Integrating biophilic design into the built environment

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Why do certain places make us feel good? Anthropologists tell us we are hard-wired to respond to nature. People viscerally respond to the same relationships in architecture because they make us feel good. These sensations are known as biophilia.

Most people would prefer a house with a porch overlooking water and distant mountains to a windowless bunker. Yet much of our building supply fails to incorporate any connection to nature or natural light. Numerous studies have shown that work, medical recovery and educational attainment are significantly correlated to a greater incorporation of nature into the design and construction of buildings. The experience of biophilic design impacts our health, productivity, sense of well-being — and ultimately our insurance coverage.

Human benefits of reconnecting to nature

The last century has witnessed an increasingly strained relationship between humans and nature. This relationship, as displayed in our built environment, has come full circle as we have realised that we cannot ignore our need for nature. Humans have historically built shelters with locally available materials and tempered them with the passive strategies tied to natural cycles. These buildings inherently responded to the local climate and their inhabitants were intimately linked to the local ecosystem.

Windows and other apertures were aligned to catch the sun's warmth in cold climates, while overhangs and arcades provided shade in hot places. The ancient Greeks aligned the street grids of Priene so that buildings would capture the sun; and the Chinese developed a similar pattern for the courtyard house hutongs. Ventilation was sometimes minimal, leading to smoky, stuffy interiors, but could be as sophisticated as the Persian downdraft towers that could ventilate and cool spaces, and whose sizes ranged from single rooms to entire districts. These naturally inspired buildings also frequently connected the structure seamlessly to the environment around it by opening directly into a green courtyard or other green space.
After the advent of the industrial revolution, the Crystal Palace in London introduced the world to large-scale steel and glass construction, and helped inspire the modernist architecture movement of the early 20th Century. Willis Carrier's invention of a practical air-conditioning system brought new levels of comfort to hot climates. In 1944, architect Pietro Belluschi integrated these systems and designed the Equitable Building in Portland, Oregon. With expanses of sea green glass, it was the world's first fully sealed and fully air-conditioned building. This was a logical strategy when outdoor air quality was extraordinarily bad and energy very cheap.

All of these innovations were intended to increase comfort; but now come at a significant energy cost. Today, while we are less subject to the changing forces of nature, we have also become increasing separated from the benefits of interaction with the natural world. A modern office building, aside from a few potted plants, often incorporates no other natural elements.

Developing a built environment, particularly in an urban context, that severs the intrinsic connection between mankind and nature has created an uncosted liability to society as a whole, and a growing body of research measures the negative impact of separation from nature. This manifests in lost productivity due to discomfort and absenteeism, unrealised revenue spent on medical care and pharmaceuticals, and more effectively allocated municipal budgets.

The built environment is progressing towards design that incorporates biophilic elements such as abundant natural daylight within buildings and thoughtful access to greenery even in the most urban centres.

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Today, the built environment is beginning to reflect a growing awareness of the benefits of a connection to nature. This can partly be attributed to the expanding field of biophilia, which studies the physiological and psychological effects of exposure to nature, identifying strategies through which we can weave nature into our built environments. Biologist E.O. Wilson described biophilia as humanity’s innate response to nature and connection to natural systems. Most of us intuitively understand that a connection to nature feels good. However, to properly study the specifics of this relationship and use this understanding to our benefit, we must break down and analyse its component parts.
There are three main strategies for incorporating biophilic elements into the built environment: nature in the space; natural analogues; and nature of the space. Nature in the space refers to the comfort occupants feel when their environment is thoughtfully filled with fresh air, natural daylight, water features, plant life, and views to nature. Natural analogues include the use of natural materials and representations of nature through art and conceptual design. Nature of the space refers to a series of spatial patterns that are found in preferred landscapes, including “prospect”, or views to open spaces, and “refuge”, or comfort in a protective, enclosed area. Categorising these specific patterns in nature helps designers construct homes, offices and whole communities that are healthier and more comfortable for their occupants. Given the historical and even intrinsic connection between people and nature, the school of thought behind biophilia seeks to re-establish peoples’ awareness and closeness to the natural world.

Terrapin Bright Green's work in biophilic design derives from over 30 years of academic research. We believe that exposure to nature correlates to improved mental and physical health, which in turn are able to affect communities at large. We propose that urban design and infrastructure should be thoughtfully re-examined to incorporate the natural elements they currently lack.

The connection between health and nature

Beginning in the 1980s researchers began studying human physiological response to nature. In 1981, Roger Ulrich undertook a seminal study in which he measured the quality of human responses to nature. The subjects in his study viewed slides of either natural or urban settings. The results showed that natural views had more positive influences on psycho-physiological states than the urban scenes (Ulrich 1981). Ulrich later conducted studies that indicate accelerated recovery rates and reduced stress in hospital patients that could see nature from their windows. Patients, who were demographically matched and recovering from the same surgery, located in recovery rooms that offered a view of nature from the window were released to go home after an average of 7.96 days, while patients located in a room with no view of nature spent an average of 8.7 days in recovery (Ulrich 1984). Another of Ulrich’s studies noted that patients were particularly responsive to water in the built environment (Ulrich 1991). In a similar vein, the positive effect of horticultural therapy on hospital patients has also been well-documented (Ulrich 2002). In fact, because of the noted improvement in patient well-being as a result of including nature in the space, most recently built hospitals now contain gardens within their interiors, as well indoor plants or views to outdoor nature.

Constructing hospitals that provide abundant exposure to nature from any vantage point could reduce the amount of hospital resources dedicated to inpatient care, simultaneously reducing that portion of a hospital’s budget. Shorter stays for inpatients could thus change the financial risk involved in insuring hospital facilities, especially for malpractice and equipment breakdown insurance. It could also reduce the risk involved in insuring individuals, especially in the case of hospital confinement indemnity insurance.

Other researchers have isolated minute human reactions to biophilic experiences in park settings. One study documented the reduction in stress levels in older adults engaging in park-based leisure experiences by measuring the relationship between length of park stay and the subjects’ systolic blood pressure (Orseg-Smith 2004). The flora and fauna commonly found at parks elicits a specific biological reaction in human observers. A study conducted at the Swedish University of Agricultural Sciences found that significant effects could be found in subjects' electroencephalograms (brain wave scans) while they were viewing fractals, or patterns repeated in various sizes. As fractal patterns commonly appear in natural elements such as vegetation, ocean waves, crystal formations and mountain ranges, this explains the physical ease felt in parks and other vegetated public areas (Hagerhall et al. 2008). The implications for the indoor built environment abound as well - incorporating a feature as simple as a waterfall into a building could expose occupants to fractal patterns that positively impact their health.

Similarly, further incorporating parks into building complexes and city planning initiatives could
affect noticeable changes on the types of stress-related conditions to which adults are prone. In fact, for adults at risk of obesity, hypertension, or other conditions linked to blood pressure, daily exposure to public parks might one day factor into insurance risk the same way that frequent gym visits currently do for individuals.

There is also evidence to suggest that exposure to nature could reduce our dependence on pharmaceutical treatments for attention deficit hyperactivity disorder (ADHD). Researchers have observed the effect of a 20-minute walk in a park in increasing mental concentration in children diagnosed with ADHD, and have concluded that “doses of nature” might serve as a safe and widely accessible new tool for managing symptoms of the disorder (Taylor & Kuo 2009). Since drug therapy for ADHD is flourishing, and is now commonly administered on children as young as two or three, the impact of an alternate treatment for ADHD could significantly change the structure of the pharmaceutical and insurance industries.

**The effect of nature on productivity**

An expanding body of research on the relationship between productivity and exposure to nature suggests that a commitment to biophilia can greatly impact business revenue streams. Terrapin Bright Green is four years into a five-year productivity study of workers in a Leadership in Energy and Environmental Design (LEED) Platinum office building, which has measured workers’ improved well-being, resulting from the incorporation of biophilic elements, such as day lighting, views to parks, and the incorporation of natural materials. The motivation for this study is the knowledge that more than 80% of a business’s operational budget is dedicated to paying and providing benefits for its staff. It is therefore critical that companies be concerned with the productivity of their workers, to ensure that they are maintaining a return on their investment in their employees.

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*Human resources account for 82% of the average company’s operating costs. Given a business’s enormous investment in its employees, it is worth ensuring their continued comfort and well-being. Access to nature has been proven to reduce employee absenteeism, as well as increase worker satisfaction and overall productivity.*
The study is investigating how exposure to nature reduces employee absenteeism, increases worker satisfaction, and increases overall productivity. In fact, the research team, which includes Terrapin Bright Green’s Bill Browning, has estimated that a 5% increase in productivity resulting from increased well-being could save the company that both owns and occupies this building as much as USD23 million a year (Browning et al. 2010*). This study provides impetus to investing in nature in the space in order to increase a company’s productivity and profits.

The integration of biophilic features into office environments, such as the green roof at the New York office of Cook+Fox Architects and Terrapin Bright Green, allows employees to reap the benefits of contact with nature. CREDIT: © Cook+Fox Architects

Studies have also identified that day lit schools improve academic performance, in comparison to schools that are lit only with artificial lighting. The Heschong Group published a study in 1999 on a series of schools in California, measuring the effects of day lit classrooms. One portion of their study suggests that classrooms in a certain school with the most amount of day lighting are associated with a learning rate that is 20-26% greater than that of the classrooms that have the least amount of day lighting. These results are evidenced by increased student test scores over one school year. While the study tested a number of different methods of day lighting, it found that classrooms with the most window area, also allowing a view to the outdoors, were associated with 15-23% rate of improvement over a one year period when compared to classrooms with the fewest windows (Heschong 1999).

It became clear that students in the most day lit classrooms progressed more quickly, gaining one to two points more over the course of the school year than students advancing at the average rate. Thus, by advancing more quickly, incorporating day lighting into classrooms could save up to one month of instructional time in reading and math curriculum that could be used for other areas of learning that are traditionally not as high a priority (Heschong 1999).

The Heschong study, along with the many others that document the effects of day lighting in schools, opens the educational field to the possibility that designing schools that are more connected to nature could create more advanced standards for each grade level. Over the long term, higher academic standards create more competent young adults entering the work force. The luxury of dedicating fewer resources to math and reading curriculum could lead to an
increased investment in underfunded programs like art, music and physical education. Incidentally, these traditionally overlooked programs are all linked to increased well-being and academic improvement.

**Broader, community-based effects of nature**

Research in the past decade has measured the effect of exposure to nature around the home, school and work-place on the general well-being of people of all ages. A 2001 study showed that views of nature specifically increased the self-discipline of teenage girls – a key component in achieving positive outcomes such as academic achievement, and avoided pregnancies and delinquency (Taylor et al. 2002). Similarly, two other studies published in 2001 looked at the relationship between acts of aggression and violence in urban public housing and the presence of green spaces. The study measured the levels of aggression in public housing residents randomly assigned to buildings with varying levels of nearby nature (trees and grass). Residents living in relatively barren buildings reported more aggression, violence and domestic abuse than did their counterparts (Kuo & Sullivan 2001, Kuo & Sullivan 2001).

Beyond the study of well-being, case studies have also measured the positive impacts of green infrastructure and demonstrated that their incorporation makes practical sense. The City of Seattle, for example, undertook a project called Seattle StreetEdge Alternatives, which reduced impervious street surfaces, narrowed streets, and added bioswales, shrubbery and trees in parts of Seattle. Two years later, the result was a 99% reduction in storm water runoff and a significantly more biophilic streetscape (Tackett 2007, Seattle Public Utilities). A city that incorporates trees into its streetscape can combat the heat island effect more effectively than cities with greater areas of asphalt and other heat-conducting surfaces (Solecki et al. 2005).

Exposure to nature also has a documented, if anecdotal, effect on demographic relations within communities. Landscape architect Herbert Dreiseitl redesigned a square in the city centre of Hannoversch, Munden, Germany, to incorporate a series of urban water art installations among pedestrian walkways. Besides connecting the residents of the area to a basic natural element, the project involved collaboration between two ethnic groups, the Germans and Turks, who have had historically tense relations. The resulting water feature has become a place where both populations meet and interact. Combined with research linking exposure to nature and enhanced well-being, one can conjecture that these installations can improve the overall lifestyle in the town. An added practical benefit is that since the installations are recharged by rainwater catchment, the town has experienced decreased drainage problems, reducing the amount of money the town has had to invest in drainage infrastructure (Grau & Dreiseitl 2005).

**Conclusions**

Communities, whether rural, urban or suburban, should also integrate policy planning with biophilia in order to achieve improved health outcomes, reduced violence, increased infrastructure resiliency, and improved water and air quality. The effects of such measures could, in a similar vein, improve the health and well-being of towns and cities, and thus lower risk.

The breadth of biophilia’s effects make a case for its integration into risk management across a variety of industries. A connection to nature has resulted in hospital patients being released an average of a full day earlier than patients who experience no nature. Children with access to natural day light and the accompanying views to the outdoors learn up to 26% faster than their counterparts in artificially lit classrooms. The improvements registered in a number of scenarios within a biophilic environment, such as worker productivity or hospital recovery, can have significant implications for a number of industries, not least insurance.

An understanding of how these quantifiable results add to the overarching quality of our lives is also critical to biophilia’s successful implementation. Apart from the risk implications of biophilia, a built environment that embraces our place alongside nature evokes a stronger positive reaction than one designed without this relationship in mind. After all, the study of biophilia
within the built environment is, at its roots, an effort to enhance our peace of mind and our contentment with the world around us.

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Rick Cook is a founding Partner at Cook+Fox Architects, a firm devoted to creating environmentally responsible, high-performance buildings, including the LEED Platinum Bank of America Tower. Over the past 25 years as a New York City architect, he has built a reputation for innovative, award-winning architectural design. In 2006, Rick and Bob Fox joined with Bill Browning and Chris Garvin to form Terrapin Bright Green LLC, an environmental consulting firm committed to improving the human environment through public and corporate policy, environmental performance strategies, and green development.

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Namita Kallianpurkar is a Research Analyst at Terrapin Bright Green, with an interest in energy issues in the built environment. In 2010, Namita interned with the Chief Economist at the United Nations Convention on Biological Diversity and completed a feasibility study of solar photovoltaics. She contributed to Crass Struggle, by Thomas Naylor, researching environmental crimes and black markets for natural goods from 2008-2009.

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A Partner at Terrapin Bright Green since 2008, Chris Garvin is an accomplished practitioner and active voice in the sustainable design community. Chris serves on the Board of Directors for the US Green Building Council- New York Chapter, and on the Advisory Board for Mayor Michael Bloomberg’s Office of Long-Term Planning and Sustainability.

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Bill Browning is one of the green building and real estate industry's foremost thinkers and strategists. His expertise has been sought out by organizations as diverse as Fortune 500 companies, leading universities, non-profit organizations, the U.S. military, and foreign governments. Bill was a founding member of the U.S. Green Building Council's Board of Directors, and served as Chair of USGBC's Governance Committee.

Works Cited


*The aforementioned citation is part of an ongoing academic study.*