

Bridging Indigenous practices and neuroscience for inclusive architectural design

Stuti Sheth¹, Judy Illes¹

¹ Division of Neurology, Faculty of Medicine, The University of British Columbia, Vancouver, British Columbia, Canada

ABSTRACT

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The built environment significantly shapes cognition, sensory processing, well-being, and the way that humans interact with one another. This research explores the intersection of the built environment, traditional and Indigenous architectural practices, and neuroscience as they apply to cognitive health and neurodivergent-friendly design. Drawing on four cultural traditions—Longhouses and other structures from Canada, Vastu Shastra from India, Feng Shui from China and the Te Aranga principles of New Zealand—the discussion synthesizes culturally sourced and peer-reviewed literature to examine how traditional design principles align with contemporary scientific perspectives. The review is structured into three sections: (1) an analysis of traditional architectural practices, (2) an evaluation of neuroscience findings on factors including natural light, spatial openness, and community spaces, and (3) an exploration of how built environments can better support neurodivergent individuals. Neuroethics provides the conceptual framework for this study, emphasizing the importance of pluralistic inquiry and the responsibility of designing pragmatic spaces that respect cognitive diversity and supportive built environments.

INTRODUCTION

Throughout history, architectural practices were not only about constructing shelters but also the deep cultural and environmental wisdom they reflected. Such practices remain relevant today as designs that integrate physical, personal, and cultural safety have been shown to have a profound impact on well-being (Mallgrave & Contandriopoulos, 2008). Neuroethics, which explores the ethical implications of advances in and related to the brain sciences, including neuroarchitecture, has shed light on how design can constrain or empower different ways of thinking and living (Clarke et al., 2022).

Past neuroarchitecture research has examined how built environments affect individuals with different conditions. For veterans with post-traumatic stress disorder (PTSD), for example, semi-structured interviews have identified architectural elements that can alleviate symptoms. Recommendations include the creation of private, acoustically insulated spaces and transparent layouts that maximize privacy and reduce sensory triggers (Maltsev, 2023). For people with sensory impairments, SEALab’s School for the Blind and Visually Impaired in Gujarat, India, employs tactile wayfinding paths, high-contrast materials, and optimized daylighting to enhance spatial orientation and reduce cognitive load for students with sensory differences (Abdel, 2022). Similarly, the Corinne Dolan Alzheimer Center (Ohio, USA) incorporates memory cues, secure wandering circuits, and soothing sensory gardens to support autonomy and emotional comfort for individuals with Alzheimer’s disease (Quesada-García & Valero, 2017).

This review uses the framework of neuroethics to address the gap between traditional knowledge embedded in Indigenous architectural practices and contemporary neuroscience, drawing on culturally grounded architectural systems from Canada, India, China, and New Zealand, alongside empirical findings from brain and mental health research. Canadian Indigenous architectural practices, developed over millennia by First Nations peoples, embody deeply held values of community, sustainability, and harmony with the land (Edward & Harold, 2020). Vastu Shastra, dating back to at least 3000 BCE and first codified in the Rigveda, represents an ancient Indian architectural science that seeks to harmonize human dwellings with the natural world (Dash & Joshi, 2022). Feng Shui, rooted in early Chinese dynasties and grounded in Taoist elemental theory, aligns buildings with qi—the vital life force. Māori traditions of New Zealand conceive architecture as a living entity that embodies ancestral lineage, communal identity, and the spiritual bond between people and the land (Berry, 2022). This discussion further applies to neurodivergence—people with autism spectrum disorder—as a case example, and concludes by highlighting the need for continued innovation in the conceptualizing of design that integrates health and heritage with neuroscience.

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Correspondence: Address correspondence to Stuti Sheth at stutisheth20@gmail.com.

METHODS

The guiding question for this research was: To what extent do Indigenous architectural practices align with neuroscience insights and enhanced well-being in the case of neurodivergence? We used scoping review methodology to capture the breadth of interdisciplinary perspectives across cultural traditions and scientific studies using heterogeneous resources, and to identify common themes, patterns, and gaps. We then synthesized the knowledge gathered from traditional design practices and neuroscience research to explore how architecture supports cognitive and sensory well-being.

Culturally rooted design practices were identified through literature published by professional organizations and cultural institutions. The search focused on the four approaches on which we chose to focus a priori—"Canadian Indigenous architecture," "Vastu Shastra," "Feng Shui" and "Te Aranga."

To retrieve peer-reviewed studies, literature searches were conducted using Google Scholar and ScienceDirect with search combinations such as "neuroscience and architecture and natural light," "neuroscience and built environment and spatial design," "neuroarchitecture and cognition," "neurodivergence and sensory design," and "autism and architectural design." Additional permutations replaced architecture with urban design, built environment, or spatial planning to capture a wider range of relevant works. Studies were limited to the English language and published between January 2000 and February 2025. The timeframe from January 2000 to February 2025 was chosen to capture the period during which research explicitly linking neuroscience and architectural design has expanded, beginning with the advent of neuroimaging-based studies in the early 2000s and extending to the most current literature available at the time of review. They were included for analysis if they addressed the relationship between architecture and cognition, mental health, or neurodivergence. Writings from gray literature were retained only if they offered culturally specific design principles with explanatory context.

Each article included for analysis was annotated with publication details and coded for its primary design emphasis categories: (1) natural light and ventilation; (2) spatial openness, materiality, and adaptability; and (3) community spaces and cultural connection. These categories reflect recurring environmental features linked to cognitive and emotional well-being across both traditional design systems and contemporary neuroscience studies, and they guided the synthesis and organization of results. A narrative synthesis approach (Sukhera, 2022) was used to group studies thematically and identify convergences and divergences between traditional practices and neuroscience-based evidence. Thematic categories were derived from the most prominent and recurring elements identified across the peer-reviewed, gray, and cultural literatures.

RESULTS

Search returns

An initial pool of 134 articles was screened by title and abstract by author SS, resulting in 64 sources selected for full review. Twenty-two (34%) were documents that examined traditional and Indigenous architectural practices: Canadian Indigenous architecture (6), Vastu Shastra (n = 6), Feng Shui, Māori

architecture and Te Aranga principles (n = 4). Forty-two articles were peer-reviewed empirical studies that investigated cognitive and psychological responses to built environments, including sensory processing and design for neurodivergent individuals. The primary design foci of these articles were: natural light and ventilation (n = 5), spatial openness, materiality, and adaptability (n = 15), community spaces and cultural connection (n = 12), and neurodivergence-focused design (n = 10).

Narrative synthesis

Figure 1 and Table 1 illustrate the shared and distinguishing features of the literature analyzed.



Figure 1. Venn diagram of key architectural principles in the four cultures studied.

The longhouses of Canadian Indigenous architectural practices are built as a timber-and-bark communal hall, functioning both as a social hub—hosting ceremonies, governance, and storytelling—and as a physical manifestation of collective identity (Edward & Harold, 2020). Portable dwellings such as tipis, wigwams, and tupiqs illustrate seasonal adaptability: they could be erected, dismantled, and transported to follow migratory food sources, with insulating materials ranging from animal skins in summer to sod or snow in winter for thermal regulation (Porter, n.d.). In Arctic regions, Thule-style winter houses incorporated whale bones to support heavy roofs, while summer tupiqs crafted from seal skins offered lightweight mobility. Entrances and façades frequently bore carved poles and totems that narrated clan histories and spiritual beliefs, embedding cultural symbolism directly into architectural form (National Trust for Canada, 2019). The prioritization of locally sourced, renewable materials such as wood, stone, and animal hides reinforced a tangible connection to place and underscored an ethos of ecological stewardship (Milosz, 2025).

The core tenets of Vastu Shastra prescribe the orientation and arrangement of spaces to optimize both environmental energy and occupant well-being. For example, entrances should ideally face north or east and open clockwise to facilitate the inflow of positive energy and support contemplative practices such as meditation

Table 1. Summary of empirical research and findings on neurodivergence in the three key themes extracted from traditional and Indigenous architectural practices.

Theme	Neuroscience Findings	Considerations for Neurodivergent People
Natural Light & Biophilia	Exposure to natural light regulates circadian rhythms, improves sleep, and enhances cognitive function (Boubekri et al., 2020; Vandewalle et al., 2009). Biophilic elements reduce stress and improve mood (Sztuka et al., 2025; Yin et al., 2018).	Neurodivergent individuals, particularly those with autism and sensory sensitivities, benefit from adjustable, non-flickering lighting. Exposure to natural elements can help regulate mood, reduce agitation, and improve cognitive stability (Black et al., 2022; Yi & Heidari Matin, 2025).
Ventilation	Proper ventilation and reduced CO ₂ levels improve cognitive performance and mental clarity (Allen et al., 2015).	Poor air quality can increase sensory discomfort and cognitive fatigue. Proper ventilation and the use of non-toxic materials reduce sensory stress and enhance comfort (Black et al., 2022).
Spatial Openness	Minimizing visual clutter enhances focus, reduces stress, and improves spatial navigation (McDowell & Budd, 2018; Zazzi & Faragher, 2018).	Overwhelming environments can cause sensory overload in neurodivergent individuals. Clear spatial layouts, defined zones, and minimal distractions improve navigation and reduce anxiety (Black et al., 2022; Sarraf, 2024).
Materiality & Colour	Strategic colour use boosts cognitive performance, logical thinking, attention, and memory, while certain hues may impair performance (Dzulkifli & Mustafar, 2013; Elliot et al., 2007; Xia et al., 2022; Xia et al., 2023). Natural materials like wood lower stress levels (Bower et al., 2019).	High-contrast patterns and artificial textures can trigger sensory discomfort. Soft textures, muted colours, and natural materials create a calming, predictable environment for sensory-sensitive individuals (Black et al., 2022; Yi & Heidari Matin, 2025).
Adaptability & Environmental Control	Flexible environments improve cognitive performance and emotional well-being (Djebbara et al., 2022).	Neurodivergent individuals benefit from control over their environment to reduce sensory overload. Adjustable lighting, sound dampening, and sensory zoning improve comfort and autonomy (Day & Martel, 2024; Sarraf, 2024; Yi & Heidari Matin, 2025).
Community Spaces & Cultural Connection	Well-designed communal spaces improve social interaction, mental health, and cognitive resilience (Fu, 2018; Pineda et al., 2021). Cultural identity strengthens mental well-being (Auger, 2021; Snowshoe et al., 2017).	Autism-led community spaces reduce isolation and improve well-being. Inclusive public spaces that allow for social participation without overstimulation support neurodivergent needs (Botha et al., 2022; Boys, 2022; Farahar, 2022).

and yoga (Staff, 2025). Living areas are positioned in the northeast or northwest quadrants to capture morning and evening sunlight, while bedrooms are placed in the southwest to minimize disruptive dawn light; beds themselves are oriented with the head to the west to allow for visible sunsets without early-morning glare. Windows and balconies are strategically located to admit beneficial UVA/UVB rays and prevailing breezes, reinforcing circadian regulation and indoor air quality (Auro Realty, 2025; Patel, 2024). Moreover, Vastu emphasizes the use of locally sourced natural materials - stone, timber, and clay - that resonate with elemental forces, and it recommends balancing heavy furnishings in the southwest against lighter objects in the northeast to maintain energetic equilibrium.

Feng Shui—through geomantic analysis and directional precision (Donovan, 2025)—divides into the Form school, which assesses auspicious landforms such as mountains and waterways, and the Compass school, which employs the luopan to calculate magnetic orientation and astrological timing (Donovan, 2025). Indoors, practitioners advocate for clear, uninterrupted layouts and uncluttered pathways to facilitate the smooth circulation of qi, a tenet supported by evidence that clutter impairs attention and elevates stress (Masterclass, 2022; Cho & Khare, 2025). Furniture is arranged to maximize visibility of entry points and provide “solid backing,” fostering psychological security (Kamal, 2023). Colour use is likewise deliberate: warm hues like red and orange energize passion and creativity, while cool tones such as blue and green promote calm and cognitive focus. South-facing façades and ample window openings are prized for capturing natural light, which is believed to invigorate occupants and sustain harmonious energy—an idea echoed by studies on daylight’s role in circadian and mood regulation.

The wharenui, or meeting house of the Māori, serves not only as a gathering space for hui and rituals but also as a physical vessel of whakapapa (ancestral genealogy). Its front façade faces east toward the rising sun, a symbol of renewal, and is adorned with whare whakairo (carvings) that personify ancestors and mana whenua (Brown, 2017). Interiors and exteriors are viewed as charged environments where the interplay of people, narratives, and natural forces animates the space. The Te Aranga design framework extends these principles through Taiao, which advocates environmental guardianship and biodiversity-sensitive siting; Mauri Tī, which emphasizes safeguarding the life-spark of land, water, and air; and Mahi Toi, which integrates iwi art and storytelling into civic and communal spaces to reinforce cultural continuity (Auckland Design Manual, n.d.).

Neuroscience and architecture

Natural light and ventilation

Among the five studies in the peer-reviewed literature that examined the cognitive and physiological effects of natural light and ventilation, Vandewalle et al. (2009) demonstrated that exposure to blue-spectrum light selectively activates subcortical regions, including the hypothalamus, brainstem, thalamus, and limbic structures such as the amygdala and hippocampus, thereby enhancing alertness and attention via circadian rhythm regulation. They reported that these effects position strategically designed daylight exposure as a powerful tool for boosting cognitive performance in learning and work environments. Boubekri et al. (2020) conducted an applied investigation in office settings, comparing conventional artificial lighting with optimized daylight conditions. Office workers under enhanced daylight exhibited a 42% improvement in standardized cognitive task performance. Dance (2017) showed that red-shifted light in late afternoon hours can foster preparatory circadian signals that improve sleep onset

and overall mood. They also found that architectural interventions such as sunlit corridors and thoughtful acoustic treatments reduce perceived stress. [Yin et al. \(2018\)](#) focused on biophilic interiors that combine daylight with natural elements like greenery and water. Their study showed that participants in these settings exhibited significant reductions in systolic and diastolic blood pressure and skin conductance levels, alongside a 14% lift in short-term memory tasks. Subjective participant reports further revealed fewer negative emotions.

Most recently, [Sztuka et al. \(2025\)](#) compared built environments dominated by natural versus artificial features. Their results revealed that spaces integrating daylight, organic forms, and natural materials markedly enhanced cognitive focus, emotional balance, and stress recovery, whereas artificial environments correlated with cognitive fatigue and reduced attentional capacity.

Spatial openness, materiality & adaptability

Fifteen studies investigated how layout, materiality, and spatial flexibility influence cognitive and emotional outcomes. [Zazzi and Faragher \(2018\)](#) found that visually cluttered classrooms lead to higher stress levels and reduced attention among students; [McDowell and Budd \(2018\)](#) observed that decluttered spaces improved visual awareness and focus.

Material characteristics also affected users' psychological states. [Azzazy et al. \(2021\)](#) reported that curved designs and natural textures such as wood and stone are associated with reduced stress and more positive neural responses than angular forms or synthetic finishes. Colour studies by [Elliot et al. \(2007\)](#) and [Xia et al. \(2023\)](#) showed that cooler hues such as blue and green promoted calm and improved cognitive performance, whereas red tones elevated anxiety levels. Additionally, high-saturation colours like bright yellows and oranges were linked to enhanced logical reasoning and sustained attention in both real and virtual environments.

[Djebbara et al. \(2022\)](#) demonstrated that flexible, modular spaces encourage movement, which in turn improves spatial awareness and mental agility. They reported that physical flexibility in the environment contributes to both cognitive and emotional benefits by fostering autonomy, engagement, and a sense of environmental control.

Community spaces and cultural connection

Twelve studies examined the relationship between communal space and mental health. [Pineda et al. \(2021\)](#) reported that residents of housing with integrated communal areas exhibit greater white matter integrity and lower anxiety than those in more isolated settings. [Fu \(2018\)](#) found that participation in shared courtyard activities in urban environments is associated with reduced depressive symptoms and stronger place attachment.

Several studies emphasized how communal design can facilitate neurocognitive and emotional development, especially in children and adolescents. For instance, access to outdoor social spaces was associated with improved attentional capacity and lower stress reactivity in children living in dense urban areas. These effects are amplified when the spaces reflect cultural familiarity and inclusivity.

Cultural engagement also contributed to mental well-being. [Auger \(2021\)](#) and [Gonzalez et al. \(2022\)](#) showed that Indigenous youth with access to cultural practices and intergenerational exchange have higher self-efficacy and school engagement. [Snowshoe et al. \(2017\)](#) and [Lamblin et al. \(2017\)](#) found that strong social networks and cultural identification among adolescents correlated with enhanced emotional regulation, focus, and resilience. Notably, [Greenwood & Lindsay \(2019\)](#) showed that architecture that supports communal rituals affirms cultural identity and safety.

Benefits of shared spaces were also noted in institutional and healthcare settings. [Ribbe Kelso et al. \(2024\)](#) observed that communal rehabilitation areas increase patient participation and recovery rates. In psychiatric facilities, patients report lower distress levels and greater trust in staff when spaces are open, naturally lit, and designed to encourage social interaction. [Zhang et al. \(2022\)](#) found that regular use of shared terraces in high-rise housing predicts lower loneliness and improves emotional well-being, regardless of age or residency duration.

Neurodivergence and built environments

Of the 10 empirical studies that focused specifically on the relationship between architectural design and the needs of neurodivergent individuals, two highlighted the role of community-oriented environments in promoting emotional well-being ([Farahar, 2022](#); [Botha et al., 2022](#)). Participants in these studies with strong autistic identity and access to peer-driven community spaces reported lower levels of anxiety and loneliness, and greater self-efficacy. Inclusive environments designed to support autistic traits, rather than suppress them, were found to enhance comfort and reduce the pressure to mask neurodivergent behaviours.

Architectural elements such as spatial clarity, indirect and dimmable lighting, and the use of sound-absorbing materials were associated with lower anxiety and increased sensory comfort ([Black et al., 2022](#)). Harsh stimuli, including fluorescent lighting and visual clutter, were identified as triggers for distress. [Day and Martel \(2024\)](#) and [Sarraf \(2024\)](#) demonstrated that features such as adjustable lighting, temperature, and sensory zoning—quiet, interactive, and transitional areas—enhance emotional regulation and autonomy.

At the scale of neighbourhoods and institutional spaces, [Chan \(2018\)](#) and [Yi and Heidari Matin \(2025\)](#) examined models such as Autism Villages and multisensory environments. Their results indicate that reduced agitation and improved focus are achieved when spaces are customized to individual needs. [Dahlstrom-Hakki et al. \(2023\)](#) further reported that user-controlled sensory input in virtual environments improves task performance and reduces stress for neurodivergent individuals.

Finally, [Boys \(2022\)](#) argued against rigid accessibility checklists in favour of inclusive, evolving design—dynamic frameworks grounded in interdependence and care.

CONCLUSION

This scoping review examined how traditional architectural principles from four distinct cultural systems align with findings based on neuroscience and examines them in the single case of neurodi-

vergence. Across these traditions, common design features emerged: orientation to natural light and seasonal rhythms, emphasis on spatial clarity and flow, incorporation of natural materials, and a focus on communal well-being and cultural identity. The adaptable, seasonally mobile structures used by Indigenous peoples in Canada reflect what Djebbara et al. (2022) and Sarraf (2024) describe as the importance of modular, user-controlled spaces for emotional regulation and autonomy. The emphasis of Vastu on directional light and solar alignment mirrors findings by Vandewalle et al. (2009) and Boubekri et al. (2020), which show that exposure to natural light regulates circadian rhythms and improves cognitive performance. The spatial clarity and clutter-free layouts of Feng Shui correspond with evidence that disorganized spaces elevate stress and hinder focus (Zazzi & Faragher, 2018). The Māori principle of Mahi Toi, which integrates narrative and cultural symbolism into public spaces, aligns with studies demonstrating the mental health benefits of cultural identity and communal rituals (Snowshoe et al., 2017; Greenwood & Lindsay, 2019).

These convergences suggest that traditional design systems offer empirically validated tools for inclusive design. Built environments shaped by ancestral knowledge can meet contemporary neurological and psychological needs, particularly those of neurodivergent individuals. Architects, urban planners, educators, and healthcare professionals can draw on these findings to design environments that support diverse cognitive profiles. This includes the incorporation of flexible layouts, sensory zones, natural materials, and community spaces that reflect local cultural values. For neurodivergent individuals, these elements can reduce anxiety, foster agency, and create environments where difference is respected rather than suppressed. Results suggest that policymakers and institutions committed to equity and inclusion should view culturally attuned, neurologically informed design not as an add-on but as foundational to ethical practice.

It is important to note the limitations of this work. We only examined four traditional design approaches. The autism spectrum focus excludes other kinds of neurodivergence. There can be some variability in methodological rigour in the gray literature. Further, by restricting sources to English, we have excluded perspectives from non-English-speaking communities with equally rich architectural traditions. Future research should address these gaps by expanding linguistic scope, engaging directly with community-based experts, and applying standardized quality appraisal tools across both peer-reviewed and gray literature.

Nonetheless, the synthesis of ancient architectural practices and neuroscience research presents a robust framework for rethinking the built environment. By honouring cultural heritage and leveraging empirical insights, architects and urban planners have the opportunity to create spaces that promote cognitive health, emotional resilience, and inclusive well-being. Such a multidisciplinary approach not only challenges conventional design paradigms but also paves the way for innovative, equitable, and health-promoting environments that can serve all members of society.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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APPENDICES

This appendix provides a legend for the colours chosen in Figure 1 as well as the definitions and contextual explanations for the terms used. It details their significance in relation to the architectural traditions discussed in this paper.

Figure 1 Legend

Green (First Nations – Canada): Green represents First Nations longhouses and other structures that emphasize sustainability and the use of natural materials.

Yellow (Vastu Shastra – India): In Vastu Shastra, the sun is a key element in guiding the orientation of structures, which made it fitting to be depicted as yellow.

Red (Feng Shui – China): Red was used to represent Feng Shui because it emphasizes the flow of energy within a bounded space, much like blood coursing through the body.

Blue (Māori Te Aranga – New Zealand): Blue represents wisdom and therefore used to represent the Māori approach to architecture which integrates ancestral identity into physical spaces.

Figure 1 Terminology

Biophilia (First Nations, Feng Shui, Vastu Shastra, Te Aranga): Biophilia refers to the design of spaces that foster a connection to the natural world. This includes using natural materials, maximizing access to daylight and fresh air, and situating structures to enhance views of nature, supporting emotional and physical well-being.

Cardinality (Feng Shui, Vastu Shastra, Te Aranga): Cardinality is the spatial orientation of structures in relation to the four cardinal

directions. It is considered significant for optimizing environmental conditions, such as light and airflow.

Colour (Feng Shui): Colour in architectural design is used to shape the atmosphere of a space. Specific colours are believed to influence emotions and behaviours, guiding choices in interior design.

Communal Focus (First Nations, Te Aranga): Communal focus highlights the importance of shared, collective spaces that encourage social interaction and reinforce community ties.

Community Spaces (Te Aranga): Community spaces are designed as central places for gathering, often serving social, cultural, and political functions within a community.

Elemental Balance (First Nations, Vastu Shastra, Feng Shui): Elemental balance involves integrating natural elements into built environments to support harmony, health, and equilibrium.

Energy Flow (Vastu Shastra, Feng Shui): Energy flow refers to the movement and distribution of life force or energy within a space. Strategic design choices are made to maintain a balanced and uninterrupted flow throughout the environment.

Materiality (First Nations, Te Aranga, Feng Shui): Materiality describes the thoughtful selection and use of materials in a space, focusing on their tactile, aesthetic, and functional properties.

Natural Light (Vastu Shastra): Natural light is the incorporation of daylight into building design, particularly morning sunlight, to enhance occupant well-being and create vibrant, energized spaces.

Natural Materials (Te Aranga, Feng Shui): Natural materials are sourced directly from the environment—such as wood, stone, or clay—and are used to promote ecological harmony and sensory connection to nature.

Nature Integration (First Nations, Vastu Shastra): Nature integration involves designing environments that align with natural systems by incorporating elements like sunlight, air, vegetation, and water into architectural planning.

Place-Based Design (First Nations, Vastu Shastra, Te Aranga): Place-based design emphasizes tailoring architecture to its local geographic, ecological, and cultural context, reflecting a deep connection to the surrounding landscape and community identity.

Seasonal Adaptability (First Nations): Seasonal adaptability is the ability of built forms to respond to changing climatic conditions. This is often achieved through design flexibility or portable structures that accommodate environmental shifts.

Spatial Narratives (Te Aranga): Spatial narratives involve embedding stories, symbolism, and cultural meaning within architectural forms and layouts, shaping how people experience and interpret a space.

Spatial Openness (Feng Shui): Spatial openness is the creation of clear, decluttered, and unobstructed environments. Such openness is associated with psychological comfort and a free flow of movement and energy.

Sustainable Materials (First Nations): Sustainable materials are locally available, renewable, and environmentally responsible, supporting long-term ecological stewardship.

Ventilation (Vastu Shastra): Ventilation ensures effective air circulation within a building. It contributes to comfort, health, and environmental responsiveness by aligning interior spaces with prevailing wind patterns.