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Human-Centric Doppelgänger to Sustainability: The Biophilic Effect in Architecture.

Abstract

This paper investigates the intersection of sustainability and biophilic architecture while advancing the novel theoretical construct of the biophilic effect. It critiques the prevailing architectural emphasis on technical precision in sustainability, contending that such approaches, while indispensable, inadequately address environmental design's perceptual, behavioral, and psychological dimensions. By centering human experience, this work advocates for integrating climate sensitivity into architectural spaces to foster a profound human-nature connection.

The biophilic effect, as introduced in this paper, constitutes its central scholarly contribution. This concept addresses the limitations of current biophilic design frameworks by offering a cohesive theoretical lens to unify diverse strategies and bridge the experiential gap in sustainable architecture. Based on the dynamic interplay between space, body, and mind and defined as a two-way path between nature, built environment, and inhabitant, the biophilic effect encapsulates the potential of architectural interventions to enhance mental well-being, ecological consciousness, and sustainable behavioral shifts. By positioning architecture as a transformative medium that mediates and reframes natural phenomena, this concept foregrounds design's psychological and sensory dimensions as integral to sustainability.

Biophilic design is presented as a transformative paradigm capable of enhancing human well-being, challenging habitual behaviors, and promoting ecological awareness. Through historical and contemporary theories of biophilia, alongside illustrative architectural examples, this paper traces the evolution and impact of biophilic principles. The analysis further extends to embodied design perspectives, emphasizing the interwoven sensory, cognitive, and emotional engagements between humans and their built environments. Ultimately, the biophilic effect is advanced as a unifying framework that synergizes the technical rigor of green design with the lived experiences and behaviors of architectural inhabitants, offering a more holistic and human-centric approach to sustainability.

Keywords
Biophilia Hypothesis, embodied architecture, cognitive psychology, ecology, act-perience

1. Introduction

As the climate crisis has been one of the most critical issues in the last decade, it is not surprising that sustainability and green design have been at the center of architecture, a self-proclaimed socially responsible profession. The mainstream design and academic discourse focused on sustainable buildings with longer lifecycles, diminishing the carbon footprint of the built environment, and energy use by our living machines. We know that buildings produce a considerable amount of carbon footprint, and architectural efforts are diverted to minimize the resources and create eco-friendly environments, in other words, to achieve technical perfection in sustainability.

While the long-term goal of saving the earth and securing humanity's future is undeniably crucial, it may seem distant. A warning about the potential future end of the world may not effectively influence our present decision-making, as the challenges in legislative transformations imply. It is a long-term goal, a future utopia, with limited benefits for our day-to-day lives. Our collective acting self can easily convince itself to procrastinate. Technical perfection in sustainability for a healthier earth's future may be the basis, yet it tends to be too invisible for users and technical for architects. Generally, the mainstream tendency is to go full-throttle in green techno-excellence, yet the scientific aspects seem to lack the mental aspects, especially mental health, when looking at the big picture depicting the earth's health. Moreover, the functional arrangements and daily life seem to revolve only around circularity but not singular human beings, and aesthetics are an afterthought, barely surpassing natural and local materials' visual effects. It seems to lack a theoretical load of design for individual inhabitants.

A more human-centric approach to ecological architecture is translating climate sensitivity into a three-dimensional experience, seamlessly integrating it with mental health, lifestyle, and perception. Such a framework not only makes the abstract urgency of climate change more tangible but also rekindles an innate sense of harmony between humans and nature, fostering responsibility and care. To achieve this, this article positions biophilic architecture as a complementary paradigm to the technical precision of sustainability. By delving into the historical evolution and thematic foundations of biophilic design, this paper introduces the concept of the biophilic effect as a unifying framework. This effect connects diverse biophilic strategies, linking the natural environment, the built space, and the human occupant in a dynamic and transformative interaction. The discussion ultimately aims to establish a theoretical foundation for reimagining sustainable architecture through the lived experiences of its inhabitants.

2. Biophilia

2.1. Historical Background

While the technical perfection of green design brings concrete benefits, the built environment's health, functional, and esthetic aspects may play vital roles in climate-friendly architecture. Stephen Kellert, one of the leading advocates of Biophilic Design, wrote in Metropolis Magazine (2015) that much of today's built environment -most of the places we call home- reminds of the barren sensory-deprived cages of the old-style zoo, now ironically banned as "inhumane." In that regard, the approach of Biophilic Design claims to suggest a working framework, a wide and varied sum of design strategies in terms of functional decisions and esthetic outlook.

The term biophilia was coined by social psychologist Erich Fromm from the 1960's on to describe the "love of life" that explained two fundamental tendencies of living organisms: sustaining life from death threats and the positive integration with each other. The biologist and naturalist Edward Wilson's 1984 book Biophilia proposed that humans are genetically predisposed to be attracted to nature, establishing an evolutionary, innate

connection between them. In his Pulitzer-winning book published by Harvard University Press, Wilson argues that our natural affinity for life—biophilia—is the very essence of our humanity and binds us to all other living species. He defined biophilia as "the innate tendency" to focus on life and lifelike processes and emotional affiliation of human beings to other living organisms, which is supported by psycho-evolutionary theory, arguing that some emotional reactions are rooted in human evolutionary history and developed to adaptive responses to modern society as explained by Roger S. Ulrich as early as 1983. The Biophilia Hypothesis, an edited volume by Wilson and Stephen Kellert, developed the biophilia hypothesis to interpret that the emotional connection with "life" was conserved after humankind migrated from the primitive natural environment into the artificial new environment and that the "innate tendency" represents the characteristics of hereditary. (Wilson, 1993, 31).

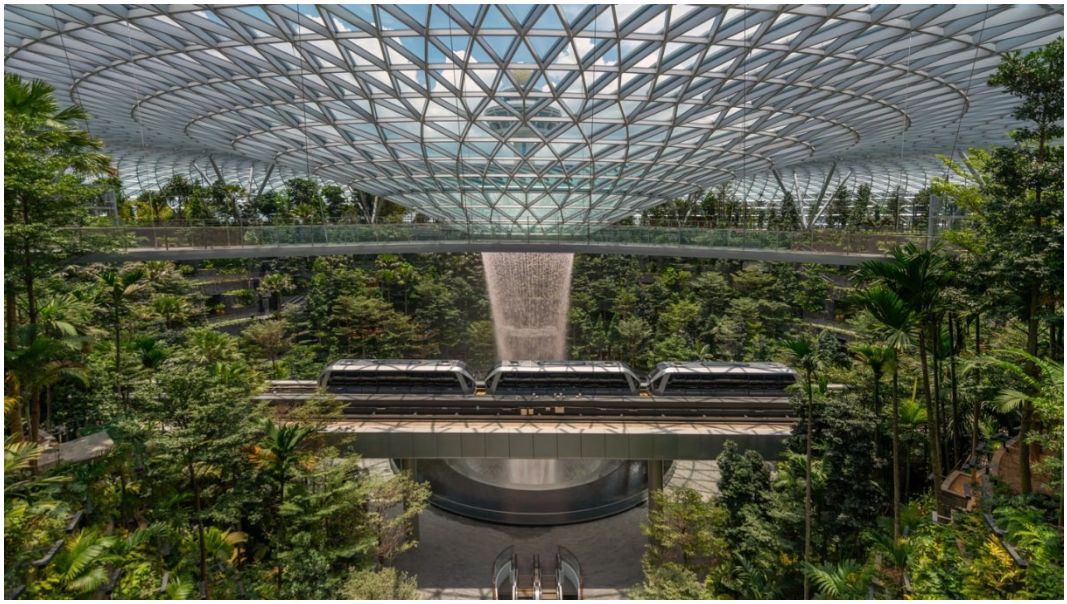
In the early 2000s, researchers began exploring the psychological and health benefits of natural elements in built environments, drawing on the concept of biophilia, which suggests humans have an inherent affinity for nature, while the academic work expanded on defining biophilic design principles. The "Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life," edited by Kellert, Heerwagen, and Mador, brought specialists from biological sciences and design together in 2008. The book has been transformative in permanently engraving the hypothesis into the realm of architecture. Empirical research and case studies, especially neuroscientific developments and cognitive psychological takeaways throughout the 2010s, validated the benefits of biophilic design, demonstrating improvements in mental health, reduced stress, increased productivity, and enhanced creativity, thus putting an emphasis on the concepts of experience and atmosphere in architecture. Pallasmaa and Robinson's multiauthored volume "Mind in Architecture: Neuroscience, Embodiment, and the Future of Design," published in 2015, demonstrated the potential of crossovers between biological sciences and user-centered design.

As the late 2010s approached, biophilic design became a hot topic and keyword occurrences in academic articles rising; it has increasingly been linked with sustainable architecture and public health, highlighting that biophilic elements not only improve occupant well-being but also contribute to environmental goals like energy efficiency and biodiversity. (Zhang et al., 2022) In the 2020s, biophilic design principles began to be incorporated into architectural standards and guidelines, with certifications like WELL and LEED including these concepts. Urban planning policies also emphasized green spaces and nature integration, driven by growing evidence of their benefits. Throughout these last two decades, the academic focus has shifted from theoretical exploration to practical implementation and policy integration, with interdisciplinary research bridging architecture, cognitive psychology, environmental science, and public health.

2.2. Biophilic Design Themes

The biophilic design arguments have several historical roots. Vitruvius discussed the necessity to respond to climate and environment in construction; Louis Sullivan's form follows function motto is based on a nature metaphor; and Gropius firmly claimed the benefits of transparent facades to workers' health regarding his Fagus factory; and the Austrian-American modernist Richard Neutra, who noteworthily worked for Frank Lloyd Wright, wrote in the aftermath of World War II the Survival Through Design (1954), an early warning that "technological wizardry might go wild," explored the critical role of architecture in enhancing human health and well-being by creating harmonious environments that respond to natural and social needs.

From Wölfflin to Rasmussen and Pallasmaa, architectural theory has suspected that we



Safide Architects, Changi Airport in Singapore, 2019

have innate preferences for spaces based on our anatomy. The recent and conscious interest in biophilia welcomes those roots, covers several historical examples, and differentiates itself with its evolutionary psychological basis. In doing so, the contemporary, self-aware biophilic design created a categorization field on how to use the innate connection between humans and nature.

Several analytical attempts have been made to define biophilic design in taxonomies, incorporating various perspectives and techniques to provide insight into the human-nature relationship rooted in biology, evolutionary psychology, neuroscience, and phenomenology.

Browning and Ryan's article, Categories and Patterns of Biophilic Design (updated from 2008 article with Cramer and 2014 booklet with Ryan and Clancy), and Zhang, Schröder, and Bekkering's critical review in 2022. A consensus can be seen among key contributors to biophilic design taxonomy based on different "types of experiences" (Kellert), "attributes" (Browning and Ryan), or "approaches" (Zhang et al.) as themes

Santiago Calatrava, World Trade Center Transportation Hub, 2016

implemented by the designer agent that recur and pervade in a work of architecture. Despite uncertainties, controversies, and overlaps in previous categorizations and the obvious usage of different terminologies, their themes maintain similar guidelines.

It is possible to observe a trend for triadic categorization in various works, especially in the neat schemes of Kellerts 2018 book Nature by Design: The Practice of Biophilic Design (developed from his 2008 book chapter and 2015 text with Calabrese),

Source	1st Theme	2nd Theme	3rd Theme
Kellert, 2018	Direct Experience	Indirect Experience	Experience of Space and Place
Browning and Ryan, 2020	Nature in the Space	Natural Analogues	Nature of the Space
Zhang, Schröder, Bekkering, 2021	Nature Incorporation	Nature Inspiration	Nature Interaction

2.1.1. First Theme: Incorporated Nature

The first theme, the incorporation of nature or the direct experience of it, is the mainstream and straightforward one. It is

about bringing in natural elements to create point-blank exposure to nature, using them as interior, façade, or landscape elements, connecting the plot area to various natural processes, and contacting with basic features and characteristics of the natural environments (water, air, daylight, plants, animals, landscape, weather, seasonal changes). A frequently used example is Changi Airport in Singapore by Safdie Architects, completed in 2019. In his essay, Thoughts on Biophilia, featured in Frank Lloyd Wright Quarterly, Moshe Safdie states that "an urban hustle bustle" was integrated with the experience of nature in a park-like setting. A public space with a garden at its center where the rainwater is collected to be reused in the building via a massive waterfall generated by the flow of the glass dome above. The waterfall becomes the central piece of the design, complimented by the interior garden, using the topical climate of long rain seasons in Singapore, thus creating a direct experience of nature by solidly incorporating elements of rain and plants inside in an ecologically sensible way.

2.2.1. Second Theme: Imagined Nature

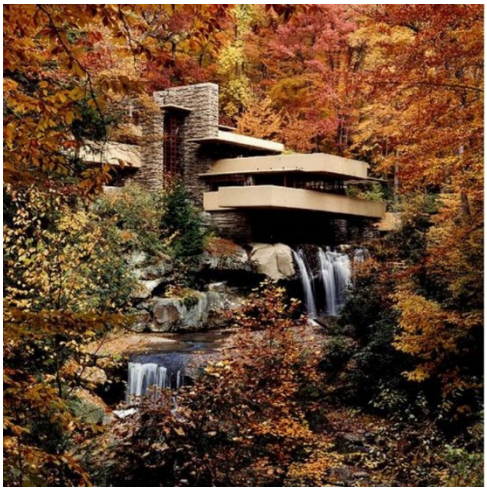
The second theme is the inspiration by nature or establishing an indirect experience of nature by using metaphorical shapes signifying a natural entity, reproducing mechanisms as in biomimicry, recreating patterns as in biomorphic design, reminding a habitat by using natural materials, and imitating nature by abstract ways. The inspiration-by-design theme utilizes design elements transformed from their original state and particular natural processes that have been especially instrumental in human evolution. A common example is Santiago Calatrava's World Trade Center transportation hub on the Ground Zero premises in NYC, which is designed at the intersection of biology, engineering, sculpture, and, most importantly, symbolism. A common image in uncommon ways, the building reminds the anatomical features of a bird ready to take off, an optimistic emblem of flight "as an answer to airborne disaster in the aftermath of 9/11," in the words of architecture critic Justin Davidson.

2.2.3. Third Theme: Simulated Nature

The third theme draws on the nature of our senses by employing certain spatial arrangement techniques derived from how

our sensing circuits have evolved, uncovering the peculiarities of our anatomy and cognitive capabilities. It is an ambiguous definition and a multi-dexterous category; Kellert calls it the “experience of space and place,” Browning and Ryan, “the nature of space,” Zhang, Schröder and Bekkering, “nature interaction.” While the terminology doesn’t overlap and the definitions are not neat, they mean the production of space strictly based on our biological and sensual mechanisms that evolved throughout millions of years while exposed to natural forces. This theme addresses spatial configurations of various kinds, which rely on how we sense the world around us. It particularly suggests exploiting the genetically encoded sensual and mental preferences. This idea is supported by neuroesthetics, a field within cognitive neuroscience investigating the neural underpinnings of esthetic experience, and rests on a compelling biological and genetic basis. For example, humans hypothetically have a tendency to appreciate organized complexity because it has increased the chance of survival by being able to recognize patterns in natural environments. They could locate danger or food better on the backdrop of a pattern of a jungle, and, thus, our visual system (a combination of several organs, electrical and chemical processes, and cognitive abilities including memory and imagination) evolved in such a way that a pattern fits in it operates. Thomas Albright (2015, 207) explains that we perceive the features of our environment with a sense of order, and such features are easily processed without visual scrutiny because they tap into our brain systems’ inherent organization for visual perception. This order provides a suitable background—and liberates neuronal resources—for detecting novelty (a predator or an intruder), which is nearly always of behavioral significance and demanding attention. The selective pressures over human evolution have yielded a visual brain with particular and tunable organizational properties for representing key statistics of the environment, such as commonly occurring features and conjunctions of features. As art historian Gombrich put it in 1961, the sense of order is deeply rooted in man’s biological heritage. Various historical examples reflect how visual perception works as landscapes locking in our senses contribute to our ancestors’ survival and how certain traits of natural spaces can be traced throughout history, as demonstrated by Hildebrant’s Origin of Architectural Places (1999).

Then, our way of perceiving the world has biological mechanisms that, almost in a Kantian sense and to a certain extent, create default preferences for certain settings, which constitute subthemes of prospect/refuge, familiarity/novelty, mystery, organized complexity, or transitional spaces. We prefer these characteristics in a setting because of our evolutionary desire to be able to see beyond our immediate surroundings, our fascination with the slightly unknown and revelatory moments, and sometimes even phobia-inducing properties when they include a trusted element of safety. An example of the third theme of using the nature of our senses is Frank Lloyd Wright’s Fallingwater House, which simultaneously provides prospect and refuge. According to the one hypothesis, “Prospect and Refuge” by Jay Appleton, dating back to 1975, taste in art is "an acquired preference for particular methods of satisfying inborn desires, which are for opportunity (prospect) and safety (refuge). Hominini, our zoological tribe of various extinct species, of which only one exists today, homo sapiens, have walked the earth for millions of years and have developed an evolutionary preference for places with an unimpeded view over a distance for surveillance and planning in front of them, while, at the same time, a place for withdrawal, from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.



Frank Lloyd Wright, Fallingwater, 1934

Wright's masterpiece of organic architecture is not only an example of the prospect and refuge balance, fulfilling our ancestral inclination, but also of how to interact with the surrounding natural environment to create the genius loci.

3. Biophilic Effect

The diverse themes of biophilic design offer valuable frameworks for exploring humanity's intrinsic need to connect with nature, grounded in the Biophilia Hypothesis. These themes delineate strategies and tactics, ranging from direct incorporation of natural elements to biomimetic inspirations and sensory engagements within architectural spaces. However, this variety, while rich, presents challenges of cohesion and conceptual clarity. Without a unifying tie, these approaches risk being fragmented, leaving a gap in understanding how biophilic principles can holistically foster design processes and experiences.

What remains essential is a precise, human-centric design concept that bridges the gap between the architectural process and the lived experiences of inhabitants. Such a concept must not only integrate the varied strategies of biophilic design but also foreground the sensory, cognitive, and emotional interactions that constitute meaningful human-nature relationships. Addressing these ambiguities, this chapter introduces the Biophilic Effect—a novel theoretical construct aimed at unifying disparate biophilic strategies into a cohesive design framework. The Biophilic Effect will serve as the foundation for reconciling nature, architecture, and human experience, offering a pathway to enhance both the psychological and ecological dimensions of sustainable design.

3.1. Embodied Perspectives

Firstly, a deeper understanding requires a closer look at the core of the idea, the human-centric focus, and, thus, how architecture brings together nature and the inhabitants. Designing using a sequence from nature through architecture to the inhabitants and back necessitates a view connecting mental processes, genetic abilities, and the space surrounding us. Humans, once the users of functionalist programs, need to be seen as a hybrid of mind and body in space so that we can create a theoretical basis for the human-nature connection, namely an embodied perspective. Sarah Robinson's Nesting: Body, Dwelling, Mind (2011) explains that body and mind cannot be separated in the sense of Descartes anymore, and our mental activities originate within and are beholden to the body. Each of our conscious states and every cognitive function -emotion, thought, perception, desire, memory, imagining—is generated, in part, "by galaxies of electrochemical interactions" that take place in the body. The concept of neural correlates, developed by neuroscientists, links the first-person subjective states to the observable biological brain activity that generates them. The consensus among experts in biology, psychology, and cognitive neuroscience is that none of our experience, thought, and communication would exist without our brains functioning as organic members of our bodies, which in turn are actively engaged with the specific physical, social, and cultural environments in which we dwell. Our presence is nested in a mind-body continuum, like two sides of the Möbius strip. Moreover, our body is nested in space, while our mind is nested in our body. (Robinson, 2015, 138) The space

around us is a continuation of the space in us, creating a nexus of space-body-mind, transforming each other. The notion of a nexus of space-body-mind linked together by knots of perception, cognition, and movement/acting has gained prominence in previous decades thanks to cognitive and evolutionary psychology, neuroscience and neuroesthetics, and ecological thinking. This relational stance can be further valued for its correspondence to the long-standing tradition of phenomenological thought in architectural scholarship, arguing that such connectedness between the inhabitant and the space is a prime characteristic of what it means to dwell and to be in the world" as put by Andrea Jelic in 2020. Phenomenology and thinkers such as Husserl, Merleau-Ponty, and Mark Johnson set up a philosophical framework that reality opens up from our consciousness, the world outside is a phenomenon we experience and is relative to our perspective based on the location and movement of our body, and presents infinite interpretation possibilities rendering the world subjective.

3.2. The Components of the Biophilic Effect

In that context, to unify various biophilic examples, we must follow a continuum from our experience to the built environment and nature through bodily actions. As a fulcrum concept to associate the design's decision-making with specific biophilic outputs, we can now identify the Biophilic effect: An biophilic outcome in an architectural setting is an effect.

The first theme's effect enables an interactive experience of natural phenomena with relative benefits. The second theme's effect facilitates an imagination of nature, a simulation of direct experience—as neuroscientific studies showed that sensing, imagination, and memory work closer together than we previously thought. The third theme's effect uncovers and extracts the nature of our senses whenever the observed environment locks in the workings of our perception. Designing through the Biophilic effect might give us a strategic path, bringing the inhabitant into the center of the design process. An effect can broken down into the natural forces, *the source,* the architectural setting, *the medium,* and the experience and actions of the inhabitant, *the recipient.*

3.3. The Role of the Biophilic Effect

A Biophilic effect starts with a natural phenomenon, whether sensual, imagined, or the natural workings of our perception. It does not matter if the phenomenon is physically part of the built environment or if the architectural setting only brings it to our attention. It does matter, though, that natural phenomena are experienced through architecture, which means they are transformed through the built environment. Architecture's archaic mission has been to control natural forces, which has been overdone in modern times to bring us to the edge of catastrophe. Still, the benefits of sunlight are limited by the danger of sunburn. Biophilic design, in various examples, has been refining and filtering, or framing in, natural forces to extract the benefits. Framing in means leaving certain parts out and creating a meaningful composition inside the frame. Incorporating nature cannot be put as a default strategy

Biophilic Effect	Source: Natural Phenomena	Medium: Architecture	Recipient: Inhabitant
Biophilic Effect Experiences	Sensual Experience of Natural Phenomena	Experience of Imagined Nature	Embodied Experience

effect brings the designer's process, the built environment, and the inhabitant's exposure together with a focus on the psychological outcome. As the space-body-mind nexus is the basis of any biophilic theme, we can break down the essence of the design theme, which is fundamentally fulfilled by a biophilic effect. Each realized

without filtering in—our biologically encoded self associates with the positive effects of natural processes, not all of them. Any organism placing itself in a space actually frames out the ill effects of the environment. Biophilia has only a selective attention focus on nature, and the role of design creativity starts here. The architectural medium frames an element of nature, rendering it a phenomenon by bringing it to our attention and weaving it into our body-mind continuum.

The way architecture filters through natural forces and brings them to our attention to create multiple effects is a testament to its transformative potential. It not only alters the perception of nature as a medium but also can transform human daily life and actions (and carbon footprint as a result) in a way that changes how it affects nature. In that regard, architecture is a two-way medium. We not only see nature through architecture, but we also affect nature through it. The perception of space is not a passive deed like a TV screen projecting the data; it is sensual and cognitive, which triggers the movement in space. Through the concept of the Biophilic effect, we can follow this two-way interaction of nature and humans.

The fulcrum concept of Biophilic effect brings all Biophilia themes together by arranging nature, buildings and humans as continuum with possibilities for meaningful interaction and the architect can realize the potentials of interaction.

4. Conclusion

Biophilic design provides an essential human-centric complement to the technical objectives of sustainability, offering tangible mental, emotional, and behavioral benefits. The concept of the Biophilic Effect introduces a unifying framework that integrates natural phenomena, architectural mediums, and the lived experiences of inhabitants. Through this lens, architecture transcends its conventional role as a shelter or eco-sustainable solution, becoming a transformative medium that nurtures human-nature connections.

By emphasizing the sensory, cognitive, and emotional dimensions of design, biophilic architecture aligns ecological goals with individual well-being. It addresses the gaps left by the abstract, long-term objectives of green design by grounding sustainability in immediate human experiences, thereby fostering deeper ecological sensitivity and influencing everyday behaviors.

Biophilic Effects can revolutionize how we design and inhabit spaces, promoting not only ecological awareness but also mental resilience, productivity, and aesthetic satisfaction. Embracing biophilic effects can help create spaces that resonate with our biological heritage and inspire meaningful interactions with our environment. Ultimately, biophilic design might embody a vital paradigm shift—a movement towards architecture that sustains both humanity and the planet, harmonizing function, sustainability, and beauty in the spaces we call home.

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