

BIOPHILIC DESIGN



Research Plan

Research Plan
Explore LAB Graduation Studio



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INTRODUCTION

"When approaching the Temppeliaukio Church you would barely know that it is there, as the building hides itself within the rocks that it was ones carved out of. However, the contrast between the exterior and interior could not be more stark. Where the exterior seems unremarkable, the interior is profound. Once inside I was in awe, seeing the diffused light enter the building, hearing the sounds fade away, feeling the texture of the walls and experiencing the radial copper roof, that feels both light and heavy at the same time, made me feel at peace with myself and my surrounding."

- Anjès Swart

This experience showed me what architecture can be. Where we often evaluate a building on their functionality, a building can be, and should be so much more. The Temppeliaukio Church demonstrated that space can evoke emotion and feeling, and that people can become one with a space, as opposed to simply occupying it. And that is what I want to create, architecture where the mind, the body and the build environment become one.

In order to create such architecture the design approach has to shift from purely functional approach to one that includes human experience and emotional connection. Lee (2022) state that the experience of space happens through the interaction of the human body with its surroundings, and that this goes beyond a mere visual connection. A spatial experience is evoked through both; physical movement, and all the bodily senses, sight, touch, smell, hearing and taste. This means that in order to create architecture that connects with humans, one has to identify what external factors positively influence both the bodily movement as well as the senses.

Creating buildings that have a positive effect on humans is perhaps more important than ever. The recent years have again shown us the negative effects that urbanized areas and its lack of nature has on people (Andreucci et al, 2021). Urbanization keeps increasing and it is expected that in 2050 around 66% of the developed world will be urbanized, meaning that over 6.5 billion people will live in urbanized areas. Already, the western world spends an average of 90% of their time indoors. In correlation with that, stress has been called the health pandemic of the 21st century (Heath et al, 2018) (Söderlund and Newman, 2015). Not only

people are suffering, nature is too. The beginning of the 21st century finds itself in a climate crisis as a consequence of the acceleration of global warming. This has led to environmental pollution, drought, rising sea levels and an increase in natural disasters, all threatening human health and welfare (Lee and Park, 2021) (Söderlund and Newman, 2015). Therefore society has to seriously reconsider its relationship with nature, not only for its own well-being but also for the benefits of the planet.

Biophilic Design offers a strategy that does just that, creating a build environment that improves both humans and natures well-being. Biophilic Design comes forth from the concept of biophilia. First introduced in 1964 by Erich Fromm and later popularized by Edward O. Wilson in 1984. Biophilia or "love of life", introduces the inherit connection that exists between people and nature (Söderlund, 2019). Biophilic design builds upon this concept, as it aims to introduce elements into the build environment that foster this human-nature connection. Despite the fact that this theory has evolved over the past sixty years, and that the positive effects of the presence of natural elements have been scientifically proven, there still seems to be a limited body of knowledge on the application of biophilic design. "The biophilic design framework still lacks explicit design strategies and guidelines to translate these approaches or elements into architectural design" (Zhong et al, 2019, p135). Therefore, this research aims to bridge the gap between the theoretical framework and its application, by answering the following question. What is the architectural expression of biophilic design, and what strategy should be used to correctly implement them into a design?

To answer this question, this paper will first outline the theoretical framework, exploring how the term biophilia has informed the theory of biophilic design. After which the different frameworks that classify the application of biophilic design will be investigated. When the theoretical framework has been established, the case study research will be introduced, explaining the process of case study selection, as well as the criteria to which the case studies will be tested. Finally, this paper will conclude a brief overview of the expected results and how these will influence the design process.

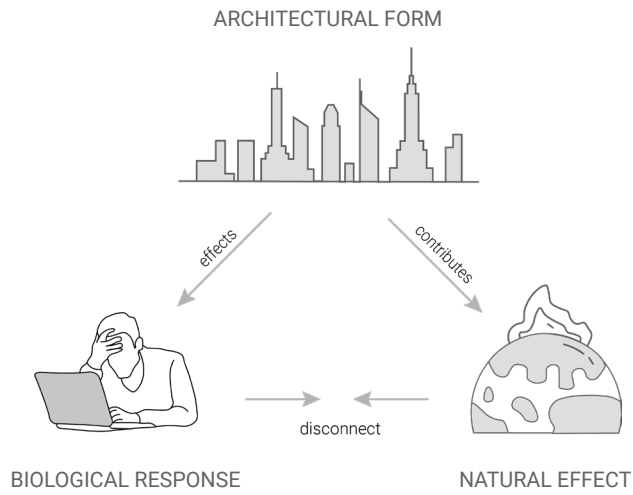


Figure 1: Current state, where the architectural form negatively influences people and nature. Source: Author

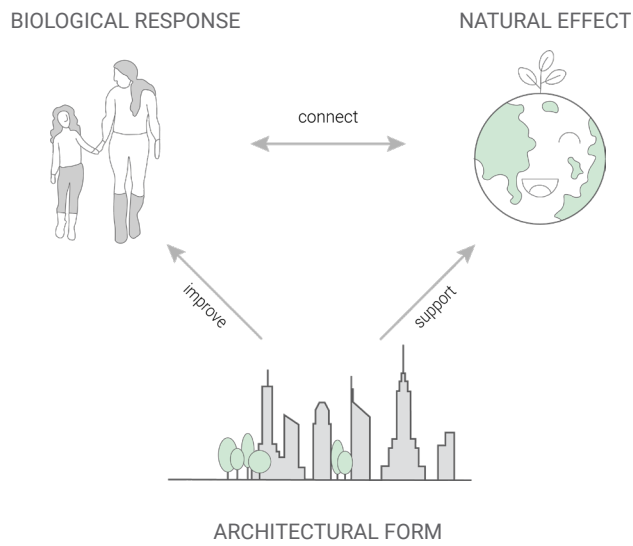


Figure 2: The architectural form derived from biophilic design positively influences people and nature. Source: Author

BIOPHILIA

From term to social movement

Biophilic design has evolved from the term biophilia, and has taken sixty years to come to where it is today, and is still growing and evolving. In order to understand its complexity, it is important to understand how it started. First mentioned in the 1960s by psychoanalyst Erich Fromm, the term biophilia, meaning 'love of life' was used to describe humanity and the 'essence of man'. Fromm described that there is a separation between humans and nature due to the humans' awareness of themselves. Where this separation makes humans free, it also installs a deep anxiety and conflict. The evolution of cities, becoming more industrialized and commoditized, separates humans even further from nature, increasing that feeling of anxiety and even evoking a hate for life (Söderlund, 2019). Humans can either regress towards this hate of life, or progress towards a love of life. Along this progressive path lies biophilia. "The biophilous conscience is motivated by its attraction to life and joy; the moral effort consists in strengthening the life-loving side in oneself" (Fromm 1964, p. 43).

It wasn't until 1984 that the term of biophilia was popularized. Sociobiologist Edward Wilson defined biophilia as "the innate tendency to focus on life and lifelike processes" (Wilson, 1984, p1). In his book *Biophilia*, Wilson (1984) builds upon the writings of Fromm, agreeing that a biophilic love for nature is inherent in humans (Söderlund, 2019). Since the beginning of human evolution, humans have co-evolved with the natural environment, making humans' response towards nature, both positive and negative, imbedded into human DNA (Kellert, 2018). The humans' 'love of life' can be fostered by recreating key features from nature (that are preferred by humans from an evolutionary point of view) that positively nourish the human-nature connection. By this point the term biophilia was very much that, a term to describe an inherent relation between nature and humans. However, Wilson's gained traction among scholars from a diverse range of fields, that were finding grounds in his biological approach (Söderlund, 2019). In *The Biophilia Hypothesis* from 1992 a multidisciplinary group of people was invited by Wilson and Kellert to build upon the previously built notions. Not idolizing nature, but rather forming a scientifically based inquiry into the effects of connection, or disconnect, between humans and the natural environment. This process let them to conclude that the current

state of modern cities asked for a change in contemporary lifestyle (Kellert and Wilson, 1995).

Despite the positive reactions towards the book *The Biophilia Hypothesis*, it wasn't until 2006 that the next progression was made, and the theory became ground for a new design approach, summarized as "the expression of the inherent human need to affiliate with nature in the design of the built environment" (Kellert and Heerwagen 2008, p. viii). This approach tries to find opportunities to express nature in urban environments, creating not only a more sustainable world, but also an improvement of human well-being. This would ask for a paradigm shift in how to design and build, providing "a new language for interpreting the built environment" (Berkebile et al, 2008, p347). This requires a multidisciplinary approach and a fundamental shift in how urban life is viewed. This led to the establishment of the term 'Biophilic Design' in 2007 (Söderlund, 2019). Publications, progressing and supporting the rational and benefits of this theory have increased, and policies have been started to form. Initiatives have started to bring nature back into the cities following the principles of biophilic design, yet it is clear that the movement is still growing and evolving (Beatley, 2016), as explicit design principles are still limited (Zhong et al, 2019). The next chapter will explore the different frameworks that have been formed to better understand the application of biophilic design.



Figure 3: The inherent connection between humans and nature, and the experience through the senses. Source: Author



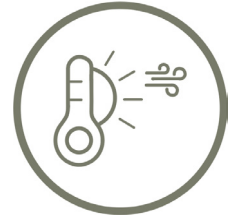
1. VISUAL CONNECTION WITH NATURE



2. NON-VISUAL CONNECTION WITH NATURE



3. NON-RHYTHMIC SENSORY STIMULI



4. THERMAL & AIRFLOW VARIABILITY



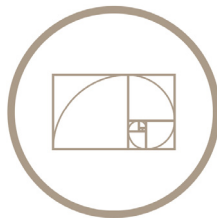
5. PRESENCE OF WATER



6. DYNAMIC & DIFFUSE LIGHT



7. CONNECTION WITH NATURAL SYSTEMS



8. BIOMORPHIC FORMS & PATTERNS



9. MATERIAL CONNECTION WITH NATURE



10. COMPLEXITY & ORDER



11. PROSPECT



12. REFUGE



13. MYSTERY & ENTICEMENT



14. RISK & PERIL



15. AWE

15 PATTERNS
TERRAPIN BRIGHT GREEN

Figure 4: Icons representing the 15 pattern of biophilic design as described by Browning et al 2014. Source: Author

BIOPHILIC DESIGN

The Frameworks for Design

In order to understand the implementation of biophilic design within the realm of architecture, various academics and practitioners have developed frameworks classifying natural aspects into categories and elements (figure 5). These frameworks differ in interpretation, some are derived from the field of evolutionary psychology others are based on the biological responses that occur in the human-nature relationship. Out of these frameworks three stand out, as they are often used in studies that investigate the application of biophilic design. These three frameworks also form the conceptual base for the criteria that are used for architectural certificates, such as LEED and WELL (Zhong et al, 2019). The framework as described by Kellert in 2008, and later refined in 2018, is perhaps the most well-known. The theory is directly built upon the concept of biophilia as described by Wilson, and focuses on evolutionary psychology. Where the first framework from 2008 leads to

some ambiguity in the relation between the two dimension; organic or naturalistic, and place based or vernacular, the second framework from 2018 has tried to resolve this by making it more concise. It focusses on how people experience 'nature' and what attributes refer to that experience (Kellert, 2008). Nevertheless, the used terminology remains vague at certain times. The third framework as described by Browning et al (2014) took inspiration from A Pattern Language, by Alexander and Murray. Derived from the biological response and benefits, the 15 Patterns of Biophilic Design focus on the physiological and cognitive benefits nature has on people. Divided into three categories these fifteen patterns try to propose a clear and standardized terminology for the application of Biophilic design (Browning et al, 2014). Both frameworks "agree that nature can be experienced psychologically through deliberate spatial arrangements" (Zhong 2019, p.121), yet the interpretation of how, is different.

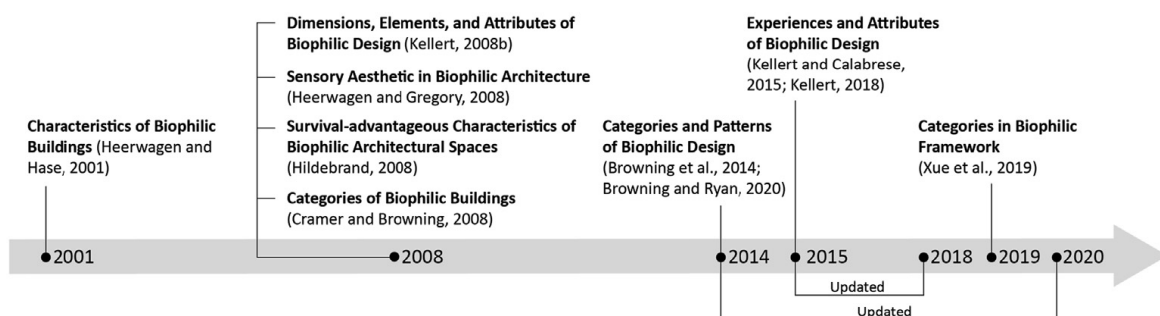


Figure 5: Description of the different frameworks of biophilic design. Source: Zhong et al, 2019







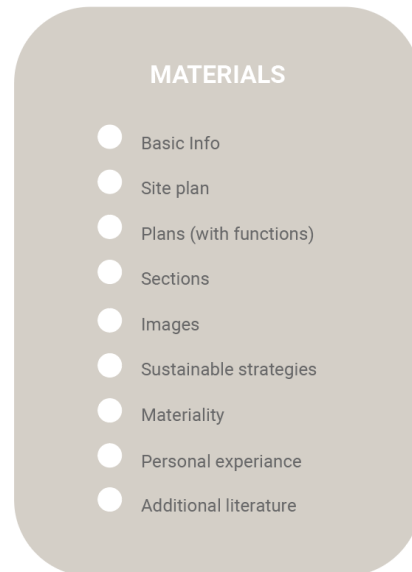
PROJECT	ARCHITECT	SITE	CLIMATE	YEAR	BUILDING TYPE	AREA	BIOPHILIC ARCHITECTURE	VISIT	
	Windhover	Aidlin Darling Design	370 Santa Teresa St, Stanford, CA 94305, Verenigde Staten	Csb	2014	Contemplative Center	372 m ²	Yes	No
	VanDusen Botanical Garden	Perkins & Will	5251 Oak St, Vancouver, BC V6M 4H1, Canada	Cfb	2011	Visitor Center	19,483 m ²	Yes	No
	Winter Park	Adjaye Associates	1050 W Morse Blvd, Winter Park, FL 32789, Verenigde Staten	Cfa	2021	Library / Cultural Center	5,184 m ²	Yes	No
	H.C. Andersen Hus Museum	Kengo Kuma & Associates	H.C. Andersen Haven 1, 5000 Odense C, Denemarken	Cfb	2022	Museum	5,600 m ²	No	Maybe
	Oodi Helsinki Central Library	ALA Architects	Töölönlahdenkatu 4, 00100 Helsinki, Finland	Dfb	2018	Library	17,250 m ²	No	Yes
	Naturalis Biodiversity Center	Neutelings Riedijk Architects	Darwinweg 2, 2333 CR Leiden, Netherlands	Cfb	2019	Museum	38,000 m ²	No	Yes

Figure 6: Overview of chosen case studies. Source: Author, Images from ArchDaily.com

CASE STUDIES

This chapter will explain the methodology that is used to answer the following question; what is the architectural expression of biophilic design, and what strategy should be used to correctly implement them into a design? First, the architectural form of biophilic design needs to be identified, this will be done through the method of case studies. Six case studies will be selected and compared to the fifteen patterns of biophilic design as described by Browning et al. Limiting myself to an exciting framework of application will help me build upon the existing knowledge and keep the research clear. The reason I choose to use the framework described by Browning et al, as opposed to the framework described by Kellert has multiple reasons. The 15 patterns of biophilic design move towards a strategy of application. Each pattern is backed with scientific evidence supporting the biological responses that the pattern has on people. In addition, each pattern explores the design opportunities, strategies and considerations for application (Browning et al, 2014). This forms a solid theoretical framework that allows for comparison with case studies. In order to compare the patterns to the case studies, each pattern will be summarized, identifying its origin in nature, the local effects that play a role on its application, the biological responses the pattern evokes, and lastly, how the pattern can be recognized within the case study.

In order to ensure their relevance towards the topic of biophilic design and to allow for comparison, the case studies will be selected according to the following framework. First, and perhaps most important, all case studies have to be located in urban areas, the theory of biophilic design has come forth as a response to the industrialization of cities, so urban architecture will best show what biophilic design is. Secondly, all buildings that are chosen have to be constructed in the western world, this is in order to limit the cultural and local factors that inevitably influence the design, limiting to a specific region will hopefully lead to finding architectural forms that support each other. Despite the fact that the application of biophilic design happens within a wide range of building types, the decision is made to limit the case studies to a similar building type, this being cultural architecture. These buildings are largely public, allowing for access to the buildings, in addition, these buildings have a wide range of spaces that are designed with different intent, hopefully resulting in the application of a wide range of patterns. Not



only buildings that have been designed as biophilic express characteristics that can be attributed to biophilic design. In order to explore the differences between conscious and unconscious intent, half of the case studies are labeled as biophilic, the other half is not, but instead find themselves within the realm of sustainable design. Because the term biophilic design wasn't established until 2007, all projects will have to be completed after 2007, in order to have a similar level of technological advancement, allowing for fair comparison. Finally, while visiting a case study holds a lot of value, I believe that this would limit the selection so severely that it would harm the representation of the patterns. However, ideally half of the case studies will be visited, so that a reflection of my personal experience to the scientific evidence that supports the biological responses can be made.

The theoretical framework of the patterns will then be cross referenced with the case studies, using plans, sections, elevations, sustainability strategies, pictures, writings related to the building, and where applicable, personal experience. The comparison will lead to the identification of architectural forms that relate to the specific patterns. Despite the fact that this gives a lot of information, it alone is not enough to create a strategy for its application. This will be formed through a reflection of the patterns architectural form, it's biological effect, and it's relation to nature. This research is meant to form a basis that can be expanded in the future with more architectural forms derived from other case studies.

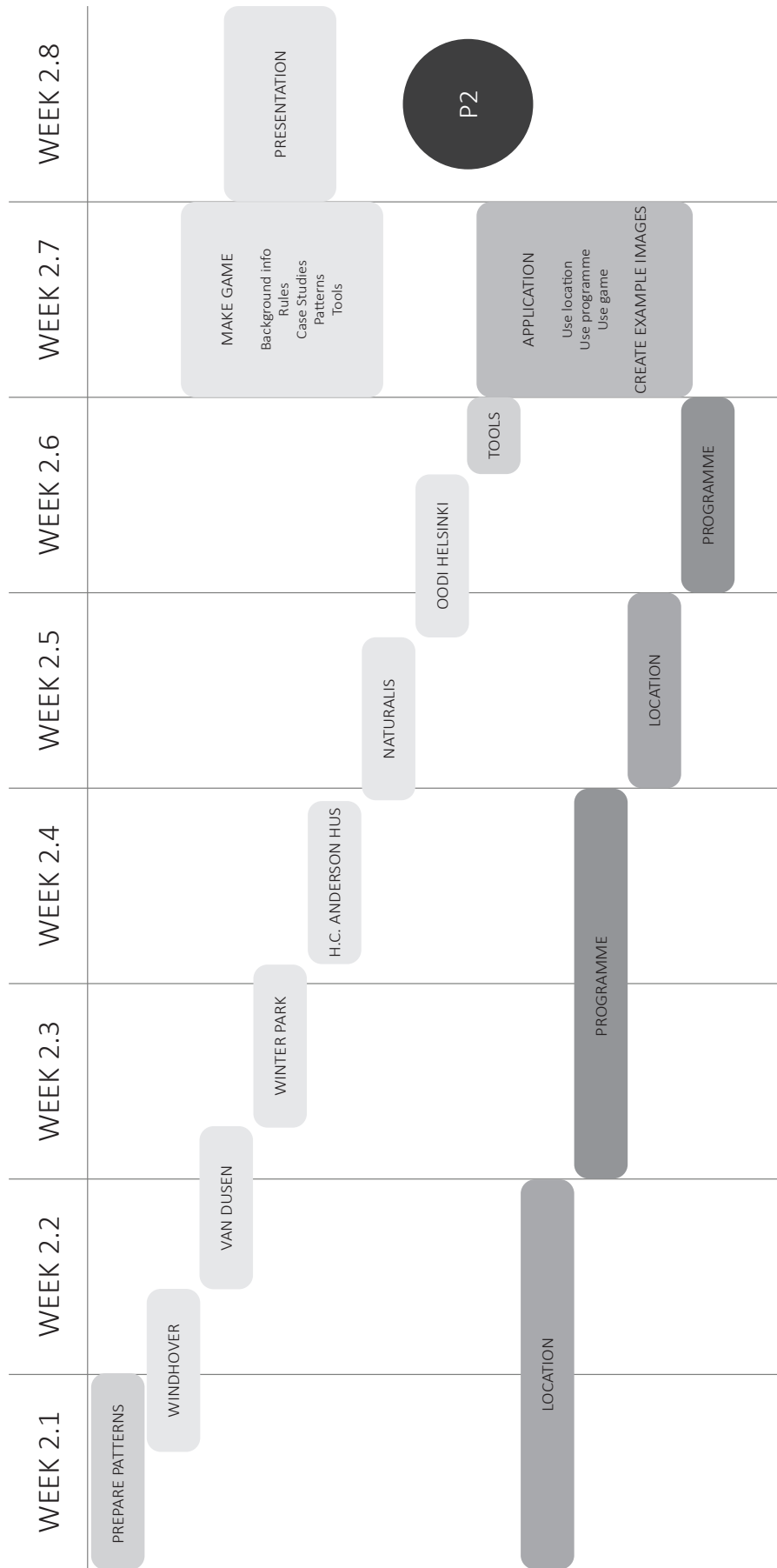


Figure 7: Planning of the research. Source: Author

RESULTS

A Game of Biophilic Design

This research seeks to divine the architectural expression of biophilic design, and determine a strategy for its application. The architectural form will be determined through the cross-reference of the '15 patterns of biophilic design' and six case studies. It is likely that not all patterns will lead to an equally strong result, as some are a lot more ambiguous than others. In these cases it might however still be possible to find useful results through hypothesizing the architectural form that allows for a certain result. The case studies have been selected in such a way that hopefully each pattern will occur at least twice. These results together with the results of the reflection will be presented in the form of a game.

This card game will consist of; pattern cards, tool cards, example cards and an instruction manual. The pattern cards will represent the 15 patterns of biophilic design. Each card will summarize one pattern, describing its relation to nature and its application therein, the biological response that the pattern evokes, and the relation that the patterns holds to its surrounding. These pattern cards will link to the tool cards. The tool

cards will show an abstracted version of the architectural form that has been identified within the case studies. The Example cards will give a short summary of the case study, with some background information, pictures and plans. The back of these example cards will show what patterns that were identified. That way they can be used as an exercise to recognize patterns, or as an example of how a pattern is applied. Lastly, the instruction manual will give an overview of the theory of biophilic design, but perhaps more importantly, it will show the strategy of application, derived through the reflection, in the form of instructions on 'how to play the game'.

This research will give me a better understanding of what the '15 patterns of biophilic design' are, how to implement them. After the research this knowledge will be used to inform the architectural form of my design. The 15 patterns will together with the location along the LA river and the program of a library determine the architectural form, resulting in a biophilic building. This will be done by following the strategy that this research produces, bringing the intent, location and patterns together.

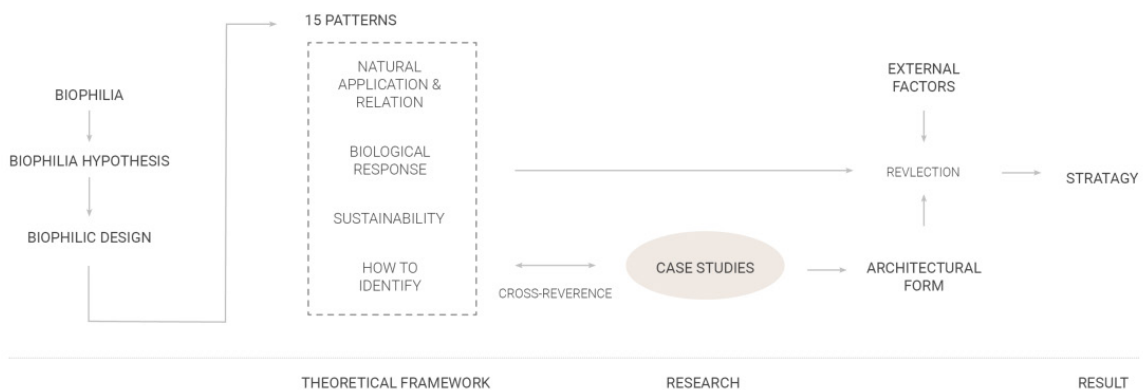


Figure 8: Research diagram. Source: Author

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APPENDIX 1

2 Dimensions, 6 Elements, and 72 Attributes of Biophilic Design (Kellert, 2008b)					
I. Organic or Naturalistic				II. Place-based or Vernacular	
1. Environmental features	2. Natural shapes and forms	3. Natural patterns and processes	4. Light and space	5. Place-based relationships	6. Evolved human-nature relationships
<ul style="list-style-type: none"> • Color • Water • Air • Sunlight • Plants • Animals • Natural materials • Views and vistas • Façade greening • Geology and landscape • Habitats and ecosystems • Fire 	<ul style="list-style-type: none"> • Botanical motifs • Tree and columnar supports • Animal (mainly vertebrate) motifs • Shells and spirals • Egg, oval, and tubular forms • Arches, vaults, domes • Shapes resisting straight lines and right angles • Simulation of natural features • Biomorphy • Geomorphology • Biomimicry 	<ul style="list-style-type: none"> • Sensory variability • Information richness • Age, change, and the patina of time • Growth and efflorescence • Central focal point • Patterned wholes • Bounded spaces • Transitional spaces • Linked series and chains • Integration of parts to wholes • Complementary contrasts • Dynamic balance and tension • Fractals • Hierarchically organized ratios and scales 	<ul style="list-style-type: none"> • Natural light • Filtered and diffused light • Light and shadow • Reflected light • Light pools • Warm light • Light as shape and form • Spaciousness • Spatial variability • Space as shape and form • Spatial harmony • Inside-outside spaces 	<ul style="list-style-type: none"> • Geographic connection to place • Historic connection to place • Ecological connection to place • Cultural connection to place • Indigenous materials • Landscape orientation • Landscape features that define building form • Landscape ecology • Integration of culture and ecology • Spirit of place • Avoiding placelessness 	<ul style="list-style-type: none"> • Prospect and refuge • Order and complexity • Curiosity and enticement • Change and metamorphosis • Security and protection • Mastery and control • Affection and attachment • Attraction and beauty • Exploration and discovery • Information and cognition • Fear and awe • Reverence and spirituality
3 Experiences and 25 Attributes of Biophilic Design (Kellert, 2018)					
1. Direct Experience of Nature		2. Indirect Experience of Nature		3. Experience of Space and Place	
<ul style="list-style-type: none"> • Light • Air • Water • Plants • Animals • Landscapes • Weather • Views • Fire 		<ul style="list-style-type: none"> • Images • Materials • Texture • Color • Shapes and forms • Information richness • Change, age and the patina of time • Natural geometries • Simulated natural light and air • Biomimicry 		<ul style="list-style-type: none"> • Prospect and refuge • Organized complexity • Mobility • Transitional spaces • Place • Integrating parts to create wholes 	
3 Categories and 15 Patterns of Biophilic Design (Browning and Ryan, 2020)					
1. Nature in the Space		2. Natural Analogues		3. Nature of the Space	
<ul style="list-style-type: none"> • Visual Connection with Nature • Non-Visual Connection with Nature • Non-Rhythmic Sensory Stimuli • Thermal & Airflow Variability • Presence of Water • Dynamic & Diffuse Light • Connection with Natural Systems 		<ul style="list-style-type: none"> • Biomorphic Forms & Patterns • Material Connection with Nature • Complexity & Order 		<ul style="list-style-type: none"> • Prospect • Refuge • Mystery • Risk/Peril • Awe 	

Source: Zhong et al, 2019

APPENDIX 2

14 PATTERNS OF BIOPHILIC DESIGN

IMPROVING HEALTH AND WELL-BEING IN THE BUILT ENVIRONMENT

NATURE IN THE SPACE



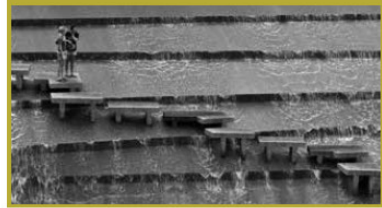
- 1. Visual Connection with Nature**
A view to elements of nature, living systems and natural processes.
- 2. Non-Visual Connection with Nature**
Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.
- 3. Non-Rhythmic Sensory Stimuli**
Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.
- 4. Thermal & Airflow Variability**
Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.
- 5. Presence of Water**
A condition that enhances the experience of a place through the seeing, hearing or touching of water.
- 6. Dynamic & Diffuse Light**
Leveraging varying intensities of light and shadow that change over time to create conditions that occur in nature.
- 7. Connection with Natural Systems**
Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem.

NATURAL ANALOGUES



- 8. Biomorphic Forms & Patterns**
Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.
- 9. Material Connection with Nature**
Material and elements from nature that, through minimal processing, reflect the local ecology or geology to create a distinct sense of place.
- 10. Complexity & Order**
Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature.

NATURE OF THE SPACE



- 11. Prospect**
An unimpeded view over a distance for surveillance and planning.
- 12. Refuge**
A place for withdrawal, from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.
- 13. 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.
- 14. Risk/Peril**
An identifiable threat coupled with a reliable safeguard.

Source: Browning et al 2014