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Biophilic design: an introduction for designers

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Cover image: Tuhoe-Te Uru Taumatua, Te Kura Whare by Jasmax. The building is largely constructed from timber harvested under the management of Tūhoe people (Image: David Olsen)

Abstract

This note highlights some of the fundamental concepts that underpin biophilic design and introduces designers to some basic principles and tools that can help develop relevant capabilities within practices to create environments that truly connect people to nature. The note explains 'what is' and 'what is not' biophilic design to assist in removing ambiguity in this area and provide tangible principles. The note also explores case studies from the Asia-Pacific region that have successfully integrated aspects of biophilic design to assist readers in visualising and recognising truly biophilic environments.

Introduction

> 'The successful application of biophilic design fundamentally depends on adopting a new consciousness toward nature, recognising how much our physical and mental wellbeing continues to rely on the quality of our connections to the world beyond of which we still remain a part' (Kellert, 2015).

Though the concept of biophilia has been in existence since the mid 1980's (Wilson, 1984) with biophilic design subsequently emerging through the work of people such as Stephen Kellert around the turn of the century, biophilic design itself remains an emerging field in Australia and internationally. This guide is written as an introduction to biophilic design and is positioned to be accessible to design professionals. It is intended to clarify some of the misconceptions surrounding biophilic design, and to better enable designers to incorporate its principles within the built environment to genuinely create places that truly connect us to the natural world.

This guide is structured in three key parts:

- Part 1: definition, background and benefits—background and formal definition of biophilic design and the benefits it can provide to building occupants
- Part 2: myth-busting—clarification of the boundaries and potential misconceptions surrounding biophilic design, as well as the complimentary disciplines that support it
- Part 3: case studies—a look at some of the world's leading examples of biophilic design in practice from both Australia and overseas.

1. Biophilic design: definition, background and benefits

Definition

Edward O. Wilson (1984) defines biophilia as 'the urge to affiliate with other forms of life', while 'biophilia' can be simply translated from its Greek meaning into English with 'bio' meaning 'life' and 'philia' meaning 'love of'. Simply put, biophilia can be described as the 'love of life' and 'biophilic design' as the methodology from which we integrate the love of life into our environments through design. Biophilia is, in effect, a description of the subconscious connection with nature that we as humans still retain as a result of constant interaction with living things which we've been immersed in for most of human history.

Best practice biophilic design

While many designers intuitively integrate biophilic design attributes in their projects, best practice biophilic design considers people as biological organisms, respecting the human mind-body systems that evolved in nature as indicators of health and wellbeing. Ultimately, good biophilic design seeks to create spaces that are inspirational, restorative and healthy, as well as integrated with the functionality of the place and appropriate in response to the (urban) ecosystem to which it is applied. Above all, biophilic design must nurture a love of place (Browning et al, 2014).

Background

While the American biologist and naturalist Edward O. Wilson is credited with coining the term 'biophilia', Stephen Kellert has had the single greatest influence on biophilic design and its application in the built environment. Two books written by Kellert, Building for Life: Understanding the Human-Nature Connection (2005) and Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life (2008), explore in depth how we can design our buildings and communities in ways that recognise the positive experience of natural systems to support human health, performance, and wellbeing. Similarly, Bill Finnegan's feature film, Biophilic Design—The Architecture of Life, with Kellert as Executive Producer, explores how biophilic design points the way toward creating healthy and productive habitats for modern humans.

Kellert's work has been further adapted to be included as part of the Living Building Challenge™ - a certification and design framework that visualises the ideal for the built environment. It uses the metaphor of a flower, calling on designers to create buildings that function 'as a flower': rooted in place, drawing all energy from the sun and water from the sky, without toxicity or waste, while being in harmony with its surrounds (International Living Future Institute, 2018). Within this framework is a requirement, or 'imperative' that addresses biophilic design. Those undertaking the Living Building ChallengeTM must demonstrate how their design will nurture the innate human-nature connection for occupants based on six elements, each supported by a number of corresponding attributes (Table 1). This framework helps to categorise biophilic design, providing a reference and inspiration for designers.

Terrapin Bright Green, a US-based consultancy has also added greatly to the knowledge of biophilic design, having created a number of freely available resources that not only support the implementation of biophilic design within built environments, but also help quantify the potential health and economic benefits of doing so by drawing on scientific research. Influenced by Wilson and Kellert's work, Terrapin Bright Green propose an alternative framework for the benefit of designers, in the form of 14 Patterns of Biophilic Design, arranged under three areas (Table 2).

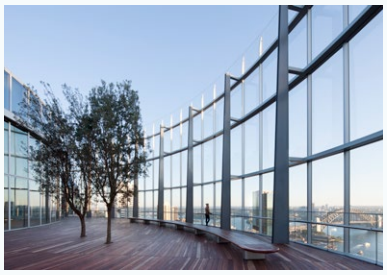
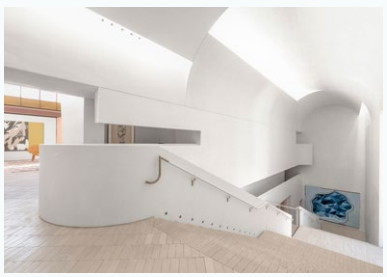
Environmental features	Natural shapes and forms	Natural patterns and processes
• Color • Water • Air • Sunlight • Plants • Animals • Natural materials • Views and vistas • Facade greening • Geology and landscape • Habitats and ecosystems	• Botanical motifs • Tree and columnar supports • Animal (mainly vertebrate) motifs • Shells and spirals • Egg, oval and tubular forms • Arches, vaults, domes • Shapes resisting straight lines and right angles • Simulation of natural features • *Biomorphy* • *Geomorphology* • *Biomimicry*	• Sensory variability • Information richness • Age, change and the patina of time • Growth and *efflorescence* • Central focal point • Patterned wholes • Bounded spaces • Transitional spaces • Linked series and chains • Integration of parts to wholes • Complementary contrasts • Dynamic balance and tension • Fractals • Hierarchically organized ratios and scales
 1 Bligh Street, Sydney by Architectus + Ingenhoven Architects (Image: Hans Georg Esch)	 Genexis theatre, Singapore, by WOHA (Image: Patrick Bingham-Hall)	 Sagrada Familia Spiral Staircase by Antoni Gaudi (Image: Danny Fay, CC BY 3.0, from Wikimedia Commons)
Light and space	**Place-based relationships**	**Evolved human-nature relationships**
• Natural light • Filtered and diffused light • Light and shadow • Reflected light • Light pools • Warm light • Light as shape and form • Spaciousness • Spatial variability • Space as shape and form • Spatial harmony • Inside-outside spaces	• Geographic connection to place • Historic connection to place • Ecological connection to place • Cultural connection to place • Indigenous materials • Landscape orientation • Landscape features that define building form • Landscape ecology • Integration of culture and ecology • Spirit of place • Avoiding placelessness	• Prospect and refuge • Order and complexity • Curiosity and enticement • Change and metamorphosis • Security and protection • Mastery and control • Affection and attachment • Attraction and beauty • Exploration and discovery • Information and cognition • Fear and awe • Reverence and spirituality
 Indigo Slam, Sydney, by Smart Design Studio (Image: David Roche)	 Paddington Reservoir Gardens, Sydney, by Tonkin Zulaikha Greer (Image: Fiora Sacco, courtesy of City of Sydney)	 The Goods Line, Sydney, by ASPECT Studios (Image: Florian Groehn)

Table 1. Elements and attributes of biophilic design (Living Building Challenge™ version 3.1, 2017)
Note: Images have been selected by the authors to further illustrate these concepts.

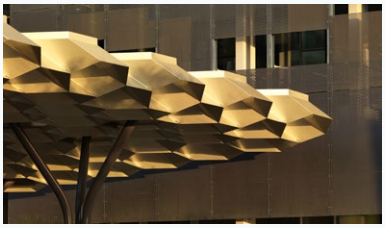
Nature in The Space	Natural Analogues	Nature of The Space
Nature in the Space addresses the direct, physical and ephemeral presence of nature in a space or place. This includes plant life, water and animals, as well as breezes, sounds, scents and other natural elements.	Natural Analogues addresses organic, non-living and indirect evocations of nature. Objects, materials, colors, shapes, sequences and patterns found in nature, manifest as artwork, ornamentation, furniture, décor and textiles in the built environment.	Nature of the Space addresses spatial configurations in nature. This includes our innate and learned desire to be able to see beyond our immediate surroundings, our fascination with the slightly dangerous or unknown; obscured views and revelatory moments; and sometimes even phobia-inducing properties when they include a trusted element of safety.
 Bertschi School Living Science Building by KMD Architects (Image: © Benjamin Benschneider)	 Cloud Canopy, Melbourne, by Maddison Architects (Image: Trevor Mein)	 Salk Institute for Biological Studies by Louis I. Kahn (Image: Jim Harper, [CC BY-SA 1.0], via Wikimedia Commons).
1. Visual Connection with Nature A view to elements of nature, living systems and natural processes.	**8. Biomorphic Forms and Patterns** Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.	**11. Prospect** An unimpeded view over a distance for surveillance and planning.
2. Non-Visual Connection with Nature Auditory, haptic, olfactory or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.	**9. Material Connection with Nature** Material and elements from nature that, through minimal processing, reflect the local ecology or geology to create a distinct sense of place.	**12. Refuge** A place for withdrawal, from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.
3. Non-Rhythmic Sensory Stimuli Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.	**10. Complexity and Order** Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature.	**13. Mystery** The promise of more information achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.
4. Thermal & Airflow Variability Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.		**14. Risk / Peril** An identifiable threat coupled with a reliable safeguard.
5. Presence of Water A condition that enhances the experience of a place through the seeing, hearing or touching of water.		
6. Dynamic and Diffuse Light Leveraging varying intensities of light and shadow that change over time to create conditions that occur in nature.		
7. Connection with Natural Systems Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem.		

Table 2. Terrapin Bright Green framework summarised from *14 Patterns of Biophilic Design* (Browning et al, 2014).
Note: Images have been selected by the authors to further illustrate these concepts.

Benefits

There have been numerous studies over the past 30 years demonstrating the value of connecting humans to the natural environment. Two key opportunities for designers to apply the values of biophilic design are firstly—its potential health and wellbeing benefits, whereby people strive to maintain and protect what they love; and secondly—the possible economic opportunities it can present.

Health and wellbeing

In the healthcare sector, over 50 studies have been published that associate biophilic elements as primary influences for faster recovery rates for patients, decreased dependency on medication, reduced staff and family stress, and improved emotional wellness as a result of natural daylighting and views to nature (Terrapin Bright Green, 2012).

In the 1980s, Roger Ulrich pioneered research identifying that patients whose windows overlooked a scene of nature were released on average after 7.96 days, while those without such a window were released after 8.71 days – a decrease in hospital stay of 8.5 per cent (Ulrich, 1984). In 2004, even if this rate was applied across only 46 patients in the United States, the associated savings were calculated to be approximately US$161,000 (Machlin & Carper, 2007).

In another study it was found that children with Attention Deficit Hyperactivity Disorder (ADHD) who take a 20-minute walk through nature are likely to exhibit significantly better concentration than by walking in a typical city environment (Taylor and Kuo. 2009). Suffice to say, there is strong research supporting the tangible health and wellbeing effects that arise from a connection to nature, particularly in a medical context.

Economic opportunities

Determining any potential economic opportunities of biophilic design can most effectively be done on a sector-by-sector basis, not least because potential benefits should be relevant to the stakeholders, who will have different drivers dependent on their respective sector. In addition to the healthcare examples provided above, there is a wide range of research applicable to other sectors.

In a commercial buildings study, the University of Oregon found that 10 per cent of employee absences could be attributed to architectural elements that did not connect with nature, and that a person's view was the primary predictor of absenteeism (Elzeyadi, 2011). From an economic perspective, the US Department of Labor (2010) reported an annual absenteeism rate of 3 per cent per employee, or 62.4 hours per year per employee, lost in the private sector. The study suggested an employer would lose US$2074 (AUD$2105 in 2011 figures) per employee per year to employee absences. This research shows the economic impacts of absenteeism in the workplace and the potential for biophilic design to reduce these.

In a retail sector study, the soothing and calming effect of nature has been used to draw shoppers into stores and boost sales, significantly improving profit margins for stores with biophilic elements compared to those without (Terrapin Bright Green, 2012). This strategy focuses on extending the dwell time in retail centres, which typically results in an increased spend per capita. When shown images of biophilic retail settings during a consumer study of store designs, respondents indicated that an acceptable price to pay was 20 per cent higher for an item in convenient shopping (eg a sandwich for lunch), 25 per cent higher for general shopping (eg a new jacket), and 15 per cent more for specialty shopping (eg a gift for a family member) compared with conventional non-biophilic retail design (Wolf, 2005).

In the education sector, studies have found that children progressed through school curricula 20—26 per cent faster when learning in daylit environments (Wells and Evans, 2003). Another US study quantified that the impact of optimum daylight within a classroom resulted in an increase of 3.2—3.8 days of additional attendance by students, which when multiplied across the number of students in the school district, resulted in US$126,283 in tax dollars that were not wasted through student absences (Nicklas and Bailey, 1996). Beyond daylighting, further studies have shown that when asked to draw their favourite place, most children will draw the outdoors (Moore, 1986).

Finally, in the residential context, sales data from Puget Sound in the US showed that homes with full views of water achieved a 58.9 per cent increase in value, compared to only a ~30 per cent increase for those with partial views. Homes on the lakefront experienced a 127 per cent increase in value, compared to a typical home in the area (Benson et al., 1998). More recently, a study in Sydney revealed that the average increase in value of an average-size property resulting from a 10 per cent increase in tree canopy was approximately AUD$50,000 (AECOM, 2017).

So, whether there are benefits from views, daylight, access to nature, or otherwise, there is strong research to suggest that implementing biophilic design initiatives within the built environment can offer strong financial benefits in return.

Figure 1. Organic geometry, natural materials and daylighting are used to attract shoppers into spaces at Highpoint Shopping Centre, Melbourne, by Grimshaw in association with The Buchan Group (Image: Peter Bennetts)

Figure 2. Daylit environment provided in the Guardian Early Learning Centre, Barangaroo, by Collins and Turner (Image: Katherine Lu)

2. Myth-busters

With any discipline in its relative infancy there is always the potential that, through no ill-intention or otherwise, misconceptions may arise around it. Similarly, due to biophilic design practice being new to most contemporary designers, those who apply it may not do so in its entirety or may only choose to promote aspects that serve their interests. The following section serves to illustrate and dispel some of the common misconceptions associated with biophilic design.

Biophilic design: what it is, and is not

During his career Stephen Kellert clearly identified what is and what is not considered biophilic design, setting out the distinctive characteristics under five conditions for its effective practice (Kellert, S., 2015):

	For Kellert, biophilic design:	**For Kellert, biophilic design is not;**
1	Emphasises human adaptations to the natural world that over evolutionary time have proven instrumental in advancing people's health, fitness and wellbeing.	Created through exposures to nature that are irrelevant to human productivity and survival or exert little impact on human wellbeing.
2	Depends on repeated and sustained engagement with nature.	An occasional, transient or isolated experience of nature as it exerts only superficial and fleeting effects on people, and can even, at times, be at variance with fostering beneficial outcomes.
3	Requires reinforcing and integrating design interventions that connect with the overall setting or space. The optimal functioning of all organisms depends on immersion within habitats where the various elements comprise a complementary, reinforcing and interconnected whole.	Created through exposures to nature within a disconnected space—such as an isolated plant, an out-of-context picture, or a natural material at variance with other dominant spatial features.
4	Fosters emotional attachments to settings and places. By satisfying our inherent inclination to affiliate with nature, biophilic design engenders an emotional attachment to particular spaces and places. These emotional attachments motivate peoples' performance and productivity, and prompt us to identify with and sustain the places we inhabit.	
5	Fosters positive and sustained interactions and relationships among people and the natural environment. Humans are a deeply social species whose security and productivity depends on positive interactions within a spatial context. Effective biophilic design fosters connections between people and their environment, enhancing feelings of relationship, and a sense of membership in a meaningful community.	

Myth: biophilic design aims to stimulate experience through visual stimuli only

A common misconception of biophilic design is that it focuses predominantly on visual stimuli and aims to harmonise us with our surroundings and experiences through only what we see. While sight is one of our primary senses we are, to a degree, over-dependent on it. When considering both Kellert's work and that of Terrapin Bright Green, many attributes and patterns of biophilic design are particularly attuned to our other senses. We see references to smell through olfactory or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes and numerous attributes including exploration and discovery, information and cognition, fear and awe, reverence and spirituality which can all be triggered, and enhanced by sound, touch, and even taste. Ultimately what is important is that biophilic design is explored and experienced through all the senses to create holistic engagement and an emotional attachment to the immediate environment.

Myth: Biophilic design is essentially about plants and green walls

While planting and greenery are important aspects of biophilic design, and can also aid in good air quality, biodiversity, and mitigating urban heat island effect, among other benefits—they are again only one approach to creating biophilic environments. On their own, and without the integration of other attributes or patterns, they can be tokenistic, providing nothing more than a feature to an environment. As Kellert outlined previously, biophilic design depends on repeated and sustained engagement with nature. By introducing, for example, a green wall that is in isolation within a design, an opportunity might be missed to create a holistic biophilic environment for occupants. To truly integrate greenery within a design and enhance the biophilic environment it must be well considered and consistent with other biophilic experiences one will encounter within a built context.

Myth: biophilic design is standard practice for designers

As described, biophilia can loosely be interpreted as the 'love of life', while life itself can arguably be described as being about experiences. While designers often design for function and efficiency, designing for experience can be more challenging. Designers can, on occasion, post-rationalise biophilic environments by identifying attributes and or patterns in isolation and argue that this constitutes a biophilic design response. To create a genuine biophilic environment, designers must consider the experiences one will encounter throughout their use of the building as part of the design concept and foster positive and sustained interactions and relationships among people and the natural environment. All too often, designers believe they have 'done' biophilic design, when they may have mistaken the inclusion of a handful of the attributes as a considered or comprehensive approach to the creation of a biophilic environment.

3. Case Studies

There are many examples of biophilic design in the built environment, but relatively few that have integrated the breadth of principles both intentionally and consistently. This following section takes a brief look at some of the leading recent examples of biophilic design in the Asia-Pacific region.

Sustainable Buildings Research Centre, University of Wollongong, NSW, by Cox Architecture, completed 2013

Figure 3. SBRC by Cox Architecture. The SBRC is arranged between two buildings, encouraging occupants to spend time outside through a connecting courtyard and to explore the natural materials and textures in the building fabric
(Image: John Gollings Photography)

The Sustainable Buildings Research Centre (SBRC) was developed to both test and demonstrate technologies in the context of a leading regional university. Situated 80km south of Sydney in the coastal city of Wollongong, the campus hosts a number of business and education buildings including the SBRC, uniquely positioned between Pacific Ocean beaches and a bushland backdrop of the Illawarra escarpment (Figure 4).

The SBRC's program is contained within two connected buildings that surround a central courtyard, with a garden to the east and food garden to the west, encouraging building occupants to spend time outside (Figure 3). From an ambiguous front entrance through to lab spaces, offices, study spaces and breakout areas, the design encourages students, staff and visitors to explore a number of environmental features, including natural materials, textures and patterns in the building fabric.

Building occupants and visitors are deliberately connected to the natural environment, with journeys through the building punctuated with framed views and vistas into the distance and a unique prospect offered from the trafficable roof.

Figure 4. SBRC by Cox Architecture. The SBRC makes the most of its unique position between Pacific Ocean beaches and a bushland backdrop of the Illawarra escarpment (Image: John Gollings Photography)

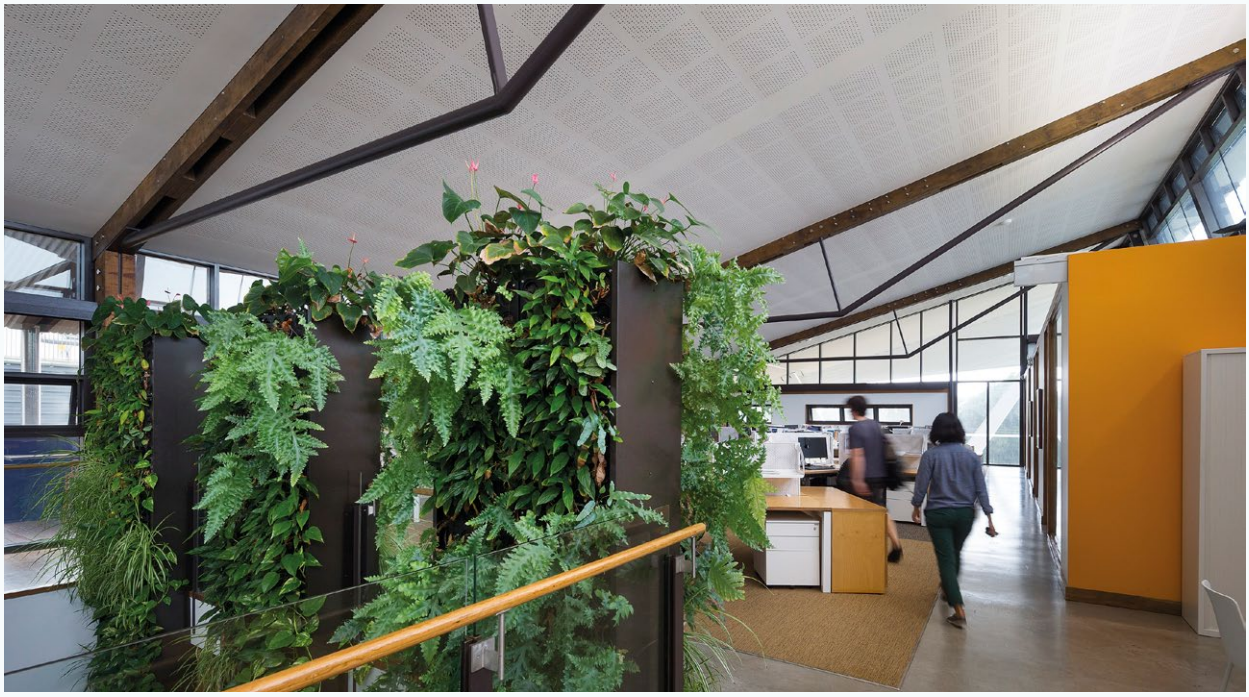


Figure 5. SBRC by Cox Architecture. Internal greening spans both ground and first floors (Image: John Gollings Photography)

The sound of birds and the rush of ocean breezes, the smell of fresh fragrances from the mountains, coastal dune plants and citrus blossoms offer a non-visual connection to nature and the seasons. This is made possible via automated openable windows and louvres that respond to the external conditions, using wider-than-average comfort bands that allow thermal and airflow variability within the building (Figure 6).

As an example of an education building with commercial elements in a campus setting, the SBRC is a great example of an Australian building that provides a geographic connection to place, making the most of the natural landscape within which it is situated.

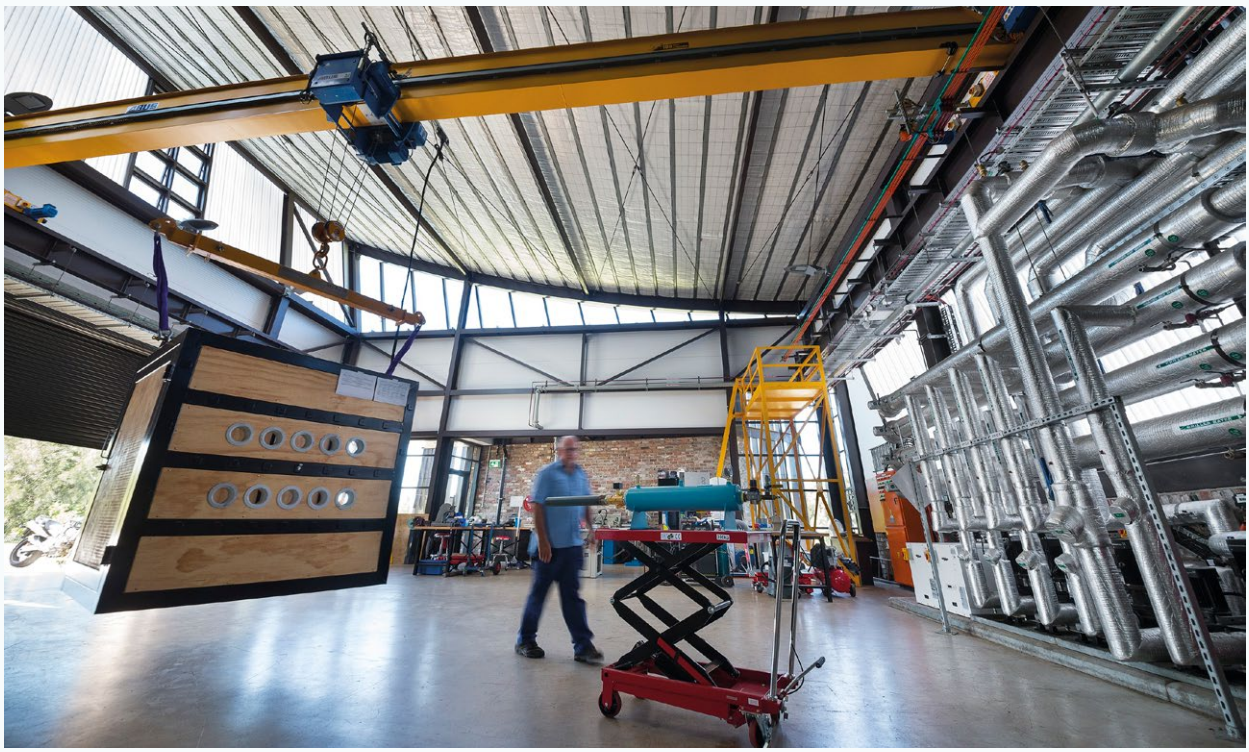


Figure 6. SBRC by Cox Architecture. As a hands-on education environment, the SBRC building encourages thermal and airflow variability (Image: John Gollings Photography)

Tuhoe-Te Uru Taumatua, Te Kura Whare, North Island, New Zealand, by Jasmax, completed 2014

Figure 7. Tuhoe-Te Uru Taumatua, Te Kura Whare by Jasmax. The Tribal Chamber connects to an external amphitheatre through a distinctive arch that echoes the sun path (Image: Arrow International)

Strategically located at the entrance of the township of Tāneatua, Te Kura Whare serves as a community centre and central space for the Ngāi Tūhoe, a Māori iwi (or tribe). The administration space, cafe, library, Tribal Chamber and amphitheatre, all combine to tell the story of how the building literally and figuratively represents the culture of the Tūhoe people.

Lighting—both natural and artificial—is cleverly varied throughout the building, warming the timber and leveraging varying intensities of light and shadow that change over time to emulate conditions that occur in nature. The Tribal Chamber connects to an external amphitheatre through a distinctive arch that echoes the sun path (Figure 7).

Natural materials, shapes and forms can be seen and touched in the logs that serve as posts, beams and trusses (Cover image and Figure 8). Together with vertical bands of glazing, they are suggestive of tree trunks in a forest. A simple materials palette is strongly connected to the land: the building is largely constructed from timber harvested under the management of Tūhoe people and several internal walls are composed of hand-shaped clay bricks that provide variations in texture and color (Figure 9). Tūhoe people can point out the names etched in the brick walls, teaching the importance of connection to place.

Te Kura Whare is an exemplar of biophilic design principles persistently expressed throughout the building, with an exceptionally compelling historic, ecological and cultural connection to place that elicits reverence, spirituality and a sense of community.

Figure 8. Tuhoe-Te Uru Taumatua, Te Kura Whare by Jasmax. Natural shapes and forms can be seen and touched in the logs that serve as posts, beams, and trusses (Image: David Olsen)

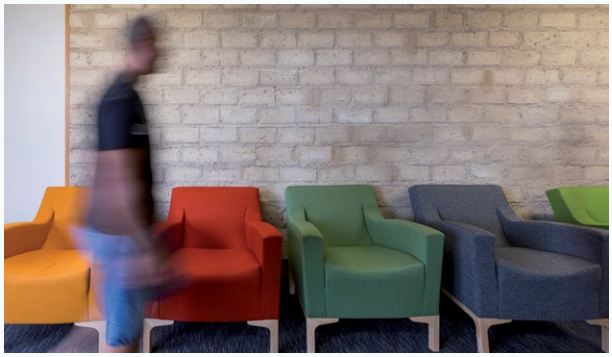


Figure 9. Tuhoe-Te Uru Taumatua, Te Kura Whare by Jasmax. Several internal walls are composed of hand-shaped clay bricks that provide variations in texture and colour (Image: David Olsen)

Khoo Teck Puat Hospital, Singapore, by RMJM and CPG Consultants (Architect of Record), completed 2010

Figure 10. Khoo Teck Puat Hospital by RMJM and CPG Consultants (Architect of Record). The complex is open to its north and deliberately sited to adjoin a pre-existing stormwater pond (Image: RMJM)

The Khoo Teck Puat Hospital is a 590-bed institution serving over 700,000 people in a dense urban setting of Singapore. Driven by the hospital's then-CEO's bold request that the environment of the hospital be able to lower blood pressure, biophilic design was a key approach to support the health and wellbeing of occupants, providing a compelling model for hospital design globally.

The complex is a V-shaped configuration open to its north and deliberately sited to adjoin a pre-existing stormwater pond (Figure 10). The design is orientated to enable air flowing over the pond to enter a central, landscaped courtyard and assisted by wall-mounted aluminum fins, it is either drawn up to carry the scent of plants to hospital beds (Figure 11), or down to a landscaped basement that is open to daylight and natural ventilation. In addition to providing the calming psychological benefits of the presence of water, this feature contributes passive evaporative cooling so that the hospital is significantly cooler in the warm afternoons, reducing demand on active mechanical services.

Private niches and alcoves offer moments of refuge, while other spaces look outwards providing multiple perspectives and invoking a sense of mystery, enticing travel deeper into the environment. Almost every available surface was used for therapeutic green spaces, including a number of unique roof gardens (one of which contains an urban farm) and terraced gardens at the podium levels. Indigenous tropical plants, both inside and out, allow the hospital to become part of the larger ecosystem of Northern Singapore, evidenced by an increasing number of butterfly species in the hospital grounds.

Figure 11. Khoo Teck Puat Hospital by RMJM and CPG Consultants (Architect of Record). Air flows up the building, carrying the scent of plants to hospital beds (Image: RMJM)

The Khoo Teck Puat development draws greenery and water into the heart of the hospital, blurring the boundary between building and landscape to make the hospital and its environment an integrated entity that attracts visitors for social and recreational reasons, not just healthcare (Figure 12).

Figure 12. Khoo Teck Puat Hospital by RMJM and CPG Consultants (Architect of Record). Greenery and water are brought into the heart of the hospital, attracting visitors for social and recreational reasons (Image: RMJM)

Figure 13. Khoo Teck Puat Hospital by RMJM and CPG Consultants (Architect of Record). Spaces of varying use and size offer different perspectives and help to place the occupant in the hospital (Image: RMJM)

Conclusion

Biophilic design appears to most as simple common sense, but given its relative infancy in mainstream design thinking, a number of common misconceptions arise that designers should be conscious of including:

- the tendency to apply only some of the principles on isolated components of a building rather than in a universal and sustained way across a project;
- a restricted focus on visual stimuli only, forgetting about non-visual senses;
- the idea that biophilic design is solely about plants and green walls; and,
- that biophilic design is standard practice for most designers, unconsciously believing that it has been done.

The most effective case studies demonstrate the integration of biophilic design principles consistently across a project with clear intention.

While concepts of biophilia have been around for several decades, and biophilic attributes have been intuitively integrated into architectural projects, the conscious integration of biophilic design into the built environment allows untapped opportunities to create places that truly connect us to the natural world. When implemented well, biophilic design can reduce stress, enhance creativity and clarity of thought, improve our well-being and expedite healing, with research demonstrating both the wellbeing benefits and the financial and economic opportunities in a variety of built environments.

Glossary

Biomimicry—learning from and then emulating nature's forms, processes and ecosystems, sometimes used in design processes.

Biomorphy / Biomorphic —a painted, drawn or sculptured free form or design suggestive in shape of a living organism, especially an ameba or protozoan.

Efflorescence—the migration of a salt to the surface of a porous material where it forms a coating. A familiar example is a crystalline deposit of salts often seen on the surface of concrete, brick, stucco or natural stone surfaces.

Geomorphology—the study of the physical features of the surface of the earth and their relation to its geological structures.

Stochastic—having a random probability distribution or pattern that may be analysed statistically but may not be predicted precisely. Familiar examples of stochastic processes include stock market and exchange rate fluctuations; signals such as speech, audio and video; or medical data such as a patient's blood pressure or temperature.

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Rory is a registered architect and holds an Honours B.Arch and MSc with distinction in Environmental Design. For the past ten years he has worked in Canada, the UK, Vietnam and Australia in architecture, development and sustainability roles.

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Stephen is a UK-registered architect and Australian-educated Project Manager with an MA in Sustainability & Design. He has been in the building industry for 17 years, working across multiple sectors and scales to advance towards a better environment.

Stephen co-founded not-for-profit environmental building and research organisation Architecture for Change in 2011, has taught at various levels from Masters-degree level to unemployed people looking to enter the industry, and has a long experience of delivering and writing curriculum. Stephen is the current Executive Director of the Living Future Institute of Australia, whose vision is one of a socially just, culturally rich, and ecologically restorative future.