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Building Biophilia: Connecting People to Nature in Building Design

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Studies show that incorporating the natural environment into buildings can have a positive influence on psychological, physical and social well being.

Contrary to Woody Allen's famous quote - "nature and I are two" - there is increasing evidence that nature and we are not separate entities. A growing body of scientific research is showing that the human brain and behavior are intricately linked to the natural world. E.O. Wilson coined the term "biophilia" to describe the deep bonds between people and nature.

The evidence for biophilia comes from many fields, with studies showing:

- Window views of natural landscapes reduce stress in office workers.
- Trees and outdoor gathering places are associated with increased social interactions and sense of community in poor urban neighborhoods.
- Passive viewing of tropical fish in a fish tank reduces blood pressure and increases relaxation.
- Recovery from surgery is aided by daylight and nature views.
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Comfortable retreats with food, distant views, and sensory variability provide places to relax and rest the mind.

A brief walk outdoors, a window view of nature, and indoor plants aid cognitive processing.

Nature isn't always beneficial, however. The natural world is rife with hazards that create fears and anxiety and "biophobic" responses. Although research in biophobia has tended to focus on fears of animals (e.g., spiders and snakes), the physical environment also elicits anxiety.

Common environmental anxieties include heights, enclosed spaces, darkness, being in the open without protective cover and being alone in a strange place. Except in highly sensitive individuals, response to these conditions is usually expressed by avoidance or dislike rather than by fear. For instance, lighting researchers have long known that people dislike gloomy spaces that are dimly lighted at the edges. Researchers suggest that the perception of gloom activates a non-conscious early warning system to alert us that visual conditions are deteriorating. Since we are diurnal creatures, it makes sense that we would seek out and prefer to be in lighted conditions that aid our ability to see far enough into the distance that we can avoid nearby dangers.

The challenge of green design is two-fold: to integrate into buildings the positive biophilic features of our evolved relationship with nature and to avoid biophobic conditions. To identify the features and attributes of biophilic environments, we draw on knowledge from habitat selection and biomimicry.

Buildings Are Habitats for People

Central to our approach is the recognition that buildings are habitats for people. For most organisms, being in "the right place" is an important determinant of survival and well being. There is no reason why this should be different for Homo sapiens. For clues about what a "right place" might be for human beings, we turn to work by Gordon Orians, who has written widely on habitat selection and its relevance to human environments.



The Herman Miller Resolve™ workstations and meeting rooms in the new Executive Center optimize the sense of prospect and refuge.

Orians' hypothesis is a simple one, with profound implications for building design. He proposes that humans are psychologically adapted to certain key landscape features that characterized our ancestral habitat, the African savannah. Although humans now live in many kinds of environments, Orians argues that our species long history as hunting and gathering bands on the African savannah should have left its mark on our psyche. After all, this is the environment in which the brain evolved. If the savannah hypothesis is true, we would expect to find that humans intrinsically like and find pleasurable environments that contain key features of the savannah that were most likely to have aided our survival and well being. These features include:

- A high diversity of plant and animal life for food and resources.
- Clustered trees with spreading canopies for refuge and protection.
- Open grassland that provide easy movement and clear views to the surround.
- Topographic relief for strategic surveillance to aid long distance movements and to provide an early warning of approaching hazards.
- Scattered bodies of water for food, drinking, bathing and pleasure.
- A "big sky" with a wide, bright field of view to aid visual access in all directions.

Even though we now live primarily in urban settings dominated by buildings, there is increasing cross-cultural evidence that savannah-like environments are highly preferred. The savannah landscape serves also as an intuitive model for many parks and golf courses, and it is even apparent in many buildings. Shopping malls and high end hotels create indoor savannahs with large trees and plants, changes in elevation, viewing ledges, water features, daylight, multiple view corridors, comfortable retreats, and an interior "big sky" created by skylights and high ceilings. Builders and developers would be disinclined to invest in such costly aesthetic touches if they didn't believe such amenities had positive payoffs. Many of these buildings, however, centralize the amenities in public areas rather than integrating them into the whole building. As a result, the benefits are realized most by people who spend the least amount of time in the building. A truly biophilic building would extend the benefits to all spaces and all occupants throughout the day.

E.O. Wilson calls aesthetics the "central issue" of biophilia. Both he and Orians argue that the pleasure we feel from being in beautiful places is part of the neural makeup of the human brain. Our sense of beauty evolved because it led our ancestors to seek out places that aided their survival and well being. Appreciating natural beauty isn't something that some people have and others don't. It doesn't need advanced education and training. It happens without effort or even conscious awareness. The more our buildings can tap into our ancient sense of beauty, the more likely they will support us psychologically and emotionally, as well as functionally.

Nature as a Model of Beauty

Janine Benyus, author of *Biomimicry*, also talks about beauty. She places it on her list of 10 things we should ask about our technologies: "Is it beautiful?" ranked right up with "Does it run on sunlight?" In turning to nature for models of resource efficiency, she recognizes that nature is more than an efficient machine - it is also a beautiful one. The patterns, forms, textures and colors of nature provide abundant models that can be used in building and product design to enhance their aesthetic appeal, not just their functionality and efficiency.

Many of the world's most revered buildings contain biomimetic features. That is, they contain the "essence" of natural objects and spaces without being exact copies. They draw on design principles of natural forms. They have intricate fractal patterns in their spatial layouts and surface materials. They contain small, random variations in key elements rather than making exact replicates of forms, visual patterns, and spaces. They use light to entice exploration. Of course, not all beautiful buildings are biomimetics. Many adhere to geometric design principles with high symmetry rather than variation. But many buildings, especially those with mass appeal across the centuries, are likely to have some components of natural beauty integrated into their design.



The Prisma building in Nurnberg, Germany, is focused around an internal greenhouse that blurs the definition between interior and exterior space.

Characteristics of a Biophilic Building

Table 1 shows the key features of a biophilic building and identifies specific design attributes and qualities associated with each feature. We derive these features from research on habitability, natural processes and the geometry of nature. We also draw on research on playfulness and humor, topics that have been largely neglected in building design. Yet research on humor and playfulness shows positive impacts on emotional functioning with far reaching benefits on social relationships, stress reduction and creative problem solving.

The attributes and qualities we suggest will certainly be expanded as we learn more about how to use the principles of nature to design.

TABLE 1. CHARACTERISTICS OF BIOPHILIC BUILDINGS	
Key Dimensions	Attributes and Qualities
Prospect (ability to see into the distance)	Brightness in the field of view (windows, bright walls). Visual distance. Ability to get to a distant point for a better view. Horizon/sky imagery (sun, distant mountains, clouds). Strategic viewing locations. View corridors.
Refuge (sense of enclosure or shelter)	Canopy effect (lowered ceilings, screening, branch like forms overhead). Variation in light levels (darkness suggests refuge). Enclosing surfaces (walls, partitions, screens). Penetrable barriers and surfaces for views out.
Water (indoors or in views)	Glimmering or reflective surface (suggests clean water). Moving water (also suggests clean, aerated water). Symbolic forms of water.
Biodiversity	Varied vegetation indoors and out (large trees, plants, flowers). Windows designed and placed to incorporate nature views. Outdoor natural areas with rich vegetation and animals.
Sensory Variability	Changes and variability in environmental color, temperature, air movement, textures, and light over time and space.
Biomimicry	Design derived from nature. Use of natural patterns, forms and textures. Fractal characteristics (self similarity at different levels of scale with random variation in key features, rather than exact repetition).
A Sense of Playfulness	Incorporation of décor, artifacts, objects, spaces whose primary purpose is to delight, surprise and amuse.
Enticement	Discovered complexity. Information richness that encourages exploration. Curvilinear surfaces that gradually open information to view.

Table 1

What Evidence Exists?

This article is not meant to be an extensive review of the literature supporting biophilia. However, a brief overview of recent studies is necessary to show that biophilia is not a design fad. It is a phenomenon founded on sound biological theory and supported by data from social science and health research. The growing body of research on the links between human behavior and nature ranges from studies of children in daycare to elderly people in public housing projects. It encompasses a wide range of topics, from physiological well being and stress reduction to cognitive functioning and social relationships.

Well-Being

A growing number of studies show that biophilic features of environments have consequences for psychological, physical and social well being. For instance, studies by Roger Ulrich have consistently found stress reducing and health promoting outcomes associated with passive viewing of nature scenes through windows. Ulrich has found similar results using videos and photographs. One of his studies, for example, assessed patients' recovery from surgery. Half of the patients had rooms with views of a small cluster of trees; the other half saw a brick wall. Patients in the rooms with the nature view stayed in the hospital for fewer days, used fewer strong pain killers, and had a more positive recovery process overall than the matched group of patients who had a view of the wall.

Similar results were found in a field study of office workers by Rachel Kaplan. Workers who had window views of nature felt less frustrated and more patient, and reported more overall life satisfaction and better health, than workers who did not have visual access to the outdoors or whose view consisted of built elements only. In a study of behavioral adaptations to windowless offices, Judith Heerwagen and Gordon Orians found that workers in windowless spaces put more natural décor on their wall (landscape posters, pictures of animals or vegetation) than similar workers in spaces with windows. In many cases, the nature items were directly in the field of view over the primary work surface, suggesting that the décor provided a sense of visual and psychological relief.

In a study of residents of public housing projects in Chicago, Byoung-Suk Kwan found that nearby outdoor spaces with trees had a significant impact on social behavior. In contrast to barren, treeless outdoor spaces, which residents disliked and avoided, spaces with large trees and benches attracted people to the outdoors. Once there, they spent more time talking to one another and developed stronger social ties with their neighbors and a stronger sense of community than residents in public housing projects lacking outdoor green spaces with trees.

Interactions with animals have also been shown to have beneficial effects. Numerous studies by psychiatrist Aaron Katcher show that animals have surprising effects on human well being. Contemplating tropical fish swimming in a fish tank reduces blood pressure and enhances feelings of calmness and relaxation. Interacting with and caring for small animals has therapeutic effects on children with conduct disorders. Studies show that these children experience reduced aggression, greater ability to focus their attention, and kinder feelings toward the animals they had previously treated cruelly.

Children who have access to natural play areas in daycare centers and schools also engage in more complex imaginative and social play than children whose environments consist of built structures and asphalt.

Cognitive Functioning

There is also growing evidence of a strong link between nature and cognitive functioning. The work in this area provides beginning evidence for potential for the link between green buildings and work performance. For instance, in a laboratory study by Virginia Lohr, subjects working in a windowless room with plants worked more efficiently, had lower blood pressure and felt more attentive than subjects working in the same room without plants. Even though the subjects' attention was focused on the computer screen and the plantings were arrayed around the perimeter of the room out of direct view, a positive impact was found.

Several studies have assessed the impact of nature contact on what Stephen and Rachel Kaplan call "attentional recovery." This refers to the ability to reactivate mental effort after a period of intense work. Researchers from the Kaplans' group at the University of Michigan have consistently found that contact with nature, from passive views of nature through windows to walking in an outdoor setting, leads to an increased ability to concentrate on tasks requiring high mental effort. In contrast, subjects in their studies who had views of built settings or who went for walks in predominantly built areas did not score as high on measures of concentration.

Research at NASA shows that long distant views - even surrogate views in photographs and posters - induce a sense of "cognitive tranquility," a natural calming down of the mind. The calming effect is especially important to maintain performance in high stress environments. Additionally, children in low-income urban housing showed improved scores on a standardized measure of Attention Deficit Disorder (e.g., scores showed greater ability to concentrate) when they moved to houses with more outdoor natural vegetation. The data were interpreted to mean that nature has a calming effect that enables sustained effort in children who normally experience high levels of distractibility.

These studies on well being and cognitive functioning show that beneficial contact with nature can be sustained in a variety of ways. Urban settings without expansive landscapes can still provide beneficial nature contact through indoor plantings, small-scale outdoor sitting areas with trees, and décor with nature themes. Buildings in natural areas can provide outdoor trails and eating areas, as well as views to the landscape from spaces throughout the building.

Examples of Biophilia and Design

Herman Miller, Inc., a manufacturer of interior furnishings and accents, has coined the term Phylogenetic Design² to refer to design that is based on an understanding of the evolved relationships between people and nature. The natural habitat becomes a model for creating a "habitable workplace."

The Herman Miller GreenHouse (formerly known as the Miller SQA manufacturing facility) in Holland, MI, incorporates nature through indoor plants, extensive views to the outdoor prairie landscape, and daylighting throughout the building. (See "Do Green Buildings Enhance the Well Being of Workers? Yes." EDC July/August 2000, pp. 24-29.) Surrogate wooden animals that delight both workers and visitors are also placed throughout the building. The animals give the building a unique and memorable sense of personality.

Herman Miller's recently renovated Design Yard, also in Holland, MI, incorporates prospect and refuge symbolism throughout, and also features moving water and biodiversity through an indoor water wall and an outdoor garden. It even integrates greenery into the design of furniture, as illustrated by the grass table in one of the conference rooms. Nature was also the inspiration for Herman Miller's new Resolve³ furniture system. Resolve has the nature-based geometry of the 120-degree angle. This angle is innately structural and replicates nature's growth angle - such as branches on trees and the bee's honeycomb. The Resolve workstation balances prospect and refuge by providing an overhead "canopy" and moveable screens with an increased ability to view out and feel connected to others in the environment.

Confronting Aesthetics and Beauty

For too long, we have ignored the discussion of nature in our building design. But research has clearly shown that biophilia means more than putting lots of plants in buildings, though this is not a bad idea. It also means more than daylight and views. Biophilia directly confronts the issue of aesthetics and our evolved sense of beauty. Incorporating this natural sense of beauty into our buildings will make them not only greener in the environmental sense, but also greener in a human sense. To this end, we suggest some questions to ask about buildings and add to Janine Benyus' list in Biomimicry.

- Is it beautiful?
- Does it engage the senses?
- Are there places to rest the mind?
- Does it use the natural geometry of nature?
- Does it incorporate a diversity of living things and life-like processes?
- Does it delight and amuse?
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Does it provide a sense of beauty in all spaces and to all occupants?

References

1 References and Further Reading

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6

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