THE BIOPHILIC DESIGN TOOLKIT

RESEARCH REPORT

ANJES SWART

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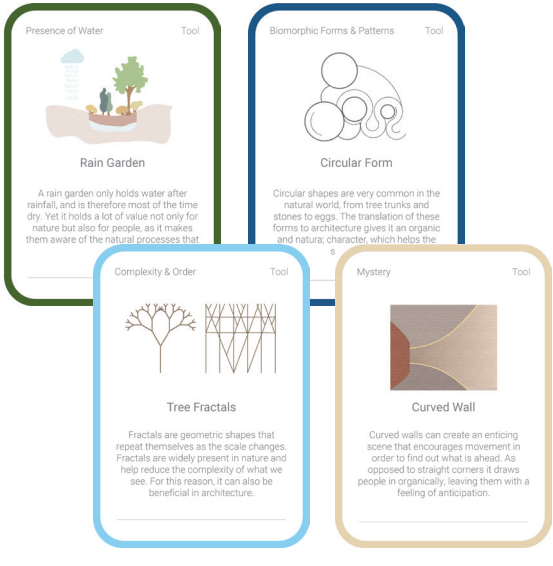


RESEARCH QUESTION

What is the architectural expression of biophilic design, and what strategy should be used to correctly implement Biophilic design?

PATTERN CARDS

PATTERN CARDS

Biophilic Sub-Category

Identification Icon

Summary explaining the physical and psychological effects on human

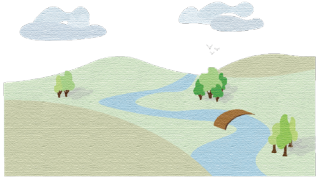
Common Pattern Combinations

Card Type

Pattern Titel

Pattern Meaning

Nature in Space Pattern



[P1] Visual Connection with Nature

A visual connection with nature is a view to elements of nature, living systems and natural processes.[1]

This pattern is perhaps the most straight forward as it focusses on the visual connection with nature, which can range from trees, flowers, ponds and animals. The objective of this pattern is to provide an environment that helps the individual shift focus to relax the eye muscles and temper cognitive fatigue.1 Because natural views stimulates a greater portion of the visual cortex then non-natural scenes more pleasure receptors are engaged increasing happiness. In addition natural scenes have proven to improve concentration and reduce stress.

Use in combination with [P2] [P3] [P5] [P8] [P11]

Nature in Space Pattern

General Application

Application Strategies

Examples

This pattern specifically focusses on the sense of sight, however the pattern becomes more effective when combined with pattern two, the non-visual connection with nature, where nature also stimulates the other senses.

Biodiversity – The impact is increased, not necessarily with a greater area but with a higher number of biodiversity.

Time – The impact is the greatest after at least 5-20 min of exposure.

View – Design in a way that upholds the desired view lines, and prevent obstructions that prevent visual access in a sitting position.

Local – In order to increase placeness it is important to create a natural environment that is representative of the area you are building in.

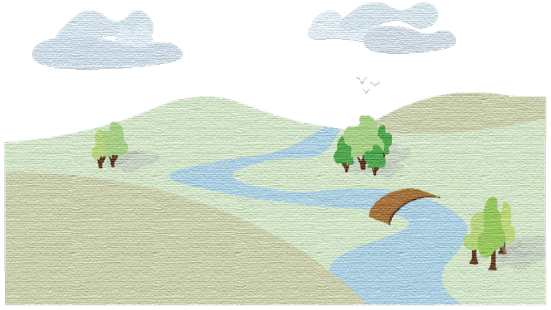
Parallax – The changing of the view due to the motion of the observer.

Ideal – The ideal scene encompasses looking down upon a trees creating shade, flowering plants, human habitation, water and non-threatening animals.

Examples in Architecture: fountain, pond, green wall, sculpted gardens, artwork of natural scenes.

NATURE IN 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. The strongest Nature in the Space experiences are achieved through the creation of meaningful, direct connections with these natural elements, particularly through diversity, movement and multi-sensory interactions.



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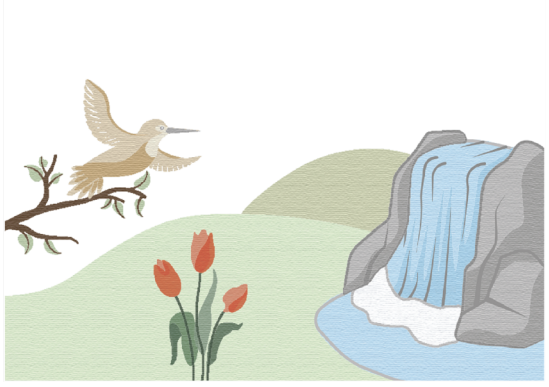
1. (Browning et al., 2014, p.24)
(Craanen, 2020, Chapter visual connection with nature)
(Plambech & Van Den Bosch, 2015)



[P2] Non-Visual Connection with Nature

Non-Visual connection with nature is the auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.[1]

In addition to the visual sense there are four other senses that are seldom specifically stimulated, yet an environment that engages an individual with sound, scent, touch and potentially taste creates a complex and changeable environment, which feels familiar and comfortable. Natural sounds have been proven to reduce cognitive fatigue and accelerate recovery. Sent stimulates the olfactory system which can trigger powerful memories that can calm and energize people. Based on other research it is believed that touching elements in nature like water and raw materials can calm people and reduce fatigue.

Use in combination with [P2] [P3] [P4] [P5] [P9]

While the experience of these senses individually is possible, the experience and effects are compounded when multiple senses are engaged simultaneously, this also relates to the visual connection of pattern one.

Sound – Try to increase the presence of natural sounds, like running water and animal sounds, when this is not possible natural sounds can be recreated.

Time – Is best experienced when a person is exposed for at least 5 – 20 minutes at a time.

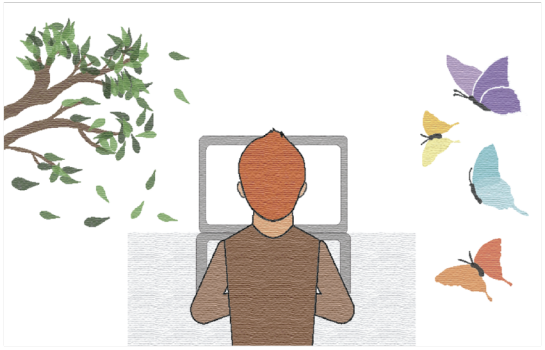
Relation – Urban sound patterns are similar to natural sound patterns and are thus perceived as positive when a visual connection to nature can be made.

Integrate – Implement the non-visual connection to other aspects of the design program.

Increase – The effects are greater when different non-visual connection and visual connections are combined.

Examples in architecture: water feature, plant wall, animals, artwork of natural scenes.

1. (Browning et al., 2014, p.26)
(Craanen, 2020, Chapter non visual connection with nature)



[P3] Non-Rhythmic sensory stimuli

Non-Rhythmic sensory stimuli are stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.[1]

This pattern reacts to the non-rhythmic stimuli of nature like the sound of birds, or the rustling of leaves, the feeling of a breeze and the change of light when the sun disappears behind a cloud. It is the non-predictable nature of these stimuli that is perceived as positive and that captures the attention of the observer. While natural stimuli are preferred it possible to recreate these experiences mechanically. These stimuli have a positive effect on the hearth rate, systolic blood pressure, and sympathetic nervous system.

Use in combination with [P1] [P4] [P5] [P10] [P13]

The 20 x 20 x 20 rule

During tasks with short visual focus, the eye muscles will start to show fatigue after about 20 minutes, resulting in physical discomfort and decreased concentration. Therefore sensory experiences that are designed to shift focus every 20 minute for about 20 seconds from a distance of 20 feet should be applied.

Peripheral – The Peripheral zones of your field of vision is the best area to place non-rhythmic sensory stimuli.

Seasonal – because many stimuli are related to seasonal changes it is important to take this shift into account and design multiple interventions that overlap.

Qualities – It is important that the stimuli have ephemeral and stochastic qualities.

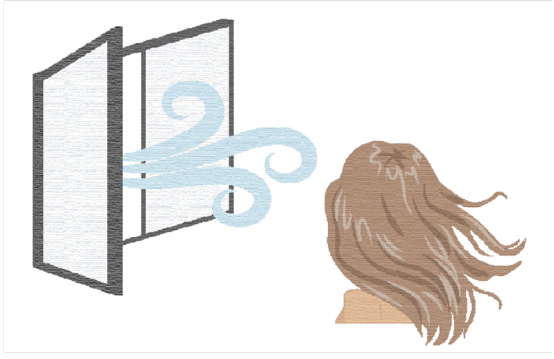
Mechanical – You can incorporate stimuli within the buildings systems, like creating an occasional breeze with the ventilation system.

Animals – non-rhythmic movement can be created by attracting animals like butterflies and bees, this can be done by planting the right plants and flowers.

Examples in architecture: Breeze, movement of animals, ruffling of trees, reflection of water on a surface, changing light

1. (Browning et al., 2014, p.28)
(Craanen, 2020, Chapter non rhythmic sensory stimuli)
(Ryan, 2015)

Nature in Space Pattern



[P4] Thermal & Airflow variability

Thermal & Airflow variability can be characterized as subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperature that mimic natural environment.[1]

This pattern promotes the experience of the sensory elements of airflow and thermal variability. The benefits of this are further increased when people are given control over these conditions. This stems from the research into the positive effects of natural ventilation, alliesthesia*, and the impact of nature in motion on concentration. As opposed to how modern mechanical systems work, people desire moderate levels of sensory variability in light, sound and temperature in order to avoid boredom. Therefore, light breezes and changes in thermal conditions increases comfort and improve both peoples well-being and productivity.

Use in combination with [P6] [P7] - sometimes [P3] [P5] [P13]

Nature in Space Pattern

Variability – Provide a range of different seating option with different conductance materials and different proximity to breezes (operable windows) or the sun (window), to supply to a wider audience.

Mechanical – This strategy has to be taken into account during the schematic design stage of the systems, and can work in conjunction with the air and heating systems.

Sustainability – When designed in such a way that a greater number of people can experience thermal comfort, the need for overall heating and cooling might decrease.

Discomfort – Implementing changes of thermal condition into the design does not have to reach the level of discomfort in order to achieve the positive effects mentioned before.

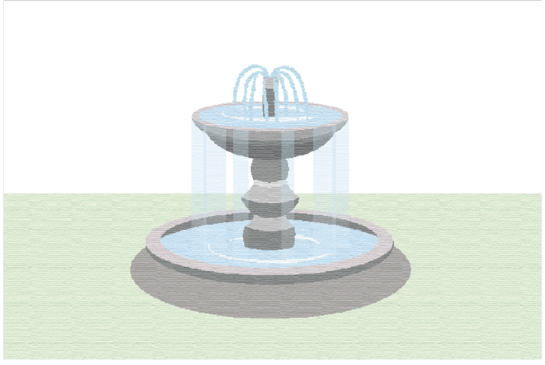
Control – By giving people control over their own thermal comfort the range of acceptable temperatures is increased by two degrease.

Examples in architecture: cross-ventilation, operable windows, material selection (different levels of heat gain), sun / shade, HVAC system, system control.

**Allieshesia – physiology and perception of temporal and spatial pleasures*

1. (Browning et al., 2014, p.30)
(Craanen, 2020, Chapter thermal and airflow variabillity)

Nature in Space Pattern



[P5] Presence of Water

Presence of water is a condition that enhances the experience of a place through the seeing, hearing of touching of water.

The incorporation of water lends itself extremely well for a multisensory experience, where the user can not only see, but also hear and touch the water. The effects of water in urban environments can create a similar impact to that of a natural environment without the presence of water, showing its profound effect. Research has shown that people prefer views that include clean bodies of water, as this creates an environment that reduces stress, and lowers the heart rate and blood pressure. Experiencing the visual stimuli of water also improves concentration and memory.

Use in combination with [P1] [P2] [P7] [P11] [P14]

Nature in Space Pattern

Interest – The interest in water elements is not easily lost, therefore even a small element maintains it effect over time.

Multi-sensory – The effect of water is greatly increased when the observer can both see, hear and touch the water.

Movement – Prioritize naturally fluctuating water movement over predictable movement or stagnancy.

Volume – Very large volumes of water could create discomfort, due to high humidity and loud sounds, ensure the water feature is appropriate for the space.

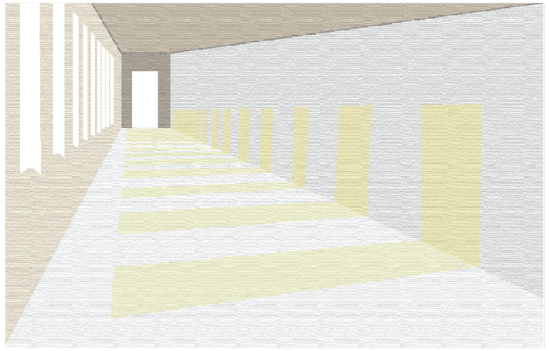
Energy – It is important to keep the energy consumption and water usage in mind (especially in water scares areas) smaller features might in some cases be more preferable.

Management – A water feature could be combined with the water management system, making the system visual and thus creating awareness.

Sound – The sound can be projected into the building changing the perception of the scale of the feature (it is important to limit continues auditory exposure, so that it doesn't become monotonous).

Examples in architecture: waterfall, fountain, aquarium, refection pool, pond, natural water features.

1. (Browning et al., 2014, p.32)
(Craanen, 2020, Chapter presence of water)
(Ryan, 2016)



[P6] Dynamic & Diffuse Light

Dynamic & diffuse light leverages varying intensities of light and shadow that change over time to create conditions that occur in nature.

This pattern promotes the experience of the changes that occur in natural light, as it is rarely uniform. The tone of the light changes throughout the day from yellow, to blue, to red, which has an effect on the humans circadian system, the system that promotes a healthy sleep pattern and improves the mood. Light also changes in intensity, due to the passing of clouds, or the interaction with other natural elements, like trees that create shade, showing its dynamic nature. In well daylighted spaces, productivity is higher, and the mood and overall well-being is improved.

Use in combination with [P1] [P3] [P4] [P14] - [P5] [P7] [P8]

The goal is both to maintain an healthy circadian rhythm, as well as to provide lighting options the positively stimulate the eye.

Variable – Create an space that experiences changes in lighting, to make it more interesting, while limiting extreme effects that cause discomfort.

Luminance – The ratio between the task lighting and its surrounding should not exceed 10 to 1.

Calm – Diffuse lighting on vertical and ceiling surfaces provide a calm backdrop.

Flexibility – Personal localized lighting control over intensity and direction, increases flexibility and comfort.

Movement – The movement of light and shadows can attract people's attention.

Imitation – If it is not possible to let daylight in a space, it is still important to imitate the circadian rhythm, which can be done by implementing color changes and intensities.

Sustainability – Daylight access can decrease the need for artificial lighting and thus the energy consumption.

Examples in architecture: illumination, accent lighting, personal lighting, windows, roof windows.

1. (Browning et al., 2014, p.34)
(Craanen, 2020, Chapter dynamic and diffuse light)

[P7] Connection with Natural Systems

Connection with Natural systems is the awareness of natural processes, especially seasonal and temporal changes characteristics of a healthy ecosystem.[1]

Despite the fact that there is little scientific research that shows the positive impact that the connection with the natural systems has on our overall heath, there are strong believes that it does. The connection to the natural systems is meant to make the observer a part of a greater whole, making people aware of seasonal cycles and cycles of life. Seeing these cycles can cause a shift in how the world is perceived, which will hopefully result in greater stewardship of the ecosystem. The pattern is often perceived as relaxing, enlightening and profound.

Use in combination with [P1] [P2] [P3] [P5] - [P4] [P6] [P13]

This pattern is meant to create a higher awareness of natural properties, where the temporal component is often the key factor in pattern recognition.

Rainwater – Integrating rainwater capture and treatment into the landscape design that respond to rain events, increases awareness of the natural water supply.

Native – Planting native vegetation that is active throughout the year helps see the seasonal changes.

Materials – Use materials that weather over time, or change in different weather conditions.

Interactive – Design for interaction like a water court or community garden.

Examples in architecture: visible rainwater storage, materials that weather, simulated daylight systems, native plants.

1. (Browning et al., 2014, p.36)
(Craanen, 2020, Chapter thermal and airflow variabillity)

NATURALE ANALOGUES

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. Mimicry of shells and leaves, furniture with organic shapes, and natural materials that have been processed or extensively altered (e.g., wood planks, granite tabletops), each provide an indirect connection with nature: while they are real, they are only analogous of the items in their ‘natural’ state. The strongest Natural Analogue experiences are achieved by providing information richness in an organized and sometimes evolving manner.

Natural Analogues Pattern

[P8] Biomorphic Forms & Patterns

Biomorphic Forms & Patterns are symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.[1]

Biomorphic comes from the Greek words; Bioic (life, living) and μορφή (form) and refers to the design of shapes and forms that are inspired by nature. Biomorphic design could be seen as symbolic representations of life, and are used to make the observer feel more connected to the natural world. While humans have a visual preference for organic and biomorphic forms, it is not known why. The Golden Angle, the Fibonacci series and Golden Section are well known mathematical patterns that occur in nature, and can be used in architecture. Biomorphic forms and patterns could increase cognitive functions and reduce stress.

Use in combination with [P1] [P10]

Nature in Space Pattern

Form – Design with organic forms, like curves, and use soft edges, or biomimetic qualities.

Integral – Integrate biomorphic forms and patterns into the structure and function of the design, it is suggested that this integration has a greater impact.

Ornamentation – Use ornamentation derived from trees, wings, seashells, leaves and flowers.

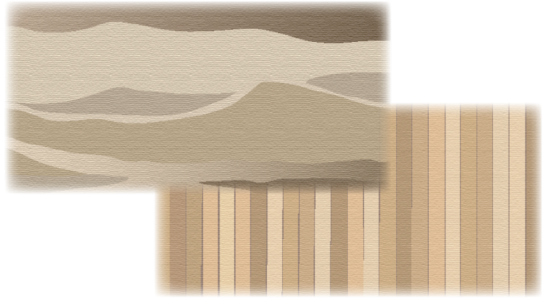
Planes – Apply biomorphic forms on 2 or 3 planes for greater diversity and frequency of exposure.

Depletion – Prevent abundant use of the pattern to avoid visual toxicity.

Examples in architecture: curved wall, window details, decorative paneling, furniture details, painted details.

1. (Browning et al., 2014, p.38)
(Craanen, 2020, Chapter biomorphic forms and patterns)
(The Design Sheppard, 2022)

Natural Analogues Pattern



[P9] Material Connection with Nature

A material connection with nature is material and elements from nature that, through minimal processing, reflect the local ecology or geology to create a distinct sense of place. [1]

The application of natural materials can occur in a variety of ways in architecture, from use in structural elements, to wall coverings and furniture. However, the goal of application is similar, as it is about exploring the characteristics and qualities of a material, in order to enhance the connection to nature, and experience the positive effects that this evokes. Sometimes there are multiple layers hidden in the material, such as learned knowledge, familiar textures, or nested fractals, that deepen the experience. The effects are dependent on the material selection, ranging from improved comfort, decreased brain activity, and improved creative performance.

Use in combination with [P1] [P2] [P8] [P10]

Nature in Space Pattern

Impact – The material connection is most effective when the material is closest to its natural form.

Variation – A degree of variation in materials is recommended over a high ratio of any material,

Minimally Processed – Real materials are preferred over synthetic materials, as the human brain can differentiate between the two.

Local – The use of natural materials that can be found in the surrounding increases placeness and are better for the environment.

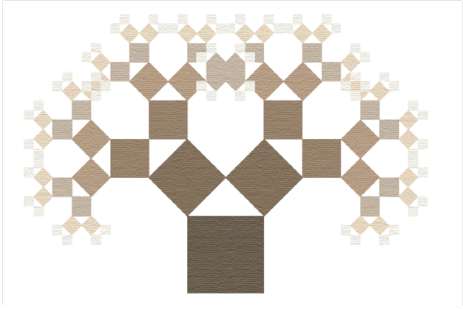
Texture – Use materials with high textures.

Time – Use materials that reflects time and use.

Examples in architecture: CLT beams, rammed earth walls, stone paths, wooden floors, veneers, wood furniture.

1. (Browning et al., 2014, p.40)
(Craanen, 2020, Chapter material connection with nature)

Natural Analogues Pattern



[P10] Complexity & Order

Complexity and Order is rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. [1]

Fractals exist in nature, art and architecture. While a correlation between these fractals has been proven, opinions on their effects and applications differ. Questions on whether there is an optimal ratio, or if it is even import to find one, dominate the field. It is clear that both ends of the spectrum of fractals can induce stress. Limmited fractal patterns can make a space dull, as they fail to stimulate the brain. While a high number of fractals can be overwhelming, causing visual perception problems. The goal is therefore to create a visually nourishing environment (with symmetries and fractal geometries) reducing stress and anxiety.

Use in combination with [P1] [P2] [P8] [P9]

Nature in Space Pattern

Fractals – Nested fractal designs expressed as a third iteration of the base design are more likely to achieve a level of complexity that conveys a sense of order and intrigue, reducing stress.

Balance – Targeting the optimal ratio between complexity and order might not always be worth it as it is difficult to find, inconsistent and time consuming. The incorporation of third-iteration fractal design is often much more effective.

Scale – Apply complexity on different scales of the design.

Rhythmic repetition – While applying rhythm and fractals ensure the absence of monotonous repetition, by using elements that slightly differ. This creates seemingly less complex structures that are more pleasing to observe.

Symmetry – Most things in nature are approximately symmetrical, humans are drawn to repetition, however too symmetrical in unnerving.

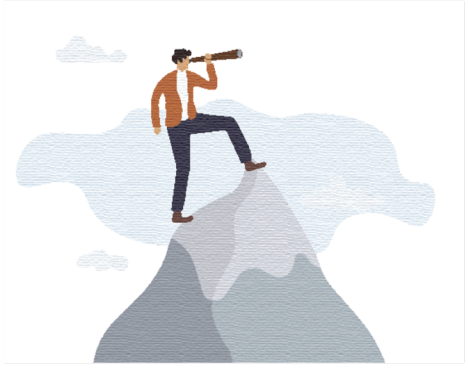
Examples in architecture: exposed structures / exoskeleton, facade and window hierarchy, floor plans / landscape plan / urban grid, material texture, wallpaper / carpet design.

1. (Browning et al., 2014, p.42)
(Craanen, 2020, Chapter complexity and order)
(Ryan, 2015b)

NATURE OF THE SPACE

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. The strongest Nature of the Space experiences are achieved through the creation of deliberate and engaging spatial configurations commingled with patterns of Nature in the Space and Natural Analogues.

Nature of the Space Pattern



[P11] Prospect

Prospect is an unimpeded view over a distance for surveillance and planning.[1]

The pattern of prospect comes from a wide range of research that explain the conditions that allow the user to visually survey and contemplate its environment. The desire for visual surveying comes forth from evolutionary research, like the Savanna Hypothesis, where humans prefer visual views where they can scan the environment for treats and opportunities. This can occur in many forms, from interior prospect to exterior prospect, short depth and high depth prospects, or a combination of these. Prospect is suggested to reduce stress, boredom, irritation, fatigue and perceived vulnerability, as well as improve comfort.

Use in combination with [P1] [P5] [P12] [P13] [P14]

Nature in Space Pattern

Focal length – Distant prospect (>30m) is preferred over shorter focal lengths (<6m) when the space permits it, removing visual barriers / limiting them to a meter high, will allow for this view.

Landscape – In landscapes, prospect is described as the view from an elevated position or across an expanse.

Interior – Interior prospect is the ability to see from one space to another. This is strengthened when it allows the viewer to see true multiple spaces with clear distinctions between them.

Balance – Often the balance between Prospect and Refuge will be more important then the size and frequency of the experience.

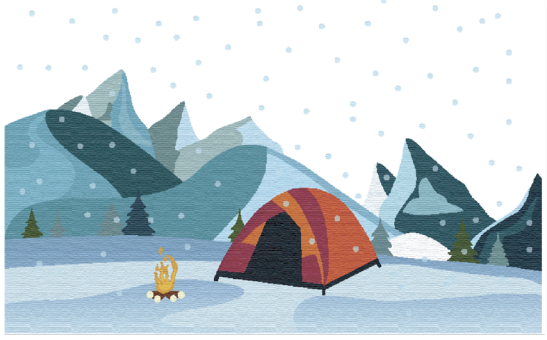
Elevation – Interior elevations between 30 and 45 cm can help enhance the prospect conditions.

Staircases – Locating stairwells at the building perimeter with glass façade and interior glass stairwell wall can form dual prospect conditions.

Examples in architecture: corridors, balconies, use of transparent materials, open floor plans, views to the exterior.

1. (Browning et al., 2014, p.44)
(Craanen, 2020, Chapter prospect refuge)

Nature of the Space Pattern



[P12] Refuge

Refuge is a place for withdrawal, form environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.[1]

The pattern of refuge holds a close relation to the pattern of prospect, and is meant to provide the user with an easily accessible and protective environment as opposed to the wide views of prospect. While the balance between the two patterns is of great importance, it is said the health benefits of refuge are stronger than those of prospect. Refuge conditions are important for recovery and stress reduction, and is additionally suggested to reduce irritation, fatigue, as well as improve concentration and attention. A place of refuge is a space where one feels safe.

Use in combination with [P4] [P6] [P11] [P13]

Nature in Space Pattern

Protection – A good place of refuge has protection from behind and overhead, and preferably from a third side.

Visual access – Limit visual access into a place of refuge, while maintaining a visual connection to the exterior from within.

Part off – A place of refuge is often a smaller portion of a larger space.

Ceiling – Interior refuge can be characterized by lowered ceiling between 30 and 45 cm below the main ceiling.

Light – The lighting levels in a place of refuge should differ from those in the adjacent spaces. Giving users control of the lighting levels will broaden the functionality of the refuge space.

Variety – In larger projects or projects with a wide variety of programs, it is beneficial to design different kinds of refuge spaces in order to supply a wider audience. This can be done through different dimensions, different lighting conditions, and different degree's of concealment.

Examples in architecture: seating with high backs, reading nooks, covered walkways, meeting rooms, arcades, sleeping pods.

1. (Browning et al., 2014, p.46)
(Craanen, 2020, Chapter prospect refuge

Nature of the Space Pattern

[P13] Mystery

Mystery is the promise of more information achieved through partially obstructed views or other sensory devices that entice the individual to travel deeper into the environment.[1]

The pattern of mystery encourages exploration by providing an environment that compels the user to move forward. For example by only providing them with a partial view of what is ahead. This pattern is derived from the understanding that people have two basic needs in the environment; to understand, and to explore. In order to engage in mystery, both of these basic needs should be present from the observers position. As opposed to other patterns, mystery implies movement to experience the pattern. Mystery decreases stress, increases cognitive restoration, and heightened curiosity.

Use in combination with [P1] [P2] [P3] [P6] - [P7] [P10] [P11] [P12]

Nature in Space Pattern

Fear – The obstruction of views should not engender fear, so in order to target the pleasure center the depth of views should be between 6 and 30 meters.

Obstruction – Mystery could be achieved by the obstruction of the boundaries and part of the focal subject, by obscuring one, but preferably two edges.

Curves – The application of curving edges that slowly reveal what is ahead draw people through a space as opposed to sharp corners.

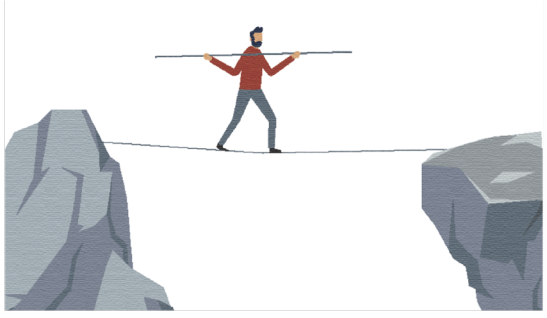
Light – Dynamic light and shadows can enhance the sense of mystery, but very dark shadows should be avoided.

Time – The effects of mystery might degrade with routine exposure, however when the focal point of the mystery has changing information, this routine could be broken.

Examples in architecture: winding paths, curving corridors, semi-transparent transitions, stairs, half walls.

1. (Browning et al., 2014, p.48)
(Craanen, 2020, Chapter mystery)
(Ryan, 2016b)

Nature of the Space Pattern



[P14] Risk / Peril

Risk / Peril is an identifiable threat coupled with a reliable safeguard.[1]

The pattern of risks might feel dangerous, but at the same time, intriguing and worth exploring. While the pattern is meant to trigger a sense of danger, it is limited by the presence of a safeguard, that allows for control over the dangerous situation. It is a controllable risk that limits fear, but evokes the response of dopamine, which supports motivation, arouses attention and curiosity, and refreshes memory and problem-solving skills. Risk can be applied in different degrees depending on the user or available space.

Use in combination with [P1] [P5] [P11]

Nature in Space Pattern

Time – The pattern of risk / peril is meant to be present for a short period of time so that it doesn't induce depression and mood disorders.

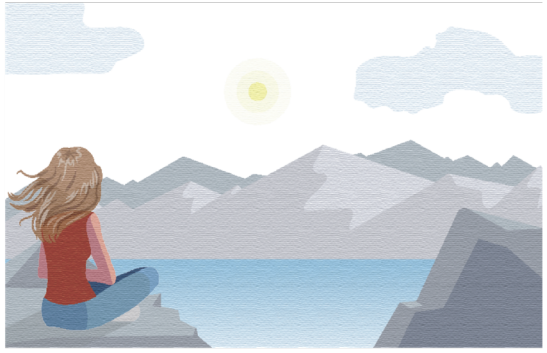
User – The application of the risk pattern is deliberate and is not necessarily appropriate for all users and spaces.

Safety – When risk is evoked is should always be complemented with a sense of safety to prevent negative effects.

Examples in architecture: balcony, cantilever, infinity edge, transparent floor, stepping stones over a creek, objects that are perceived to defy gravity.

1. (Browning et al., 2014, p.50)
(Craanen, 2020, Chapter risk peril)

Nature of the Space Pattern



[P15] Awe

Stimuli that defy an existing frame of reference and lead to a change in perception.[1]

The feeling of awe or wonderment is evoked by a sight that makes the user feel smaller, humble, and in some cases, more charitable. In nature, this happens for example in places that open up to a broad horizon, like the top of a mountain, or on a cliff overlooking the ocean. In a way this feeling makes us feel part of something much larger then ourselves. Throughout the day we experience ephemeral phenomena, or in other words short lived moments of awe, like a rainbow or a ray of sunshine. The moments of awe have proven to be able to reduce stress, boost creativity and improve overall happiness.

Use in combination with [P6] [P7] [P11] [P12]

Nature in Space Pattern

Compression and release – where large open spaces can be hard to achieve in architecture, a similar effect can be created when a small compressed space suddenly open up into a large one.

Sun – Paying great attention to incorporating the effects of diurnal patterns, like the sunrise and sunset, and the occurrence of the full moon, helps people reconnect to the natural world.

Scale – Increasing the perception of scale can improve the perception of feeling small within the space.

Examples in architecture: use of mirrors, great change in lighting levels, great change in room size

(Crossley, 2023)

CASE STUDY CARDS

CASE STUDY CARDS

Case Study

Case Study Titel

Case Study Data

Summary of the building

Visible Patterns

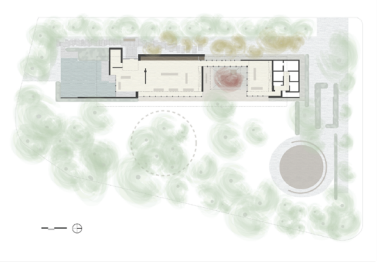
Card Type

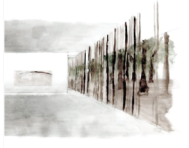
Architectural Inspiration

Windhover

Case Study

Windhover Contemplative Center





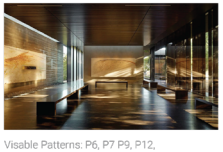
Architect:
Aidlin Darling Design
Year:
2014
Site:
Stanford, CA, United States
Type:
Public Gallary
Area:
372m²

The Windhover Contemplative center is designed to promote personal renewal and well-being, and serves as a spiritual retreat for the students, faculty and staff of Stanford University. The designer wanted to create a space where art, landscape, and architecture come together. The art gallery connects with its location, a natural oak grove, through large windows, that blur the lines between the interior and exterior. Making nature part of the art that can be experienced in the gallery.

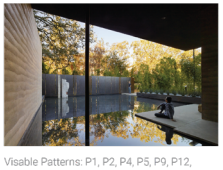
The spaces are designed in such a way that they take the visitor out of the exterior environmental conditions and main flow of daily life. This is mainly done with the material selection and routing that direct the visitor further into the space, strengthening the concept of contemplative refuge.

Pressent Biophilic Patterns: P1, P2, P3, P4, P5, P6, P7, P8, P9, P11, P12, P13

Images with visible patterns



Visable Patterns: P6, P7 P9, P12,



Visable Patterns: P1, P2, P4, P5, P9, P12,

Visable Patterns: P1, P2, P9, P12,

Visable Patterns: P1, P6, P7 P9

P1 Visual Connection with Nature

Nested in a natural oak grove the building offers plenty of opportunities for far views into the grove. The addition of a reflection pool [P5] and courtyard create moments that break up the interior spaces, obscuring the line between inside and outside. The still water of the reflection pool reflects the surrounding oak grove, further emphasizes its presence which allows for a moment of peace and reflection.

P6 Dynamic & Diffuse light

The art is lit by individual skylights to wash them in light, putting emphasis on them and creating a moment of reflection. Louvers on the east façade mimic the non-rhythmic layering of tree trunks [P8], that due to the eastern orientation cast dynamic shadows, that change in accordance to the path of the sun [P7], on the dark oak wood flooring. Due the abundance of glass there is no need for artificial lighting during the day, only at night are the lights turned on, creating a light box which acts as a beacon [P11].

P9 Material Connection with Nature

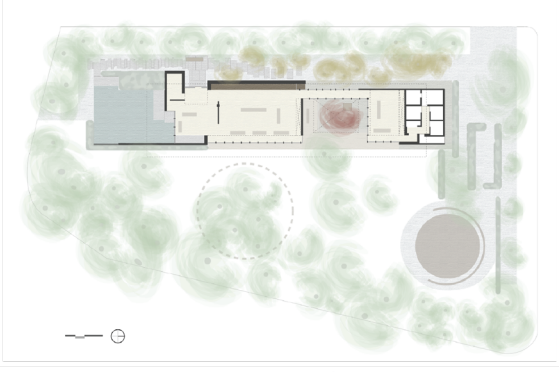
The materials are carefully chosen to increase the experience of nature and refuge. Almost all materials represent the local ecology, and come from natural sources that are minimally processed. Rammed earth walls form a solid mass, creating a sense of safety [12]. The elegant striations, created by the various layers of earth [P8], root the building into the site. The representation of stained oak on both the floor and the ceiling creates a grotto effect [P12]. The stained oak is seen again in the furniture, connecting it to the rest of the building. Earthtones dominate the color palate, representing the local environment, creating a calming atmosphere.

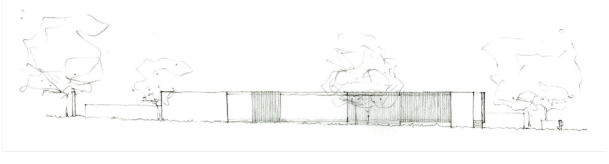
P12 Refuge

Most of the decisions made in the other patterns are in support of the pattern of refuge, as this pattern embodies the main function of the building. The building is entered through a narrow path between the exterior rammed earth wall and a row of ginkgo trees. The change form gravel, to concrete, to wood amplifies the change from the exterior noise to the quit on the interior [P2] pulling the visitor in. The spaces themselves are designed in such a way that they provide cover from behind and above, while still preventing the feeling of being trapped by providing multiple means of egress, allowing the visitor to feel safe. The variety of spaces allows the visitor to find their own way.

Summary of how the patterns are applied and how they relate to each other

Windhover Contemplative Center





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Type:
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Area:
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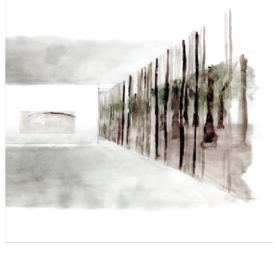

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Present Biophilic Patterns: P1, P2, P3, P4, P5, P6, P7, P8, P9, P11, P12, P13

Visable Patterns: P6, P7 P9, P12,

Visable Patterns: P1, P2, P4, P5, P9, P12,

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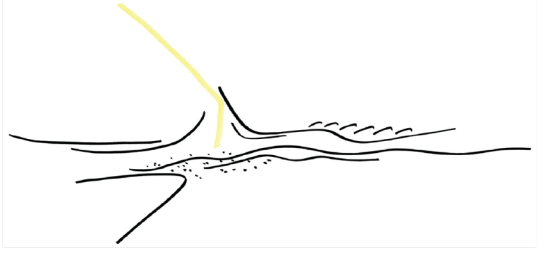
VanDusen Botanical Garden Visitor Centre

Architect:
Perkins & Will
Year:
2011
Site:
Vancouver, BC, Canada
Type:
Visitors Center
Area:
1858m²

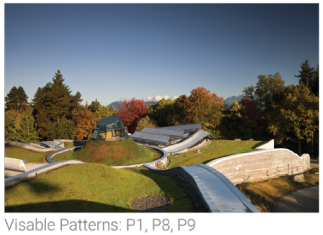
The VanDusen Botanical Garden Visitors Center is designed as a gateway into the botanical garden, and invites the visitor to explore what is beyond. The building balances the architecture and landscape through the integration of both natural and human systems, supporting the needs of people, and the biodiversity. Sustainability has been an integral marker during the design process, resulting in a building that reaches net-zero energy on an annual basis, and is constructed carbon neutral. The building hosts various functions like a café, library, volunteer facilities, a garden shop, office spaces and flexible classroom spaces.



"A flower as metaphor – A flower is rooted in its own place by harvesting all its own energy and water, by adapting to the climate and site, by operating pollution free, and by promoting health and well-being." [1]

– Perkins&Will

Present Biophilic Patterns: P1, P3, P4, P5, P6, P8, P9, P13, P14, P15



Visable Patterns: P1, P8, P9

Visable Patterns: P5, P6, P8, P9, P15

Visable Patterns: P6, P8, P9, P14

P1 Visual Connection with Nature

The building adds on to the existing infrastructure of the botanical garden, and further restores the local ecosystem and biodiversity. The green spaces only contain native vegetation, which creates a series of distinct ecological zones. The forest system is maintained by the preservation of many large trees that together with wetland vegetation and rain gardens improves the existing water system, allowing the rainwater to infiltrate naturally. The meadow system with long grasses and wildflowers [P2] have been extended onto the roof, which is connected to the ground plane via the implementation of a vegetated land ramp, supporting the local bee and butterfly population [P3].

P6 Dynamic & Diffuse light

Many of the spaces make use of ceiling high windows to increase daylight intake, giving 85% of the spaces views to the outdoors [P1], and allowing 93% of the spaces to function without the need for artificial lighting. In addition to the ceiling high windows, one-meter clerestory glazing is located above the solid rammed earth walls, not only letting in light, but also making it look like the roof is floating [P14]. The solar chimney in the entrance hall provides natural ventilation[P4], as well as a moment for reflection [P8][P15]. The stained glass fills the atrium with a pool of light, that reflects off the surrounding materials, creating an ever changing space.

P8 Biomorphic Forms & Patterns

The design is strongly inspired by the native orchid. The six sections of the green roof represent petals, and mimic the complex geometry of the flower. The shape of the roof is carried down into the walls, resulting in a building that knows very few straight angles. The curvatures of the building are closely tied to movement and seem to promote the way finding within the building [P13], leading the visitors to the central oculus [P4][P6]. The form of the oculus is inspired by a termite mound, and serves the same function. The oculus expels hot air, cooling the space. The buildings biomorphic forms and patterns, as well as the natural color palate, emphasize its connection with nature.

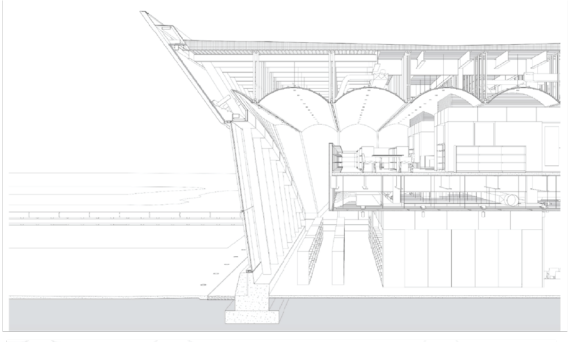
P9 Material Connection with Nature

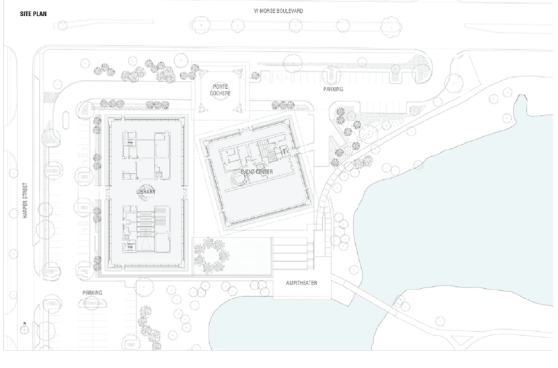
The material use has received much attention, not only from a sustainability perspective, but also from a visual perspective. The building is mainly constructed out of wood, which has a low embodied energy, and is locally sourced. The material creates a warm environment, and is applied from the roof structure, to the cladding, and the millwork. The rammed earth walls are made out of local soils and the earth-toned bands evoke a natural geologic strata [P8].

Winter Park Library & Event Center

Architect:
Adjaye Associates
Year:
2021
Site:
Winter Park, FL, United States
Type:
Library
Area:
5.184m²

The library and cultural center have been designed in conjunction with the greater revitalization of the Martin Luther Kink Jr. Park, that aims to create a civic and cultural hub, providing a place of knowledge and community empowerment. The hub consists of three pavilions, each of a different scale housing a different function, but with the same formal language. The pavilions are placed on a raised belvedere that provides views over Lake Mendsen. The library offers more then just books, as it also contains a makerspaces, technology portals, a center for entrepreneurship, and continuing educational spaces.

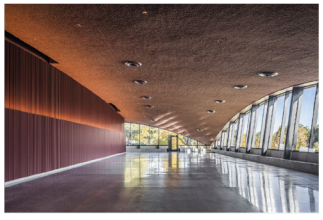




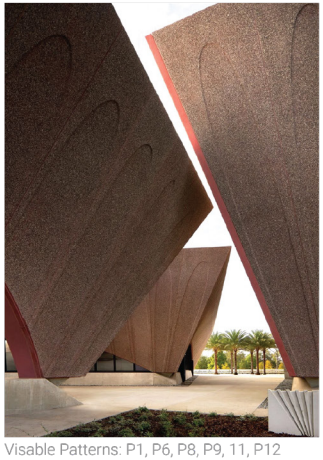
"Arches, inspired both by local fauna and the region's vernacular architecture, establish the form of the pavilions, with vaulted rooflines and sweeping windows creating a porous relationship between interior and exterior, drawing natural light deep into the buildings." [1]

– Adjaye Associates

Present Biophilic Patterns: P1, P5, P6, P7, P8, P9, P11, P12



Visable Patterns: P1, P8, P9



Visable Patterns: P1, P6, P8, P9, 11, P12

Visable Patterns: P1, P6, P8

The Winter Part Library and Event Center is said to be based on biophilic principles. And there are certainly references to this, mainly in the decisions made regarding form. However, the majority of the references fall within passive design, while this falls under the umbrella of biophilic architecture, it by itself, does not make a building biophilic.

P1 Visual Connection with Nature

The buildings aim to create an porous relationship between the exterior and interior, this is done using various methods. The shape of the buildings create an overhang, which while being outdoors protects the visitor from undesirable weather conditions like harsh sunlight and rain. Additionally, large windows give visitors a great view of the park and lake, with a rooftop terrace providing an even faster view. All vegetation on the site are native to the region and locally sourced, creating a great sense of place.

P6 Dynamic & Diffuse light

Natural light is drawn into the building through large arched windows. In the library the light is able to reach both floors because of the mezzanine, leaving a double height space in front of the windows. The windows are angled decreasing the solar gain, which reduces the negative effects of the environment. The overhang of the roof creates further shade, both inside and around the building.

P8 Biomorphic Forms & Patterns

The three pavilions share the same formal language, which was inspired by a tree canopy that branches out to provide shade. These three pavilions are placed in such a way that they create a shaded in-between space, making it functional throughout the year. From this in-between space small slivers of the sky are visible. The roof is supported by large arches that open up the building to the outside. These arches are also extended to the interior of the event space, where the arched roof creates an organic cave like feeling. The ceiling of the library is vaulted, decreasing the scale of the ceiling, makes the space feel more intimate, while maintaining the natural reference to shape.

P9 Material Connection with Nature

Materials are sourced nationally and produced locally. The façade is constructed out of rose-pigmented precast concrete with a large grain, this large grain increases the connection to nature. The textured concrete that lines the ceiling of the event center, creates a cave like effect. The open plan is divided by timber lined volumes, and uses a color palate that matches the exterior, using darker and earth like tones.

H.C. Andersen Hus Museum

Architect:
Kengo Kuma & Associates

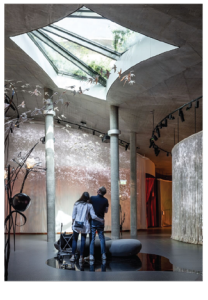
Year:
2022

Site:
Odense, Denmark

Type:
Museum

Area:
5600m²

With the design of the H.C. Andersen Hus museum the architect draws inspiration from the storytelling of Anderson, in particular The Tinderbox, which tells the story of a tree revealing a magical world. The visitor enters in a heavily landscaped garden that reveals various wooden pavilions. The rest of the building finds itself on the subterranean level, where a series of linked circular spaces form the exhibition space. The curvature of the subterranean level are mirrored in the hedges of the garden, creating meandering paths that can be seen as an extension of the exhibition spaces.



The building is meant to be a journey, guiding the visitor through it in a sequence that shows a duality of opposites, real and imaginary, inside and outside, natural and man made, human and animal, light and dark, inside and outside. At some places two dualities meet, making the duality visible to the visitor.

Present Biophilic Patterns: P1, P2, P3, P4, P5, P6, P7, P8, P9, P11, P12, P13

Visable Patterns: P1, P8, P9,

Visable Patterns: P1, P11, P13

Visable Patterns: P1, P2, P3, P8, P9, P11, P12

P1 Visual Connection with Nature

The exterior space is an integral part of the story that is told throughout the building. Because much of the building is pushed below the surface, the ground plane can be used for a highly sculpted garden, with meandering paths and curved hedges. The hedges are used as a sort of living architecture, creating various open and closed 'spaces'. The vegetation in the garden consists mainly of indigenous flora, and is selected in such a way that the changing of the seasons can be observed [P7]. The connection to the subterranean level is made through the use of various sunken gardens, which can be observed from above [P11]. To further tie the pavilions in with the garden, the roof space is covered in a green roof, that due to the angels can be seen from the garden space.

P8 Biomorphic Forms & Patterns

The building is constructed out of various circular shapes, these curves are experienced throughout the whole building and are used to guide the visitor throughout the building. The circular roofs are supported by radial wooden beams that represent tree branches. Trees are also represented in the façade. Here traditional Danish wall construction is combined with the fractal pattern of tree branches [P10] adding an ordered complexity to the façade.

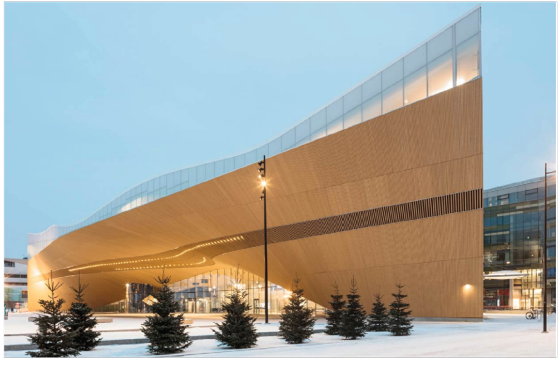
P11 Prospect & P12 Refuge

The duality of the building is also translated into the alternation between prospect and refuge. The meandering paths lead the visitor into the building, letting them leave reality behind, allowing them to enter a place of refuge [P12]. Along the path that leads down to the subterranean level, there are various moment where the visitor can view an area of the floor below, offering a prospect of the destination [P11]. The large exhibition space is divided into smaller rooms trough the use of semi-transparent drapes, this offers for various places of refuge within the large space.

P13 Mystery

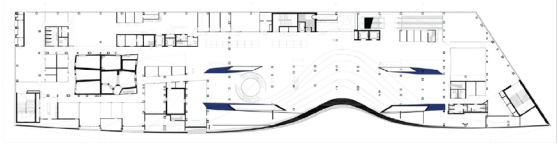
Mystery is also created in various ways, and is an integral part of the storytelling. The subterranean spaces are arranged in a non-hierarchal way, which means that there is no central point, this evokes the feeling of being lost, making it a mystery where the path will lead you. The curved walls also add to a sense of mystery as it evokes a need to find out what is at the end of hallway.

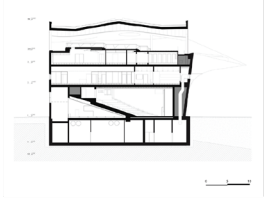
Oodi Public Library

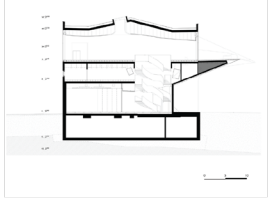


Architect:
ALA Architects
Year:
2018
Site:
Helsinki, Finland
Type:
Public Library
Area:
17.250m²

The Oodi library is located in the heart of Helsinki, among various arts and culture institutions, and opposite of the Finnish parliament, symbolizing its role within society. The library is designed as a public space that is owned by citizens, and open to all, inviting active participation. This with the goal to promote lifelong learning, active citizenship, democracy and freedom of expression. The ground floor is an expansion of the public square, and hosts an info desk restaurant, and cinema. The second floor hosts makerspaces, recording studios, and meeting spaces. The third and final floor hosts the library and rooftop terrace.

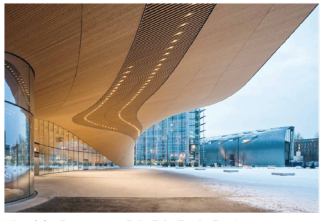






The design of the Ooid public library wants to promote a strong relationship with the public live of the central square in front. The shape of the building aids in this, not only by letting the curves of the building lead to its entrance, inviting the visitors inside. In addition, the cantilever blurs the lines between the inside and the outside, making the public square part of the ground floor program.

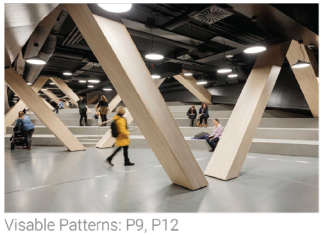
Present Biophilic Patterns: P1, P6, P8, P9, P10, P11, P12, P14, P15



Visable Patterns: P8, P9, P12, P14

Visable Patterns: P1, P6, P8, P9, P11

Visable Patterns: P6, P9, P11, P12



Visable Patterns: P9, P12

P1 Visual Connection with Nature

The presence of flora and fauna is quite limited, both in the building as well as on the public square in front. The full-height glass facades on the top floor allows for a lot of natural daylight [P6] and fast views, making an otherwise hidden nearby park and lake visible. In the interior, large potted trees on the top floor are meant to break up the view and add a hint of green, yet the presence of nature remains quite minimal and monotones.

P8 Biomorphic Forms & Patterns

The shape of the building is perhaps its most striking feature. Both the front facade and the roof are double curved surfaces, constructed with the assistance of parametric computer software. The shape makes the building feel more organic, and less colossal. The shape of the façade helps guide the visitor into the building while the cantilever ads a moment of risk [P14]. The roof break up the monotonousness of the ceiling on the top floor, maintaining its visual appeal, which is further extenuated with the circular light wells [P6].

P9 Material Connection with Nature

The building is primarily constructed out of local materials, most notably, the Finnish spruce which wraps across the double curved surface of the facades. This wood will change in a darker hue over time as the material weathers [P7] emphasizing its natural properties. The wooden louvers that allow for natural daylight [P6] on the 2nd floor maintain the overall appearance. The solid appearance of the lower floors contrasts the lightness of the glass top floor, creating a balance.

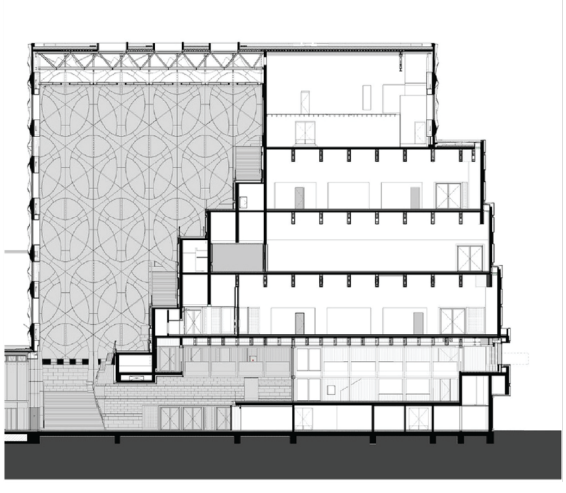
P11 Prospect & P12 Refuge

There is a great contrast between the 2nd and 3rd floor, where the second floor can be seen as a place for refuge [P12], the 3rd floor as a place of prospect [P11]. The second floor offers many nooks and small meeting spaces that can be used to retreat. It facilitates the need for a space where one is not exposed and can feel safe being in it's own bubble. There are however very few long sightlines that offer prospect, this together with the relatively low ceiling can make spending longer periods of time in this space feel uncomfortable. The 3rd floor is a large open space, with very few visual obstructions. The low bookcases help maintain the long sight lines, as one can look over them. At both ends of the space, the floor is raised, which offers an even better vantage point over the whole floor. In addition, the raised floor create smaller spaces underneath, which functions as a place of refuge. The space between the bookcases also create spaces of refuge, it be in a lighter degree. This place of refuge is created because the view is obstructed from a sitting position, making the space feel smaller.

Naturalis Biodiversity Centre

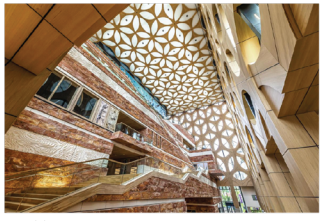
Architect:
Neutelings Riedijk Architects
Year:
2019
Site:
Leiden, ZH, The Netherlands
Type:
Museum
Area:
17.000m²

Naturalis Biodiversity Center is the national research institute for biodiversity, which host a variety of functions; laboratories, the depot, offices, a library, and the museum. There was a great need to renovate the old building as the collection had simply outgrown it. In addition to this renovation, multiple buildings were added, all are connected through a central atrium. This case study will focus on the new-build section that houses the public function of the museum, as well as the central atrium. This is to limit the scope as well as to allow for better comparison to the other case studies.

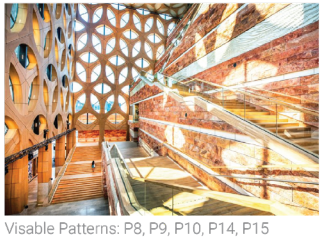


The program of the building, nature, is also reflected in the architecture. Many of the architectural shapes are inspired by natural forms. There are a wide range of materials with different textures that all show their natural aging process, making them feel alive. Also the artworks, sounds and lighting in the exhibition halls bring the visitors closer to nature.

Present Biophilic Patterns: P1, P2, P3, P5, P6, P7, P8, P9, P10, P11, P13, P14, P15



Visable Patterns: P8, P9, P10, P11, P15



Visable Patterns: P8, P9, P10, P14, P15

Visable Patterns: P8, P9, P10,

P1 & P2 Visual and Non-visual connection with nature

The exhibits show different aspects of nature and evolution, from a large collection of specimens and dinosaur bones, to an insight into the evolution of the world and how everything is connected. Various techniques are used to make the exhibits more immersive. There are around 100 wall panels that depict images of nature, but perhaps more interesting are the videos of animals in their natural habitat that are playing on large projections throughout the exhibition, as well as the projections of moving dinosaurs [P3]. Water is depicted by a projection onto an overhead fabric screen, making it look like you are walking under water [P3] [P5]. Sound also plays an important role, as animal sounds and weather conditions are played throughout. These effects do not replace actual nature, but are effective in the realm of the exhibition.

P8 Biomorphic Forms & Patterns & P10 Complexity & Order

The use of natural forms happen primarily in the atrium, where the walls and ceiling are constructed out of concrete panels that form a pattern of intertwining honeycombs [P10]. These shapes cause for the light [P6] to project leaves [P9] on the walls and floor of the atrium. The concrete relief pattern that brakes up the natural stone wall in the atrium shows a sense of movement that could be compared to air, or water.

P9 Material Connection with Nature

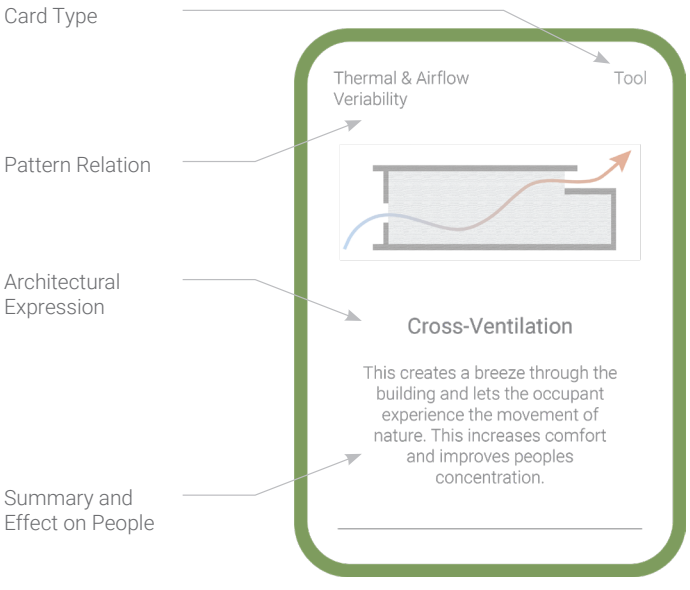
The material use is perhaps the most striking feature of the building. All materials are selected to be robust and have long lifespans. The museum building is covered in textured natural stone, that due to its horizontal placement represent geological structures. These panels also include natural crystals that reflect in the sun. The interior face of the concrete honeycomb walls of the atrium are covered in acoustic wood panels, making them much softer, allowing the two volumes to blend together. The floors on the ground floor is made of natural stone, while the floors on the other levels are covered in oak flooring emphasizing the their different character. All materials weather and age, showing time [P7].

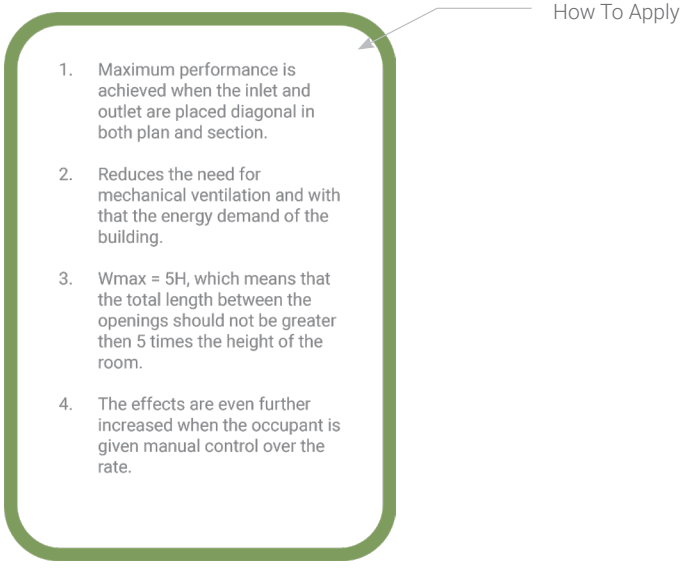
P15 Awe

The entrance of the building is nested between the different volumes, and feels quite small in comparison to the rest of the building. Once you enter the building the sightline into the atrium is blocked by a column, and it isn't until you walk past it, that you see the impressive atrium, inviting you to look up. The atrium is experienced repeatedly throughout the museum visit when moving between floors. Moments of risk [P14] can be experienced on the balcony, and the feeling of prospect grows [P11] the higher you get, and the overview over the atrium increases.

TOOL CARDS

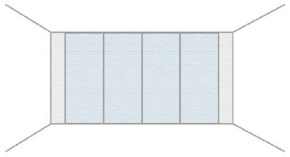
TOOL CARDS


Card Type
Pattern Relation
Architectural Expression
Summary and Effect on People
Thermal & Airflow Veriability
Tool
Cross-Ventilation
This creates a breeze through the building and lets the occupant experience the movement of nature. This increases comfort and improves peoples concentration.


How To Apply
1. Maximum performance is achieved when the inlet and outlet are placed diagonal in both plan and section.
2. Reduces the need for mechanical ventilation and with that the energy demand of the building.
3. Wmax = 5H, which means that the total length between the openings should not be greater then 5 times the height of the room.
4. The effects are even further increased when the occupant is given manual control over the rate.

Visual Connection with Nature

Tool



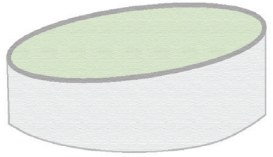
Floor-to-Ceiling Window

Due the lack of boundary, these windows offer an unobstructed view to the outside. It blurs the lines between the exterior and the interior, enlarging the space and increasing the connection to the outdoors.

1. Floor-to-Ceiling windows also offer a great intake of natural light. With this it is important to keep the orientation in mind in order to prevent overheating of the space [P6].
2. When these windows or sections thereof are operatable, it can also allow for fresh [P4].
3. Grant views of the exterior, can also mean a loss of privacy, when this is not desired, adjustments to the landscsaoe can be made, or various forms of sun shading can be added in order to maintain this privacy.
4. Ensure that the furnishing doesn't obstruct the view to much as it would diminish the effort.

Visual Connection with Nature

Tool



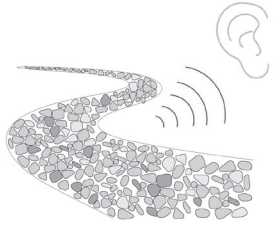
Green Roof

Green roofs can offer a welcome break in an otherwise gray environment. It increases biodiversity and creates an habitat for animals. Besides this, a green roof has many other ecological and economical benefits.

1. Green roofs can be applied in various degrees, creating different environments for flora and fauna. This effect is further increased when the green roof is connected to the ground plane via a vegetative ramp.
2. The green roof provides a rainwater buffer, purifying the water and reducing the load on the sewage system.
3. It reduces ambient temperatures and can in cities help reduce the heat island effect by 3°C.
4. Green roofs absorb sound, decreasing ambient sound levels, both inside and outside.

Non-Visual Connection with Nature

Tool



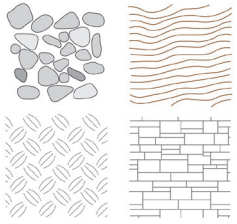
Sound of Path

Different floor materials each create a distinct sounds when walking over them, this speaks to the sense of hearing. These sounds can effect the way a space is experienced, influencing emotions and feeling.

1. When you want to create a space for meditation, softer materials like carpets and fabrics could be more beneficial as they mute the sounds, maintaining a quite oasis.
2. Sound can also be used to emphasize the transition between functions. For example, you can emphasize going from a busy space to a space that is more quite by changing the floor materials, going from gravel to concrete, to wood. Each becoming more and more quite, or in reverse becoming increasingly louder.

Non-Visual Connection with Nature

Tool



Textures

Texture plays an important role within architecture, and not only on surfaces that can be touched. As one already has a perception on how something feels, even by just looking at the surface. Different textures can evoke different emotions.

1. Natural material create a warmer and more inviting space due to their colors and the way they reflect light.
2. Contrast in textures is a great way to draw attention to a surface, and amplify the effect that that material holds.
3. The same material, concrete for example, can evoke different moods when using different types of texturization.
4. When materials have the same hue, but different texuteres, texture will guide the eye.

Non-Rhythmic sensory stimuli

Tool

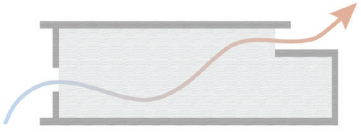
Bees and butterflies

The presence of bees and butterflies doesn't only speak to the biodiversity of the site. It also engages the observer, as the non-rhythmic movements of the animals attrect attention and can prevent boredom.

1. Bees and butterflies can be attracted to a site by planting the right flowers that attracts them.
2. The presence of bees and butterflies reflect an healthy ecosystem, ensuring pollination and attracting other animals like birds.
3. When attracting these animals for the purpose of short distraction, it is important that they are visible, for example through a window, or when sitting in a terrace.

Thermal & Airflow Veriability

Tool



Cross-Ventilation

This creates a breeze through the building and lets the occupant experience the movement of nature. The air increases comfort and improves peoples concentration.

1. Maximum performance is achieved when the inlet and outlet are placed diagonal in both plan and section.
2. It reduces the need for mechanical ventilation, and with that, the energy demand of the building.
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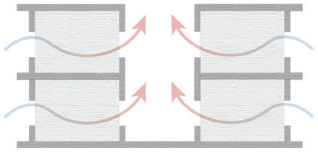
Thermal & Airflow Veriability

Tool

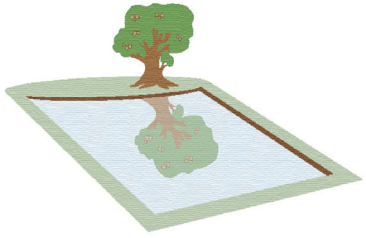


Courtyard / Atria

The addition of a courtyard doesn't only provide a green space. It also adds the possibility of natural ventilation, as it creates an airflow trough the surrounding rooms. It can both supply cool air or subtract hot air depending on the design.

1. When the roof is sloped downwards to the courtyard it allows for cool air to enter, effectively supplying the adjacent rooms with cool air.
2. A courtyard can also function as a solar chimney, extracting hot air from the surrounding rooms.
3. When combined with cross-ventilation, the cooling effect of a courtyard is further increased.
4. Besides the added connection to nature [P1], a courtyard also offers an abundance of natural light [P6] to the surrounding rooms.

Presence of Water Tool



Reflective Pool

A reflective pool offers a body of water that stands almost still, that is due to its character, often used as a place of reflection. The main feature is that it offers a reflection of its surrounding, enhancing its (natural) effect.

1. The pool reflects its surrounding, which is important to keep in mind with its placement.
2. Reflective pools do not need to be very deep 15-30 cm will allow for a nice reflection. With this it is important to have a dark floor.
3. While the pool will probably need a degree of filtration, it is important to prevent ripples, in order to maintain the silky surface.
4. The materials that are used for the floor and walls should reflect the shape and character of the pool, sleek or natural.

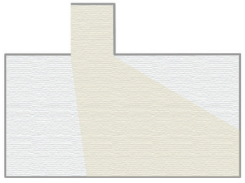
Presence of Water Tool

Rain Garden

A rain garden only holds water after rainfall, and is therefore most of the time dry. Yet it holds a lot of value not only for nature but also for people, as it makes them aware of the natural processes that occur.

1. Raingardens prevents flooding, as it gives the ground time to take in the excess water, after which the vegetation helps filter out the pollutants.
2. Native vegetation should be incorporated into the raingarden, as they posses a root system that can better take out the nutrients of their native soil. Avoid planting trees.
3. The raingarden should be about 20% of the solid or paved area from which the water needs to be absorbed.
4. Ensure the site is at least 10 feet from buildings with basements, and away from utilities.

Dynamic & Diffuse light Tool

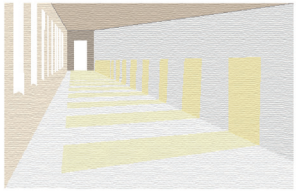


Skylight

A skylight can bring natural light into a room where that would otherwise be impossible. They can also be used as an architectural statement, to for example, give emphasis to an art piece on the wall, or as moment of reflection in a light well.

1. Skylights can come in all shapes and sizes which allows the designer to choose according to the architectural needs.
2. It is important to keep the solar heat gain in mind, high sloped skylights have a lower heat gain than low sloped ones, in addition, glazing can either decrease or increase heat gain.
3. A skylight, when operatable, can also assist in natural ventilation. It can drain the rising hot air, or create a draft when opened up to another opening.
4. Keep the cleaning and drainage of water in mind.

Dynamic & Diffuse light Tool



Light & Shadows

Light and its counterpart shadow are used in architecture to create a certain environment, atmosphere or mood. It also connects us to nature due to its temporal chaeacter. The contrast between the two can give more emphasis to an object.

1. Light, in contrast with darkness can offer a sense of mystery as it guides the observer towards it [P13].
2. The path of the sun adds movement, not only making a space more dynamic, but also connecting us to the cycles of nature [P7].
3. The textures of the walls and floors can change the way shadows fall.
4. Where modern architecture mainly focuses on illuminating the whole space it is important to maintain a balance between light and shadow in order to prevent the space from becoming flat.

Connection with Natural Systems

Tool

Seasonal Garden

A seasonal garden is active throughout the whole year, showing the seasonal changes that occur, with different vegetation blooming at different times. Providing visual pleasure throughout the year.

1. It is important to use native vegetation as these react best to local climate conditions and the changing of the seasons. They also provide a better sense of place for the observer as they belong there.
2. Use trees and scrubs as a base, they represent long term growth, change with the seasons, or maintain their color, and provide shade during the time it is desired [P6].
3. Plant a large variation of plants that bloom in different seasons, so that something blooms at any time.

Connection with Natural Systems

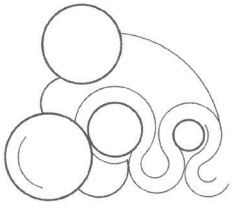
Tool

Oriantation

The orientation will help perceive the daily and seasonal changes and give a sense of placeness. The sun angle will be different during the different seasons, and depend on the region. Prevailing wind pattern also change and differ in intensity.

1. It is important to first identify the climate region, sun path and angels, and wind direction.
2. To prevent the need for cooling, solar gain should be eliminated (with shading) during hot seasons and access to cooling (a breeze) should be maximized.
3. To prevent the need for heating, the building should be oriented towards the direction of the sun to increase solar intake during colder seasons.
4. It is beneficial to place highly used functions towards the path of the sun, as they will then receive sunlight throughout the day.

Biomorphic Forms & Patterns Tool

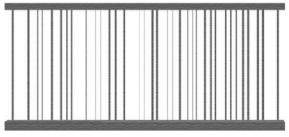


Circular Form

Circular shapes are very common in the natural world, from tree trunks and stones to eggs. The translation of these forms to architecture gives it an organic and natura; character, which helps the spaces flow.

1. Circular building use inherently fewer materials, up to 15–20%.
2. Circular shapes act better in extreme winds, as it can easily flow around them.
3. Due to less surface area, it will automatically decrease the cooling and heating needs.
4. Circular shapes can also be used in contrast to sharp angles, emphasizing the shape and its calm character.
5. Circular or curved forms can also help naturally guide the visitor in a certain direction.

Biomorphic Forms & Patterns Tool



Non-Rhythmic Louvers

Non-rhythmic louvers can break up the otherwise monotonous nature of window framing and provide a decrease in solar gain. Non-rhytmic louvers also create an interesting pattern of shadows.

1. The effect is further increased when the louvers can be combined with a outdoor view of trees. In this case, vertical louvers mimic the irregular pattern of the trees, blending in the glass façade with the exterior, thus decreases the boundary between the interior and exterior.
2. The size of the louvers and the space in-between should be derived from the exterior image, and should, when applicable, match the thickness and density of surrounding trees.
3. The surface on whitch the shadows fall can also effect its perception.

Material Connection with Nature

Tool

Timber

Timber is a widely used building material that comes in many different forms. Timber can by applied from wall cladding to flooring, as decoration or as structural element. Timer has a highly natural appearance due to its color and grain.

1. Timber is a renewable raw material that absorbs CO2 during its growth. Making the embodied energy much lower then non-renewable materials.
2. In order to truly benefit from the low embodied energy, it is important to use locally sourced timber.
3. Timber is a very light and versatile material, which makes it generally easy to work with.
4. Timber is a highly durable material, when used and maintained properly. This also gives the possibility for reuse.

Material Connection with Nature

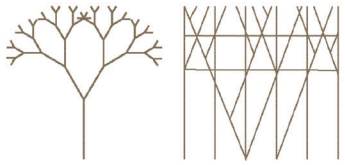
Tool

Rammed Earth

Rammed earth can be used for multisensory loadbearing constructions, using a method that rams various layers of aggregates into a formwork. More complex shapes may need additional reinforcement.

1. The patterns of a rammed earth wall can be designed, and color difference occur through the use of various earth types.
2. Due to the mass of the walls, rammed earth offer a great thermal mass, which makes for a great insulator.
3. Rammed earth walls have better durability in hot and dry climates. They should be lifted of the ground by at least 225mm and be protected from rain by overhanging roofs.
4. Is environmentally conscious due its readily availability and low embodied energy.

Complexity & Order Tool



Tree Fractals

Fractals are geometric shapes that repeat themselves as the scale changes. Fractals are widely present in nature and help reduce the complexity of what we see. For this reason, it can also be beneficial in architecture.

1. They can occur in two ways, intentional or unintentional. Unintentional fractals are often used for aesthetics, creating a pleasing pattern. Intentional fractals have a clear idea in mind and are often generated with the aid of computers.
2. Tree fractals translate to the way a tree branches off into smaller and smaller twigs. These can be used in 2D as decoration, but also in 3D as structural elements.
3. It makes a complex pattern seem simple, attracting the viewers' attention, while not being overwhelming.

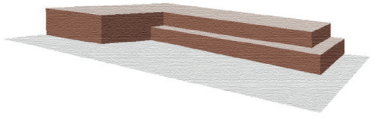
Complexity & Order Tool

Honeycomb

Honeycombs can be used in architecture and are hexagonal shapes derived from that of a beehive. It can either be used as decoration, but also as a structural element, in walls for example.

1. Honeycomb structures are favored due to their high specific strength, low density, and decreased material usage in manufacturing.
2. When many honeycombs are combined, a large grid appears. Which despite their monogenous appearance can hold transitions in size.
3. When interlocking honeycomb patterns, the complexity is further increased, and that initial pattern might be lost to some, yet it maintains its fractal qualities.

Prospect Tool

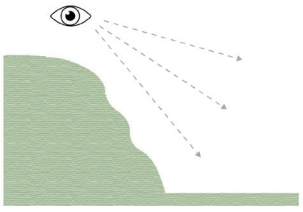


Raised Floor

Raising a section of the floor can increase the prospect conditions. Because it will allow for a better overview over the rest of the space. It can also change the meaning (more important) of what is on the raised platform.

1. The elevation does not need to be very high. Interior elevations between 30 and 45 cm can already help enhance the prospect conditions.
2. The benefits of the view are best utilized when a focal length of over 30m is achieved.
3. The raised platform can ensure that objects, that are otherwise visual barriers, are overlooked when on the platform.
4. It is important to alternate these open settings with protected ones. The will strengthen the experience of both and give options to the user.

Prospect Tool

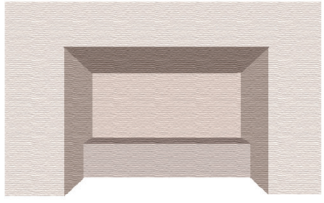


Vantage Point

A vantage point is essentially a place that provides a good view, they can be achieved in various ways and at various degrees. But it should allow a position in which a large part of the space can be observed.

1. The effect of a vantage point is increased when the point allows to look down upon a scene. For example in an atrium, where one can look down from a higher floor.
2. A vantage point can also include a view of the exterior. Windows that allow looking upon an exterior view increase the experience of the interior space.
3. A vantage point from a low position towards a large object are often not desirable, as they can be overwhelming.

Refuge Tool

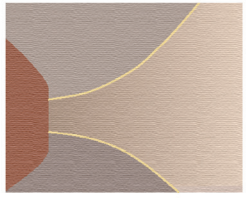


Nooks

These are places where people can hide, or retreat from the larger whole. This gives comfort and allows for a space with less stimuli. Also here, there are various degrees of protection that can be achieved.

1. There should at least be protection from behind and above and is increased when you are protected from a third side.
2. Visual access into the nook should be limited, while good visual access from the nook is encouraged.
3. Lighting can play a large part in the experience of the nook, to increase the contrast with the surrounding spaces, lighting levels should be different.
4. The furniture in the nook can also increase the feeling of being comfortable, think of soft materials, cushions etc.

Mystery Tool

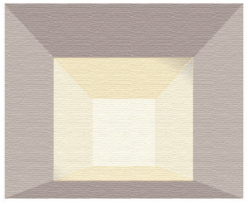


Curved Wall

Curved walls can create an enticing scene that encourages movement in order to find out what is ahead. As opposed to straight corners it draws people in organically, leaving them with a feeling of anticipation.

1. With a curved wall you can give a glimpse of what is ahead without revealing everything at once.
2. In order to prevent fear, it is important to create a certain depth of view. This is ideally between 6 and 30 meters. And in some cases, for bigger spaces, even more.
3. This space is stimulating and captivating engaging the mind on a deeper level, as it refers back to a feeling of curiosity that nurtures an instinctive drive.

Mystery Tool



Darkness with Guiding Light

While spaces that are too dark can feel uncomfortable, spaces that are less illuminated can feel mysterious. Especially when light is used to guide a person through the space the uncomfortable felling is taken away.

1. Shadow pools should be avoided as these engender a feeling of fear.
2. Accents of light in a darker space can lead the eye in a certain direction, sequencing of this can help guide the visitor.
3. The textures of the walls and floors can further enhance or decrease the feeling of mystery. Highly textured surfaces are more prone to add mystery.
4. This tool can also be combined really well with other tools of mystery, like curved walls for example.

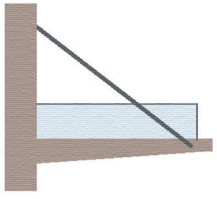
Risk / Peril Tool

Stepping Stones

Stepping stones can be used to pass various surfaces, each with their own degree of risk. Probably the most obvious is crossing water. With the risk of getting wet, but the excitement of the task, this creates an enticing moment.

1. The surface that is crossed determines the level of risk, water seems to give the best balance between risk and safety.
2. In order to ensure a sense of safety, the depth of the water should not be too deep. Preferably, the bottom can be seen.
3. The size of the individual stones and distance between them also plays a role. The larger the stone, the further the risk is decreased. While with a greater distance between the stones, the risk can be increased.

Risk / Peril Tool

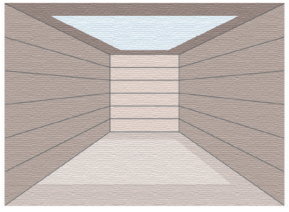


Cantilever

A cantilever or an overhang is a building element, or mass, that protrudes from the main form of the building. While one side is attached, the other side floats. Examples of this are balconies, stairs or roof overhangs.

1. The size of the overhang impacts the feeling of risk, where an increase in size will increase the risk.
2. It is important to ensure a sense of safety, when it is unclear whether or not the cantilever is supported properly, the risk can become too high, making people avoid the cantilever.
3. The materiality of the cantilever can make it feel heavier or lighter, each with their own consequences.
4. The same with the height of the cantilever, is it a thin roof, or multiple floors.

Awe Tool



Atrium

Atriums are often impressive elements of the building. It creates a central location in the building and spans multiple floors. The scale is often much larger than the surrounding rooms, increasing its impact.

1. Atria are often covered with skylights, flooding them with natural light. This light source from above, invites the visitor to look up, which could also evoke a feeling of awe.

2. An atria is the perfect space to apply the principle of compression and release. Where the approach comes from a small compressed space and opens up into the atrium, increasing the scale of the atrium even further.

TOOLKIT ANALYSIS

PRESENT PATTERNS IN CASE STUDIES

	Windhover Contemplative Center	VanDusen Botanical Garden Visitor Center	Winter Park Library & Event Center	H.C. Andersen Hus Museum	Oodi Public Library	Naturalis Biodiversity Center
P1. VISUAL CONNECTION WITH NATURE	X	X	X	X	X	X
P2. NON-VISUAL CONNECTION WITH NATURE	X					X
P3. NON-RHYTMIC SENSORY STIMULI	X	X				X
P4. THERMAL & AIRFLOW VARIABILITY	X	X				
P5. PRESENCE OF WATER	X	X	X			X
P6. DYNAMIC & DIFFUSE LIGHT	X	X	X	X	X	X
P7. CONNECTION WITH NATURAL SYSTE	X		X	X		X
P8. BIOMORPHIC FORMS & PATTERNS	X	X	X	X	X	X
P9. MATERIAL CONNECTION WITH NATURE	X	X	X	X	X	X
P10. COMPLEXITY & ORDER				X	X	X
P11. PROSPECT			X	X	X	X
P12. REFUGE	X		X	X	X	
P13. MYSTERY & ENTICEMENT		X		X		X
P14. RISK & PERIL				X	X	X
P15. AWE					X	X

EVALUATION

BIOPHILIC DESIGN

- Predomenently patterns in the category Nature in Space (P1 - P7)
- The narrative comes mainly from Biophilic Design
- Much stronger integration of passive energy systems (however this alone does not make is Biophilic)
- There is more integration between the patterns, where for example the principles of Nature of Space are strengthened by those of Nature in Space
- Reoccurrence of Light P6 / Material P9 / Form P8

NON-BIOPHILIC DESIGN

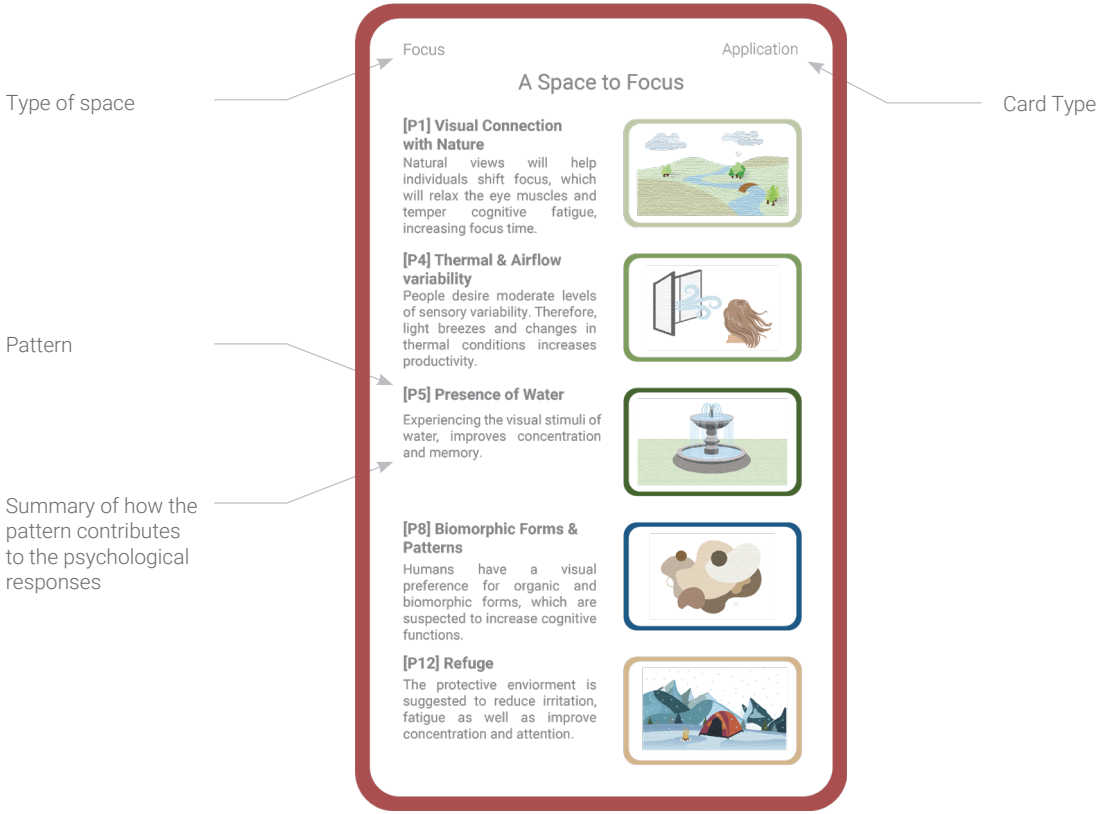
- Predomenently patterns in the category Nature of Space (P11 - P15)
- The narrative comes from functionality or storytelling
- Climate strategies are either mechanical or not mentioned
- The experience of nature is sometimes faked
- Reoccurrence of Light P6 / Material P9 / Form P8

APPLICATION OF CARDS

PSYCOLOGICAL RESPONSE

		Reduces Stress	Reduces Blood Precure / Hart Rate	Improves Comfort	Improvses Concentration	Reduces Cognitive Fatigue	Increases Productivity	Increases Creativity	Improves Overall Happiness	Improves Well-Being	Activates Pleasure Responses	Safety	Human Preference Towards
P1. VISUAL CONNECTION WITH NATURE	***	X	X		X	X			X				
P2. NON-VISUAL CONNECTION WITH NATURE	**	X	X			X				X			
P3. NON-RHYTMIC SENSORY STIMULI	**	X	X		X								
P4. THERMAL & AIRFLOW VARIABILITY	**			X	X	X	X			X			
P5. PRESENCE OF WATER	**	X	X		X						X		
P6. DYNAMIC & DIFFUSE LIGHT	**						X			X	X		
P7. CONNECTION WITH NATURAL SYSTE									X				
P8. BIOMORPHIC FORMS & PATTERNS	*	X			X						X		
P9. MATERIAL CONNECTION WITH NATURE			X	X				X					
P10. COMPLEXITY & ORDER	**	X									X		
P11. PROSPECT	***	X		X		X						X	
P12. REFUGE	***	X			X	X						X	
P13. MYSTERY & ENTICEMENT	**	X											X
P14. RISK & PERIL	*												X
P15. AWE	*	X						X	X				

APPLICATION CARDS



Relax Application

A Space to Relax

[P1] Visual Connection with Nature

Natural views will help individuals shift focus, which will relax the eye muscles and temper cognitive fatigue and reduce stress.

[P5] Presence of Water

People prefer views that include clean bodies of water, as this creates an environment that reduces stress, and lowers the heart rate and blood pressure.

[P9] Material Connection with Nature

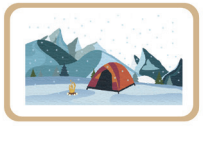
Wood in moderate quantities have a calming effect and thus reduces stress, but ensure variation to prevent boredom.

[P11] Prospect

In balance with refuge, a clear overview of the surrounding offers control. Which decreases the feeling of stress and improves comfort.

[P12] Refuge

Refuge conditions, the feeling of being protected, are important for recovery and stress reduction. Which is increased when there is a sense of prospect from that position.



Focus Application

A Space to Focus

[P1] Visual Connection with Nature

Natural views will help individuals shift focus, which will relax the eye muscles and temper cognitive fatigue, increasing focus time.

[P4] Thermal & Airflow variability

People desire moderate levels of sensory variability. Therefore, light breezes and changes in thermal conditions increases productivity.

[P5] Presence of Water

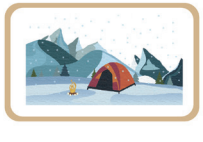
Experiencing the visual stimuli of water, improves concentration and memory.

[P8] Biomorphic Forms & Patterns

Humans have a visual preference for organic and biomorphic forms, which are suspected to increase cognitive functions.

[P12] Refuge

The protective environment is suggested to reduce irritation, fatigue as well as improve concentration and attention.



Creative Application

A Space to be Creative

[P1] Visual Connection with Nature

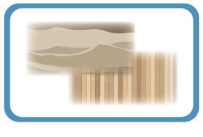
Nature has the capacity to enhance creativity, it is said to make us more curious, as well as evoke ideas. It also helps us to recharge our directed-attention.

[P8] Biomorphic Forms & Patterns

While our brain knows that biomorphic forms and patterns are not living things, they are a symbolic representations of life. Relating to pattern P1

[P9] Material Connection with Nature

Experiments conclude that viewing the color green before a task can facilitate creativity.



[P15] Awe

The feeling of awe can evoke new inspiration and increase creativity. In addition, high ceiling promote abstract thinking, freedom, and creativity.

Engage Application

A Space to Engage

[P1] Visual Connection with Nature

This is because natural views stimulates a greater portion of the visual cortex and thus more pleasure receptors are engaged, increasing happiness.

[P3] Non-Rhythmic sensory stimuli

The non-rhytmic sensory stimuli prevent boredom, but also evokes a sense of exploration.

[P13] Mystery

The pattern of mystery implies movement in order to experience it and therefore heightens curiosity.

[P14] Risk / Peril

When a controllable risk is presented, it evokes the response of dopamine, while fear is limited. This arouses curiosity.

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