative examples. The next part will focus more on design applications relevant to architects, the role of biophilic concepts in urban planning and congruence of these philosophies with the NetZero and sustainability goals. Some case studies will also be presented to help explain the design applications of Biophilic Design and Biophilic Urbanism.

This concludes Part 1 of the course.

Part 2 of the course will cover:

Biophilic Design in Practice

- Biophilic design principles applied to buildings.
- Biophilic Urbanism concepts in city planning and urban development.
- Biophilic design impact on NetZero and alignment with sustainability goals.
- Selected projects employing biophilic design and urbanism concepts.
- Challenges with biophilic design implementation.

Part 1 Review Questions

1. **Who wrote the book: "The Practice of Biophilic Design"?**
    a. Stephen R Kellert and Elizabeth F Calabrese.
    b. Erich Fromm
    c. George Orwell
    d. None of the above.

2. **One of the earliest examples of a "biophilic" building from ancient times is :**
    a. The Parthenon
    b. The Tempe of Abu Simbel
    c. The Hanging Gardens of Babylon
    d. Cleopatra's River Garden

3. **Which of the following is not a historic Urban Park?**
    a. Balboa Park, San Diego
    b. Stanley Park, Vancouver
    c. Chapultepec Park, Ciudad de Mexico
    d. Tranquility Park, Houston

4. **According to the course material, which political ideology does biophilic design appeal to?**
    a. Left leaning liberal ideology
    b. It has universal appeal
    c. Ultra conservative nativist ideology
    d. Only conservationists

5. **Which of the following is true?**
    a. Biophilic design is a sound economic investment in our health and wellbeing
    b. Biophilic design, by virtue of its costs, is only a luxury
    c. Biophilic urbanism has no impact on climate change
    d. Biophilic Urbanism is losing popularity

6. **Which of the following are elements of Stephen Kellert's biophilic framework?**
    a. Direct Experience of nature
    b. Indirect Experience of nature
    c. The Experience of Space and Place
    d. All of the above

7. **The Detroit East Riverfront Revitalization is an example of?**

   a. Rewilding
   b. Urban sprawl
   c. A failed use of taxpayer funds
   d. River water recycling

8. **Which of the following is related to bionics?**

   a. Biomorphic
   b. Biomimicry
   c. Anthropomorphic
   d. Demetric

PART 2

2.1 Biophilic Design Principles Applied to Buildings.

Building on the Biophilic design framework developed by Stephen Kellert and translating that to actionable architectural design elements or broader urban planning is not a very complicated or structured process. To some extent, all reasonably thought-out architectural design should already include many of the elements, whether consciously implemented as biophilic or simply a result of sound design practice.

Fig. 1 (next page) illustrates graphically how the end design elements link up with base biophilic design theory. It is, for the most part, a summary of much of what has been presented in some detail in Part 1 of the course. This section will address each of the main elements in terms of architectural application.

NATURAL ELEMENTS

These are the most obvious applications of biophilic design in buildings or urban spaces. These are also among the easiest to incorporate into a new design or add onto an existing facility or space.

- **Plants**:

  Generally, the addition of plants is the feature that is most associated with biophilic design. Adding plants and green spaces can bring a host of benefits to your building and its occupants. From improving air quality to reducing stress levels, there are many reasons to incorporate plants into your space. According to

research published by *e-architect*, here are some of the ways that plants and green spaces can benefit your building[70]:

1. Improve Air Quality:

   Plants can help to improve air quality by filtering out harmful pollutants and releasing oxygen into the air. This can create a healthier environment for your occupants and also help to decrease energy costs by reducing the need for ventilation systems.

2. Reduce Stress Levels:

   Studies have shown that being around plants can help to reduce stress levels and promote relaxation. This can lead to improved mental health for your occupants and increased productivity in the workplace. Having plants in the workplace has been shown to boost morale and improve job satisfaction. According to a recent survey on the benefits of plants, 94% of respondents said they noticed an improvement in their mental health just from owning houseplants.

   (*continues on Page 54*)

[70] e-architect.com: How Plants and Green Spaces Benefit Your Building; updated 11 February 2024

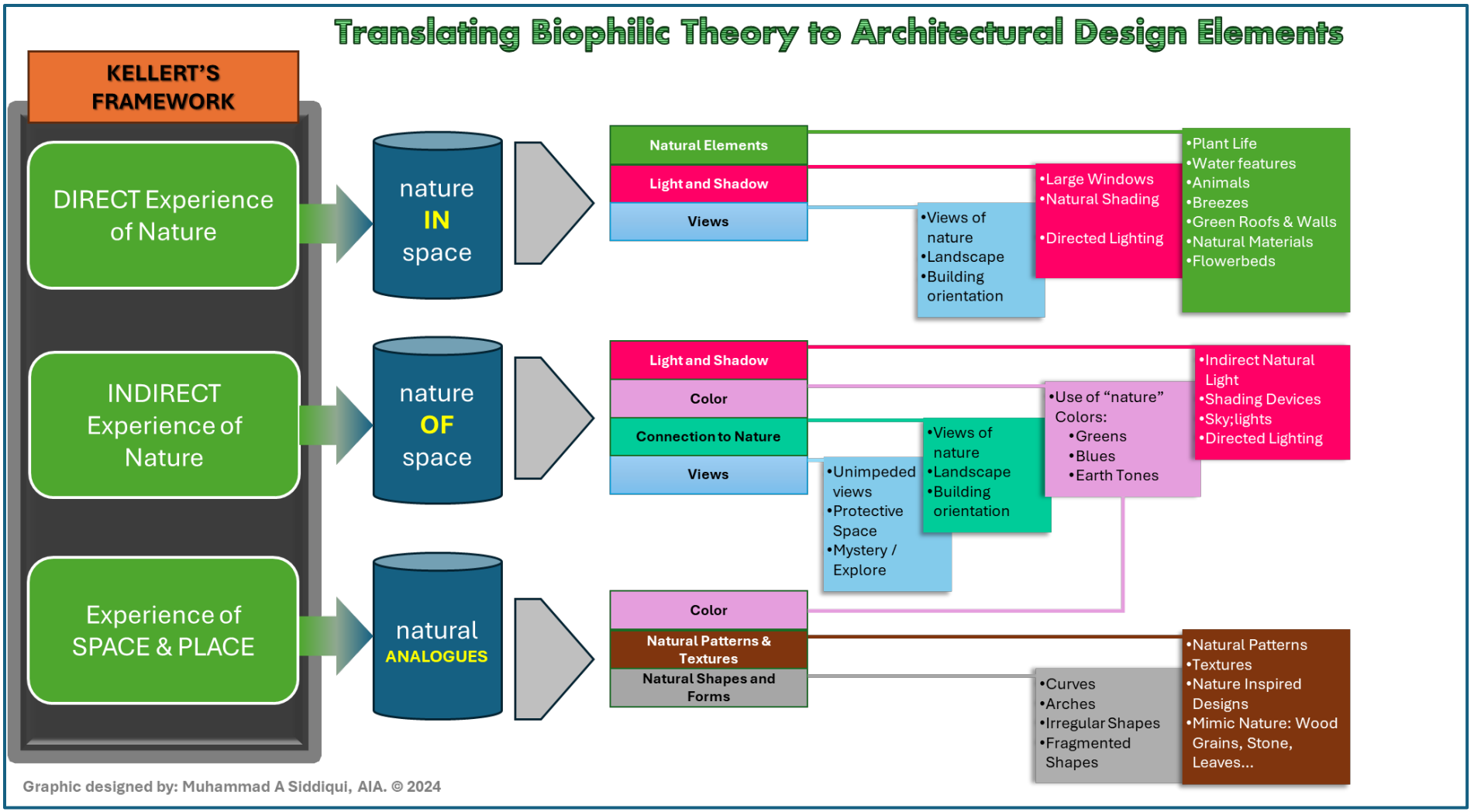


Fig. 1: Translating Biophilic Theory to Architectural Design Elements. *Graphic courtesy of the author.*

(*continued from Page 52*)

Plants can enhance the aesthetics of your building, making it more inviting and pleasant for occupants and visitors alike. This can also lead to a more positive work environment and increased motivation among employees.

3. Increase Property Value:

   Plants have been found in studies to promote feelings of well-being and satisfaction. This is due to the fact that plants give a natural source of beauty and comfort, which may enhance emotions and mental health. Properties with well-landscaped gardens and green areas are more valued than those that do not.

4. Improve Sanitation and Save Energy:

   Plants, especially indoor plants, can help to improve sanitation by absorbing smoke, dust, and other airborne particles. This can create a cleaner environment for your occupants and also help to reduce the spread of illness. Plants can provide shade and block wind, both of which can help to reduce energy costs by keeping your building cooler in summer and warmer in winter.

5. Reduce Noise Levels and Provide Privacy:

   Plants can help to reduce noise levels by absorbing sound waves. This can create a more pleasant environment for your occupants and also help to reduce stress levels. Plants can provide privacy by screening windows and outdoor areas from view. This can be beneficial for both occupants and businesses, as it can help to reduce the risk of crime and increase security.

Of course, plants, especially living plants, have some significant maintenance and ecological issues when they are made part of a building or an urban environment. Some things to consider:

- **Maintenance**: Plants require water – supply and drainage. This consideration should be built into the design of the building. In cases where the plants are a later addition, especially in an indoor application, accommodation for irrigation and drainage could be a deal breaker. In addition to water issues, plants need trimming and periodic fertilization. Even in outdoor applications, proper maintenance is essential to ensure that the viability of the space remains attractive and not a derelict outcropping of green. Just as a well-maintained green space can be welcoming and stress relieving, a weed infested, chaotic space can be eerie and hostile.
- **Choosing the "right" plants**: Plant selection for the location and purpose is critical. Architects should work in collaboration with professional horticulturalists to use plants that are native to the area as these will naturally be adaptable to the climate and require the least amount of artificial irrigation. For indoor applications, consider the intended purpose – purely visual or more

integrated with the design – to determine the best mix of plants, available lighting, and irrigation. Since sustainability is an implicit goal of biophilic design, low water consumption id important considering the shrinking supply of global fresh water.

- **Green Roof Issues**: Green roofs have gained much popularity over the last couple of decades, with many large-scale installations around the world. The Ford Motor Company's Rouge plant roof was cited in Part 1. There are green roofs of all sizes and shapes that have become ubiquitous – from paved terraces with potted plants and planters to entire roofs covered with vegetation. When opting for this solution, architects need to be cognizant of some concerns with these roofs in order to properly design the installation.

  - Costs

    There is no singular metric for the premium on costs for a green roof as cost impact is a function of the type of roof, weight, shape of the roof and the climate of the project location. Estimates vary from 40% more up to double the cost of a conventional roof, depending on whether it's an intensive or extensive green roof. However, there is much evidence that green roofs are cost-saving in the long run. They last longer: 35 - 40 years. They can save on energy usage and provide superior insulation over a conventional roof. They also may give small, but difficult-to-cost benefits – improved air quality reduces negative health outcomes, and they can serve as tiny but productive carbon sinks.[71]

  - Weight

    Consider that a green roof adds hundreds or thousands of pounds of soil and plants as added live load plus the water from irrigation that has to be held. So, structural integrity is a paramount concern.

  - Leaks

    Secondly, the vulnerability to leaks is perhaps the most considerable downside of a Green Roof. Roofs, particularly flat roofs, leak all the time. Adding soil and plants that will work to retain water on top of a building makes green roofs especially prone to leaks. Furthermore, the complex, multi-layered base that a green roof sits on makes it especially difficult to find the source of a leak.[72]

- **Insects & Critters**: Biophilic design's environmental and social benefits are clear, it raises some questions about pest control. Pests love plants, too, and termites alone cause $5 billion in building damage annually. However, well-

[71] LAIIER: "The Disadvantages of Green Roofs and How the IoT Can Help"; Dec 1, 2022.
[72] Ibid 2

planned biophilic design can help provide natural pest control. Here's a closer look at how biophilic buildings and neighborhoods impact pest control[73].

- Pest-Repellent Plant Life

  While many plants attract pests like termites and mosquitos, others are natural repellents. Some studies have found that catnip can repel mosquitos more effectively than DEET, the active ingredient in most artificial mosquito sprays. Mint, basil, lemongrass and wormwood also contain oils that repel various pests, including some mice. Incorporating these plants in a building can create a natural barrier to pests that could bother occupants or cause damage. While they may not be as effective as synthetic repellants in all circumstances, they could bolster pest control methods. Using these plants in tandem with traditional pest control may yield the best results.[74]

- Natural Predators

  Biophilic design also applies to communal structures and neighborhoods, not just individual buildings. More open, natural spaces between artificial structures can provide some natural pest control by fostering complete ecosystems. Pests won't be as much of a problem when their natural predators also live in the area. Predators eat as much as 50% of wild rats, which is why rural areas often have less of an infestation problem than cities. Allowing for more natural space within a city can encourage reptiles and birds to move in to help control pest populations. While cities must also keep these populations in check, enabling a natural ecosystem can mitigate infestation problems[75].

- Redirection

  Just as biophilic design can repel pests from some areas, it can also attract them to others. Some plant life has the opposite effect of plants like catnip and wormwood, and city planners and designers can use these to their advantage. Cities can redirect pests by planting natural repellents in some areas and attractive plants in others. This strategy can draw pests away from areas where they'd cause harm or irritation and to places where they're safe. This is particularly important for controlling pests while maintaining a balanced ecosystem[76].

- Potential Issues

  While biophilic design has many advantages in pest control, it carries some complications, too. Pest-repellent plants do not grow in every environment and their effectiveness can vary. Many green spaces today report higher

[73] ARCHITECTURE: "How Does Biophilic Design Impact Pest Control?"; by Jane Marsh; March 10th, 2022.
[74] Ibid 4
[75] Ibid 4
[76] Ibid 4

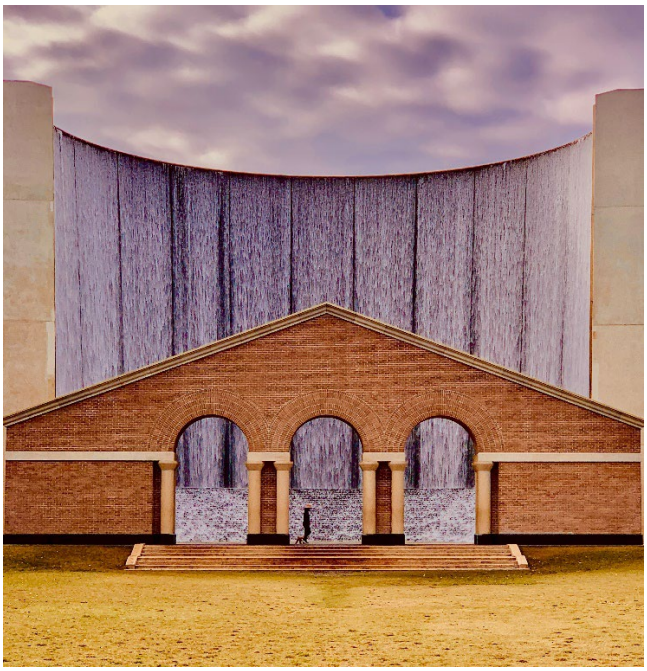
insect populations, but many of these problems come from poor design. These insect-attracting green spaces overlooked repellent plant life in favor of simply creating more greenery. Many also went untended for extended periods, enabling more pest growth. If these areas considered their anti-pest strategy more thoughtfully and gardened more frequently, they could minimize pests.[77]

- Biophilic Design Can Help Control Pests With the Right Strategy

  Pests are a part of nature, so bringing nature closer to living and working spaces will naturally raise some infestation questions. However, if planners and architects understand how design choices and ongoing care can repel pests, biophilic design can control pests more than it attracts them.[78]

- **Water Features**:
  Plants are just a single aspect of biophilic design. Water, in particular moving water, is something that our bodies are biologically designed to respond to, with some biophilic circles believing that are body's own internal rhythm moves to match that of water when we hear it.[79] From historical examples to some of the most successful current public projects, fountains and other water features are among the most popular and significant features of an urban space. Even in residences, swimming pools, koi ponds and other smaller water features are frequently seen. Architects can use bodies of water like ponds, lakes, fountains or waterfalls for a variety of effects ranging from providing tranquility to recreation or to mask surrounding sounds.

[77] Ibid 4
[78] Ibid 4
[79] Designwell: "Water Features' Importance in Biophilic Design"; July 22, 2021.



Gerald D Hines Waterwall Park – *formerly Transco Waterwall* (1985), Houston, TX; Philip Johnson & John Burgee Architects; Photo: courtesy of the author; © Muhammad A Siddiqui 2020

But water features tend to be expensive relative to other biophilic design elements.

- **Cost:** This is among the most common deterrents to incorporating water features. Large or extensive water features can have a high first cost with continuous maintenance requirements built into the design. While thoughtful design should be able to mitigate concerns for energy intensity, risk of leakage, or humidity balance, large awe-inspiring water features are not always the most appropriate solution for optimizing health impact at a project site. For instance—when not value-engineered out—large water features are often situated in spaces where people don't spend a lot of time (e.g., lobbies and other low-density spaces), and as a result they tend to be a missed opportunity for engendering cognitive restoration and other benefits to our wellbeing. When larger features are deemed appropriate and financially feasible, they should be placed in locations where the maximum number of people can experience them for a prolonged period of time, perhaps in locations with adequate seating. Smaller water features are often a good alternative, since they require less energy and maintenance, are generally self-contained, and can be designed to be mobile, allowing flexibility in space planning. Strategically situated, small fountains or water walls can serve multiple purposes, such as providing visual and speech privacy, increasing concentration, and supporting relaxation.[80]

[80] Ibid 10

- **Sanitation:** Sanitation is a frequent concern with the presence of active water features, particularly for healthcare and food processing facilities. In spaces where such features cannot be introduced, projections and representations of water can provide some semblance of the presence of water and associated health benefits, while both minimizing first costs and maintenance and meeting health and sanitation requirements.[81]

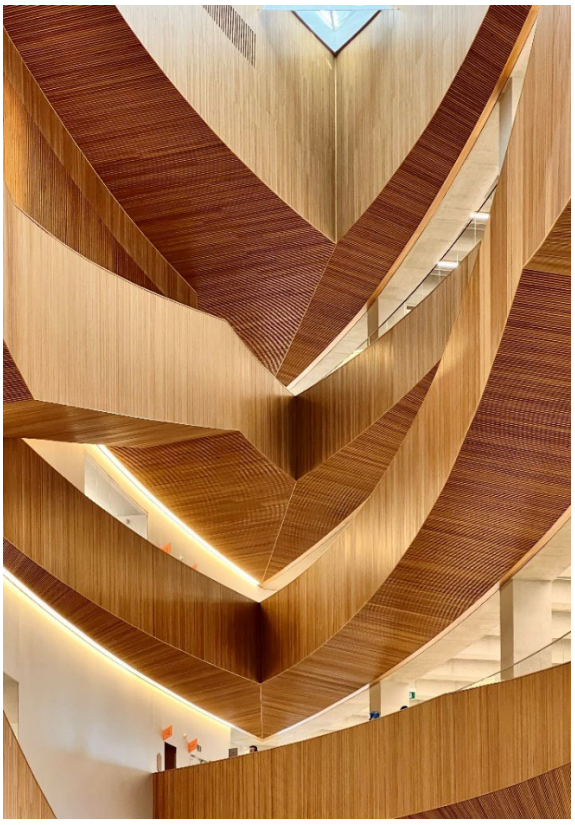
- **Conservation**: As appealing as water features are, they do consume water and energy. Even when recirculating systems are used in fountains and pools, there is frequent need to "top off" the water levels due to loss from evaporation and splashing in recreational uses. Additionally, electric motors are needed to keep the systems working. As such, water features, while providing many calming benefits, also exact a conservation penalty in terms of water use and electricity. These are not high costs, but they do warrant that designers approach these elements with sensitivity to minimize waste and maximize recapture.

- **Natural Materials**:

  Plants and water features are complimentary to the main building or the urban space which they supplement. The materials for the building itself or the hardscape portions of an urban park can also be biophilic in their selection and source. This is another aspect of design where sustainable and biophilic designs intersect. Architects can select materials that are natural and local to the area. This use of vernacular materials like wood, stone, adobe, and bricks can create a direct link to nature, not only because of the nature of the material but also in how they are employed in the design. If local or close by sourcing is added to the mix, the choice further helps environmental and NetZero objectives.

  - **Wood:** Timber construction can have significant benefits in reducing the embodied carbon footprint of buildings. If sourced from sustainably managed forests and produced locally, these building components can store more carbon than is emitted in their production. In effect, the mass timber portions of a building could offset the carbon footprint of other materials—a significant achievement for green building. That said, another major reason for the attention to mass timber likely is that we find wood to be natural and beautiful.[82] *Wood Application in architecture:*

[81] Ibid 10
[82] Naturallywood.com: "The Nature of Wood: An Exploration of the Science on Biophilic Responses to Wood",



Calgary Public Library (2014), Canada; Snøhetta Architects**;** Photo: courtesy of the author; © Muhammad A Siddiqui 2023

The physiological and psychological benefits of being in a space with wood are many: lowered blood pressure and heart rate, perception of warmth, and connection to living things to name a few. In addition, research continues to indicate that nature-made and human-made environments are processed differently in our brains, influencing which is the preferred experience. Even though wooden objects are crafted by humans, the wood itself is still considered to be natural, which is why users like having wood around them in buildings – no wonder it has been used in construction for thousands of years.[83]

The areas of concern for wood construction are exposure to water damage, termites, rot, and combustibility (fire). Depending on the use, architects can use wood as long as it is properly treated for protection against the expected threats.

- **Stone:** For centuries, natural stone has been used for its durability, strength, and aesthetics. Natural stone was often quarried near a project, so people associated the material with the specific place. Some of the oldest stone

[83] ArchDaily.com: "The Biophilic Response to Wood: Can it Promote the Wellbeing of Building Occupants?"; by Valeria Montjoy; March 02, 2022.

buildings are still sought after for the effect they have on people and their strong sense of place. Ancient stone buildings were constructed using patterns in nature that were translated to mathematical proportions. For example, the Egyptian Pyramids, the Parthenon, Notre Dame, and the Taj Mahal all incorporated aspects of the Golden Mean, a ratio that shows up in plants like sunflowers and the spiral of seashells. The patterns and arrangements of these buildings became symbolic representations of the natural world.[84]

Natural Stone, with its natural aesthetics, textured surfaces, and earthy tones, stands as an embodiment of the outdoors, offering a myriad of biophilic benefits that seamlessly integrate nature into our built environments.[85] Yet, despite the appeal and positive psychological aspects, natural stone also creates an environmental enigma – the scarring of the landscape resulting from excessive quarrying. Add to this the relatively high cost of good craftspeople to shape and install the material. This can add costs as well. The good news is that as a compliment to natural stone, manufactured stone and composite stones-like products using recycled natural stone particles are emerging as a versatile and affordable solution that allows architects to achieve the characteristics of stone and attain its biophilic benefits.

An example of stone use in biophilic context is the Bell County Rest area in Texas, near Austin.

Stone application in architecture:

[84] usenaturalstone.org: “Using Natural Stone in Biophilic Design”; by Stephanie Vierra, AIA, LEED; Oct 31, 2022.
[85] Creativemines.us: ”The Elegance of Stone in Biophilic Design: Harnessing Nature's Beauty”; January 13, 2024.

Bell County Rest Area (2008), Jarrell, Texas; TxDOT Roadside Facilities Design Group**;** Photo: courtesy of the author; © Muhammad A Siddiqui 2008.

- **Masonry & Concrete:** Along with stone, brick or block masonry and concrete can serve the same purpose in incorporating biophilic design into a project. Brick offers a more modular, structure design option that projects a "warm" feel to the building. Concrete Masonry Units (CMUs) are a more economic and rougher material. However, for the most part CMUs are primarily used for their economic and structural/fireproofing benefits as a material of choice rather than their biophilic potential. When enhanced with color or surface texture treatments, they can add an earthy feel to a building. CMU construction tends to be more labor intensive so is less common in developed countries, but it is overwhelmingly the material of choice for building frames in most developing countries. On the other hand, face brick, decorative bricks and brick veneer are popular in North America and Europe. These are used extensively in residential and light commercial projects as a material that is widely accepted as a familiar and comfortable choice – symbolizing durability, security, and a feeling of shelter – that evokes the earthy softness of soil and the protective strength of stone with the agility to enable decorative treatments if budgets permit.

  Concrete, as poured in place concrete, is not inherently perceived as biophilic due to its cold , almost brutal appearance in large, industrial. "boxy" buildings. It is also the material associated most with mass urbanization, roads, endless overlays of desolation over natural ground – hence the term "concrete jungle" refers to all that is wrong with urbanization. So, why would it be considered

biophilic as well when it seems to epitomize the exact opposite? To answer that, one must separate the material from its application. Any of the materials mentioned in the context of biophilic design, depending on how they are used, can provide positive results or the opposite. For example, plants, if left untended, can create places of foreboding rather than tranquility, A graceful water fountain, if dry and broken, becomes an object of emptiness that repels people rather than attracts them. Similarly, because concrete has largely been used for mass infrastructure and industrial looking, "fit for purpose" type of projects, it has earned its reputation as the antithesis of humane design. Concrete is a composite material composed of aggregate bonded together with a fluid cement that cures over time. Concrete is the second-most-used substance in the world after water and is the most widely used building material.[86] According to the Portland cement Association (PCA): "Concrete is a sustainable building material – providing energy efficiency, long-life cycle, lower life-cycle costs and resilience following natural and man-made disasters."[87] On the other hand, concrete also has significant environmental impacts, including a carbon footprint of up to 5% of worldwide emissions.[88]. The use of concrete in biophilic design depends on how it is used to compliment other elements as in Frank Lloyd Wright's Fallingwater (discussed earlier). One special ability of concrete is to enable extremely graceful curvilinear forms and biomorphic designs as was illustrated in the Lotus temple example earlier in the course.

Use of Brick in architecture:

[86] Wikipedia: Concrete
[87] PCA: "Cement and Concrete Sustainability"
[88] ArchDaily.com: "16 Materials Every Architect Needs to Know (And Where to Learn About Them)"; by Ariana Zilliacus; January 7, 2024.

Presidential Plaza Offices (1982); National Parliament Building, Dhaka, Bangladesh**;** Louis Kahn, Architect; Photo: courtesy of the author; © Muhammad A Siddiqui 2018.

Use of concrete, plants and water features in architecture:

Hyatt Regency Hotel Riverwalk (1981); San Antonio, Texas**;** Photo: courtesy of the author; © Muhammad A Siddiqui 2022.

NATURAL SHAPES & FORMS

By and large much of the focus in biophilic design is on the natural elements that can be incorporated directly into the design of the building or urban space. That is a primary reason for the extensive discussion of these elements in the foregoing section. This section will look at the way architects and urban planners can invoke biophilic design by the use of nature evoking shapes and forms. These include visible shapes, forms and patterns found in plants, vegetation, leaves, fruits, rocks and patterns of animal skins, horns, feathers, and the structures insects create such as spider webs and beehives. There are also natural shapes and forms that are microscopic but can provide a creative basis for a design parti diagram.

Most often shapes that have curves or are irregular tend to get associated with nature. As illustrated in Part 1, Gaudi's work is both curvilinear and irregular to the extreme. More recently, much of the architecture of the late Zaha Hadid features many irregular shapes. Although she did not identify as a biophilic designer per se, her work demonstrates many of the formal characteristics that would qualify in that genre. Another world-famous landmark that took inspiration from nature is the Sydney Opera House. Although the 'shells' of the Opera House resemble sails of a ship, the building's design was actually inspired by nature.

Architect Jorn Utzon says he was more influenced by birds, clouds, walnuts and trees. Devising the roof sails proved to be one of the most difficult aspects of the process. The problem was, no one had ever attempted such an out-there design before engineers blasted it as 'unbuildable'. As one of the more popular myths has it, Utzon was supposedly struck with an epiphany as he sat peeling an orange and admiring its segmented structure. Like an orange, a geometrical sphere can be carved into a limitless variety of interlocking curved triangles. Ten curved triangular segments would form the Opera House's iconic roof. If you were to stick them back together, they would form a perfect symmetrical sphere. While it's true that the solution can be demonstrated in this way, it had in fact been architect Eero Saarinen who, over breakfast one morning years earlier, cut into a grapefruit to describe the thin shell structure of the roof of his TWA Building (shaped to resemble a bird in flight), and later used an orange to explain the shape of the shells to others.[89]

Use of nature inspired shapes in architecture:

Heydar Aliyev Center (2012); Baku Azerbaijan; Zaha Hadid Architect; Photo: courtesy of the author; © Fowzia Siddiqui, 2022.

Sydney Opera House (1973); Sydney, Australia; Jørn Utzon AC Architect; Photo: Wikimedia Commons - Sydney Opera House with Tall Ship.jpg.

[89] Operabar.com: "5 WEIRD AND WONDERFUL THINGS YOU MIGHT NOT KNOW ABOUT THE SYDNEY OPERA HOUSE!" undated.

TWA Terminal [now Hotel] (1962); Queens, New York; Eero Saarinen Architect;
Photo: courtesy of the author; © Muhammad A Siddiqui 2021.

NATURAL PATTERNS & TEXTURES

Just as shapes derived from nature are part of the lexicon of biophilic design, so is the use of patterns and textures that are borrowed from nature. These can either be abstracted or literal applications. At a philosophical level. There is an implicit understanding that there is a connection between natural patterns and human well-being.

Nature has incredible patterns. Everywhere we turn in the natural world, these intricate patterns emerge, painting a complex tapestry that spans from the expansive spirals of distant galaxies to the delicate symmetry found in a leaf's structure. These inherent patterns in nature are more than just visual marvels for us; they carry an essential bond to our human psyche. Humans are drawn to nature's patterns, finding solace, inspiration, and balance within them. They serve as a reminder of the interconnectedness of all things and the delicate equilibrium that sustains life.[90]

Some of the most common examples of patterns occurring in nature are[91]:

- **Symmetry**: A pervasive pattern in nature, symmetry ensures balance and functionality. It's seen in the face of many mammals, the petals of flowers, and even in the arrangement of leaves on a stem.
- **Spirals**: From the galaxies in the night sky to the DNA structure within us, spirals are omnipresent. On Earth, the sunflower head and the nautilus shell are testament to this mesmerizing pattern.
- **Waves and Ripples**: Beyond the obvious waves in oceans and lakes, this pattern can be seen in sand dunes, wind-blown grass, and even in certain rock formations shaped by erosion.
- **Spots and Stripes**: The animal kingdom showcases this pattern beautifully. The spotted coat of a leopard helps it camouflage, while the zebra's stripes may play roles in confusing predators and managing body heat.

[90] TERRAMAI: "PATTERNS IN NATURE: THE IMPORTANCE AND EXAMPLES"; undated blog.
[91] Ibid 21

- **Cracks**: Often seen in dried landscapes, mud cracks, and tree barks, these patterns arise due to tension and drying.
- **Tessellations:** Honeycombs, with their hexagonal cells, and the scales of certain fish are classic examples of patterns made of repeated shapes fitting together without gaps.
- **Branching:** Nature uses branching for distribution, be it the veins in leaves, the structure of coral reefs, or river deltas.

Natural patterns can be merely visual if they are photographically applied or mere veneer applications. Often this lacks a full send or reality. When texture is added, the "look" and "feel" come together. Architects sometimes have to settle only for the look due to budget or technical constraints. However, when texture can be properly fused into the design, it brings the surface to life. Perception, to be fully realized must involve as many human senses as possible. Texture engages tactile senses to add to the visual and, sometimes, olfactory senses. Texture can also influence acoustics thereby affecting auditory senses as well.

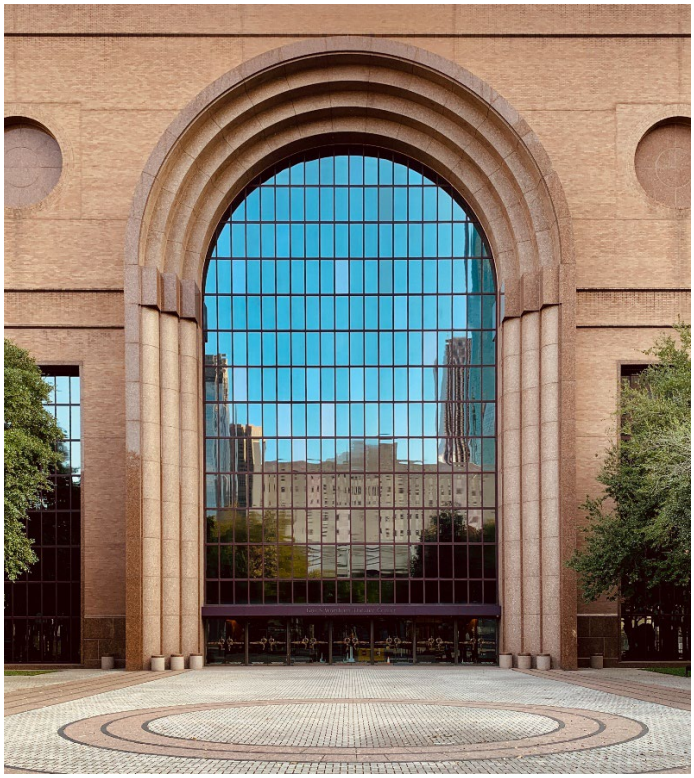
Use of texture in architecture and urban design takes place at two levels. The distant perception of the space or building and the closer, more intimate physical contact with the human users. Depending on what surface materials are used, a building can appear smooth, dull, heavy, light earthy or industrial irrespective of its use or form. A glass clad building "feels" different from one that is masonry.

Compare the texture and opacity of the Glass building in the foreground vs opaque, brick building in the background.

5th Ave @ E59th St. (2023); New York; Photo: courtesy of the author; © Muhammad A Siddiqui 2023.

If the above examples seem extreme, the choices in applying biophilic design to architecture are not binary. It is quite possible, even encouraged, to combine, mix and match different concepts in a single project. This is perhaps the most common approach. Not always are these combinations the result of biophilic design goals but by products of generally thoughtful design.

One example, among many, of a building that simultaneously combines many elements of texture, material and form variations in one structure is the Wortham Theater building in Houston, Texas.



Wortham Theater Center (1987); Houston, Texas; Morris * Aubrey Architects; Photo: courtesy of the author; © Muhammad A Siddiqui 2020.

Similarly, in terms of biophilic urbanism, the types of hardscapes (paving, seating, planters, retaining walls) and selection of vegetation can create a space that is hard or soft in appearance. Stone walks and desert landscape exude a different feeling that a heavily landscaped area with smooth walkways and grass lawns. People can perceive these characteristics without even getting close enough to touch anything.

Compare the very different treatment of the textures and the emotions they conjure up in the Butchart Gardens in Victoria, British Columbia, Canada and then grounds of the Clark County Government Center in Las Vegas, Nevada:

Butchart Gardens *(left)* and **Clark County Govt. Center Grounds** (right); Photos: courtesy of the author; © Muhammad A Siddiqui 2017/2019.

The second level at which texture is relevant in architecture is when surfaces come into contact with people. This is the most intimate physical interaction between a designer's creation and the user. Whether it is a door handle, the floor one walks on, the chair, table, bench, wall panels, ceilings or any other surface that is either seen or touched up close, the user either finds it comfortable, indifferent, awkward or, even painful. While safety and functionality determine many texture choices such as slip resistant flooring or acoustic ceilings, the role of biophilic design in influencing interactive textures is in the shapes, and feelings that these can derive from nature. These are used mostly in interior architecture and design as well as in surface material choices for some outdoor elements like seating, visual décor or exposing users to physically feel and experience nature.

Elements like leaf patterns, wood grain and snowflakes are just some examples of fractal patterns in nature. Fractals are patterns in nature created by repeating shapes in different scales, where the individual part resembles the whole. *[Author's note: A Fractal is a type of mathematical shape that are infinitely complex. In essence, a Fractal is a pattern that repeats forever, and every part of the Fractal, regardless of how zoomed in, or zoomed out you are, it looks very similar to the whole image.]*[92] Fractals have been proven to have a calming effect, and there are endless ways of incorporating them in library interiors, from wall decorations to nature-inspired carpets. Fractal textures and patterns add dimension and depth and will make any library space feel warmer and more welcoming. Feel the grass beneath your feet or touch the pretty snowflakes… There are lots of ways to bring out nature inspired textures![93]

Biophilic design in building interiors engages the selection of furnishings, choices of textiles and fabrics for upholstery, wall coverings, window treatments and flooring. Each of these elements are an amalgamation of many biophilic elements like color, shapes, patterns but also texture. How a piece of fabric looks is as important as it feels.

Example of texture interplay – wall, furniture, fabric and flooring integrated

[92] ITERNAL.us: "What is a Fractal?"; Sep 24, 2020
[93] Wearelibrarypeople.com: "BIOPHILIC LIBRARY DESIGN - MATERIALS AND PATTERNS"; undated.

Photo: courtesy of the author; © Muhammad A Siddiqui 2019.

LIGHT & SHADOW

"'Architecture is the learned game, correct and magnificent, of forms assembled in the light."
– Le Corbusier.[94]

Every architect knows the importance of light and shadows in architecture. It is coached into the psyche of every architecture student from the earliest design studios. So, rehashing this here will be redundant. What is relevant for discussion is that these same design considerations play a similarly important role in biophilic design. Maximizing the use of natural light has already been emphasized.

The principle of biophilic design that refers to lighting is all about dynamic and diffuse light. This means that it is important to incorporate varying intensities of light and shadow that change over time and mimic the lighting conditions that we might experience out in nature.[95]

Recent research has focused more heavily on illuminance fluctuation and visual comfort, human factors and perception of light, and impacts of lighting on the circadian system functioning. Sunlight changes color from yellow in the morning, to blue at midday, and red in the afternoon/evening; the human body responds to this daylight color transition. The response is apparent in body temperature, heart rate, and circadian functioning. Higher content of blue light (similar to skylight) produces serotonin; whereas, an absence of blue light (which occurs at night) produces melatonin. The balance of serotonin and melatonin

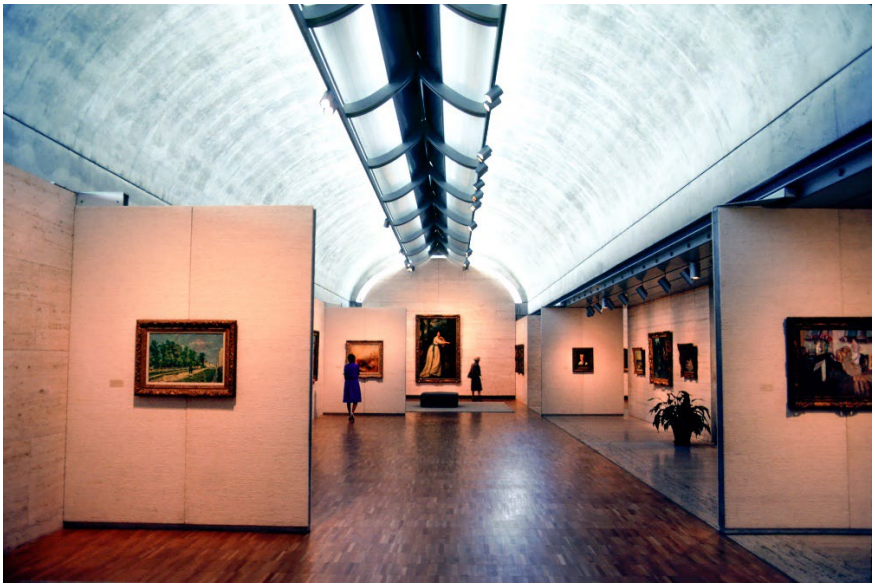
[94] Study.com " Famous Quotes of le Corbusier".
[95] The Design Sheppard: "Biophilic Design : How to Harness the Power of Natural Light at Home"; August 14, 2022.

can be linked to sleep quality, mood, alertness, depression, breast cancer and other health conditions.[96]

With better knowledge of how light affects users, there is an increasing emphasis to move away from excessive lighting of interior spaces and focus more on diffused lighting with augmented task lighting. Not only does this decrease energy consumption but also provides a more productive environment.

The objective of the Dynamic & Diffuse Light pattern is twofold: to provide users with lighting options that stimulate the eye and hold attention in a manner that engenders a positive psychological or physiological response, and to help maintain circadian system functioning. The goal should not be to create uniform distribution of light through a (boring) space, nor should there be extreme differences (i.e., glare discomfort). For example, when the lighting difference between adjoining sources or surfaces has a brightness or luminance ratio of greater than forty-to-one, glare may occur, which diminishes visual comfort (Clanton, 2014). For work areas, luminance ratios between task and immediate surroundings should not exceed 10 to one. So, while dramatic lighting differences may be great for some religious, socialization and circulation spaces, they are not a good idea on work surfaces. Diffused lighting on vertical and ceiling surfaces provides a calm backdrop to the visual scene. Accent lighting and other layering of light sources creates interest and depth, while task or personalized lighting provides localized flexibility in intensity and direction. These layers help create a pleasing visual environment (Clanton, 2014).[97]

Indirect, diffused lighting accentuates the architecture without distracting from the art display.



[96] Terrapin Bright Green: "14 PATTERNS OF BIOPHILIC DESIGN"; William Browning, Hon. AIA, Terrapin Bright Green • Catherine Ryan, Terrapin Bright Green • Joseph Clancy, Pegasus Planning Group Ltd.
[97] Ibid 27

Kimbell Art Museum (1972); Louis Kahn Architect; Photo: courtesy of the author; © Muhammad A Siddiqui 2007.

Movement of light and shadows along a surface can attract our attention. For example, the dappled light under the canopy of an aspen tree, or the reflections of rippling water on a wall. These patterns tend to be fractals, and the brain is attuned to moving fractals. Just as variations in lighted surfaces are important for interpreting surfaces, conducting a variety of tasks, and safe navigation, circadian lighting is important for supporting biological health. Leveraging opportunities for illuminance fluctuation, light distribution and light color variability that stimulate the human eye without causing discomfort will improve the quality of the user experience.[98]

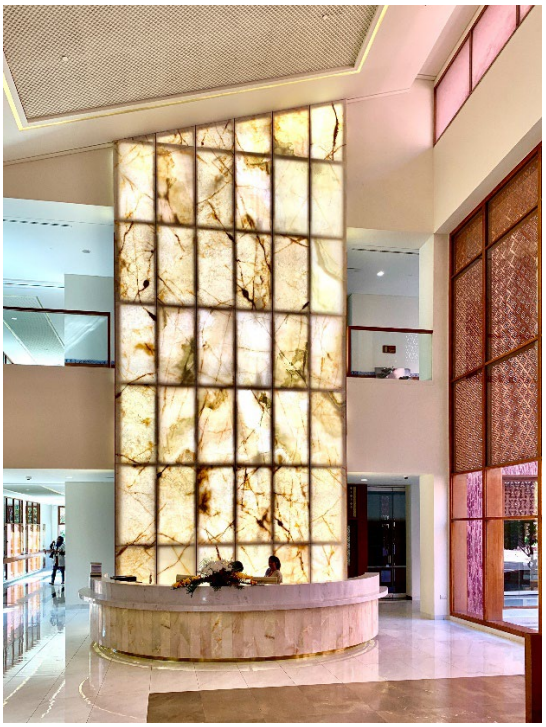
Design considerations for establishing a balance between dynamic and diffused lighting conditions[99]:

- Dynamic lighting conditions can help transition between indoor and outdoor spaces.
- Drastically dynamic lighting conditions, such as with sustained movement, changing colors, direct sunlight penetration and high contrasts, may not be appropriate for spaces where directed attention activities are performed.
- Circadian lighting will be especially important in spaces the people occupy for extended periods of time.

The impact of lighting and shadows in biophilic design are inextricably linked to materials, shapes, colors and textures. All these elements affect each other in a circular relationship. Good design practice requires balancing them to achieve optimal results. This pursuit of balance is a pervasive characteristic of biophilic design – the attainment of harmony.

Dynamic, diffused lighting infused with natural daylight accentuates materials and creates calm.

[98] Ibid 27
[99] Ibid 27



Princess Zahra Pavilion at the Aga Khan University Hospital, Karachi, Pakistan (2019); Payette Architects; Photo: courtesy of the author; © Muhammad A Siddiqui 2019.

Shadows and texture highlight the forms of the Qatar national Museum building, inspired by the desert rose (biomimicry) – also making it a biomorphic design.

Qatar National Museum, Doha, Qatar (2019); Jean Nouvel Architect; Photo: courtesy of the author; © Muhammad A Siddiqui 2020.

COLOR

Nature is full of color and all color is seen in the context of the light it is viewed in. Often it is thought that biophilic design is all about using colors of "nature" – greens, browns, blues and earthy neutral colors. That is a very narrow and limited filter that excludes all the vibrant, bright and pastels that are also abundant in nature. As has been argued throughout

this course, biophilic design extends beyond just vegetating the design. It is about encompassing all elements of life to make the spaces humans occupy become what le Corbusier called "machines for living" (not to be confused with a "Living Machine" which is a form of ecological sewage treatment based on fixed-film ecology.[100]).

First, let's consider the traditional "green" or biophilic color palette:

One of the most basic ways to create biophilic interiors is to use a color palette inspired by nature. It's crucial to note, though, that a natural color palette isn't confined to earthy tones and rich greens. In fact, you have a spectrum of colors at your disposal. If you're having problems deciding on a color scheme, consider your favorite natural environment. Perhaps it's the beach, with its soothing beige and blue tones. Consider the ever-changing colors of the sky, which range from blue to pink to grey and everything in between. Consider the desert, which has sandy, warmer hues. [101]

Beyond that, it can be argued that any accents or even prolific use of colors to bring interest, dynamism and "life" to abuilding is biophilic. The guiding principle should be one of choosing colors that are calming rather than those that agitate or create discomfort for people.

Emotions are commonly associated with various colors, but these associations vary among individuals and cultures. Some research indicates red, yellow and orange are associated with excitement, stimulation and aggression. Blue and green are associated with calm, security, and peace. Yellow is associated with cheer and joyfulness, and purple with dignity and sadness. Black, gray and brown are associated with strength, sadness and depression. These color associations may be the result of learned responses. For instance, in China red is associated with good luck and is commonly considered a good color for brides.[102] Yet, in western countries the bridal color is decidedly white.

Some Terms Related to Color

- **Hue** is artist-speak for the actual color.
- **Value** is a description of how light or dark a color is.
- **Chroma** is how bright a color is.
- **Shade** describes the addition of black.
- **Tone** describes the addition of gray.
- **Tint** describes the addition of white.

Source: Life of an Architect: "Introduction to the Color Wheel"; Bob Borson; March 21, 2011.

Color associations are complex. The value and intensity of a color changes the associations. Studies have shown that in rooms of strong, intense colors perceived excitement is increased. Weak colors give an impression of calmness regardless of hue. For example, calm can be reflected in warm hues. Pale, dull peach may appear calmer than bright, intense green. Associations may relate to how we

[100] Wikipedia: "Living Machine".
[101] JayScotts.com: "6 Simple Ways To Incorporate Biophilic Interior Design To Enhance Your Home"; May 23, 2023.
[102] University of Kentucky, College of Agriculture: "Responding to Color"; Linda Adler, MA; 1/99.

view our environment and may stimulate our other senses. For example, color suggests warmth and coolness. Persons in a blue-green room in one study felt that 359 degrees F. was cold, but in the red-orange room, the temperature had to fall from 52 to 42 degrees F. before people reported being cold. In another study, people tended to set the thermostat four degrees higher for comfort in a blue room than in a red room. Due to color associations, a noisy environment may be experienced as noisier if painted in glaring yellows and reds. Experiments have shown that a given sound appears to have different intensities in the same room when wall colors are changed.[103]

What does this mean to us as we plan our environments? In using color, extensive monotony can lead to under-stimulation and therefore anxiety, and extreme complexity to over-stimulation. A balanced approach and a variety of color is suggested. One color does not satisfy all the physical and emotional needs in our environment.[104]

Typically, architects like to use whites, greys, ochres and neutral colors with a slight embellishment of accents like red or black to key in on specific features. However, as colors become more acceptable and enter into the "green" environmental glossary of design preferences, architects are increasingly adopting a varied color palette. Below are some of the primary color palette types that are used:

- **Monochromatic**: Using shades, tints, and tones derived from a single color

Ruby City Contemporary Art Center (2019); Adjaye Associates Architects; Photo: courtesy of the author; © Muhammad A Siddiqui 2024.

- **Analogous**: Embracing adjacent color associations

[103] Ibid 33
[104] Ibid 33

Bluff Dwellings Resort, Bluff, Utah (2020); Jared Berrett Designer; Photo: courtesy of the author; © Muhammad A Siddiqui 2022.

- **Complementary**: Contrasting colors for lively and active spaces

Russia Pavillion, Expo2020, Dubai (2021); Sergei Tchoban Architect; Photo: courtesy of the author; © Muhammad A Siddiqui 2022.

- **Pastels**: Pale tones of colors (can be applied to any other palette)

9420 Seawall Blvd, Galveston, Texas (2006); Photo: courtesy of the author; © Muhammad A Siddiqui 2019.

- **Primary**: Traditionally, Red, Yellow and Blue (RYB) are considered the basic colors

Four Seasons on the Gulf Condos, Galveston, Texas (1980s); Photo: courtesy of the author; © Muhammad A Siddiqui 2019.

- **Secondary & Tertiary:** Secondary are color combinations created by equal mixture of two primary colors whereas tertiary are combination of primary and secondary colors. These fall between primary and secondary colors on a color wheel. Most mild colored buildings fall in this category.

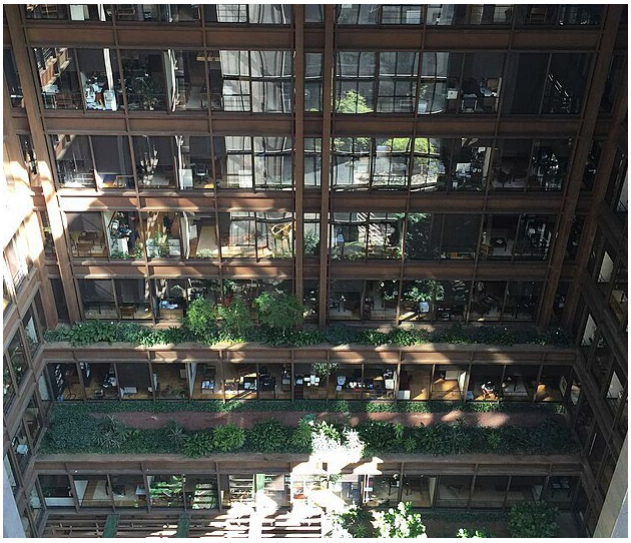
The Portland Building, Portland, Oregon (1982); Michael Graves Architect; Photo: Wikimedia Commons: Portland Building 1982.jpg.

VIEWS

To conclude the section on the application of biophilic design principles to architecture, it seems fitting to discuss how views from buildings can contribute immensely to garnering biophilic benefits. Buildings, whether residential, commercial, institutional or any other category will typically have windows, and these will have a view. There is a small category of buildings that do not have windows or views by virtue of their function. Setting those aside, the management of the views is something architects can influence. During the 1960s through the 1990s, unfortunately, in the big building boom and rapid urbanization, consideration of views became a low priority, if not an afterthought, except for projects where the view was the actual project driver (e.g. resorts, luxury high rises). The fact that "views" (meaning pleasant, dramatic and natural scenes) are desirable is not in dispute. Just check hotel rates or rental costs for rooms or spaces with a "view" and the payment rises as the view improves. Homes with "views" of nature like lakes, rivers, mountains, gardens, golf courses or just plain open green space tend to command premium prices. Increasingly, developers and planners are recognizing that by encouraging architects to incorporate views of greenery into their designs. In suburban settings or sites with large

sites, incorporating views is easier than buildings in dense, urban settings. In these situations, newer projects are resorting to creating internal views using some of the following techniques:

- **Atriums**: Interior space where plants, water features and controlled lighting can create biophilic ambiance.



Ford Foundation Atrium (1963); Kevin Roche John Dinkeloo and Associates Architects; Photo: Wikimedia Commons: Ford Foundation's atrium.JPG

- **Plant friendly balconies**: These allow for both a personal connection to nature, and the vegetation also acts as a screen from adjacent buildings and privacy from voyeurs.

Bosco Verticale, Milan, Italy (2014); Stefano Boeri Architect; Photo: Wikimedia Commons: Osco Verticale, Milan, Italy (Unsplash).jpg

- **Infill Terraces**: To complement, or in lieu of balconies and atriums, terraces can be incorporated into the building providing outdoor access to occupants. These can be open air or "carved" into the faced in between levels.

Oasis Terraces, Singapore (2017); Serie Architects and others; Photo: Wikimedia Commons: Oasis Terraces 2018.jpg

- **Roof gardens**: Every building has a roof. Unless it is sloped or has another architectural feature, flat surfaces are ideal for creating a green space. These can be very simple with minimal vegetation, or even artificial turf or elaborate live gardens. Roof gardens can also provide dramatic and open views.

Houston Skyline view from the Roof Garden, **POST Houston (2021);** OMA and Powers Brown Architects; Photo: courtesy of the author; © Muhammad A Siddiqui 2023.

- **Building orientation**: During the site planning of a building, architects can orient the building to maximize the best available views. In some cases, the building shape can be manipulated to create varying views within the same plan or extend the building vertically to rise above the surrounding buildings for better views.

  Price Tower by Frank Lloyd Wright is a pioneering example of a building which utilized building orientation and window orientation to secure the best views and account for sun movement and wind directions. A remarkably biophilic "green" building before the terms were even conceived.

Price Tower, Bartlesville, Oklahoma (1952); Frank Lloyd Wright Architect; Photo: courtesy of the author; © Muhammad A Siddiqui 2019.

- **Window orientation**: When building orientation is restricted, or in addition to building orientation, windows can be angled, extended, or recessed to maximize views. This technique is very popular in areas like seaside locations where windows on the perpendicular façade of the building are angled towards the water to give at least a partial seafront view.

Radisson Blue Dubai Creek; Diera, Dubai *(originally Intercontinental Hotel)* **(1975 / 2018);** Renovated by Lulie Fisher Design Group; Photo: courtesy of the author; © Muhammad A Siddiqui 1988.

2.2 Biophilic Urbanism concepts in city planning and urban development.

Shifting attention from biophilic design applied to architecture now to the urban environment. Biophilic urbanism utilizes the same basic principles as have been articulated above but the scale and context differ. Biophilic urbanism strives to fit into the overall urban planning framework of a community, city or metropolitan area.

Urban planning, also known as town planning, city planning, regional planning, or rural planning in specific contexts, is a technical and political process that is focused on the development and design of land use and the built environment, including air, water, and the infrastructure passing into and out of urban areas, such as transportation, communications, and distribution networks and their accessibility. Traditionally, urban planning followed a top-down approach in master planning the physical layout of human settlements. The primary concern was the public welfare, which included considerations of efficiency, sanitation, protection and use of the environment, as well as effects of the master plans on the social and economic activities.[105] In translating these goals, urban centers grew rapidly throughout the 20th century. During that process, the focus was mostly on transportation, utilities and land use, viewed primarily through those lenses. This led to what has become known variously as the urban jungle or concrete jungle. According to Collins dictionary, "If you refer to a city or area as a concrete jungle, you mean that it has a lot of modern buildings without grass or trees, and you think it is ugly or unpleasant to live in." Merriam-Webster defines it as "a modern city or urban area filled with large buildings and regarded especially as a harshly competitive, unwelcoming, or dangerous place." None of these are very flattering and certainly do not conjure an image of a place where

[105] Wikipedia: Urban Planning

people would live happily. Yet, square mile upon square mile of pavement and densely packed buildings continued to infect the landscape and towns grew into cities and these became Metropolises which began to morph into megalopolises where boundaries between urban and rural continue to blur, if not completely disappear. Much of this was due to economic drivers rather than social or other human preferences. The rapidity of urbanization kept planners so busy with physical and technical infrastructure needs that human needs, social networks and psychological strains were overlooked.

Fortunately, enough alarms went off to bring attention to not only the damage that unchecked urbanization was doing to the natural environment, but also to the toll it was taking on humanity as social structures began to break down, divorce rates skyrocketed, lifestyle induced depression became normal, crime increased and education quality decreased. This trajectory was simply not sustainable to maintain or build a productive society for the future. And so, an urgent sense of course correction was felt among designers and planners. On the one hand it was necessary to reduce the polluting effects of mass industrialization, but it was also equally, if not more, important to make human livability a priority. The task before urban planners was that they were no longer working with virgin land or "greenfield" projects. Most cities were already too big to be abandoned and land was too expensive to be reclaimed for the "common good". The challenge, therefore, has been to rehabilitate what exists and, as new projects come up or older ones are renewed, planners are using a combination of regulatory mandates and economic incentives to push a reincarnation of the urban environment. Among the techniques that are finding favor with developers, communities and planners are the biophilic approaches that can sometimes be relatively quick, simple and appealing.

The biophilic approach to urbanism cannot be successful if it is thought of as a one-time implementation. It is a long term total paradigm shift that requires mass commitment at a grass roots level so it is not at the mercy of political whims or private financial interests. One of the positive outcomes emerging from biophilic influenced urban (re)development projects is that they have tended to improve the area they are in and also create impetus for surrounding communities to engage in similar undertakings, even if it is as simple as planting trees, adding color or flowers.

A comprehensive well conducted research paper released in 2012 by the Sustainable Built Environment National Research Centre (SBEnrc), Curtin University and Queensland University of Technology, asked the question: "Can biophilic urbanism deliver strong economic and social benefits in cities?". The researchers examined five cities around the globe that have made long term commitments to biophilic urbanism. These were:

- Chicago, IL, USA
- Berlin, Germany
- Toronto, ON, Canada
- Portland, OR, USA
- Singapore, Singapore

The researchers concluded that "The rise of biophilic urbanism is a phenomenon that builds on earlier traditions of environmental planning and landscape architecture and has

taken a more deliberate and detailed approach to bringing nature into the very fabric of cities. The examples provided here show that there are multiple benefits, but unfortunately not enough cities are implementing biophilic urbanism policies and reaping these benefits. The mainstreaming of biophilic urbanism and the development of key metrics to measure its outcomes does, therefore, need to be clearly on the agenda for all competitive cities of the future."[106]

Since 2012, the disappointment of the researchers has been mitigated to a significant extent as many more cities and urban development projects have embraced biophilic urbanism in varying degrees. In the same year as the report was released, the Biophilic Cities Network (BCN) was launched in 2012 in order to create a global alliance of partner cities, organizations and individuals working collectively in pursuit of the vision of a 'natureful' city (*https://www.biophiliccities.org*). In a decade the BCN has grown to 31 cities.

Members of the Biophilic Cities network include the following:

1. Arlington, Virginia, USA
2. Austin, Texas, USA
3. Barcelona, Catalonia, Spain
4. Birmingham, UK
5. Colombo, Sri Lanka
6. Curridabat, Costa Rica
7. Edinburgh, Scotland
8. Edmonton, Canada
9. Fremantle, Australia
10. Kansas City, Missouri, USA
11. Karşıyaka (Izmir), Türkiye
12. Los Angeles, California, USA
13. Miami-Dade, Florida, USA
14. Milwaukee, Wisconsin, USA
15. Norfolk, Virginia, USA
16. Panama City, Panama
17. Phoenix, Arizona, USA
18. Pittsburgh, Pennsylvania, USA
19. Portland, Oregon, USA
20. Raleigh, North Carolina, USA
21. Reston, Virginia, USA
22. Richmond, Virginia, USA
23. San Francisco, California, USA
24. *Singapore, Singapore*

[106] SBEnrc (2012) Can biophilic urbanism deliver strong economic and social benefits in cities? An economic and policy investigation into the increased use of natural elements in urban design, Sustainable Built Environment National Research Centre (SBEnrc), Curtin University and Queensland University of Technology.

25. St. Louis, Missouri, USA
26. Toronto, Canada
27. Verona, Italy
28. Vishakhapatnam, India
29. Vitoria-Gasteiz, Spain
30. Washington, DC, USA
31. Wellington, New Zealand

With these cities already on board, membership and interest are likely to expand substantially. In part this is due to increased public awareness in cities where there is a highly informed public but also because of the increasing pressure to meet NetZero and sustainability targets.

The design features that help cities become biophilic can be broken down based on the scale and urban zone they affect. A useful listing is provided below based on research by Ana Karinna Hidalgo using her adaptation of principles postulated by Beatley in 2011.[107]

[107] Hidalgo, Ana. (2014). Biophilic Design, Restorative Environments and Well-Being. 9th International Conference on Design and Emotion 2014: The Colors of Care.

Biophilic Green Urban Design Elements in Cities	
Implementation Level	**Design Elements**
Region	• River systems and floodplains • Riparian areas • Regional greenspace systems • Greening major transport corridors
Community	• Urban creeks and riparian areas • Urban ecological networks • Green schools • City tree canopy • Community forest and community orchards • Greening utility corridors
Neighborhood	• Stream daylighting, stream restoration • Urban forests and ecology parks • Community gardens • Neighborhood parks and pocket parks • Greening grayfields and brownfields • Walking and biking trails *
Street	• Green streets and sidewalk gardens • Urban trees • Low-impact development • Vegetated swales and skinny streets • Edible landscaping • High degree of permeability
Block	• Green courtyards • Clustered housing around green areas • Native species yard and spaces
Building	• Green rooftops • Sky gardens and green atria • Rooftop garden • Green walls • Green façade • Daylit interior spaces

**Added by author*

Below are some examples of urban biophilic design element implementations:

Region level: Garden State parkway in New Jersey is an example of a regional greening of a transportation corridor passing through a mix of urban and suburban areas.

Garden State Parkway, New Jersey; Early rendering (undated); Photo: Wikimedia Commons: Aerial view of the Garden State Parkway, looking south in Monmouth County towards Red Bank, N.J. (8471535266).jpg

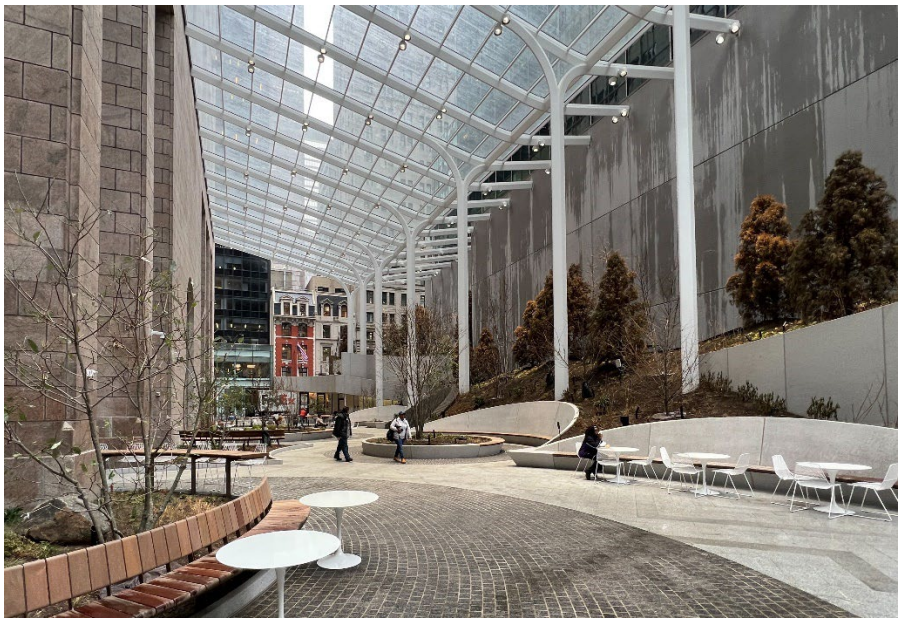
Community level: Al-Azhar Park,in Cairo, Egypt has been dubbed the "Green lung of Cairo". The selected location was the derelict *Darassa* site, a 30-hectare mound of rubble between the eastern edge of the 12th century City Walls and the "City of the Dead".[108] Created by the *Historic Cities Support Programme* of the *Aga Khan Trust for Culture*, this project exemplifies a biophilic urban development achieved with institutional, government and neighborhood cooperation.

Al-Azhar Park, Cairo, Egypt (2005): Photo: Wikipedia – Al-Azhar park website . Public Domain.

Neighborhood level: Beyond Central Park, New York City has some very successful neighborhood and pocket parks. Amongst some of the most dense and expensive

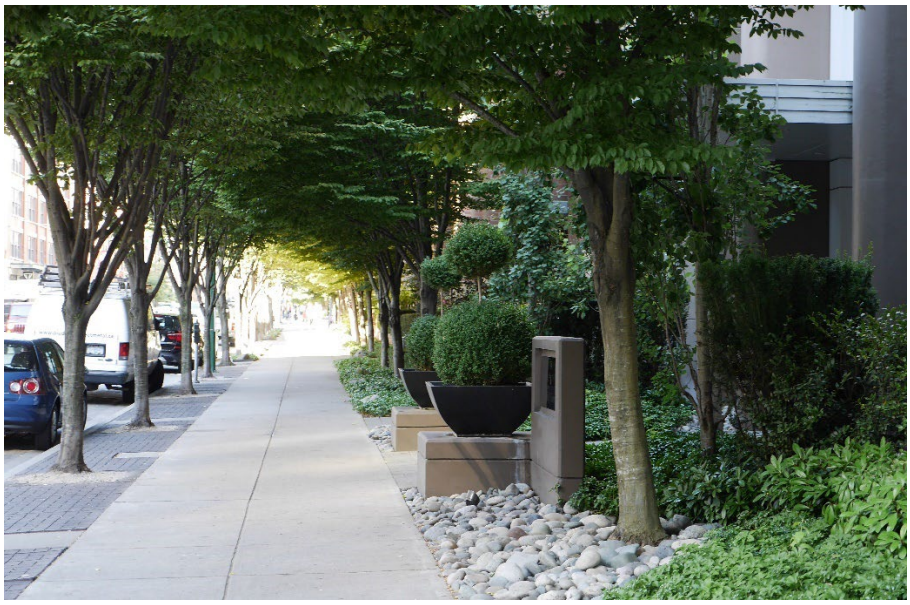
[108] AlAzharPark.com: History of Al Azhar Park.

sites anywhere, these parks demonstrate a biophilic commitment to neighborhoods.



550 Madison Public Atrium, Manhattan, New York (2022); Snøhetta Architects; Photo: courtesy of the author; © Muhammad A Siddiqui 2023.

Street level: As cities implement biophilic urbanist practices, treating the narrow strips between streets and adjacent buildings can have a magnified experiential impact.



Street Greenery, Vancouver, BC, Canada; Photo: courtesy of the author; © Muhammad A Siddiqui 2017.

Block level: Just as courtyards within buildings can add a biophilic design element, clustering buildings around a block dedicated as a "block park" in an urban setting can provide pockets of greenery, recreation and light.

Block Park, Vancouver, BC, Canada; Photo: courtesy of the author; © Muhammad A Siddiqui 2017.

Building level: Much has already been covered about biophilic design for buildings. In the biophilic urbanism context, the façade that the building presents to the public and how it physically interfaces with its adjacent spaces can enhance the building's individual appeal but also add to the overall community.

Green Wall Façade; Photo: Wikimedia Commons: Miscellaneous facades in Madrid - Green wall.JPG

2.3 Biophilic design impact on NetZero and alignment with sustainability goals.

In 2015 the United Nations held its 21st **C**onference **O**f **P**arties (COP21) conference in Paris. This conference resulted in an agreement (also referred to as the Paris Accord or Paris Climate Agreement) that created the provisions known as NetZero. Put simply, net zero means cutting carbon emissions to a small amount of residual emissions that can be absorbed and durably stored by nature and other carbon dioxide removal measures, leaving zero in the atmosphere.[109]

This was the most comprehensive agreement to date on combating climate change and it has the endorsement of 197 countries including the United States and China. The goal of zero emissions by 2050 and simultaneously limiting average global temperature rise (Global Warming) to no more than 2^0C is ambitious and is being taken seriously in varying degrees. As 2024, according to Net Zero Tracker (zerotracker.net), as of 2024, 28 countries have already enshrined Net Zero targets in Law. The United States, Canada and most EU countries are in this category. This has buttressed efforts by architects and planners who have been trying to implement broad design changes since the early 2000s. Municipalities and large corporations have also acknowledged the need to take these issues seriously. The result has been that the "nice to have" environmentally friendly design options are now moving up the priority ladder to a current status of "like to have". The objective, of course, is to get to a "must have" status.

With time and a combination of increasing public and political pressure, developers, planners, architects, builders, material manufacturers and politicians are seeking all viable options that can contribute to Net Zero goals. As the options are evaluated, those that offer "sustainable" solutions quickly emerge as preferences if the economics and technical conditions are favorable.

Sustainable buildings minimize energy and water consumption and are a key part of sustainable urban development that seeks to combat climate change.[110]

Biophilic design fits neatly as a "green", sustainable, and relatively simple technological solution that is easy to implement. Because of the wide range of options and easy scalability, Biophilic design in architecture and biophilic urbanism applications in city planning are becoming more and more visible.

One of the more confusing and troubling aspects of sustainable design is that there are too many labels, philosophies, guidelines and "standards" being promoted which begin to sound alike with differences that, at an academic or semantic level, may be valid but in practical, layperson terms, they all seem to be variations of the same theme. And that is closer to the facts. As one explores the design options, whether they are labeled "green", "biophilic", "sustainable", "low carbon", or a host of other environmentally friendly terms,

[109] United nations (un.org): Climate Action

[110] Iberdrola.com: "The 'green' buildings are leading the way to more sustainable and efficient urban planning"; undated.

most of these options are essentially variations of the same themes – nature friendly, low energy consumption, water conservation, material reuse and socially adaptable. As designers and planners, it is perhaps less important to focus on a label or philosophy but rather look at the best combinations of all options to achieve the longest lasting, economically viable, measurable results that can be achieved in a reasonable time with the least complicated technology. If this approach is adopted, many solutions, by virtue of their characteristics, will be biophilic, almost by definition – after all the whole objective of Net Zero and sustainable design is to restore a balance with nature. The whole awareness is the result of a desire to get back to the "love of life" ideals that seek to restore harmony between all living elements – humans, plants, animals, and the air and water that they all need to sustain their existence.

2.4 Selected projects employing biophilic design and urbanism concepts.

In this section Four projects will be shown that employ biophilic and sustainable design features. Two are architectural and two are urban projects.

PROJECT PROFILE ONE - Biophilic Design – Residential Project.

Project: Begum Ismat Farooqi Residence

Location: Karachi Pakistan.

Architect: Muhammad A Siddiqui

Date(s): 1980 ~ 2000

SUMMARY: The project was commissioned in 1980 as a family residence for Begum Ismat Farooqi in Karachi. She had 4 main requirements:

1. The house had to be airy and feel like a garden – to reflect her love of plants.
2. The house should accommodate her family's many pets – dog, cats, partridges, parakeets, and the occasional goat.
3. The house should not rely on air conditioning for comfort – for both economic and practical considerations.
4. Privacy. The site was in a dense residential area and all neighboring properties would likely have 2-3 levels and the house was to maximize visual screening.

The house was built over several years, but the essential design and gardens were started in 1980. The house, made of reinforced concrete and colored all white was designed in an "L" shape to take advantage of cross ventilation using large windows and employing overhangs for shade. The main verandah is the communal heart of the house that overlooks the front lawn and a side open air patio with a rock garden and waterfall to block the neighboring wall. Rapid growth trees were planted along the perimeter along with bougainvillea bushes that quickly grew into excellent visual barriers. A dog run and kennel were placed on one side and a partridge cage was at the from lawn concealed by flowering plants. Parakeet cages were at the back of the house looking into the interior family room (Den). The cats made their

own places. The goat, while it lasted, made its home in one corner of the front lawn but the house just could not accommodate a goat. Initially the house had no air conditioning, and the breezes were sufficient accompanied by ceiling fans. However, over time as neighboring homes expanded and blocked the prevailing winds, air conditioning was added to a couple of rooms. The verandah and open patio along with the abundance of plans, still keeps the house pleasant except for the most brutal summer months when temperatures exceed 100^0 F. During her lifetime, the owner resisted adding technology but after her passing, solar panels have been added to continue the house's sustainability credentials.

Begaum Ismat Farooqi Residence Aerial; Photo: © Muhammad Ahmad 2024.

Begum Ismat Farooqi residence, Karachi, Pakistan (1980 ~ 1990); Muhammad A Siddiqui Architect; Photos: courtesy of the author; © Muhammad A Siddiqui 1990 ~ 2015.

PROJECT PROFILE TWO - Biophilic Design – Healthcare Project.

Project: M D Anderson Cancer Center – Multiple buildings

Location: Houston, Texas.

Architect: Multiple

SUMMARY: Use of biophilic elements is known to have a very positive influence in patient care. In 1984, Robert Ulrich, one of the first to research the impacts of biophilic design, conducted a landmark study that compared the recovery rates of patients with views of nature to those with views of an exterior wall of another hospital wing. His findings showed that patients with natural views had an average length of stay that was 18 hours shorter than patients with no natural views.[111]

Subsequent studies have shown that introducing biophilic design elements into healthcare settings can lead to a host of benefits, including more positive health outcomes, better pain and stress management, and better staff performance – all of which contribute to how occupants regard a facility. In fact, research into the effect of biophilic design on patient experience found that rates of patients who responded "would definitely recommend this facility" on evaluations improved between 6.1% and 12.4% for those exposed to biophilic interventions. [112]

Newer buildings like MD Anderson Cancer Center West Houston and the Sheikh Zayed Bin Sultan Al Nahyan Building were designed and built using energy-efficient practices, as well as sustainable building materials. With several new projects on the horizon, we're working to expand what we've done in the past and explore even better options. LED lighting, motion sensor lights and temperature setbacks in unoccupied spaces are some of our standard practices that we'll include in all new buildings, though these are a small percentage of our energy conservation. Mainly, we aim to minimize use by optimizing the energy needed and dynamically reducing consumption where it's not required through real-time, daily and monthly monitoring tools.[113]

A lot of these new buildings have planned green spaces and outside areas for people to sit and enjoy nature. Our team is working with designers to see if there are opportunities for native plants to be planted in these spaces. Currently, we're planning to relocate two mature oak trees in the construction zone that have been on campus for several years. Native species are invaluable to our ecosystem. They help promote biodiversity and support local wildlife. We hope to preserve and replenish as much of the native ecosystem as possible.[114]

[111] Interface: "How Biophilic Design Contributes to Healthcare Excellence"; November 4, 2023.
[112] Ibid 42
[113] MD Anderson Cancer Center (mdanderson.org): "Prioritizing sustainability for MD Anderson's future"; by Elise Featherly; January 04, 2024.
[114] Ibid 44

M D Anderson Cancer Center – Multiple Buildings; Houston, Texas; Photos: courtesy of the author; © Muhammad A Siddiqui 2016 ~ 2023.

Waterwall at M D Anderson Cancer Center; Houston, Texas; Photos: Wikimedia Commons; MD Anderson Cancer Center.jpg

PROJECT PROFILE THREE - Biophilic Urbanism – Public Urban Park

Project: The Gathering Place

Location: Tulsa, Oklahoma.

Architect: Michael Van Valkenburgh and Associates

Date: 2018

SUMMARY: Gathering Place is a 66.5-acre park along the Arkansas River in Tulsa, Oklahoma. Created by the George Kaiser Family Foundation, and designed by landscape architect Michael Van Valkenburgh, the park was established September 8, 2018. It is open to the public free of charge. At $465 million, Gathering Place is the largest private gift to a community park in U.S. history.[115]

In the words of the planner's website: Topography subdivides the site into separate zones, each supporting a unique set of activities, with the goal that every visit is an opportunity to enjoy something different. Local stone, used generously throughout the park, helps connect Gathering Place to the region's natural geology. Play spaces within the park are bold and richly programmed, focusing on imaginative and tactile play and providing a robust array of physical challenges for every age group.[116]


(1)


(2)

Photo: (1) Wikimedia Commons: Boathouse @ The Gathering Place.jpg (2) Rock Trail; Muhammad A Siddiqui, © 2019

[115] Wikipedia: Gathering Place
[116] Michael Van Valkenburgh Associates (mvvainc.com/projects/gathering-place2): Gathering Place for Tulsa.

Gathering Place Underpass (2018); Tulsa, Oklahoma; Photos: courtesy of the author; © Muhammad A Siddiqui 2019.

PROJECT PROFILE FOUR - Biophilic Urbanism – Public Trail

Project: High Line & Pier 57

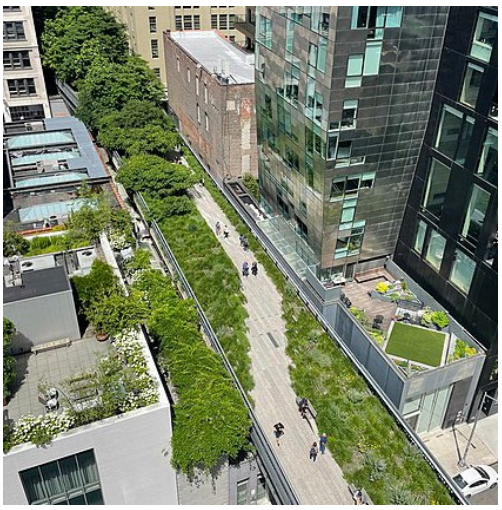
Location: New York City, New York,

Architect: Ricardo Scofidio + Renfro

Date: 2009 ~ 2014

SUMMARY: The High Line, elevated park and promenade built on an abandoned freight rail line on the West Side of Manhattan, New York, U.S. Its first section opened in 2009. With the completion of its final section in 2014, the High Line extended about 1.5 miles (2.4 km) from Gansevoort Street in the Meatpacking District (officially Gansevoort Market) in Greenwich Village west and north to West 34th Street, occupying 22 of the 41 blocks originally traversed by the railway. The park was inspired by Paris's Promenade Plantée (1994).[117]

The popularity of the High Line and the simultaneous rezoning of the neighborhood along it spurred a building boom nearby. The Whitney Museum of American Art constructed a new edifice (2015) by Renzo Piano at the High Line's southern end, and a private real estate firm built a mixed-use development (Hudson Yards) at the park's northern terminus. It includes The Shed (2019), an arts centre designed by Diller Scofidio + Renfro; a spiral structure called the Vessel (2019) by Heatherwick Studio; an office park; luxury housing; and a mall. Meanwhile, world-renowned architects such as Jean Nouvel and Zaha Hadid designed luxury condominiums (2010 and 2018, respectively), while Jeanne Gang built an office tower (2019) adjacent to the park. Plans to expand the High Line were announced in 2021.[118]


(1)


(2)

[117] Britannica.com: High Line; by Kathleen Kuiper; undated.
[118] Ibid 48

High Line, NYC (2009-2014); Ricardo Scofidio + Renfro Architects; photos: (1) Wikipedia Commons-Highline 02.jpg; (2) Muhammad A Siddiqui ©2023

2.5 Challenges with biophilic design implementation.

Almost all of the discourse has advanced the view that biophilic design offers a practical, beneficial and greater presence in the architectural design vocabulary and heightened priority in urban planning. However, it would be prudent to be aware of some of the limitations and challenges that biophilic design implementation has to contend with[119]:

- **Cost**: One of the main challenges can be costly, as incorporating natural elements and systems into the built environment often requires a higher upfront investment.
- **Limited space**: Another challenge can be limited space, as it may not always be possible to incorporate large amounts of nature into small or densely built environments.
- **Integration into existing built environments**: Integrating biophilia into existing built environments can also be challenging, as it may require building retrofitting or modifying outdoor spaces.
- **Maintenance and upkeep**: The maintenance and upkeep of natural elements and systems can also be challenging, as they may require more frequent attention and care than traditionally built elements.
- **Education and awareness**: There may also be challenges in education and awareness, as it may be necessary to educate people about the benefits of biophilia and how to incorporate it into their spaces.
- **Regulation and codes**: There may also be regulatory and code-related challenges to implementing biophilic design, as it may require the modification of existing building codes or the development of new standards.
- **Funding and financing**: There may also be challenges in funding and financing the implementation of biophilic design, as it may require allocating additional resources or developing new financing mechanisms.

Not all of these challenges apply to every project and strategies for overcoming them will vary depending on the situation. Many times solutions are creative combinations of unconventional techniques or collaborations. A structured framework to addressing the challenges is provided below as published in LInkedin[120]:

1. **Assess your needs and goals.**
   Before you start designing, you need to assess your needs and goals for the project. What are the benefits you want to achieve from biophilic design? Who are the users and stakeholders of the space? How can you measure the outcomes and impacts

[119] Ugreen.io: Nature in the Modern World: A Guide to Biophilic Design.
[120] Linkedin: "How can you overcome challenges to implementing biophilic design?"; updated Feb 10, 2024.

of your design? By answering these questions, you can define the scope and purpose of your biophilic design, and align it with your vision, values, and objectives.

2. **Research and learn from best practices.**
   One of the best ways to overcome the challenge of lack of knowledge or inspiration is to research and learn from best practices. You can find examples of biophilic design in various settings, such as offices, schools, hospitals, hotels, and public spaces. You can also consult experts, guides, and tools that can help you understand the principles and elements of biophilic design, such as the 14 Patterns of Biophilic Design by Terrapin Bright Green, or the Biophilic Design Toolkit by Interface. By learning from others, you can gain insights and ideas for your own project.

3. **Involve and engage stakeholders.**
   Another challenge to implementing biophilic design is resistance to change or lack of support from stakeholders, such as clients, managers, colleagues, or users. To overcome this, you need to involve and engage them in the design process, and communicate the benefits and value of biophilic design. You can do this by conducting surveys, interviews, workshops, or co-design sessions, and by sharing feedback, stories, or testimonials. By involving and engaging stakeholders, you can build trust, collaboration, and ownership for your biophilic design.

4. **Be creative and flexible**
   Implementing biophilic design can also be challenging if you have a limited budget, space, or resources. However, this does not mean you have to compromise on quality or impact. You can be creative and flexible with your design solutions, and use low-cost, high-value, or multi-functional interventions. For example, you can use plants, natural materials, artwork, or lighting to create a sense of nature, or you can use movable furniture, partitions, or curtains to create different zones or moods. By being creative and flexible, you can adapt to your constraints and optimize your opportunities.

5. **Evaluate and improve**
   Finally, implementing biophilic design is not a one-time event, but a continuous process of evaluation and improvement. You need to monitor and measure the performance and impact of your design, and collect feedback from users and stakeholders. You can use tools such as the Biophilic Design Quality Index by Oliver Heath Design, or the WELL Building Standard by the International WELL Building Institute, to assess your design against various criteria and indicators. By evaluating and improving your design, you can ensure its effectiveness and sustainability.

2.6 Outlook and Conclusion.

Biophilic features in architecture and urban planning have been present for a long time and will continue. What has noticeably changed is that now there is greater consciousness about incorporating these elements not purely for beautification and relaxation purposes but for their positive contribution to environmental issues and sustainability. As the world's population continues to grow and become even more urbanized, making nature an integral part of the new urban fabric is not only desirable, but vital. The last two decades have demonstrated that biophilic urbanism and biophilic inspired architecture are not only appealing but increasingly popular and economically viable. The gap between these being vestiges of wealth and luxury, biophilic spaces are becoming more commonplace. What is more encouraging is that the public beyond the design community is developing more awareness of the benefits and are seeking out places that respond to nature.

The outlook for biophilic design in developed economies with an educated and sophisticated population is very positive and can be expected to accelerate. In a post COVID assessment, the Global Wellness Summit declared that "Biophilia is not a "trend" but the long-term future of architecture and design"[121]. If one looks at all mainstream architecture and planning magazines, blogs and conferences, sustainability and incorporation of nature are pervasive in all forums. It is hard to recall when design consciousness was so popular in recent times. These indications all suggest that biophilic inspired sustainable design methods will continue to gain momentum.

The situation is not as bright in the lower developed and poorer economic societies. The issues of survival and economic disparities between the elite minority class and the vast majority is such that basic necessities like food and basic shelter are far more urgent concerns than the quality of the urban habitat. Ironically, many of the stresses brought about due to poverty can be improved by making the harshness of urban life a little more comfortable. But as long as the disconnect between powerful money interests and the quality of life for the poorer masses remains, there is little incentive for those in control to let improvements and comfort trickle down. Interestingly, even in the poorest countries, the neighborhoods of the wealthy are replete with lush gardens, parks and all the biophilic elements discussed in this course. So, it is not ignorance of the benefits that is preventing the normalization of better community design but simply a lack of will or, to put it bluntly, callous laziness and corruption. There is, however, a spark of hope in that social media and the internet has made the world much more informed and educated, even if not in the formal sense. This has created grass roots awareness about the need for healthier diet, air, water and environment. Micro projects about creating greenspaces and water reclamation

[121] Global Wellness Summit: "Biophilia is not a "trend" but the long-term future of architecture and design"; Oct 12, 2021.

techniques are starting to germinate in many urban communities in so-called 3rd world cities. Architects and planners in these regions are among the most active in research and innovation for sustainable and biophilic design. In the end that is perhaps the most encouraging sign.

Biophilic design, to be fully successful, has to embrace the masses and that is the path to it making a measurable impact on the bigger goals of Net Zero and healthy societies. A look once again at Singapore shows that this is achievable. in 1965 Singapore was a polluter's paradise: mucky rivers, polluted canals and raw sewage running rampant. The city's approach has been to build a livable and sustainable city, through pragmatic policymaking based on sound economic principles and science; a focus on long-term planning and effective implementation; and the ability to mobilize popular support for the common good." The message was clear: if Singapore could transform itself from a polluted backwater into a global green powerhouse, so can any city. [122]

For thirty years, the city-state painstakingly cleaned up its polluted areas, created agencies like the National Parks Board, and determined that everywhere one looked, one could find greenery. A concrete jungle was never what the pioneers had in mind. From urban planning to policy inducements to zoning to public awareness campaigns, the successive governments of Singapore have followed this central vision for their nation. They now call it the 'biophilic City in a Garden,' and the government calls upon every Singaporean to do their part to keep their city green and clean.[123] These are words of wisdom for all urban cities to adopt.

In conclusion, biophilic design and biophilic urbanism offer diverse and flexible approaches to help address many of the challenges of urban blight and social decay. There is ample empirical data to show that when successfully applied, biophilic design techniques can transform communities, cities and even entire countries.

Part 2 Review Questions

9. **Which of the following is not an example of a pattern occurring in nature?**
    a. Spirals
    b. Orthogonal grid
    c. Waves and ripples
    d. Hexagonal tessellations

[122] UN environment programme: "'A city in a garden': Singapore's journey to becoming a biodiversity model"; 30 Jul 2018.
[123] Ibid 53

10. Which of the following buildings are said to have received some inspiration from an orange peel?

1. **The Heydar Aliyev Center by Zaha Hadid**
2. **TWA Terminal by Eero Saarinen**
3. **The Sydney opera House by Jørn Utzon**
4. **Casa Battló by Antonio Gaudi**

a. 2 & 3
b. 1 & 3
c. 4 & 2
d. 1, 2, & 3

11. If an interior space within a building has a pleasant or dramatic view, which of the following is a true statement?

a. Price (rent) goes up
b. The building likely wasted a lot of valuable real estate.
c. The space would be considered bio phobic.
d. No additional features biophilic elements should be considered.

12. Which of the following are elements of Building level implementation?

a. Green courtyards and green streets
b. Green rooftops and Green walls
c. High degree of permeability and Riparian areas
d. City tree canopies and ecology parks

13. As of 2023, which of the following cities were members of the Biophilic Cities network?

a. Tulsa , OK.
b. San Jose CA.
c. Ann Arbor, MI.
d. None of the above

14. Which community park project received a $465 million gift, the largest such gift in US history?

a. Gathering Place, Tulsa OK.
b. East Riverfront redevelopment, Detroit, MI.
c. Central Park, New York, NY.
d. Silicon Valley Nature Preserve, Sausalito, CA.

15. In its outlook for biophilic design, the Global Wellness Summit declared:

a. Biophilic design is a "flavor of the day trend" that will quickly fade away.
b. Biophilic design can only prosper of global population is reduced.
c. Biophilia is not a "trend" but the long-term future of architecture and design.
d. While biophilic design is useful, it is not a long term option for reducing the effects of climate change.

16. Which of the following buildings mentioned in the course is not mentioned as an example of biophilic design?

a. Fallingwater
b. AT&T (Sony) Tower
c. The Orchard, Hammad International Airport
d. La Sagrada Familia

17. Monochromatic colors schemes:

a. Use black and white only.
b. Are the same as RGB color sets.
c. Use combinations of two colors to create a single color.
d. Use shades, tints, and tones derived from a single color.

END of COURSE.

Answers to review questions:

1. **Who wrote the book: "The Practice of Biophilic Design"?**
   a. **Stephen R Kellert and Elizabeth F Calabrese.**
   b. Erich Fromm
   c. George Orwell
   d. None of the above.

   The correct answer is A. Both Fromm and Wilson put forth hypotheses that biophilia has a biological basis and that it is fundamental to develop harmonious relationships between humans and the biosphere. However, it was an American Stephen R Kellert who took the theory towards architecture and design. He went on to publish the book titled "The Practice of Biophilic Design" along with co-author, Elizabeth F. Calabrese. The book is a very useful text on the subject and a must for any architect who wishes to indulge in biophilic design. It is also an easy read. The principles articulated by Kellert have earned him the honorific "Father of Biophilic Design", a title that he served well during his lifelong commitment to the ideals of Biophilic design.

2. **One of the earliest examples of a "biophilic" building from ancient times is :**

a. The Parthenon
b. The Tempe of Abu Simbel
c. The Hanging Gardens of Babylon
d. Cleopatra's River Garden

The correct answer is C. One of the most famous and ancient mentions of the usage of nature integrated with the buildings are the Hanging Gardens of Babylon, considered one of the Seven Wonders of the Ancient World. They were described as a remarkable feat of engineering with an ascending series of tiered gardens containing a wide variety of trees, shrubs, and vines, resembling a large green mountain constructed of mud bricks. It was said to have been built in the ancient city of Babylon, near present-day Hillah, Babil province, in Iraq.

3. Which of the following is not a historic Urban Park?

a. Balboa Park, San Diego; incorrect, this is a historic urban park
b. Stanley Park, Vancouver; incorrect, this is considered a historic urban park
c. Chapultepec Park, Ciudad de Mexico; incorrect, this is considered a historic urban park
d. Tranquility Park, Houston; correct, this is not a historic urban park.

4. According to the course material, which political ideology does biophilic design appeal to?

a. Left leaning liberal ideology
b. It has universal appeal
c. Ultra conservative nativist ideology
d. Only conservationists

B is the correct answer. The biophilic approach to urbanism has a unique quality in that regardless of the political side of the climate change issue, the transformations encouraged by using biophilic concepts create spaces that have universal appeal regardless of politics, gender, race or any other demographics.

5. Which of the following is true?

a. Biophilic design is a sound economic investment in our health and wellbeing
b. Biophilic design, by virtue of its costs, is only a luxury
c. Biophilic urbanism has no impact on anything
d. Biophilic Urbanism is losing popularity

A is the correct answer. Biophilia is increasingly recognized as an important element in building design for creating spaces that support health and wellbeing. Luckily, biophilic design does not require extensive or expensive interventions to have an impact. Simply ensuring offices have views to the outside, contain plants, receive adequate daylight or have decorative nature-inspired art all help create a more inviting, healthy and desirable environment. Biophilic design is not a luxury,

it is sound economic investment in our health and wellbeing.

6. **Which of the following are elements of Stephen Kellert's biophilic framework?**
   a. Direct Experience of nature
   b. Indirect Experience of nature
   c. The Experience of Space and Place
   d. All of the above
   D is the correct answer. These are all elements of Stephen Kellert's biophilic framework.

7. **The Detroit East Riverfront Revitalization is an example of?**
   a. Rewilding
   b. Urban sprawl
   c. A failed use of taxpayer funds
   d. River water recycling
   The correct answer is A. The term rewilding was coined by members of the grassroots network Earth First!, first appearing in print in 1990. Rewilding is a form of ecological restoration aimed at increasing biodiversity and restoring natural processes.

8. **Which of the following is related to bionics?**
   a. Biomorphic
   b. Biomimicry
   c. Anthropomorphic
   d. Demetric
   B is the correct answer. Biomimicry, or Biomimetics is the emulation of the models, systems, and elements of nature for the purpose of solving complex human problems. The terms "biomimetics" and "biomimicry" are derived from Ancient Greek: (bios), life, and (mīmēsis), imitation, from (mīmeisthai), to imitate, from (mimos), actor. A closely related field is bionics.

9. **Which of the following is not an example of a pattern occurring in nature?**
   a. Spirals
   b. Orthogonal grid
   c. Waves and ripples
   d. Hexagonal tessellations
   B is the correct answer. The following are some of the most common examples of patterns occurring in nature: Symmetry, spirals, waves and ripples, spots and stripes, cracks, tessellations, branching.

10. **Which of the following buildings are said to have received some inspiration from an orange peel?**

    A. The Heydar Aliyev Center by Zaha Hadid

    B. TWA Terminal by Eero Saarinen

    C. The Sydney opera House by Jørn Utzon

    D. Casa Battló by Antonio Gaudi

    a. B & C

    b. A & C

    c. D & B

    d. A, B, & C

    A is the correct answer. The TWA Terminal and the Sydney Opera House.

11. **If an interior space within a building has a pleasant or dramatic view, which of the following is a true statement?**

    a. Price (rent) goes up

    b. The building likely wasted a lot of valuable real estate.

    c. The space would be considered bio phobic.

    d. No additional features biophilic elements should be considered.

    A is the correct answer. Most biophilic projects are still on the high end of the price spectrum whether it is commercial rental space or residential developments. A major reason for this is that incorporating natural elements and systems into the built environment often requires a higher upfront investment.

12. **Which of the following are elements of Building level implementation?**

    a. Green courtyards and green streets

    b. Green rooftops and Green walls

    c. High degree of permeability and Riparian areas

    d. City tree canopies and ecology parks

    B is the correct answer. According to the Biophilic Green Urban Design Elements in Cities Chart, Green Rooftops, Sky gardens, Rooftop gardens, Green walls, Green Facade and Daylit interior spaces are all at the Building implementation level.
    Green courtyards or part of the Block implementation level
    Green Streets are part of the Street implementation level
    High Degree of permeability is part of the Street implementation level
    Riparian areas are part of the Region implementation level
    City Tree Canopies are part of the Community implementation level

Ecology parks are part of the Neighborhood implementation level

13. **As of 2023, which of the following cities were members of the Biophilic Cities network?**
    a. Tulsa , OK.
    b. San Jose CA.
    c. Ann Arbor, MI.
    d. None of the above
    D is the correct answer. There is a list of 31 cities that are currently listed as Members of the Biophilic Cities Network of which none of these cities are listed on.

14. **Which community park project received a $465 million gift, the largest such gift in US history?**
    a. Gathering Place, Tulsa OK.
    b. East Riverfront redevelopment, Detroit, MI.
    c. Central Park, New York, NY.
    d. Silicon Valley Nature Preserve, Sausalito, CA.
    A is the correct answer. Gathering Place is a 66.5-acre park along the Arkansas River in Tulsa, Oklahoma. Created by the George Kaiser Family Foundation, and designed by landscape architect Michael Van Valkenburgh, the park was established September 8, 2018. It is open to the public free of charge. At $465 million, Gathering Place is the largest private gift to a community park in U.S. history.

15. **In its outlook for biophilic design, the Global Wellness Summit declared:**
    a. Biophilic design is a "flavor of the day trend" that will quickly fade away.
    b. Biophilic design can only prosper of global population is reduced.
    c. Biophilia is not a "trend" but the long-term future of architecture and design.
    d. While biophilic design is useful, it is not a long term option for reducing the effects of climate change.
    C is the correct answer. In a post COVID assessment, the Global Wellness Summit declared that "Biophilia is not a "trend" but the long-term future of architecture and design". If one looks at all mainstream architecture and planning magazines, blogs and conferences, sustainability and incorporation of nature are pervasive in all forums. It is hard to recall when design consciousness was so popular in recent times. These indications all suggest that biophilic inspired sustainable design methods will continue to gain momentum.

16. **Monochromatic colors schemes:**

a. Use black and white only.

b. Are the same as RGB color sets.

c. Use combinations of two colors to create a single color.

d. Use shades, tints, and tones derived from a single color.

D is the correct answer. Monochromatic: Using shades, tints, and tones derived from a single color.