# **Biophilic Design**

AN ALTERNATIVE PERSPECTIVE FOR SUSTAINABLE DESIGN IN SENIOR LIVING

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# PERKINS-EASTMAN Human by Design



Age and patina, series and pattern, light, complexity, and color are a few elements and principles of Biophilic Design.

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## BIOPHILIC DESIGN

Architectural theorist Juhani Pallasmaa once said, "The task of architecture is to make visible how the world touches us." This social aspect of the built environment should be in the forefront of our conversation about sustainability. Our connection with the world has the potential to transform and positively affect us. As designers, we can better understand how our environments impact us psychologically and physiologically to create architecture that promotes these positive, transformative interactions. This article presents knowledge of how the brain and body respond to their environment and how the application of this knowledge, specifically in designing Senior Living environments, helps demonstrate a commitment to sustainability, and simultaneously, a commitment to enhancing the resident experience by measurably improving resident health, wellbeing, and performance. This approach, known as Biophilic Design, lends focus to the sustainability conversation while enabling us in the design community to adopt a human-centered approach to the design process and use human-centered metrics to deepen the definition of success of the project.

Senior Living is a constantly evolving sector that molds itself to meet generational shifts in the perception of "aging." Demands are changing and increasing more than ever before. There is more interest in environmental control, hospitalityinspired finishes, amenity spaces like dining venues, wellness components, cultural arts, and creating an emotional connection to "home." Senior Living has gradually improved the model of care and progressed the physical architecture of facilities in order to address the evolved expectations of residents. The market clearly has an appetite for innovation and change. So where does sustainability fit in?





The process of aging causes physiological and psychological changes for seniors. Values also change. Architectural theorist Juhani Pallasmaa once said, "The task of architecture is to make visible how the world touches us." This social aspect of the built environment should be in the forefront of our conversation about sustainability. Our connection with the world has the potential to transform and positively affect us. As designers, we can better understand how our environments impact us psychologically and physiologically to create architecture that promotes these positive, transformative interactions. This article presents knowledge of how the brain and body respond to their environment and how the application of this knowledge, specifically in designing Senior Living environments, helps demonstrate a commitment to sustainability, and simultaneously, a commitment to enhancing the resident experience by measurably improving resident health, wellbeing, and performance. This approach, known as Biophilic Design, lends focus to the sustainability conversation while enabling us in the design community to adopt a human-centered approach to the design process and use human-centered metrics to deepen the definition of success of the project.

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Biophilic Design is a focused area of research that brings people to the center of the sustainability discussion. It attempts to scientifically understand how people interact with their environment and, consequently, how their environment can be designed to better support them. Although it has existed for nearly 30 years, Biophilic Design is not yet standard practice nor a common topic of discourse for architects and their clients. It applies the idea of Biophilia, the human affinity for elements and principles in nature, as a structure to organize knowledge of how we interact with our environments, and how our environments interact with us, measurably impacting our health, well-being and performance. Biophilic Design studies the impact of environmental qualities such as light, color, space, shape, air,









In order to commit to innovation, the process of designing for Senior Living should incorporate a knowledge of Biophilic Design principles. material, and vegetation on human psychology and physiology. By applying this knowledge to architecture, designers can mindfully manipulate space to improve the human experiences that occur when interacting with these qualities. It is with the application of this knowledge that our understanding of the built environment begins to transform, which helps us redefine what we deem as important metrics for how we measure the success of the environment. Understanding and implementing the knowledge of Biophilic Design is evocative because it simply tweaks the way architects and clients speak about sustainability and participate in the sustainability conversation, pushing the human experience towards the front and letting the inherently integrated economic and environmental benefits of certain sustainable design strategies be recognized, but subtly become secondary.

Discussions about sustainable architecture and LEED in Senior Living have become more important as the client works to meet the desires of rapidly evolving residents and because they, themselves, are economically savvy and desire to be environmental stewards. Additionally, dedication to sustainable architecture represents a unique marketing strategy. By the nature of service a Senior Living facility provides, the experience of the resident has always been of the utmost importance. The goal of Senior Living architecture is to enhance and support the human experience. To do this, architects and interior designers have been using well known "good design" practices, like knowledge of human behaviors from Chris Alexander's A Pattern Language, basic sustainable architectural strategies like those in G.Z. Brown's Sun, Wind and Light, or simply listening to desires of future

residents in user group meetings. However, designers could improve their design process by taking advantage of access to a documented scientific understanding of how humans' interactions with certain environments could measurably improve their health, well-being, and performance.

It is a natural fit for Senior Living clients and architects to blend a knowledge of Biophilic Design into early conversations. Establishing Biophilic Design principles as invaluable design goals not only demonstrates a commitment to sustainability, but, more importantly, embodies a dedication to the resident experience by recognizing the imperative role a building plays in resident health, well-being, and performance. As the mindset of future residents continues to change and evolve, so too will conversations about sustainable architecture between Senior Living clients and architects. Regardless of whether a client is pursuing LEED, a project can champion the social aspects of sustainability. In a specialty area like Senior Living, prioritizing the human experience is of the utmost importance. Senior Living can benefit from establishing a framework of human metrics, which present the perceived success of a facility's design in a way that resonates with clients, as well as their residents.

The following case studies are used to promote an understanding of the potential benefits of applying Biophilic Design principles in Senior Living projects. It is with this knowledge that the ownership team and design/engineering team can become better equipped to make decisions, both in concept and value engineering, about the ramifications of architecture on the health, wellbeing, and performance of the residents.



# **Rockwood Retirement Community**

SPOKANE, WASHINGTON

Perkins Eastman's remaking of this CCRC changed nursing home standards for the state of Washington, while transforming this 1960's institutional-style nursing home into the Rockwood Health and Wellness Center. The transformation has dispelled considerable family anxiety about appearances, noise, security, and lack of dignity. Residents socialize in intimate community dining and living rooms, country kitchens, private dining, corridor seating, and walk along meaningful pathways throughout the facility. A wandering garden located outside The Courtyard and planted with non-toxic greenery provides residents with a secure place to enjoy the outdoors.

### Exemplary of Biophilic Design Principle: Exploration and Discovery

Human beings are an innately curious species. We want to explore, discover, and try new things. We keep seeking new experiences and exploring, for when we do, our brains are flooded with "feel good" neurotransmitters like dopamine and norepinephrine (Gronier et al 2000). These chemicals prepare the body and brain for activation by stimuli, known colloquially as "flight or fight mode," which actually boosts our performance because it makes us more alert (Nieuwenhuis 2005), helps improve our cognitive functioning (Aston-Jones and Cohen 2005), improves our memory (Donchin 1981), and helps us learn (Stephen Siva).

Since neural activity reduces with age, experiences of excitement and discovery can function to augment arousal, alertness, and cognitive functioning, all qualities that contribute to an overall sense of vitality for seniors. It is important for seniors to maintain a sense of freedom and discovery, albeit in a safe environment. In the Rockwood Retirement Community, the design and layout suggest that a building can actually help propagate a sense of novelty and complexity among its residents. Spaces can be organized along a snaking main corridor. The surprise that comes with turning a corner and discovering a door to an unexpected space can elicit a psychological response, flooding the brain with dopamine and norepinephrine, which elicit an emotional response and "increased sense of vitality." As residents walk a given hallway, they may receive the sensation of discovering public spaces like dining rooms, art rooms, or a chapel; this experience can help break the pattern of familiarity that inevitably develops in seniors' daily lives. Furthermore, exploratory behaviors have had positive and stimulating repercussions for seniors, such as increased creative thinking and a desire to make new discoveries in the future (Berlyne 1963).





# Sun City Park

In the midst of Yokohama's industrial bustle, Half Century More acquired 7.6 hectares (19 acres) of rolling hillsides and mature forest for the new Sun City Park continuing care retirement community. The 53,500 sm (576,000 sf) facility follows a one-campus, two-village plan. While Sun City Park Yokohama is a large facility overall, both in area and number of resident rooms, the client placed a high priority on responding to the scale of the individual resident. Large wings are stepped in plan to yield smaller neighborhoods, while south-facing units maximize light quality and views. Formal and casual dining rooms and a full complement of public spaces are available in both villages, while amenities like Sun City Hall, a spa and pool, the conservatory, and the billiards parlor are distributed between villages to encourage resident mixing. Sun City Park's success prompted an expansion, adding 600 units featuring views of neighboring park lands and interiors done by Sandler Design.

### Exemplary of Biophilic Design Principle: Natural Materials

Human beings are attracted to natural materials. Natural materials are complex due to their highly textured, undulating surfaces, which allows light to reflect in non-linear and fascinating ways. And unlike those that are man-made, natural

materials reduce physical stress on the eye because they absorb more light than they reflect, resulting in less glare. They possess tonal and color variations that are difficult to recreate in the manufacturing process. The complexity of their surface textures and colors helps to reduce stress on the eyes because it allows the eye to constantly move over the complex visual information, pick it up, and process it.

Natural materials can effuse scent as well. Wood essential oils have been shown to lower the heart rate and reduce blood pressure (Tsunetsugu et al 2013). Exposure to untreated woods, a traditional Japanese practice of shinrin-yoku, or "forest bathing", has been shown to promote a healthier immune system (Li 2010). It is exposure to the Phytoncides (antimicrobial essential oils in wood like  $\alpha$ -pinene and limonene) that increases the production of cancer-fighting natural killer (NK) activity in the blood, a lasting effect, present even 30 days after forest bathing. Not only are natural materials important for our ability to absorb information from our environment and improve immune function, but environments rich with natural materials also result in an increase of our levels of creativity (McCoy and Evans 2002).



Untreated wood can be used in many interior applications. The use of wood with interesting grains may help residents of Sun City Park more easily pick up visual information from their environment, which has the potential to reduce their physical stress.

It is common for interior wood products to be treated with clear finishes and lacquers to increase durability. However, using untreated wood can promote healthier immune systems. With no reflective finish, untreated wood reduces glare, and unlike veneers or manufactured products, it has the ability to effuse natural wood oils. Promoting the use of untreated wood could have a transformative effect on a main corridor, creating a serene experience—a type of indoor forest bathing as residents walk and breathe in the wood essential oils, which have been shown to lower heart rate and blood pressure.





### Westminster Village

SCOTTSDALE, ARIZONA

Westminster Village initiated a repositioning effort to enhance its marketability with the construction of a new 63,000 sf town center. Perkins Eastman provided planning, architecture, and interior design for the facility, which features 37,000 sf of amenities on the first floor including multiple dining options, a wellness/fitness center, spa, library, and lounge. On the second floor, 23 assisted-living apartments are complemented by additional dining, living, and activity spaces. Market demands prompted a focus on dining variety. The new town center gives residents many options. Residents also enjoy a constant connection to the outdoors. Common areas on the first floor encircle a dynamic courtyard, where residents can take advantage of expansive views thanks to floor-to-ceiling windows. This design approach effectively blurs the lines between the building's interior and exterior spaces. A central living and dining space on the second floor offers views to the courtyard below and neighboring mountain range.

#### Exemplary of Biophilic Design Principle: Movement & Unpredictability

Human beings need movement both for the sake of physical health and to maintain a functional visual system. Movement keeps our brains subtly stimulated and humming. With movement, nearly every second, a novel and unpredictable visual image crosses the visual field, which increases our galvanic skin response and neural activity, making us feel aroused and alert (Zajonc 1968). Humans have two types of attention: undirected (involuntary attention which requires no effort at all, typically something that is fascinating or interesting) and directed (voluntary attention which requires effort, typically problem solving and mental tasks). Subtle movements in nature, like fluttering leaves or rippling water, capture our undirected attention and stimulate our brains, similar to white noise, allowing better focus of our directed attention (Kincade et al 2005).

Movement, because it captures our attention, actually improves our ability to focus and accomplish tasks (Allen et al 1997). Movement can occur in our visual field as well as on a more tactile level. A breeze across our skin can increase skin conductance levels, prompting us to feel alert and present in the moment. Entities that evoke movement have other benefits as well. Natural ventilation can deliver much higher ventilation rates than mechanical ventilation in an energy efficient manner. High ventilation rates reduce  $CO_2$  levels, which when high, increase levels of fatigue and degrade our decision making ability. Natural ventilation has been shown to reduce sick leave by 35% in office buildings (Milton et al 2000 and Wargocki et all



2002), reduce transmission of airborne infections like TB (Escombe et al 2007), and increase productivity by 3-18% (Carnegie Mellon 2004). Natural ventilation also presents a significant cost savings. A 2004 Carnegie Mellon study suggests an average ROI of at least 120% which comes from a 47-79% in HVAC energy savings. Natural ventilation has also been shown to increase the marketability of a work-space, with an estimated added value of \$248/m<sup>2</sup>/year in value for occupants (Corney 2007).

For seniors with decreased nerve sensitivity, stimulating physical and neural activity is important in order to improve awareness, alertness, and connection to the present moment. In the Westminster Village project, accordion glass doors allow cross ventilation in sitting areas, transforming a simple living space into something invigorating, where residents benefit from the warm Arizona breezes. Furthermore, the space is psychologically stimulating thanks to direct views of rippling movements of reflecting pools adjacently located, potentially resulting in increased alertness, arousal levels, and neural activity.





# Camphill Ghent

Sponsored by the Camphill Foundation, this community is dedicated to enhancing the lives of developmentally disabled adults who are now reaching an age where they may need assisted-living care in a nurturing environment. Perkins Eastman designed the community to sit lightly on the land. The design follows the topographical contours of the landscape and is nestled between two natural ponds and the crest of the site. The community consists of ten independent-living townhomes, three buildings of independent apartments known as "co-houses", a village house for younger residents and care givers, and three adult homes, comprising 29 assisted-living beds. A re-created barn and silo serve as a pantry, central services, and administrative building. The master plan includes a future community cultural center, manual arts building, and additional independent and assisted living buildings on the upper portion of the site. The awardwinning landscape design includes areas for biodynamic farming of flowers and produce.

### Exemplary of Biophilic Design Principle: Light

Human beings are innately attracted to light. Light is important for our visual system and it is simply necessary to inform us of information from our environment. Its ephemeral qualities can be a source of delight, constantly changing throughout each day, month, and year, which creates dynamic spaces for residents. Light helps connect us physically to the space around us, and because light is a form of energy, it has the ability to create temperature differentials which humans can interact with through experiences like sitting in a warm thermal pocket or feeling a variety of air temperatures on a short walk.

Indeed, light affects the quality of our spaces, but it is also a necessary ingredient for our physical and emotional health. We need light to regulate our circadian rhythm, our sleep cycle. We specifically need short wavelengths of light (460-480 nm), which are only present in the morning hours, to suppress the production of melatonin in our bodies and ensure a healthy rhythm. Studies suggest the peak light absorption by our eyes occurs at 479 nm (Bailes and Lucas 2013). As light enters our eyes, it's detected by ganglion cells on the back of the eye, which send electrical signals to our suprachiasmatic nucleus (SCN), an area in the brain which regulates our internal clocks. The SCN does this by regulating our body temperature and telling our pineal gland to produce melatonin (Terman 2001). Sunlight is necessary for the synthesis of vitamin D (Webb 1988), which is also linked to the production of serotonin, the "happiness" neurotransmitter, in our body (Patrick and Ames



2015). Short wavelengths of morning light are correlated to increased production of serotonin. Additionally, light has been shown to increase our pain threshold, helping to reduce the amount of medications needed, which consequently presents a significant cost savings to a senior living facility (Walch et al, 2005). Not only is light important for our biological functions, but light exposure can also make us more alert and productive (Vandewalle 2006 and West Bend Mutual Insurance Study).

Adequate light levels are necessary to create safe environments, particularly in senior living facilities, where residents have reduced visual capabilities. As we age, our ability to produce melatonin reduces, so light is necessary to promote healthy sleep and increase alertness for seniors. Aging also physically changes the functionality of the eye; light is necessary to improve visual functionality and reduce stress on the visual system. In the Camphill Ghent project, eastern light floods program spaces that residents occupy in the early morning hours, such as the dining room, chapel, and art rooms. This exposure to morning light can help promote more natural circadian rhythms in residents, by more effectively activating the SCN, and improving the production of serotonin, which tends to be associated with an improved sense of overall well being.





### Moorings Park NAPLES, FLORIDA

Moorings Park initiated an overall campus repositioning with a strategic and master plan led by Perkins Eastman. Site design, building scale and detail, and landscape amenities are all pedestrian inspired. The design team took great care to integrate the landscape with the new buildings in a way that encourages an active lifestyle. The end result brought new character to the campus, acting as a catalyst for future strategic planning. One of the first projects was the design of a new wellness center that has become a focal point for the 83-acre campus. To encourage wellness dimensions beyond the physical, the center also offers a meditation room, zen garden, creative arts studios, and classroom space for visiting lecturers.

#### Exemplary of Biophilic Design Principle: Connection to Nature

We are attracted to elements of the natural world like air, water, and vegetation, elements we can use our senses to see, hear, smell, and touch. Biologically, we evolved in a primarily natural place, so we are attuned to colors, shapes, and subtle movements of nature. Nature is effortlessly fascinating, allows for escape, and has richness and coherence. Nature has many restorative properties. It is subtly complex and ever changing; it captures our undirected attention so we can better focus on the task at hand. We can actually recover from difficult tasks or overstimulation quicker when coupled with views of nature (Hartig 1991). Views of nature have been shown to help patients recover faster from surgery and with less medication (Ulrich 1984), and help improve the cognitive functioning and attentional capacity of students (Tennessen and Cimprich 1995 and Wells 2000). A connection to nature is important for seniors because it could help increase pain threshold (Tse Ng Chung Wong 2002) and reduce attentional fatigue. This results in the need for less pain medication and an overall cost savings to the senior living provider.

It is with some careful tweaking of the site plan that designers can better promote and utilize views of nature from all spaces. The village style plan of the Moorings Park project, for example, allows vegetation to be inserted in between multiple buildings with small footprints that are sprinkled throughout the site, which increases the potential for views of nature from every vantage point. For seniors, views of nature have profound psychological and physiological benefits as well, and have the ability to reduce cortisol levels and heart rate (Ulrich et al 1991 and Laumann 2003). Such views are not only important for residents but also staff members, who might feel overworked and stressed. Overall, views of nature for both residents and staff could help reduce the cost of care: residents may take less pain medication, staff job satisfaction may increase, and staff absenteeism may reduce.





### North Chicago VA Community Living Centers CHICAGO, ILLINOIS

Perkins Eastman designed two Community Living Centers for the US Department of Veterans Affairs (VA), at the North Chicago VA campus. Each CLC is approximately 8,700 square feet with 10 private bedrooms each. Perkins Eastman worked with the VA to create home-like environments that are appealing to their heavily male population, offering environments that differ from the mostly female-dominated "small house" projects that have been developed in recent years. The CLCs feature open living areas and kitchens, short hallways, and direct views to common areas from bedrooms. The open layouts lend themselves to easy connections between residents and staff. It was awarded LEED Silver (LEED-NC v2009).

#### Exemplary of Biophilic Design Principle: Connection to Others

As human beings, we desire to connect with one another. Our social networks help us live longer (Angerer et al 2000), improve our ability to heal (Couin et al 2010), and lower our blood pressure and stress levels (Thorsteinsson and James 1999).

Understanding that large social support networks promote better mental health, it is important to design spaces for seniors to connect with one another (Spencer and Pahl 2006). Perkins Eastman helped to pioneer a new model of skilled nursing care for seniors, one that promotes smaller scale households which allow for an enhanced quality of care and more familial social ties between residents.

Designed under the VA's CLC guidelines, the Green House model used in the North Chicago project was the first Geripsyche "small house" in the United States. The floor plan consists of a variety of gathering spaces at many scales. Large open dining rooms and living rooms allow for group interactions, while small reading rooms tucked at the end of a corridor allow for quieter, intimate, one-on one-interactions. It is by mindfully organizing large **and** small spaces that designers can better promote various levels of social interaction.

In addition, these buildings not only provide for a variety of social interaction indoors but also provide a variety of high quality outdoor environments to populations that have historically been underserved.







# Saint John's On The Lake

MILWAUKEE, WISCONSIN

Saint John's On The Lake, a lakefront senior living community in Milwaukee, WI, formed a multi-disciplinary team to deliver a plan to create an innovative, healthier, and greener urban residence for aging adults in the city. The existing campus housed an assisted living and 10-story independent living tower. Perkins Eastman designed a new 21-story, 88-unit tower and created connections between the two towers to establish continuity between the architecture and the residents. The Owner wanted sustainability to have a strong presence in the design and architecture of the building. The target was an integrated, whole-building design process with the entire team involved from an early stage in evaluating options and guiding choices. Affordability and long-term vision of life-cycle costing formed the basis for evaluations. Natural materials, such as salvaged and reclaimed lumber, were incorporated into the overall design to create, for residents, a strong sense of and connection to place.

### Exemplary of Biophilic Design Principle: Spatial Experiences

Human beings desire different spatial experiences, in part because we are intrigued by the unique and varying emotional and spiritual impacts they have on us. Different spacial layouts generate different experiences. Subconsciously, we are fascinated by the ability of our physical environment to elicit a variety of reactions. Narrow spaces have high levels of pressure from sinking air and increased air molecule collisions; they make us feel enclosed and embraced. Wide open spaces, on the other hand, have low pressure resulting from rising air and reduced air molecule collisions; these spaces tend to make us feel light and a greater sense of freedom.

Studies suggest we have evolved to prefer certain spatial experiences, ones that are similar to being in a coniferous forest (Han 2007). We like to have a sense of prospect and refuge, spaces with views that imply an environment of mystery and potential bounty, but also offer a sense of security (Appleton 1975). Not only do we prefer certain types of spatial experiences, but we desire spatial variety which has been shown to increase our levels of creativity (McCoy and Evans 2002).



Seniors desire experiences that will elicit fond memories of being in nature and other spaces that offer emotional security; they may be inherently attracted to spaces that allow for the idea of prospect and refuge. At Saint John's On the Lake, residents may find a sense of security while lounging in a narrow sitting area and looking through an expanse of windows onto scenes of nature. Similarly, private apartment balconies offer the potential for residents to feel a sense of protection as they look out onto Lake Michigan. Saint John's also provides for a variety of spatial and emotional experiences—open airy wellness centers and small nooks for intimate gathering address the various emotional and spiritual needs of the residents.





### NewBridge on the Charles

DEDHAM, MASSACHUSETTS

Hebrew SeniorLife wanted to create one of the most comprehensive, thoughtful, and sustainably-designed campuses in the nation. The design is based on their research and understanding of how to best preserve the dignity of aging adults. This vision focused on a community where seniors have abundant choices in residential-care environments, activities, dining venues, support systems, and medical services, where residents age in place, where couples with different service needs remain on one campus together, where isolation is combated through strong connections, where children bring vitality to everyday life, and where a healthy environment plays a key role in an individual's overall wellbeing.

NewBridge on the Charles' planning incorporates the highest standards of sustainable design practices. The new community harmoniously fits into a beautifully wooded, 162-acre site along the Charles River, where it provides housing for 750 aging adults in a variety of residential-care settings, as well as a setting for 450 students in the Rashi School. The site design protects environmentally sensitive areas, controls stormwater, minimizes irrigation, maintains native landscape materials, captures rainwater for irrigation, and integrates the Northeast's largest geothermal system to serve more than 1,000,000 sf of enclosed conditioned space. This system utilizes 400 heat transfer wells with gas savings of 50% and a 34%  $CO_2$  emissions reduction equating to about 18,000,000 lbs per year.

### Exemplary of Biophilic Design Principle: Variety and Difference

Human beings crave variety. In fact, our visual system needs variety and fractal shape in order to understand the world around us. The eye picks up on areas of light and shadow, information which is then projected onto the retina where cells send information to the brain. The brain deciphers the difference between the light and shadow in order to "see" the space. We need variety to simply understand our space. Streamlined and sterile environments that lack detail are actually stressful on our eyes and brains because they provide no variance or point of reference for our brain to generate information from (Hubel 1988).



Not only do we need variety to inform our understanding of the world, but we seek variety because we enjoy a sense of novelty (Sheldon 1969). Novelty increases our skin conductance levels, our arousal, and our alertness (Hagerhall et al 2004). Increased arousal levels are actually what motivates us to do things (Yerkes-Dodson Law).

For seniors, the reduction of physical stress on the eyes and brain is achieved by creating fascinating environments that are rich in fractal, shape, and texture. NewBridge on the Charles, for example, employs an expansive material palette throughout the building, both interior and exterior, which stimulates the visual field of seniors and has the potential to increase their arousal levels, which could increase their well being and sense of vitality.



# CONCLUSION

Understanding that there is a fundamental humanfocus within the Senior Living market, the application of Biophilic Design can offer novel design criteria and a novel set of metrics to address sustainability in a way that is more tactile, emotional, experiential, and human scale than a purely numeric or technological conversation. With that said, Biophilic Design doesn't disregard the inherent environmental and cost benefits of its use, it simply represents a different perspective from which the client and architect can discuss the sustainability goals of a project. Biophilic Design focuses on the many parallel social benefits that could occur when incorporating sustainable architecture. Using Biophilic Design from the onset of a project and including it in conversations with the project team, including the Owners, Board Members, engineers, and contractors, will improve the end result and resident satisfaction. With the LEED checklist already established as a standard sustainable building metric, incorporation of Biophilic Design principles can run as an energizing, momentum-building addition to the design process to address sustainability from a social side. The following set of guidelines is intended to be used as a tool for project teams to navigate the decision making process with Biophilic Design in mind.





Biophilic Design helps us understand our interaction with our environment and our connection to life.



#### Establish Biophilic principles as a project goal

Have the conversation early with all project team members and ensure it remains a top priority throughout the life of the project. Whether the thought is to embody the principles to the greatest extent possible, or to simply choose one or two key principles that speak to the Ownership team and support the concept of the project, the principles of Biophilic Design are flexible and don't have to be understood as "all or none".

#### Conduct a site analysis with Biophilic Design in mind

It is important to recognize the feasibility of adhering to Biophilic Design. Some environmental qualities may be easy to access on a site while others may require added effort or additional resources.

#### Educate the entire design team

To ensure commitment to Biophilic Design principles, it is important to educate engineers and other consultants on the scientific knowledge presented in this article, which highlights the psychological and physiological effects of the environment on the occupants. This knowledge adds a deeper understanding of the ramifications of **every** architectural and engineering decision on human health and well being.

#### **Evolve the design process**

Understanding what happens to the body and brain when we interact with our environments is baseline knowledge that is necessary to recognize the ramifications of any design strategy. When items come up within a value engineering process, a column should be dedicated to the human health and well being impacts of those items. The knowledge that comes from Biophilic Design can provide solid evidence and associated dollar value for many architectural and engineering-related decisions. If Biophilic Design principles are established as key goals for the client, an additional framework of human metrics **must** be added to the decision-making processes.



#### **Express commitment to Biophilic Design in marketing**

In order to fully commit to Biophilic Design, it is important to continue the education of the future residents. Marketing materials, websites, and conversations should prominently feature the fact that the design of the building was directly influenced by the desire to improve the health, well being and performance of the residents. Documents should feature a discussion about the commitment to all areas of sustainability simultaneously, as the resident, owner, and environment benefit from buildings designed with Biophilic Design principles in mind.

### **Works Cited**

Allen, G et al. "Attentional activation of the cerebellum independent of motor involvement." Science 275 (1997):1940–1943.

Angerer, Peter, et al. "Impact of social support, cynical hostility and anger expression on progression of coronary atherosclerosis." *Journal of American College of Cardiology* 36.6 (2000): 1781-1788.

Appleton, J. Experience of landscape. London: Wiley, 1975.

Aston-Jones, G and Cohen, JD. "An integrative theory of locus coeruleus-norepinephrine function: adaptive gain and optimal performance." *Annual Review of Neuroscience* 28 (2005):403-50.

Bailes, HJ and Lucas, RJ. "Human melanopsin forms a pigment maximally sensitive to blue light (Imax 479 nm) supporting activation of Gq/11 and Gi/o signalling cascades." *Proceedings of the Royal Society B 280* (2013).

Berlyne, DE, et al. "Novelty, complexity, incongruity, extrinsic motivation, and the GSR." *Journal of Experimental Psychology* 66.6 (Dec 1963): 560-567.

Carnegie Mellon. "Guidelines for High Performance Buildings – Ventilation and Productivity." (2004). http://cbpd.arc.cmu.edu/ebids/ images/group/cases/mixed.pdf

Corney, A. "Summary Report: Demystifying Health and Productivity Benefits of Heating, Ventilation and Air Conditioning Design Alternatives. (2007): http://www.wspgroup.com/upload/documents/ PDF/Lincolne%20Scott/ Refresh\_1.pdf

Donchin, E. "Surprise!... Surprise?" *Psychophysiology* 18 (1981): 493–513.

Escombe, AR, et al. "Natural ventilation for the prevention of airborne contagion." *PLoS Medicine 4.2* (Feb 2007): 68.

Goleman, Dan. "The Sweet Spot for Achievement: What's the relationship between stress and performance?" Psychologytoday.com. 12 March 2012.

Gronier, B, et al. "Activation of the mesocorticolimbic dopaminergic system by stimulation of muscarinic cholinergic receptors in the ventral tegmental area." *Psychopharmacology (Berl).* 147. 4 (Jan 2000) 347-55.

Hagerhall, C, et al. "Fractal dimension of landscape silhouette outlines as a predictor of landscape preference." *Journal of Environmental Psychology 24.2* (June 2004): 247–255.

Han, Ke-Tsung. "Responses to Six Major Terrestrial Biomes in Terms of Scenic Beauty, Preference, and Restorativeness." *Environment and Behavior* 39.4 (Jul 2007): 529-556.

Hargrove, Todd. "The Importance of Play for Motor Learning." www. bettermovement.org 8 Jan 2011.

Hartig, Terry, et al. "Restorative Effects of Natural Environment Experiences." *Environment and Behavior* 23.1 (Jan 1991): 3-26.

Hubel, David. Eye, *Brain, and Vision*. New York: WH Freeman and Co, 1988.

Kincade, JM, et al. "An Event-Related Functional Magnetic Resonance Imaging Study of Voluntary and Stimulus-Driven Orienting of Attention." *The Journal of Neuroscience* 25.18 (May 2005): 4593-4604.

Kroner, Walter, et. al. "Using Advanced Office Technology to Increase Productivity." *The Center for Architectural Research* (1992).

Laumann, K, et al. "Selective attention and heart rate responses to natural and urban environments." *Journal of Environmental Psychology* 23.2 (June 2003):125–134.

Li, Qing. "Effect of forest bathing trips on human immune function." Environmental Health and Preventative Medicine 15.1 (2010 Jan): 9–17.

McCoy, Janetta Mitchell and Evans, Gary. "The Potential Role of the Physical Environment in Fostering Creativity." *Creativity Research Journal* 14.3-4 (2002):409-426.

Milton, Donald et al. "Risk of Sick Leave Associated with Outdoor Air Supply Rate, Humidification, and Occupant Complaints." *Indoor Air 10* (2000): 212–221.

Nieuwenhuis, Sander, et al. "Decision making, the P3, and the locus coeruleus--norepinephrine system." *Psychological Bulletin* 131.4 (Jul 2005): 510-532.

Patrick, RP and Ames, BN. "Vitamin D and the omega-3 fatty acids control serotonin synthesis and action, part 2: relevance for ADHD, bipolar disorder, schizophrenia, and impulsive behavior." *FASEB J.* 29.6 (Jun 2015):2207-22.

Sheldon, Alice. "Preference for familiar versus novel stimuli as a function of the familiarity of the environment." *Journal of Comparative and Physiological Psychology* 67.4 (Apr 1969): 516-521.

Spencer, Liz and Pahl, Ray. *Rethinking Friendship*. United States: Princeton University Press, 2006.

Tennessen, CM and Cimprich, B. "Views to Nature: Effects on Attention." *Environmental Psychology* 15 (1995):77-85.

Terman, JS, et al. "Circadian time of morning light administration and therapeutic response in winter depression." *JAMA Psychiatry* 58.1 (2001 Jan): 69-75.

Thorsteinsson, E and James, J. "A meta-analysis of the effects of experimental manipulations of social support during laboratory stress." *Psychology & Health* 14.5 (Oct 1999): 869-886.

Tse, MM, et al. "The effect of visual stimuli on pain threshold and tolerance." *Journal of Clinical Nursing* **11.4** (Jul 2002):462-9.

Tsunetsugu, Yuko, et al. "Physiological and psychological effects of viewing urban forest landscapes assessed by multiple measurements." *Landscape and Urban Planning* **113** (May 2013): 90–93.

Ulrich, RS, et al. "Stress recovery during exposure to natural and urban environments." *Journal of Environmental Psychology* **11.3** (Sep 1991): 201-230.

Ulrich, RS. "View through a window may influence recovery from surgery." *Science 224.4647* (Apr 1984): 420-423.

Vandewalle, G, et al. "Daytime light exposure dynamically enhances brain responses." *Current Biology*. 16.16 (Aug 2006):1616-21.

Walch, JM, et al. "The effect of sunlight on postoperative analgesic medication use: a prospective study of patients undergoing spinal surgery." *Psychosomatic Medicine: Journal of Biobehavioral Medicine* 67.1 (Jan-Feb 2005):156-63.

Wargocki, Pawel et al. "Subjective perceptions, symptom intensity and performance: a comparison of two independent studies, both changing similarly the pollution load in an office." *Indoor Air 12* (2002): 74-80.

Webb, AR, et al. "Influence of season and latitude on the cutaneous synthesis of vitamin D3: exposure to winter sunlight in Boston and Edmonton will not promote vitamin D3 synthesis in human skin." *Journal of Clinical Endocrinology and Metabolism.* 67.2 (Aug 1988): 373-8.

Wells, Nancy. "At Home with Nature: Effects of "Greenness" on Children's Cognitive Functioning." *Environment and Behavior 32.6* (Nov 2000): 775-795.

Zajonc, Robert. "Attitudinal effects of mere exposure." *Journal of Personality and Social Psychology Monograph Supplement* 9.2 (June 1968).

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### Authors



# Hillary DeGroff IIDA, LEED AP ID+C ASSOCIATE PRINCIPAL

Hillary has nine years of experience in the interior design of senior living, residential, healthcare, hospitality, corporate interiors, and higher education projects. Her areas of expertise include space planning, colors and materials, design research, and construction administration. An instrumental member of Perkins Eastman's Green Design Group, Hillary applies her knowledge of sustainable practices to many of the firm's interior design projects.

Hillary's experience includes interior design for a new 20-story independent living building for Saint John's On The Lake in Milwaukee, WI, which has been honored with design awards from the Illinois Chapter of the International Interior Design Association (IIDA), American Institute of Architects (AIA), and National Association of Homebuilders (NAHB). She has recently completed an assisted living and skilled nursing renovation and addition in Tulsa, OK for Tulsa Jewish Retirement and Health Care Center. Current work includes a new assisted living and dementia care addition in Colorado.

Hillary is an Adjunct Instructor of Interior Architecture at Chicago's Columbia College where she teaches Business Practice for Interior Design. Hillary is currently Past President for the IIDA Illinois Chapter and previously served as President. She has also served as Director of the Illinois Chapter of the IIDA Chicago City Center. Hillary is an NCIDQ Certified Interior Designer and a Professional Member of IIDA. She graduated Magna Cum Laude from the Fashion Institute of Technology with a Bachelor of Fine Arts in interior design.



### McCall Wood RA, WELL AP ASSOCIATE

McCall joined the Perkins Eastman team in 2013, following her graduation from one of the top environmental design programs in the country. With initial assignments in Senior Living, followed by Healthcare, most recently on the Stanford Hospital renovation project, McCall has artfully applied her background in science and biochemistry from her undergraduate studies at the University of California, Berkeley to explore the application of science in architecture.

While pursuing her Master in Architecture at the University of Oregon, she pioneered an M.Arch focus in Biophilic Design, conducting lab research on the built environment and developing a scholarly database on human psychology and physiology in relationship to the environment. Since joining Perkins Eastman, McCall has applied her passion and knowledge of Biophilic Design in Senior Living to promote the principals and concepts of this exciting and emerging field. McCall has given numerous presentations on the topic of Biophilia and its application in architecture, most recently with the AIA COTE.



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