THEORETICAL INVESTIGATION

Branded Retail Servicescapes, Biomimicy & Biophilia

This chapter forms the theoretical background for the design intervention. Firstly, retail design, branding and added value strategies are discussed, creating a foundation for the design parameters. Secondly, nature as a model and mentor for design is investigated through Biomimicry and Biophilic design principles.

02

2.1 RETAIL SERVICESCAPES

Retail design has become a discipline that involves expertise from various different professionals including architects, interior designers, graphic designers, product designers as well as web designers. The word retail refers to the selling of products to an end-user (Quartier, 2011); therefore the design of retail spaces is there to facilitate the selling of these products and services.

In his book New Retail (2000: 10), Rasshied Din describes the role of contemporary retail design;

> *"The role of contemporary retail design is to link instinct, art and commerce...to come to efficient (in terms of space, flexibility and cost) and effective (to communicate the retailer's brand values and encourage consumer activity) retail environments that meet the ever-tougher consumer demands. It incorporates the management of people and space to meet up to the essential characteristic of retail: change. Therefore a designer's task is to combine his expertise and the retailer's knowledge of the market with elements of psychology, technology and ergonomics.".*

Din suggests that change is one of, if not the most essential characteristic of retail design since retail spaces need to accommodate for seasonal changes, as well as the change in consumer trends over time (Din, 2000: 10). Branding is another essential pillar to retail design, which is often used as a means to distinguish different retailers in the market and to ultimately promote sales of products and services.

At the time in which retail design was in its infancy in the 1960's, it was believed that the product was king and that the design of retail spaces merely served the purpose of complementing the product (Din, 2000). However, over the past few decades the retail space itself has become just as much apart of the product being sold and is now seen as a 3D representation of the brand and its values (Quartier, 2011). The design of a retail space should communicate a message about the products without the buyer even having a look at the merchandise. Branding of a retail space therefore serves a great purpose in the role of encouraging consumer purchases (Quartier, 2011).

Branding of products and retail spaces however has become homogenized, which is why consumers are finding it hard to make purchasing decisions based on branding alone. This has led to an increase in consumer demands - consumers are no longer satisfied with just purchasing a branded product, but are looking for added value – something to take away from the purchase other than just the product or service itself.

The rest of this chapter will specifically look at branding and added value and its significance to retail design.

2.1.1 BRANDING

What is a brand?

The term brand is Germanic in origin, which translates into the English word 'burn', and refers to the act of using an iron stamp to burn a mark onto farmers' cattle (Quartier, 2011). The burn mark was a means for farmers to differentiate one herd of cattle from another and essentially became a trademark that was stamped onto steaks to be sold to consumers. These trademarks added conversational value to the steaks and would allow consumers to associate certain qualities with the different trademarks (Quartier, 2011).

This idea of a brand evolved and eventually translated into what we recognize a brand to be in contemporary society – a trademark that provides a means of differentiation between products and services (Wheeler, 2009: 2). In a world with infinite product choices, a brand allows companies to stand out amongst its competitors and to develop a relationship with its customers. People develop brand preferences and become loyal to the brands that offer them good quality products and services (Wheeler, 2009: 2).

Figure 2.1. Origin of Branding: Showing the process of branding cattle (Library of Congress, 1905).

Brand Primary Functions

NAVIGATION	REASSURANCE	ENGAGEMENT
Brands help consumers choose between a bewildering array of choices.	Brands communicate the intrinsic quality of the product or service and reassure customers that they have made the right choice.	Brands use distinctive imagery, language, and associations to encourage customers to identify with the brand.

What is Brand Identity?

In her book Building Brand Identity (2009: 4), Alina Wheeler defines brand identity as:

"Brand identity is tangible and appeals to the senses. You can see it, touch it, hold it, hear it, watch it move. Brand identity fuels recognition, amplifies differentiation, and makes big ideas and meaning accessible. Brand identity takes disparate elements and unifies them into whole systems."

Brand identity can be seen as the personality of a company (Davis, 2009:12), which embodies its core values, strengths and passions (Mesher, 2010:11). It is the way in which the brand wants to be perceived in the market. Brand image on the other hand refers to the way in which the market perceives a brand in reality (Duffy, 2015). A brand strategy is the way in which the organization will communicate and deliver its brand identity to the market to ensure that the perceived brand image correlates to the projected brand identity.

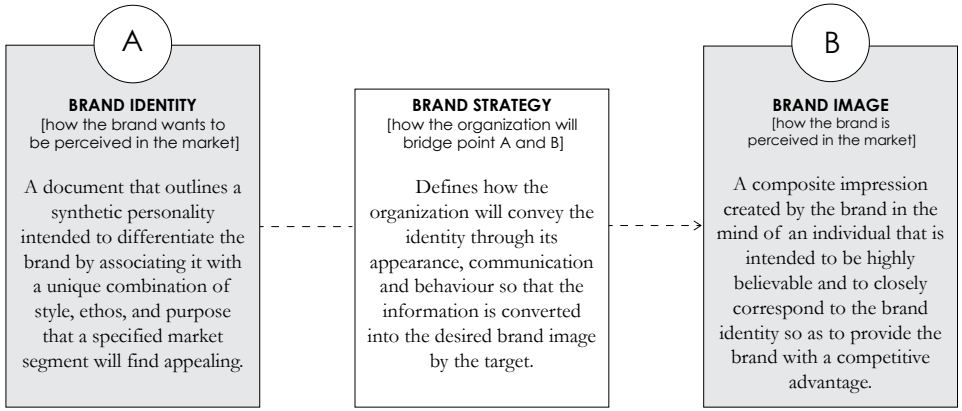


Figure 2.2. Brand Identity Diagram (Author, 2016) compare with (Duffy, 2005)

Brand Identity Prism

Corporate branding specialist Jean-Noël Kapferer has created a "Brand Identity Prism" (Kapferer, 2012) which illustrates the six different aspects of a brand identity, namely; **PHYSIQUE**, **PERSONALITY**, **CULTURE**, **RELATIONSHIP**, **REFLECTION** and **SELF-IMAGE.** According to Kapferer (2012), it the synthesis of these six elements that creates a successful brand identity.

PHYSIQUE
Physique refers to the physical and recognizable characteristics of the brand. Such as the logo, colour scheme, packaging as well as online interfaces.

PERSONALITY
Personality is the character associated with the brand and how the brand communicates with the outside world. For instance the personality of a brand might be playful and energetic. The personality of a brand identity is communicated through the physique of the brand and the way the brand expresses itself.

CULTURE
The culture of a brand is the set of values and beliefs that a company's behaviour is based on. For instance, the culture of Coca-Cola's is based around socializing and sharing.

RELATIONSHIP
Relationship represents the connection that the brand aims to create between the brand and the consumer.

REFLECTION
Reflection refers to the stereotypical consumer of the brand, but does not necessarily coincide with the intended target market of the brand.

SELF-IMAGE
Self-image symbolizes the persona that the consumer sees him/herself as. Consumers often look for products and/or services that reflect their self-image.

Kapferer's Brand Identity Prism will be used in Chapter 5 to develop a new brand identity for Margaret Roberts.

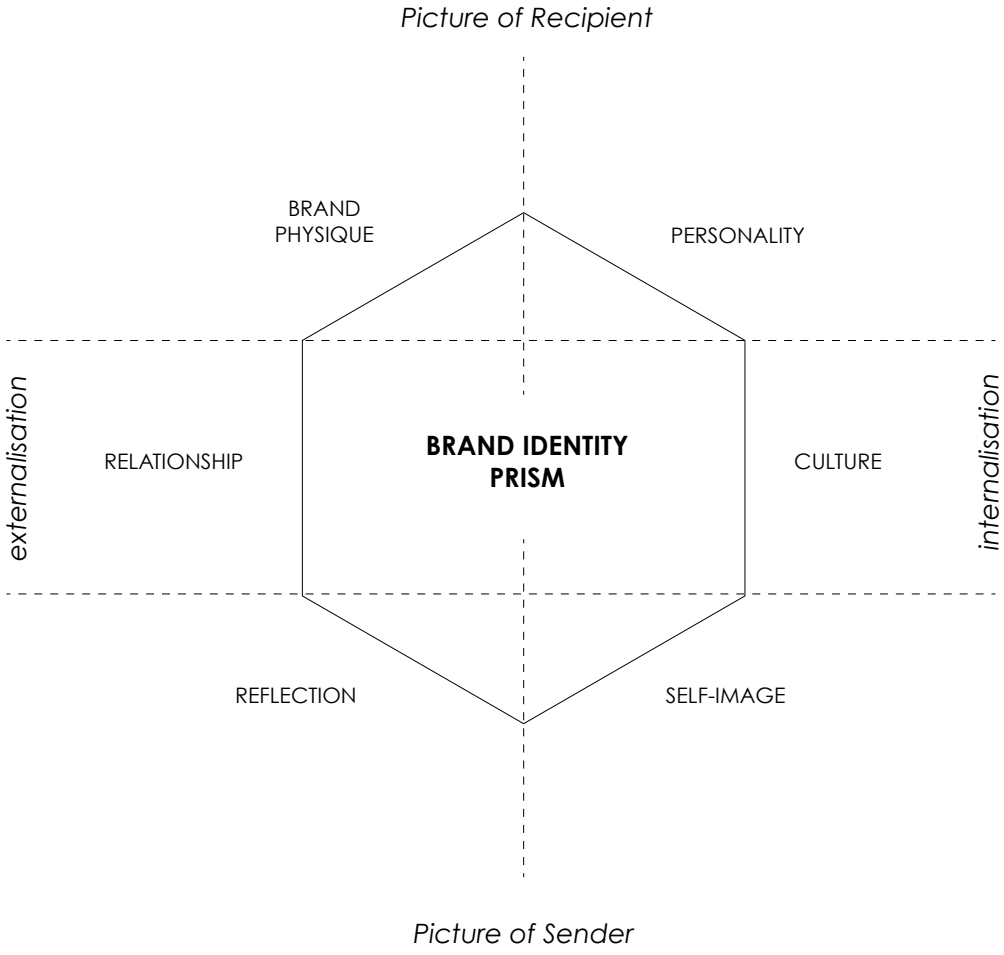


Figure 2.3. Kaferer's Brand Identity Prism: Showing how a brand identity is developed (Kapferer, 2012).

Brandscaping

Otto Riewoldt (2002) coined the term 'brandscaping' – referring to "*the creation of a three-dimensional microcosm representing the brand*". In other words, brandscaping is the act of translating a brand (that is often experienced in two-dimensional form) into a three-dimensional space that clearly represents the brand identity. Mesher (2010:11) states – "*in retail terms, the store is built around the concept of the brand and the products sold within it. The interior emulates the aspirations of the brand values and qualities to enhance the relationship between the space and the message*". Through this statement, Mesher highlights the significant role played by interior designers in creating retail spaces that reflect brand identity. The retail space should be treated as an extension of the brand and not a separate entity.

> *"The physical space is the only place where you have 100 percent control over the band and the messaging and the media. So that space is and has to be the true manifestation of the brand. And because the brand eventually exists in people's minds, you have to understand it mentally, and everything you do with the physical space relates to that, then it will work."*
>
> *(Zuidhof, 2007)*

2.1.2 ADDING VALUE

As previously mentioned, contemporary consumers are seeking products and services with added value. This has forced retailers to adopt new branding and retail strategies in order to ensure their competitive edge on the market. Consumer trend studies and forecasts suggest that practices of sustainability and experiential design are amongst some of the leading strategies employed by retailers to provide added value (Davis, 2009: 14).

Sustainability in Retail Design

The growing concern of environmental issues such as climate change has caused a shift in social trends in which consumers are starting to seek out products and services that are socially and environmentally responsible (Davis, 2009:14).

The Nielsen Global Survey (Adams, 2014) on Corporate Social Responsibility conducted online in 2014, polled statistics from over 30, 000 consumers spread over 60 different countries worldwide in the aim of gaining insight on the influence of corporate social responsibility, and more specifically sustainability on consumers' purchasing behaviour. The survey hoped to find out whether consumers care enough about environmental issues in order for it to affect their purchasing decision.

The study found that 55% of global online consumers are in fact willing to pay a higher price for a product or service that is committed to creating a positive social and environmental impact (Adams, 2014). It is interesting to note that 52% of the Nielsen Global Survey participants stated that the packaging of a product and the presence of an environmentally conscious indicator on the packaging affects their purchasing decision (Adams, 2014).

For this reason, it has become essential for organizations to adapt the message of their brand towards becoming socially and environmentally responsible competitive. Part 2.2 of this chapter therefore explores the use of Biomimicry as a design tool for developing a sustainable retail design solution for the Margaret Roberts brand, which will ensure her competitive edge in the contemporary market.

The Brand Experience

Experience Economy is a term coined and published by Jospeh Pine II and James Gilmore (1999) referring to a fourth level of an economic offering, the first three levels being commodity, goods and services (see table 2.1) for a comparison between the levels of economic offering and distinction). Experiences can be seen as a new source of value added to a customers' purchase of goods and services and is ultimately a means of differentiation (Pine & Gilmore, 1999: 10) between competitors in the market.

Economic Differentiators

ECONOMIC OFFERING	COMODITIES	GOODS	SERVICES	EXPERIENCES
Economic Model	Agrarian	Industrial	Service	Experience
Economic Function	Exact	Make	Deliver	Stage
Nature of Offering	Fungible	Tangible	Intangible	Memorable
Key Attribute	Natural	Standardised	Customised	Personal
Method of Supply	Stored in Bulk	Inventoried After	Delivered on Demand	Revealed over Duration
Seller	Trader	Manufacturer	Provider	Stager
Buyer	Market	User	Client	Guest
Factors of Demand	Characteristics	Features	Benefits	Sensation

Table 2.1. Economic Differentiators (Author, 2016) compare with (Pine & Gilmore, 1999).

The Four Realms of an Experience

Pine and Gilmore (1999: 30) suggest that an experience is encountered on two different dimensions – the first dimension being the level of guest participation (horizontal axis). Guest participation can be passive; where they do not directly affect the performance, or it can be active; where guests do have a direct influence on the performance. The second dimension (vertical axis) refers to the environmental relationship between customers and the event. The environmental relationship can be one of absorption – in which the guest's attention is occupied by projecting the experience in the mind of the guest. Contrary, the environmental relationship can be one of immersion – in which guests physically become part of the experience itself (Pine & Gilmore, 1999: 30).

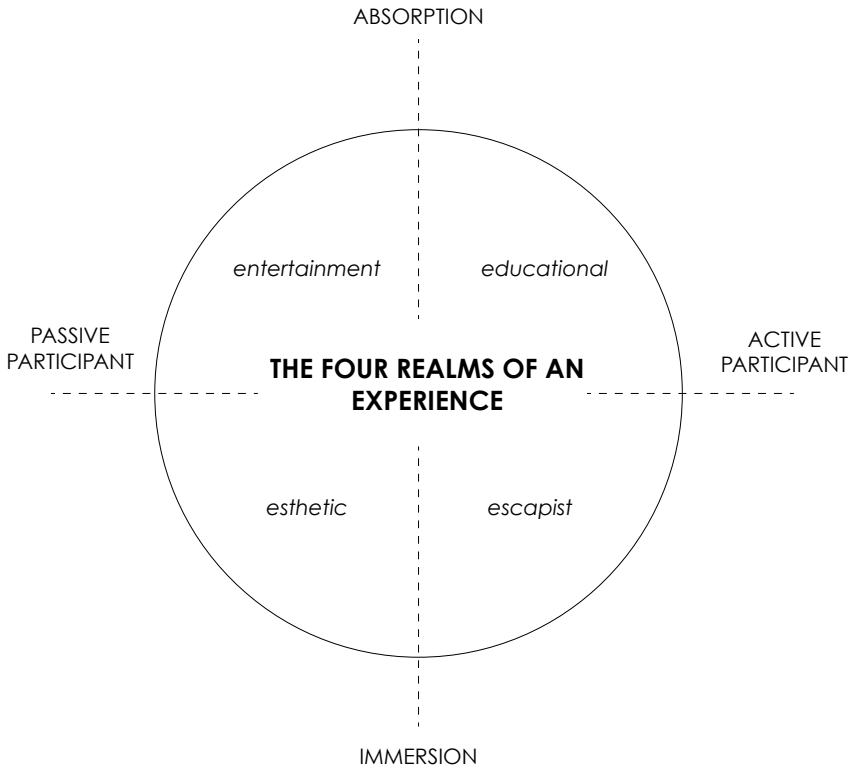


Figure 2.4. The Four Realms of an Experience: (Author) compare with (Pine & Gilmore, 1999).

The relationship between these dimensions defines the four realms of an experience – *ENTERTAINMENT, EDUCATION, ESCAPE*, and *ESTHETICISM* (Pine & Gilmore, 1999: 30). These realms can be exclusively applied to create an experience; however Pine & Gilmore (1999:31) suggest that it is the combination of these four realms that makes an experience new and exciting.

THE EDUCATIONAL

Creating an educational experience involves active participation of the guest. The purpose of this experiential realm is to inform and educate the guest, to increase his/her knowledge and skills both on an intellectual and physical level (Pine & Gilmore, 1999: 32).

Ask yourself:
What do you want your guests "to learn" from the experience?
What information or activities will help to engage them in the exploration of knowledge and skills?

THE ESCAPIST

Creating an escapist experience involves active participation of the guest in order to induce an immersive experience.
Ask yourself:
Once there, what should your guests do?
Focus on what you should encourage your guests "to do" if they are to become active participants in the experience.

THE AESTHETIC

An aesthetic experience is one of immersion but the guest does not actively participate in the experience, for instance visiting an art gallery or museum. "The aesthetics are what make your guest want to come in, sit down and hang out. Think about what you can do to make the environment more inviting, interesting, or comfortable. You want to create an atmosphere in which your guests feel free "to be".

THE ENTERTAINMENT

Through this article Pine and Gilmore suggest that creating memorable events and experiences within a trading environment contributes directly to the success of the products being sold. Pine and Gilmore argue that businesses must orchestrate memorable events for their customers, and that memory itself becomes the product — the "experience".

'Experiential Interior Design' (EID) links directly to the studies in environmental psychology that suggests that the physical environment has a significant impact on its users and inhabitants and can be used to stimulate emotional responses and ultimately affect behaviour of inhabitants (Davis, 2009:19).

EXPERIENCE REALMS	DESCRIPTION	GUEST PARTICIPATION	ENVIRONMENTAL RELATIONSHIP	EXAMPLE	GUIDING QUESTIONS
EDUCATION	The purpose of this experiential realm is to inform and educate the guest, to increase his/her knowledge and skills both on an intellectual and physical level.	Active Participation	Absorption	Interactive Science Museums	What do you want your guests "to learn" from the experience? What information or activities will help to engage them in the exploration of knowledge and skills?
ESCAPIST	The escapist realm creates an experience in which guests can 'escape' their reality to be completely immersed in a fantasy world.	Active Participation	Immersive	Theme Parks Casinos Chat Rooms	Once there, what should your guests do? Focus on what you should encourage your guests "to do" if they are to become active participants in the experience.
AESTHETIC	The aesthetics are what make your guest want to come in, sit down and hang out. You want to create an atmosphere in which your guests feel free "to be".	Passive Participation	Immersive	Museum Art Gallery	Think about what you can do to make the environment more inviting, interesting, or comfortable.
ENTERTAINMENT	An entertainment experience is the act of occupying a guest's attention in an attempt to amuse them. When your guests are entertained, they're not really doing anything but responding to (enjoying, laughing at, etc.) the experience.	Passive Participation	Absorption	Theatre Musical Performances	What can you do by way of entertainment to get your guests "to stay"? How can you make the experience more fun and enjoyable?

Table 2.2. Realms of Experience: Comparing the four differnt realms of experience (Author, 2016) compare with (Pine & Gilmore, 1999).

Figure 2.5. Succulent Garden showing Biomimicry Inspiration (Margolis, 2016)

2.2 **BIO**MIMICRY

2.2.1 DEFINING **BIO**MIMICRY

Nature provides **3.85 billion years** worth of ingenious design examples that have been succumbed to **natural selection**, and as a result have been perfected over time (Benyus, 2013). Biomimicry is an eco-design paradigm that recognizes this and aims to provide a **nature-inspired design tool** for designers, architects and engineers to use when grappling with sustainable design issues in the built environment.

Founder of the design paradigm, Janine Benyus, coined the term Biomimicry in 1990. The term is a compilation of the Greek word *bios*, meaning **life** and the word *mimesis*, which means to **imitate**. Benyus defines Biomimicry as:

> *"...an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies. The goal is to create products, processes, and policies—new ways of living—that are well-adapted to life on earth over the long haul."*

Biomimicry is often confused with similar eco-design paradigms, which is why it is also important to highlight what is not classified as Biomimicry. Harvesting of natural materials for design purposes such as timber flooring does not qualify as Biomimicry but rather bio-utilization. Biomimicry is also distinguished from bio-assisted technologies, which is the act of domesticating an organism to carry out a design function – for instance manipulating silkworms to spin enclosures onto frameworks. Biomimicry aims to learn from nature and use it as a model and mentor for design inspiration instead of taking away from nature by harvesting natural resources and exploiting organisms (Benyus, 2013).

The more our world functions like the natural world, the more likely we are to endure this home that is ours, but not ours alone.

Janine Benyus (2013)

2.2.2 LEVELS OF BIOMIMICRY

The application of Biomimicry can be achieved on three different levels namely **Form, Process** and **Systems.** Benyus (2013) suggests that it is the mimicking of all three levels of Biomimicry that successfully creates conditions conductive to life.

"If we can biomimic at all three levels - natural form, natural process, and natural systems - we'll begin to do what all well-adapted organisms have learned to do, which is to create conditions conductive to life"

Benyus (2013)

FORM

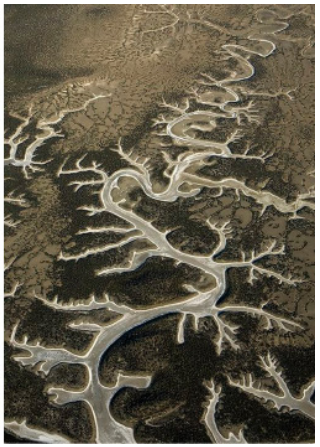
The first level of Biomimicry is the mimicking of **natural form**; for instance, designing a solar panel in the shape of a leaf. Mimicking of natural form achieves Biomimicry on a surface level only, which is why it is important to also mimic the processes and systems involved (Benyus, 2013).

SPIRAL FORMATIONS

Spiral formations in nature can be seen in plants and see organisms and serves a specific purpose for each organism.

HEXAGON & TRIANGULATIONS

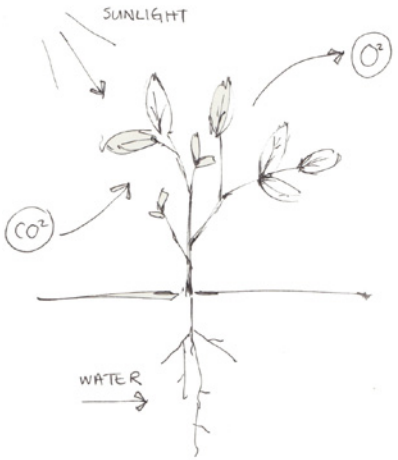
Hexagons and triangulations in seen in nature are resource efficient and structurally sound forms.



FRACTAL FORMATIONS

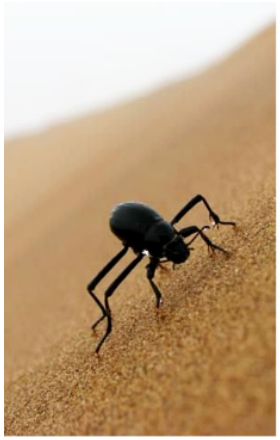
Fractals seen in nature are a series of geometrical patterns that follow a mathematical sequence creating beautiful patterns and forms.

Figure 2.6. Biomimicry Inspiration: Form - Collage (AskNature, 2016)



PROCESS

The second level of Biomimicry is the mimicking of **natural processes** or the way in which nature builds and produces. Photosynthesis is an example of a natural process that is carried out by plants in which renewable energy (sunlight) is used to produce nutrients from a waste product (CO2) and water. Mimicry of photosynthesis could be in the form of a man made process in which renewable energy is harvested and waste is used as the building material (Benyus (2013).



WATER HARVESTING

The Namib beetle has a cleverly designed shell that collects water from early morning dew.

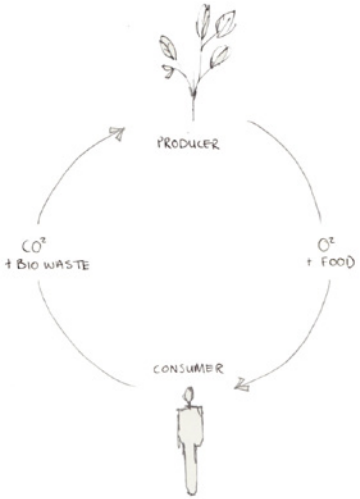
PASSIVE VENTILATION

Termite mounds are constructed with ventilation channels in order to regulate the internal temperatures throughout fluctuation external temperatures.

PASSIVE COOLING

Nature has designed the camel to have a built in cooling system to cool itself down in the dessert heat.

Figure 2.7. Biomimicry Inspiration: Process - Collage (AskNature, 2016)



SYSTEM

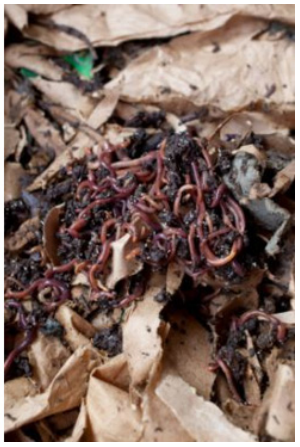
The third level of Biomimicry is mimicking of **natural ecosystems**. For instance the closed-loop life cycle in which producers and consumers have a co-dependant relationship and where zero waste is produced in the cycle. This closed loop system can replace the linear and wasteful model commonly employed by human systems and practices (Benuys, 2013)z.

SYMBIOSIS

Different organisms in an ecosystem have a symbiotic and mutually beneficial relationship.

CRADLE TO CRADLE

Ecosystems in nature functions in closed loops - where waste is continuously recycled.



ZERO NET WASTE

There is no such thing as 'waste' in nature - waste produced by one organism is fuel for another.

Figure 2.8. Biomimicry Inspiration: Systems (AskNature, 2016)

2.2.3 BIOMIMICRY DESIGN SPIRAL

The Biomimicry Design Spiral is a framework that has been formulated to aid designers in their approach when practicing Biomimicry. There are two pathways to the design spiral, the first being Challenge to Biology and the second Biology to Challenge. The Challenge to Biology pathway is used in a scenario where a problem is identified that looks for possible solutions in design found in nature. The Biology to Challenge pathway is when an inspirational process is observed in nature that can be manifested into design to solve a human problem.

For the purpose of this thesis, the Challenge to Biology pathway is selected as the design approach, since a problem/challenge has been identified that will look to nature's genius for possible solutions. The following steps of the Biomimicry Design Spiral are to be taken when approaching a design problem:

DEFINE
Specify your design challenge and its context. What human problem are you trying to solve? What is the nature of the problem?

IDENTIFY
Determine the key function(s) that need to be carried out by the design. What is the purpose of the design? What does it need to do?

INTERPRET
Translate the design problem into Biological terms and define parameters.

DISCOVER
Search for inspiration and biological models in nature that successfully deal with the problem at hand. How does nature do it?

ABSTRACT
Analyse the process/mechanism used by each organism and translate into design principles. What makes the organism so successful at solving the problem at hand?

EMULATE
Develop a design concept using the information gathered and check against Life's Principles.

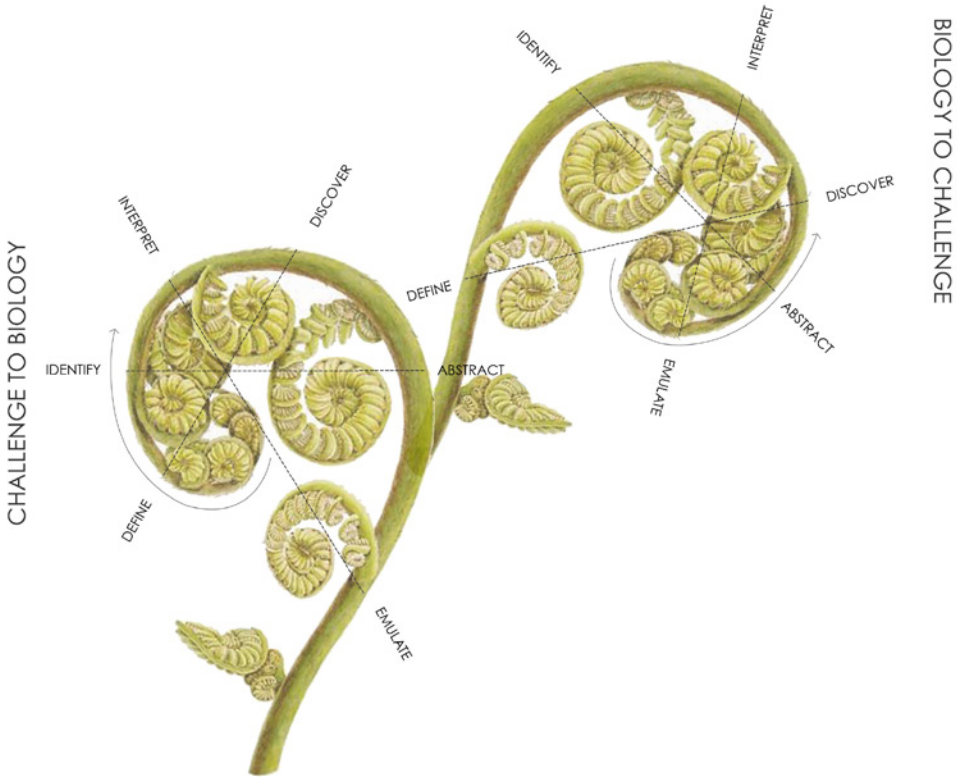


Figure 2.9. Biomimicry Design Spiral (Author, 2016).

Figure 2.10. Botanical imagery of plant life (Etsy, 2007).

2.2.4 LIFE'S PRINCIPLES

Life's Principles represents the survival strategies employed by Mother Nature in order to ensure longevity on planet Earth. These strategies are divided into six groups and are as follows:

Definition: "Invest optimally in strategies that promote both development and growth" (Zanowick, 2012).

Nature recognizes that development and growth need to occur simultaneously for organisms to survive. This is achieved through **combining modular and nested components**. Modularity in nature is seen through repeating patterns that can fit within a larger version of the same pattern – commonly known as fractals. By using these 'modular building blocks', nature is able to save energy, resources and time (Zanowick, 2012). Nature also demonstrates the ability to **self-organize**, which refers to the interplay between individual parts coming together to form a much more powerful and efficient system as a whole. Furthermore, nature **builds from the bottom up** in an additive process instead of a subtractive process. In other words, nature builds and constructs organisms one cell at a time and will only disperse material where necessary.

Definition: "Fit into and integrate with the surrounding environment" (Zanowick, 2012).

The conditions of the natural environment are forever evolving, whether it be seasonal changes or changes that occur slowly over years. Organisms in nature have developed the ability to adapt to their immediate surroundings in order to survive (Benyus, 1997). For instance, nature only makes **use of readily available materials and energy** provided within their local environment. The supply of materials and energy may be limited which is why nature has become responsive to such conditions in order to ensure survival. Nature **leverages cyclic processes**, taking advantage of reoccurring cycles on Earth (Zanowick, 2012), for instance animals will foster their young in springtime when food is available in abundance. Additionally, life fosters **cooperative relationships** by creating conditions that encourage symbiotic relationships in which a mutual benefit is shared between two organisms.

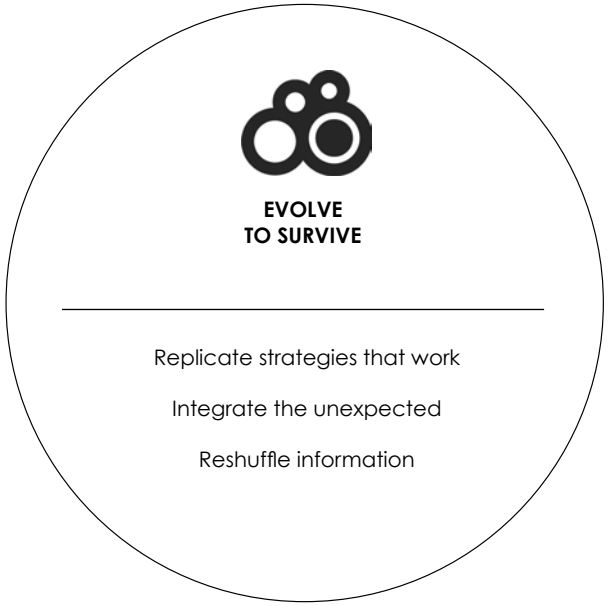
Definition: "Appropriately respond to dynamic context" (Zanowick, 2012).

Nature has the ability to adapt to changing conditions in order to survive. Nature **incorporates diversity** of forms, processes and systems to prepare for a better chance at survival. Without diversity, nature would become volatile and vulnerable to environmental threats. Nature **maintains integrity through self-renewal**, a strategy that allows organisms to heal themselves and repair damage. This forms part of an adaptive strategy since organisms are constantly practicing self-renewal and simultaneously adapting to the changing environment (Benyus, 1997). Furthermore, nature **embodies resilience, though variation, redundancy and decentralization** suggesting that a variety of different forms, processes and systems are utilized and are mutually exclusive to prevent the whole ecosystem from collapsing in the event of an unpredicted disturbance.

Figure 2.11. Biomimicry Life's Principles Diagrams (Author, 2016).

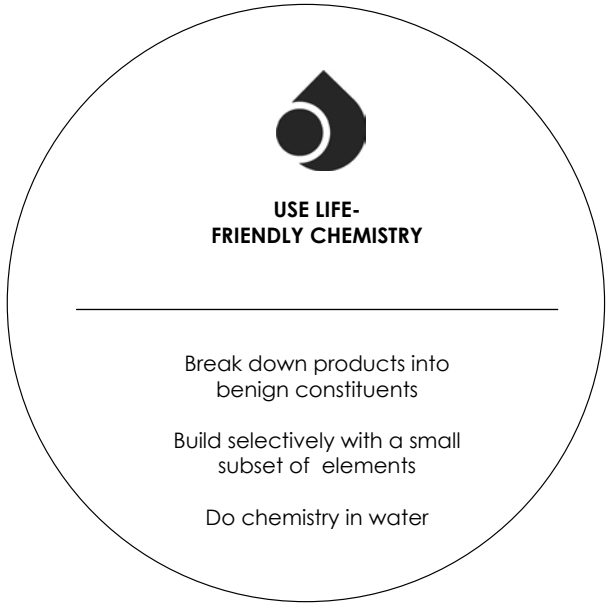
Definition: "Skillfully and conservatively take advantage of resources and opportunities"(Zanowick, 2012).

Organisms in nature have developed strategies to use resources such as raw materials and energy efficiently in order to survive. These organisms use minimal resources and produce no waste when performing their necessary functions (Zanowick, 2012). Nature uses **multi-functional design** allowing multiple needs to be met with one solution, sparing resources in the process. Nature builds and constructs organisms using l**ow energy processes** in order to reduce energy consumption (Benyus, 1997). Nature **recycles all materials** and uses 'waste' as a resource to form a closed-loop system. The organic waste produced by one organism is fuel for another. Nature practices being resource efficient by f**itting form to function** (Zanowick, 2012). Patterns and shapes in nature are created based on the functional need. These forms in themselves display resource efficient properties (see Chapter 5).



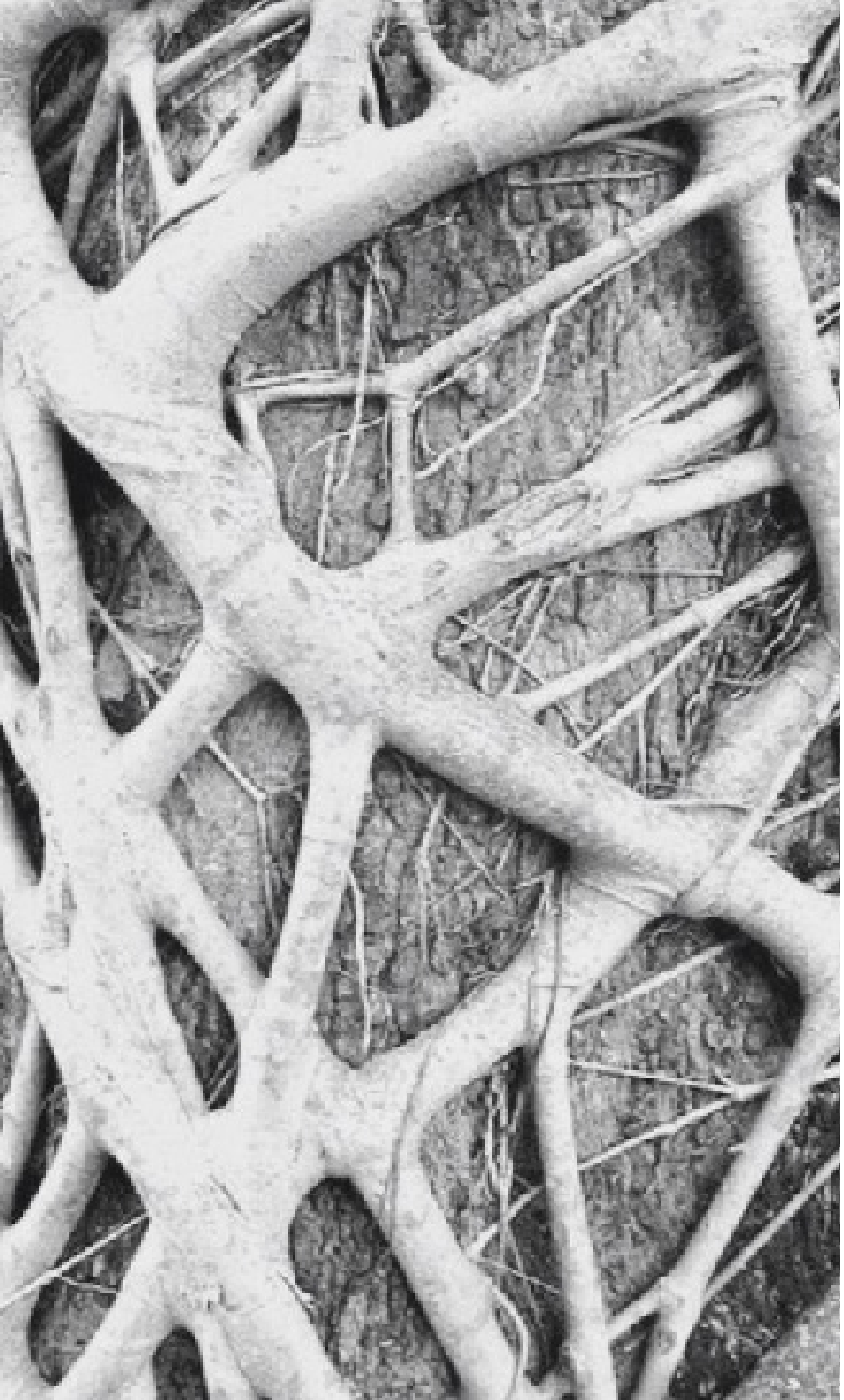
Definition: "Continually incorporate and embody information to ensure enduring performance" (Zanowick, 2012).

Nature is **replicates strategies that work** and is continuously evolving and adapting to environmental conditions in order to survive. Evidence of this includes natural selection and evolution, which proves that only the species capable of adapting to their changing environment will prevail. Nature **integrates the unexpected** in the form of genetic mutations, which might offer a solution to a problem faced by the organism. Nature **reshuffles information** such as genetic material that is combined and reconfigured through reproduction (Zanowick, 2012). This ensures variety, which is essential to survival.



Definition: "Use chemistry that supports life's processes" (Zanowick, 2012).

The biochemical composition of materials and structures in nature is not harmful to the environment in any way and can be **broken down into benign constituents** that can be recycled back into the ecosystem (Zanowick, 2012). For instance the venom of a snake is only toxic to its prey and once digested by the snake it will be broken down into natural elements that pose no harm to the environment. Nature **builds selectively with a small subset of elements** defined by the periodic table. These are the only elements needed to produce a vast variety of living organisms and structures, and this small subset of elements can be recycled and used over and over again within an ecosystem.



2.2.5 RESOURCE EFFICIENCY IN NATURE

In nature, resources are 'expensive' and cannot be used lavishly. Nature has evolved over 3.8 billion years and in the process developed the ability to construct organisms from "*raw materials, procured locally, manufactured at body temperature and pressure*" and at the end of their lifecycle "*these materials are regathered and reconfigured by other organisms, up-cycled again and again with the energy of the sun*" (Benyus, 2013).

So the question is; how can the built environment learn from nature and its processes in order to become more resource efficient?

Life's Principles - Resource Efficiency

The Biomimicry principles (Biomimicry, 2014); more specifically the principle related to resource efficiency provides a series of strategies that should be followed when dealing with the use and management of natural resources. These strategies include – *USING MULTIFUNCTIONAL DESIGN, USING LOW ENERGY PROCESSES, RECYCLING OF ALL MATERIALS* and *FITTING FORM TO FUNCTION* (see diagram to the left for further details).

Figure 2.12. Material configuration in Nature: Wood Weave (Flickriver, 2006).

SKILLFULLY AND CONSERVATIVELY TAKE ADVANTAGE OF RESOURCES AND OPPORTUNITIES

USE MULTIFUNCTIONAL DESIGN
Meet multiple needs with one elegant solution.

USE LOW ENERGY PROCESSES
Minimise energy consumption by reducing requisite temperatures, pressures and/or time for reactions.

RECYCLE ALL MATERIALS
Keep all materials in a closed loop.

FIT FORM TO FUNCTION
Select the shape or pattern based on need.

Figure 2.13. Biomimicry Life's Principles (Author, 2016) compare with (Biomimicry, 2014).

Minimum Inventory / Maximum Diversity Theory

Theories by Peter Pearce (1978) and D'Arcy Thompson (1961) further elaborate on the strategies employed by nature towards being **resource efficient**.

In his book *Structure in Nature is a Strategy for Design* (1978), Pearce suggests that in order for man to have a synergetic relationship with nature, we need to become **responsive** and **adaptable** to our environments whilst using natural resources conservatively. Pearce (1978: xii) brings forth the concept of MINIMUM INVENTORY/MAXIMUM DIVERSITY systems as the foundation of resource efficiency. This concept boils down to the idea of *using less to create more*, in which **less natural resources** are used to provide an equal or **greater value output**.

Pearce elaborates on this idea and suggests that the concept of minimum inventory/maximum diversity (1978: xii) can be implemented through **standardization of components** that are used as **'a kit of parts'**. In other words, a minimum amount of components should allow for a maximum output of **'genetically related structural forms'**. Pearce states;

"When properly used, the principle of component standardization is a system of great production and distribution efficiency. It can also be a system, which conserves natural resources. In a fundamental way, standardization is a principle of modularity. We need to develop a building strategy with which diversity and change can be accomplished by modular systems, which are efficient in their use of natural material and energy resources"
- (Pearce, 1978: xii)

This extract suggests that the use of both **standardization** and **modularity** in the built environment is a strategy that can be employed towards energy and resource efficiency.

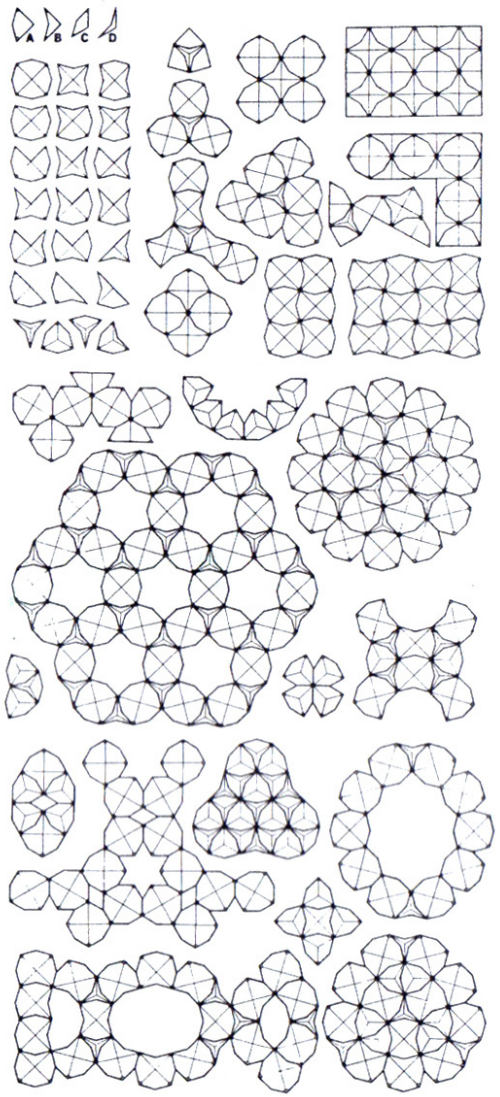


Figure 2.14. Minimum Inventory/Maximum Diversity System (Pearce, 1978: xii).

Intrinsic & Extrinsic Forces in Nature

Both Pearce (1978: xiv) and Thompson (1961: 11) discuss the notion of resource efficient structures and forms found in nature. They convey that these natural forms and structures is a result of minimum-energy processes employed by nature. Thompson (1978: 11) poetically states:

"in short, the form of an object is a diagram of forces; in this sense, at least, that from it we can judge of or deduce the forces that are acting or have acted upon it; in this strict and particular sense, it is a diagram".

Through this statement, Thompson expresses the way in which forces have the ability to shape and mould forms whilst using minimum energy and resources.

Pearce elaborates on this notion and proposes that form is created as a result of the interplay between intrinsic and extrinsic forces. INTRINSIC FORCES are the internal properties or forces within the structural system that governs its potential performance (Pearce, 1978: xiv). EXTRINSIC FORCES are external to the structural system; often environmental factors, which gives direction to the form (Pearce, 1978: xiv). Figure 2.15 illustrates Pearce's theory of intrinsic and extrinsic forces and how these forces apply to creation of form and structures in the built environment:

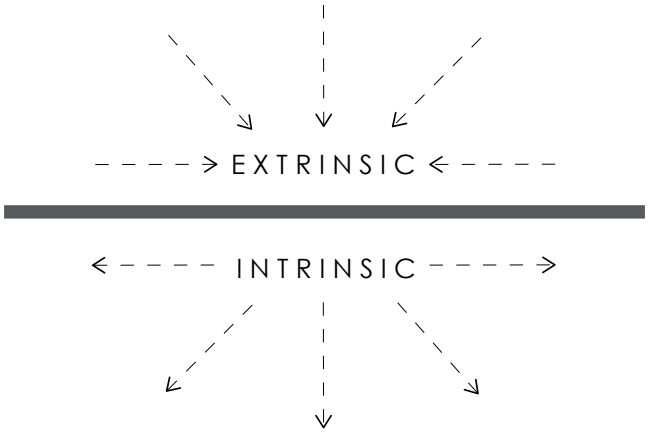
" FORM AS A DIAGRAM OF FORCES "

(a) limitations of resources including energy and materials

(b) building function including the change of its use over time

(c) relationship to the community

(d) emotional ambience



(a) structural efficiency relative to use of material

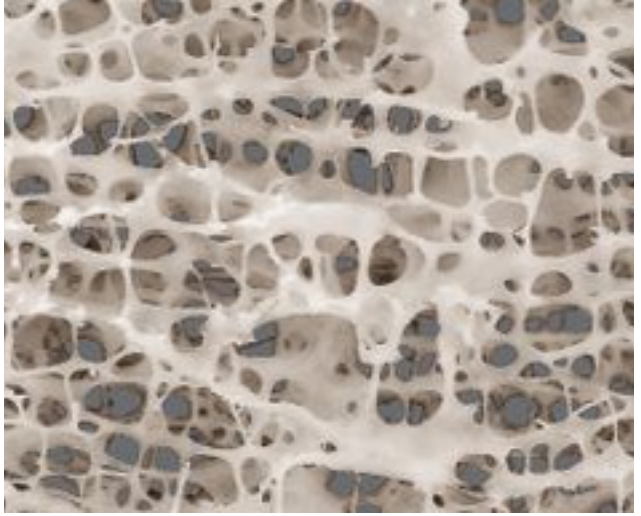
(b) provide diversity of form in order to respond (adapt) optimally to the actions of an array of extrinsic forces

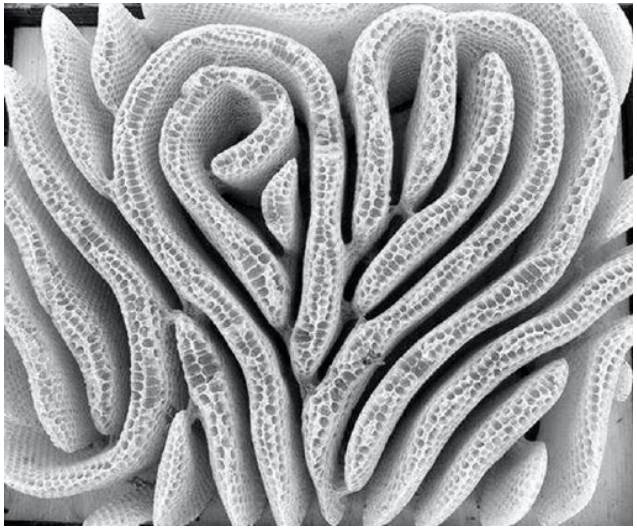
(c) accommodate change in response to the inevitable long term variations of certain extrinsic forces

(d) define a minimum inventory of component types in order to simplify and economize the production and use of the system

(e) take advantage of materials that are consistent with an optimum response to the actions of extrinsic forces and to the economical production of the system's

Figure 2.15 (Above) Form as a diagram of forces (Author, 2016) compare with (Pearce, 1978: xiv).





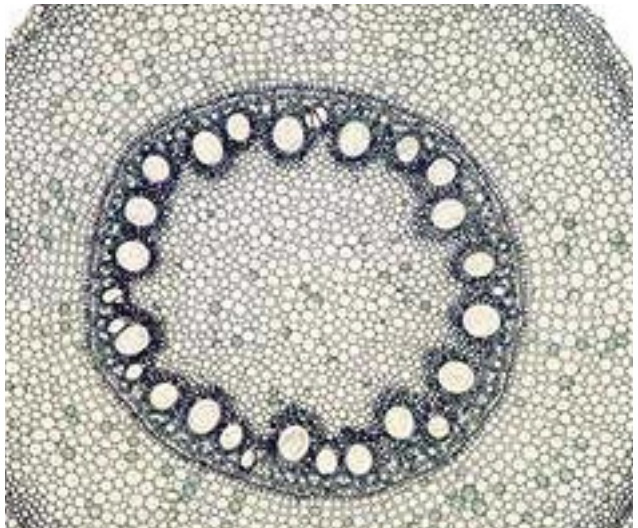


Figure 2.16 (Right) Lightweight structures in nature (AskNature,2015)

Closest Packing & Triangulation

When looking at the forms and structures in nature, both Pearce (1978: 2) and Thompson (1961: 103) identified the reoccurring hexagonal and triangulation patterns that are a result of the interplay between intrinsic and extrinsic forces governed towards creating resource efficient systems.

Pearce (1978:3) suggests that the occurrence of hexagonal patterns in nature is a result of closest packing. Closest packing is the way in which spherical cells are packed together as tightly as possible. Spherical cells themselves are the most resource efficient form since a sphere is the three-dimensional form that can hold the largest volume with the smallest surface area (Pearce, 1978:4). However, an array of spheres stacked together in a square formation (see Figure 2.17) is not economical and results in a series of empty voids and wasted space between the cells. It is for this reason that spherical cells are stacked in a triangulated formation, which proves to be 7% more economical and allows more spherical cells to be placed in a given area (Pearce, 19878: 3).

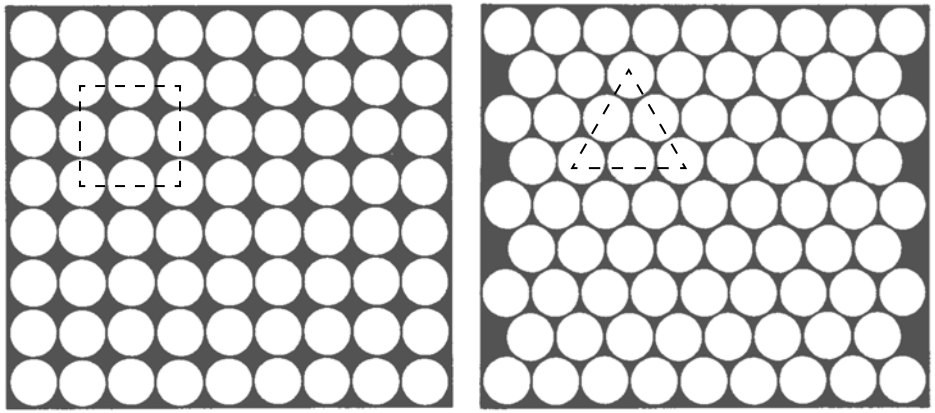


Figure 2.17. Closest Packing in Nature: Triangulation grid connecting cells (Peace, 1978:3)

Triagulations

The triangulation network created between stacked cells is what gives these structures in nature its inherent stability and robustness. Pearce argues, "The triangle is the only polygon that is stable (rigid) by virtue of its geometry" (Pearce, 1978: 4), which is why these patterns are so prevalent in nature. He suggests that cube geometry does not occur in nature and that we should question its application within the built environment, and create a movement towards implementing triangulated structures. This proposition ties in with the idea of minimum inventory/maximum diversity, which together can be used as a guiding principle towards developing resource efficient structures in the built environment.

CUBE

"There can be no doubt that cube oriented geometry is extremely important and relevant to architectural design; however, it has serious modular limitations with respect to the generation of diversity of form, and as a structural framework it has inferior strength-to-weight properties when compared to triangulated systems... A cursory observation of natural structures shows that cubes rarely occur. This alone suggests that a careful study of other alternatives is advisable."
(Pearce, 1978: xvii)

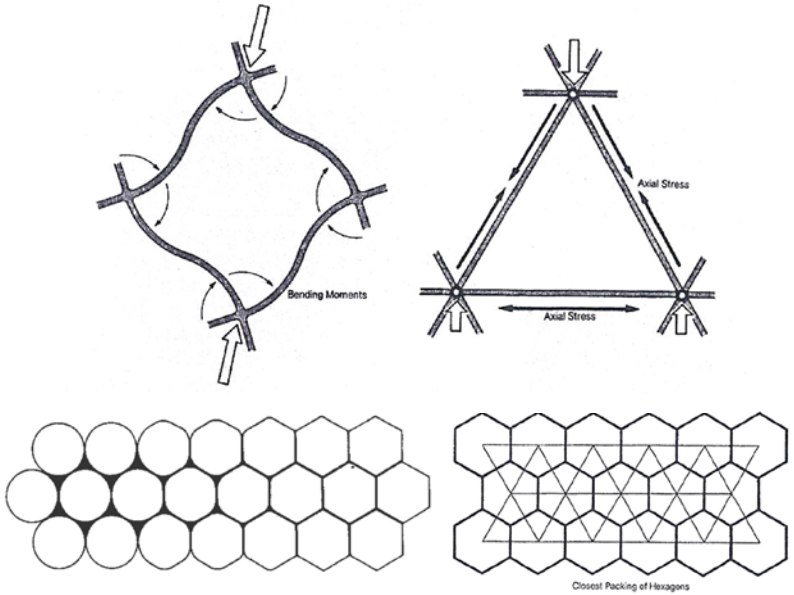
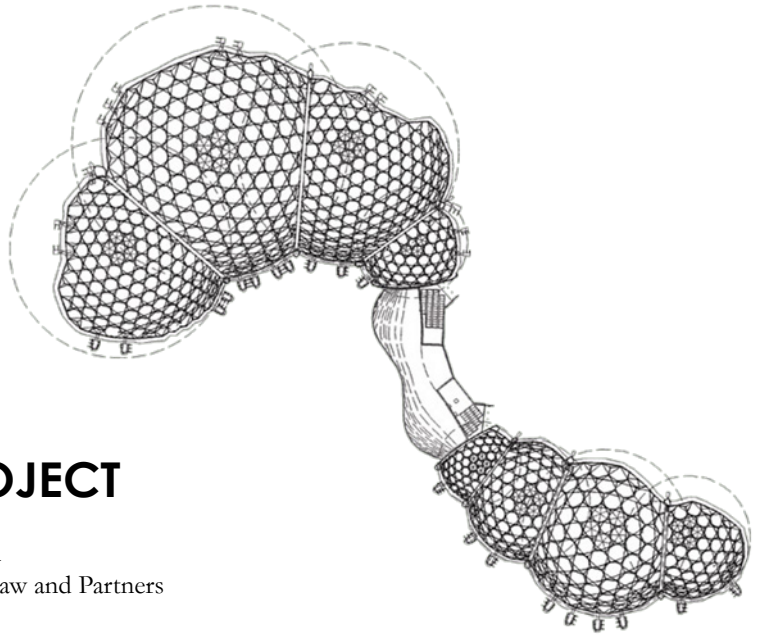


Figure 2.18. Stability of triangular structure (Pearce, 1978: xvii)

TRIANGLE

"It can be readily seen that the principle of closest packing is equivalent to that of triangulation; and it is well known that triangulated frame works exhibit inherent geometric stability. Such properties enable framework structures to be built without moment joints, insuring axially loaded members; and this in turn results in high strength-per-weight minimum energy structures"
(Pearce, 1978: xiv)



EDEN PROJECT

Cornwall, UK
Architectural Design
By Nicholas Grimshaw and Partners
2001

2.2.6 BIOMIMICRY PRECEDENT STUDIES

The Eden Project is a series of biomes set in place to not only conserve over five thousand different species of plants from various climatic zones across the world, but to also educate and provide an enjoyable experience for the public who wish to visit the space. One of the main aspirations that the Eden Project hopes to achieve is to "promote the understanding and responsible management of the vital relationship between plants, people, and resources, leading towards a sustainable future for all" (Perrin, 2007).

A series of design criteria were to be met in the creation of the Eden Project. Firstly, an enclosure had to be designed to span over great distances without the need for internal support structures. Secondly, it was important for the structure to be rendered lightweight in order to cut carbon emissions produced in the transportation process since most of the raw materials were not retrieved locally. The structure being lightweight would also eliminate the need for extensive foundations that would have otherwise caused potential damage to the soil conditions (Bissegger, 2006).

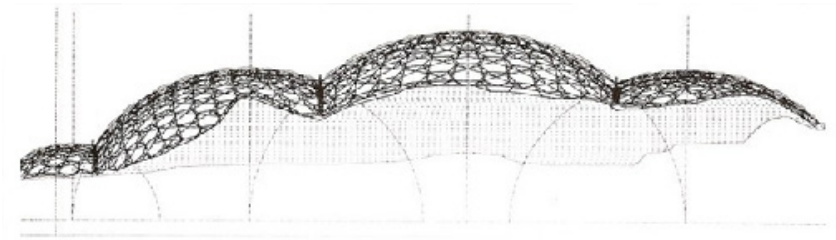


Figure 2.19 Eden Project (Perrin, 2007)



Figure 2.20. Photos of Eden Project (Perrin, 2007).

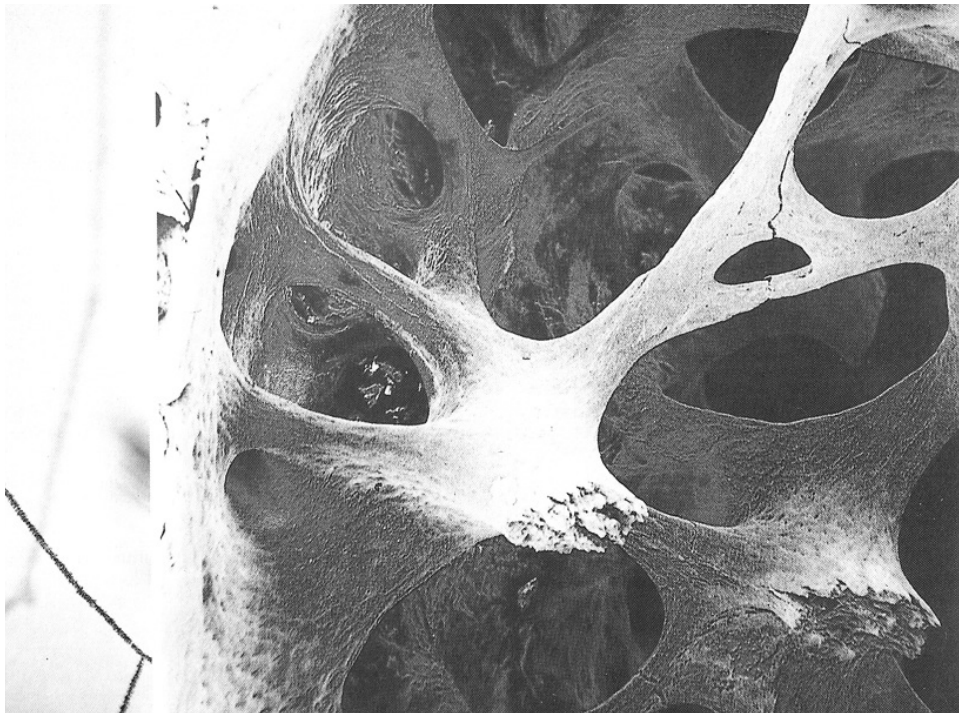
BIOMIMICRY PAVILION

Architectural Concept Design
By Andres Harris

Andres Harris' proposed pavilion design is a brilliant example of the application of Biomimicry in the field of architecture. Harris aspired to design a structure that would be strong and durable and that would be constructed using material in the most efficient way possible so as to render it lightweight (Harris, n.d).

Bone tissue, especially that of bird skulls was used as the source of inspiration for this project. Bird skulls are an interesting study. The skull has to be strong enough to protect the organs of a bird, yet remain lightweight enough to allow the bird to take flight with ease. The structural system of a bird skull achieves this through providing a higher density of bone tissue in areas that undergo higher external pressures, and little or no bone tissue in areas that are not greatly subjected to external pressures. Air pockets fill the voids between the bone tissues, reducing the overall weight of the structure without affecting its strength (Harris, n.d).

The image below shows Andres Harris's pavilion design. It consists of two leafs of solid material that is held together with vertically elongated supporting structures. These vertical members create air pockets between the upper and lower solid leafs giving it greater strength with 'lightweight' properties – much like that of a bird skull.



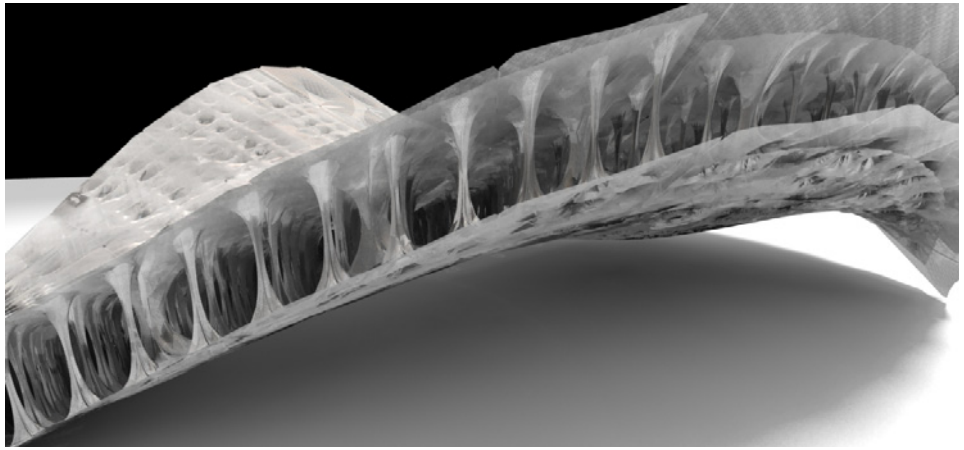


Figure 2.21 Biomimicry Pavilion Design by Andres Harris (Harris, n.d.)

3D PRINTED CHAIR

Industrial Design
By Lilian van Daal
2014

Dutch industrial designer, Lilian van Daal, recognized the resource-intensive and wasteful production process of traditional upholstered furniture and aimed to explore alternative methods of production to create streamline and resource-efficient furniture pieces. She used biomimicry as a design tool and looked to nature for inspiration on how to tackle this problem (Hogan, 2013).

Van Daal looked at the cell structure of plants to understand how nature distributes material to create strong and durable yet lightweight and resource efficient structures. She then emulated the processes observed in nature and applied it in her design to create a 3D printed chair that resembles the cell structure of a plant. Using 3D printing technology, van Daal was able to test the flexibility and stiffness of various materials to identify their individual structural properties. Van Daal wanted to challenge the resource-intensive nature of traditional furniture production methods by producing a furniture piece using one material alone. Nylon was the chosen material for the first prototype of her chair; however van Daal is working on using a biological material instead for the chair to be more sustainable (Hogan, 2013).

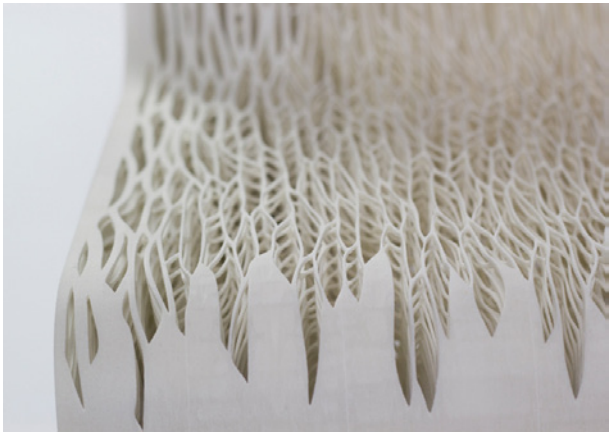


Figure 2.22. 3D Printed Chair by Lilian Van Daal (Hogan, 2013).

2.2.7 WASTE AS A RESOURCE IN NATURE

Nature exemplifies a 'cradle-to-cradle' model, in which 'waste' is seen as a valuable resource (McDonough & Braungart, 2002). By studying the cradle-to-cradle model we can learn from nature's approach to recycling waste, in the aim of applying these practices in a retail design scenario.

Theories regarding Cradle-to-Cradle Design

William McDonough and Michael Braungart (2002) are leaders of the cradle-to-cradle design model. They proposed the concept of 'houses like trees' and 'cities like forests' – and refer to the metaphor of the 'cherry tree';

"As it [the cherry tree] grows, it seeks it own regenerative abundance. But this process is not single- purpose. In fact, the tree's growth sets in motion a number of positive effects. It provides food for animals, insects and microorganisms. It enriches the ecosystem, sequestering carbon, producing oxygen, cleaning air and water, and creating and stabilizing soil. Among its roots and branches and on its leaves, it harbors a diverse array of flora and fauna, all of which depend on it and on one another for the functions and flows that support life. And when the tree dies, its returns to the soil, releasing, as it decomposes, minerals that will fuel healthy new growth in the same place."

Through this metaphor, McDonough and Braungart suggest that buildings and cities should operate like an ecosystem; in which buildings are seen as nutrient dense structures that have the ability to give back to its surrounding environment, and also for these buildings to form part of a greater whole that sustains not only itself but a greater community.

Three Defining Principles of Cradle-to-Cradle Design

McDonough and Braungart proposed that there are three essential principles to the Cradle-to-Cradle model, which are as follows:

(A) WASTE EQUALS FOOD
> Everything is a nutrient for something else

(B) USE CURRENT SOLAR INCOME
> Energy that can be renewed as it is used.

(C) CELEBRATE DIVERSITY
> Species, cultural and innovation diversity.

Figure 2.23. Waste Equals Food: Growth of fungi (StudioChoo, 2010)

(A) WASTE EQUALS FOOD

The **Waste Equals Food** principle is undoubtedly a trademark of the Cradle-to-Cradle model, and represents the 'closed-loop' cycle of materials, water and energy – where all materials are recycled and nothing is wasted (McDonough & Braungart, 2002).

As inspired by ecosystems in nature; McDonough and Braungart (2002) created a closed loop material recycling model that emulates natures systems and processes. These closed loop models are defined as the **Biological Metabolism** and the **Technical Metabolism** (see Figure 2.24).

The *BIOLOGICAL METABOLISM* is the process of recycling biological nutrients; characterized by biodegradable materials that are not harmful to the environment after human use and can be returned to nature for biological processes. Both natural and synthetic materials can be classified as biological nutrients, as long as they are safe for human and environmental systems.

The *TECHNICAL METABOLISM* is the process of recycling technical nutrients, which are classified as materials such as polymers and minerals that can be safely (re) used within an industrial cycle; but are never returned back to the natural environment for biological processing. It is important for technical nutrients to maintain their quality and value through the continuous cycles of production, recovery and reuse to avoid 'down cycling' of materials, which would eventually end up as waste materials in a landfill.

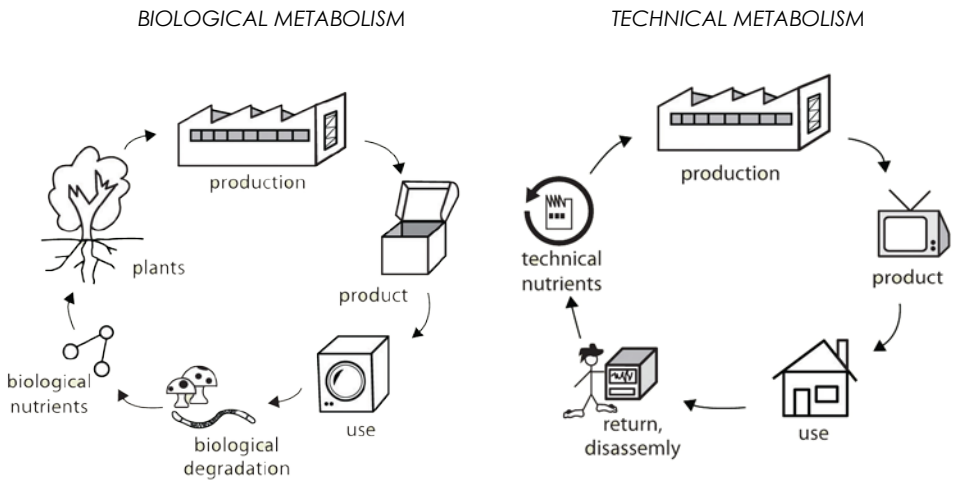


Figure 2.24 Biological and Technical Metabolism (McDonough & Braungart, 2002)

(B) USE OF CURRENT SOLAR INCOME

Nature taps into the abundant supply of energy from the sun to carry out all biological processes. McDonough and Braungart (2002) promote the use of this renewable source of solar energy for human needs within the built environment including electricity, heating and lighting.

(C) CELEBRATE DIVERSITY

Nature is one large ecosystem that supports an abundant array of different organisms that coexist and often foster interdependent relationships. We as human beings on the other hand, only look out for ourselves and destroy habitats of other living organisms in our natural environment through processes such as mining and deforestation.

The third principle of the Cradle-to-Cradle model; Celebrate Diversity, therefore aims to guide human processes towards an ecosystemic model as seen in nature, that allows a complex network of living organisms not only to co-exist but to work together to build a healthier and sustainable living environment that is conductive to life. This principle encourages both bio-diversity and diversity of form in the built environment, which leads to innovative design that allows for adaptation to local conditions.

> *"A cradle to cradle building contains elements that add value and celebrate innovation and enjoyment by: measurably enhancing the quality of materials, biodiversity, air, and water; using current solar income; being deconstructable and recyclable, and performing diverse practical and life-enhancing functions for its stakeholders"*
>
> - McDonough & Braungart, 2002

2.2.8 BIOMIMICRY PRECEDENT STUDIES

Closed-Loop Coffee Farm

A closed-loop coffee farm system was developed by ZERI (Zero Emissions Research and Initiatives) that reuses waste as a resource. This ecosystemic approach to agriculture was inspired by Biomimicry's Life Principles and emulates the concept of closed-loop systems (AskNature, 2015). ZERI recognized that the making of coffee from raw coffee beans only has a 0.2% yield, which leaves 99.8% waste as a by-product. In order to prevent this waste from ending up in a landfill or in rivers, ZERI aimed to devise a closed-loop scheme for the farmers in which the waste would be recycled back into their coffee production systems (AskNature, 2015).

The success of the system lied in discovering that Shiitake mushrooms thrive in bio-waste – such as the waste produced in the coffee making process. The closed-loop system therefore involves growing of Shiitake mushrooms in the coffee bio waste, which is then sold to the local market (Ask Nature, 2015). Furthermore, cattle and pigs are fed with the organic residue left over after harvesting of the coffee beans. The manure from the farm animals is then fed into a bio-digester that produces heat for the mushroom farming, and organic fertiliser that is used for growing the coffee plants (AskNature, 2015).

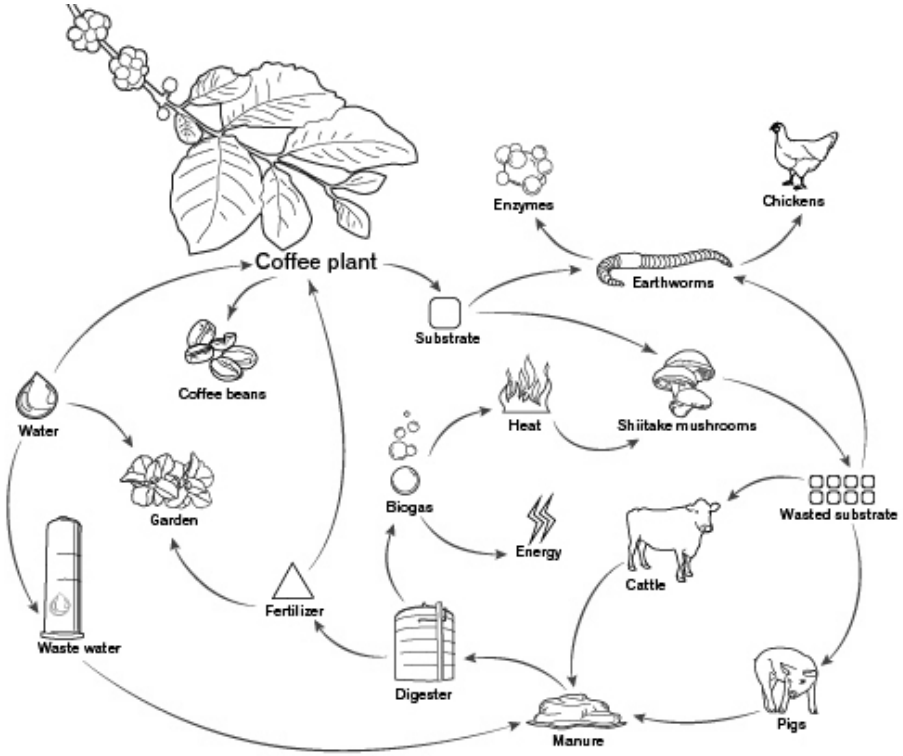


Figure 2.25. Closed-Loop Coffee Farm (AskNature, 2015).

Cardboard to Caviar Closed-loop System

The Cardboard to Caviar model; developed by Graham Wiles, mimics closed-loop systems found in nature with the aim of using waste as a resource (Bradley, 2016). Wiles recognized an opportunity to use the cardboard boxes discarded as waste in a caviar restaurant business and turn it into a resource that at the end of the cycle aids cultivation of caviar – hence forming a closed-loop cycle.

The operations of the Cardboard to Caviar closed-loop model is as follows:

1. Mr. Wiles collects cardboard boxes from the caviar restaurant.
2. These cardboard boxes are shredded and sold to a stable for horse bedding
3. Mr. Wiles collects and removes the spent horse bedding from the stables.
4. Mr. Wiles then uses the spent horse bedding as feed for the worms that he farms.
5. The worms are used as feed for Sturgeon, which produce caviar.
6. Mr. Wiles then sells the caviar to the restaurant and also collects their cardboard boxes, repeating the cycle.

(Bradley, 2016) CO^2

The Cardboard to Caviar model is another great example of how we can learn from nature to use waste as a resource.

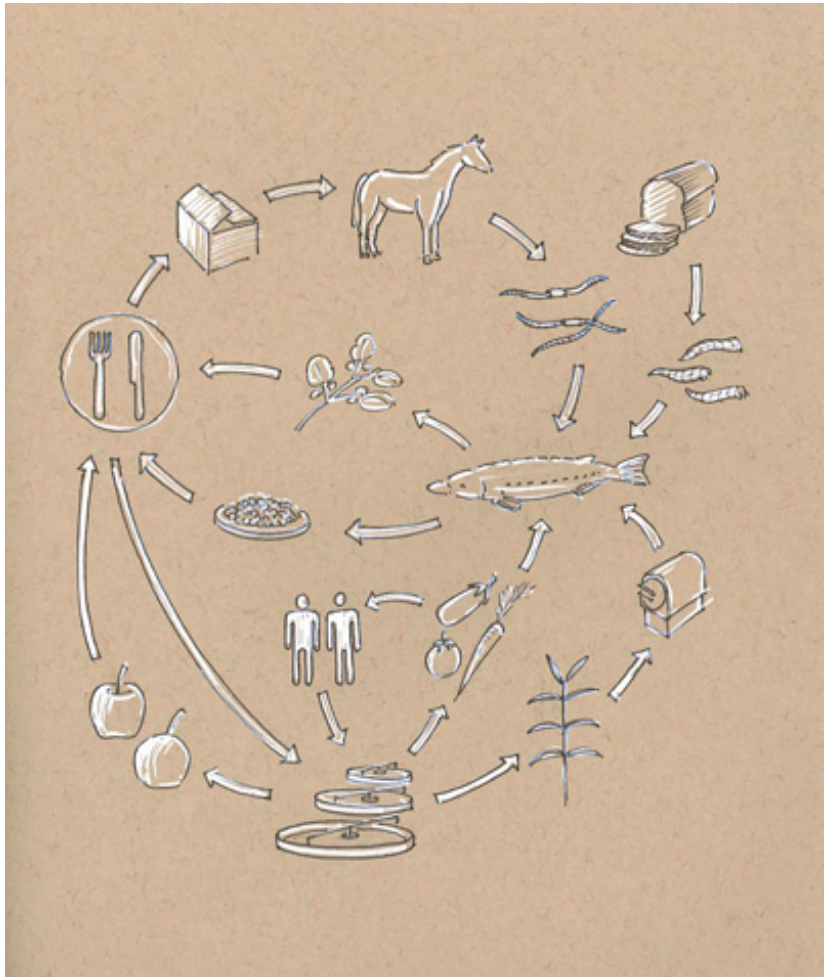


Figure 2.26. Cardboard to Caviar Closed-Loop System (Bradley, 2016)

2.3 EXPERIENTIAL & BIOPHILIA DESIGN THEORY

Looking at human cognitive and behavioural responses is important for the purpose of this study, as it will provide insight to the psychology and scientific facts behind the reason why we feel and behave a certain way in a given environment. Such research can be used to manipulate the users experience of a spatial environment, and in this case, a brick-and-mortar retail environment.

The following theories explore the relationship between the environment and its inhabitants. By nature, many of the theorists involved in such studies have varying opinions on the environmental factors that most significantly contribute to certain cognitive and behavioural responses. For this reason, it was decided to investigate a variety of theories to gain a broad understanding of the topic at hand.

2.3.1 ATMOSPHERICS

The term atmospherics was coined by Kotler (1974: 50) to describe the "*conscious designing of space to create certain effects in buyers*". The literal meaning of the word "atmosphere" translates into the air surrounding a sphere. The word atmosphere is often casually used to describe the quality and feel of ones surroundings. Kopec believes that the incorporation of atmospherics in the design of retail space can contribute to an enhanced environmental experience (Kopec 2006: 301).

According to Kotler (1974: 51), atmosphere is perceived as a sensory experience of a space including sight, sound, touch and scent. Taste is also a sensory experience but is excluded within Kotler's theory of atmospherics since an atmosphere cannot be tasted (Kotler, 1974: 51). Kotler further breaks down these four sensory channels into sub- dimensions. The visual sub-dimensions of an atmosphere include colour, brightness, size and shapes. The aural sub-dimensions of an atmosphere include volume and pitch. The olfactory sub-dimensions of an atmosphere include scent and freshness. And lastly, the tactile sub-dimensions of an atmosphere include softness, smoothness and temperature (Kotler, 1974: 51). These sub-dimensions can be used to describe the atmosphere of a particular environment. For example, the atmosphere of a spa is subdued, quiet, invigorating and soft whilst a recreational park on the other hand is bright, noisy, loud and rough (Kotler, 1974: 51).

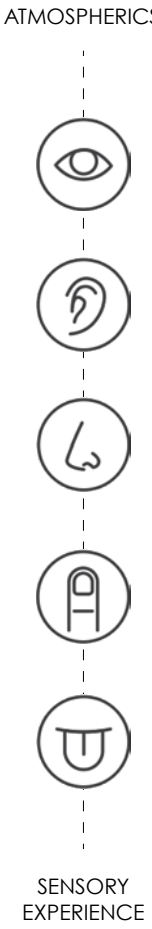


Figure 2.27 Atmospherics and sensory experience diagram (Author, 2016).

Kotler further explains that differentiation must be made between intended atmosphere and perceived atmosphere (Kotler, 1974: 53). Designers may intend to induce a certain atmosphere in any given setting such as a restaurant through manipulating colour, brightness, sound and temperature for instance. However it is not a given that the intended atmosphere of the space will translate into the users perceived atmosphere since our perceptions is partly a learned experience and will differ from person to person (Kotler, 1974: 53).

Furthermore, Kotler (1974:48) proposes the notion that atmospherics can be used as a means to design a retail space to provide added value - "*One of the most significant features of the total product is the place where it is bought and consumed. In some cases, the place, more specifically the atmosphere of a place, is more influential than the product itself in the purchase decision*". Through this notion, Kotler argues that there may be a misperception in the consumer industry in thinking that the product or service is the main element of attraction, when in actual fact it is the spatial environment or the 'brick-and-mortar' as he refers to it, that has the greatest influence on the consumer's decision making process (1974: 48). Kotler touches on the concept of Gestalt psychology, which states - "*the whole is greater than the sum of its parts*" (Humphrey, 1924). Kotler suggests that buyers respond to a total product; which is comprised of the product/service, packaging, images, advertising and the in-store environment as a collective whole (Kotler, 1974: 63). Kotler believes that the place/in-store environment where the product or service is purchased is the most significant feature of the total product.

"Total design is the philosophy of creating a unified decor and tone throughout a building"

Kotler (1974: 63)

Why is atmospherics important?

Atmospherics can be used as a marketing tool and is most effective under certain circumstances (Kotler, 1974: 53). Kotler makes the following 5 propositions of circumstances in which the use of atmospherics as a marketing tool would be most effective.

_ Atmospherics is a relevant marketing tool mainly in situations (a) where the product is purchased or consumed; and (b) where the seller has design options.
Ultimately, this implies that atmospherics is a useful tool for retailers but not wholesalers, and that consumers purchasing from retailers will have greater control over where they buy, and as previously mentioned, place (atmosphere) contributes greatly to the total product.

_ Atmospherics becomes a more relevant marketing tool as the number of competitive outlets increase.
Atmospherics has the ability to distinguish one merchant over another competing in the same sector. It has the ability to attract and hold a specific segment of the market and ensures customer returns and loyalty.

_ Atmospherics is a more relevant marketing tool in industries where product and/or price differences are small.
Merchants competing in the same market sector usually use price and product to distinguish themselves from their competition. Atmospherics can be used as a marketing tool that will set one merchant above another in the event of competitors providing similar products and price ranges.

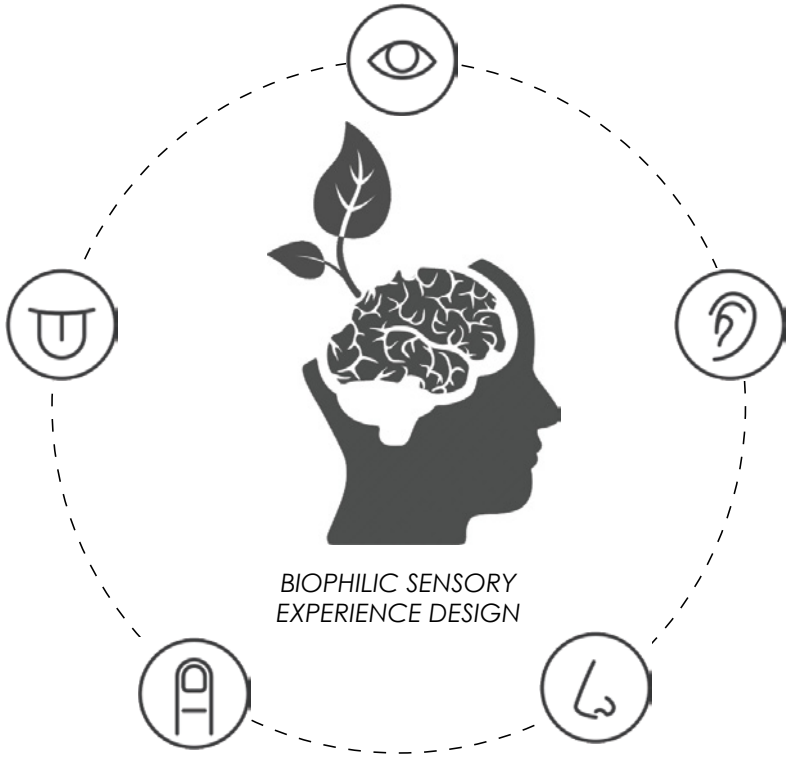
_ Atmospherics is more relevant as a marketing tool when product entries are aimed at distinct social classes or life style buyer groups.
Atmosphere can provide consumers clues to the particular market segment of the store. For example, a high-class retailer would display fewer products than a low class retailer to brand its products as exclusive and one of a kind.

2.3.2 EXPERIENTIAL DEISGN TOOLS

In her article Come to Your Senses (2008: 36), Catherine Warren Leone elaborates on the power of the five senses within sensory design. According to Leone, "*emotions form the basis of thoughts*", which is fueled by the five senses – **sight, touch, sound, smell** and **taste** (2008: 36). Leone elaborates on the topic of emotions by quoting Dan Hill, author of Emotionomics: Winning Hearts and Minds (Adam Business & Professionals) – "*Emotions affect awareness, consideration, persuasion, recall and loyalty in the marketplace*". Therefore it is understood that sensory design affects consumers' emotional response to an environment, which affects perceptions of corporate brand identity.

2.3.3 BIOPHILIC SENSORY EXPERIENCE

Biophilic design incorporates nature into the built environment in order to provide occupants with the physiological and psychological benefits gained from exposure to nature (Browning, 2014). Biophilic design differs from Biomimicry, in the sense that Biomimicry is a design tool that encourages mimicking of natural forms, processes and systems in order to solve sustainability issues in the built environment (Benyus, 1997), whereas Biophilic design focuses on mimicking the experiential qualities of nature. The use of Biophilic design in the built environment is geared towards healing and rejuvenation of occupants through reducing stress, improving cognitive function and uplifting moods (Browning, 2014). For the purpose of this study, the Biophilic design patterns will be analysed and subdivided into the five sensory categories, namely visual stimuli, audio stimuli, olfactory stimuli, tactile stimuli, and gustatory stimuli; in order to understand how these patterns in nature can be used to influence an in-store sensory experience.



"...the enjoyment of scenery employs the mind without fatigue and yet exercises it, tranquilizes it and yet enlivens it; and thus, through the influence of the mind over the body, gives the effect of refreshing rest and reinvigoration to the whole system."

Browning, 2014

Figure 2.28. Sensory Experience Diagram (Author, 2016).

Biophilic Design Patterns

There are fourteen patterns of Biophilic design that are subdivided into three groups, including Nature in the Space, Natural Analogues and Nature of the Space (Browning, 2014), which are explained in the table below:

NATURE IN THE SPACE Ephemeral Presence of Nature in a Space	NATURAL ANALOGUES Organic, Non-living & Indirect Evocations of Naturee.g. objects, materials, colours, shapes, sequences, patterns	NATURE OF THE SPACE Spatial Configurations in Nature
 *[P1] VISUAL CONNECTION WITH NATURE* A view with elements of nature, living systems and natural processes.	 *[P8] BIOMORPHIC FORMS & PATTERNS* Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.	*[P11] PROSPECT* An unimpeded view over a distance for surveillance and planning.
 *[P2] NON-VISUAL CONNECTION WITH NATURE* Auditory, haptic, olfactory or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.	 *[P9] MATERIAL CONNECTION WITH NATURE* Material and elements from nature that, through minimal processing, reflect the local ecology or geology to create a distinct sense of place.	*[P12] REFUGE* A place for withdrawal, from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.
[P3] NON-RHYTHMIC SENSORY STIMULI Stochastic and ephemeral connections with nature that may be analyed statistically but may not be predicted precisely.	 *[P10] COMPLEXITY & ORDER* Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature.	*[P13] MYSTERY* The promise of more information achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment
 *[P4] THERMAL & AIRFLOW VARIABILITY* Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.		*[P14] RISK/PERIL* An identifiable threat coupled with a reliable safeguard.
[P5] PRESENCE OF WATER A condition that enhances the experience of a place through the seeing, hearing or touching of water.		
 *[P6] DYNAMIC & DIFFUSE LIGHT* Leveraging varying intensities of light and shadow that change over time to create conditions that occur in nature.		
[P7] CONNECTION WITH NATURAL SYSTEMS Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem.		

Table 2.3 Biophilic Design Patterns (Author, 2016) compare with (Browning, 2014).

Psychological and Physiological Influences of Nature

Biophilic design is geared towards understanding how nature in the built environment can improve human cognitive, psychological and physiological well-being, often referred to as a mind-body system (Browning, 2014).

Cognitive functionality and performance encompasses the mental aspects of well-being such as memory, ability to learn, to make logical decisions and creativity. Performing cognitive tasks can be mentally draining and energy intensive resulting in mental fatigue (Kellert et al., 2008; van den Berg et al., 2007). Research shows that a connection with nature combats mental fatigue and restores mental cognitive performance (Browning, 2014).

Psychological well-being mainly deals with human emotions and moods, but also includes alertness, concentration and stress management. Various studies (Alock et al., 2013; Barton & Pretty, 2010; Hartig et al., 2003) prove that a connection with nature in the built environment supports reduction of stress, anxiety, confusion and fatigue and has a positive effect of moods and emotions.

Physiological well-being refers to a person's overall physical comfort and encompasses the functionality and performance of musculoskeletal and respiratory systems as well as human circadian rhythms which impacts sleeping patterns (Browning, 2014). According to Park et al. (2009), exposure to nature has to ability to lower blood pressure and heart rate, and also helps relaxation of muscles.

	14 PATTERNS	STRESS REDUCTION	COGNITIVE PERFORMANCE	EMOTION, MOOD & PREFERENCE
NATURE IN THE SPACE	*VISUAL CONNECTION WITH NATURE*	Lowered blood pressure and heart rate	Improved mental engagement/ attentativeness	Positively impacts attitude and overall happiness
	NON-VISUAL CONNECTION WITH NATURE	Reduced systolic blood pressure and stress hormones	Positive impact on cognitive performance	Improves mental health and tranquility
	NON-RHYTHMIC SENSORY STIMULI	Positive impact on heart rate, systolic blood pressure and sympathetic nervous system activity	Quantified behavioural measures of attention and exploration	x
	THERMAL & AIRFLOW VARIABILITY	Positive impact on comfort, well-being and productivity	Positive impact on concentration	Improves perception of temporal and spatial pleasure
	PRESENCE OF WATER	Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure	Improves concentration and memory resotration Enhances perception and psychological responsiveness	Positive emotional responses
	DYNAMIC & DIFFUSE LIGHT	Positive impact on circadian system and visual comfort	x	x
	CONNECTION WITH NATURAL SYSTEMS	x	x	Enhances positive health responses and shifts perception of environment
NATURAL ANALOG	*BIOMORPHIC FORMS & PATTERNS*	x	x	Positive view preferences
	MATERIAL CONNECTION WITH NATURE	x	Decreases diastolic blood pressure Improves creative performance	Improves comfort
	COMPLEXITY & ORDER	Positive impact on perceptual and physiological stress response	x	Positive view preferences
NATURE OF THE SPACE	*PROSPECT*	Reduced stress	Reduces boredom, irritation and fatigue	Improves comfort and perceived safety
	REFUGE	x	Improves concentration, attention and perception of safety	x
	MYSTERY	x	x	Induces strong pleasure response
	RISK/PERIL	x	x	Strong dopamine and pleasure responses

Table 2.3. Psychological influences of nature (Author, 2016) compare with (Browning, 2014).

Visual Stimuli

Sight is our most dominant sense and therefore plays the largest role in the way we perceive a space. There are four patterns in nature that are attributed to visual stimuli; these patterns include [P1] VISUAL CONNECTION WITH NATURE, [P6] DYNAMIC & DIFFUSE LIGHT, [P8] BIOMORPHIC FORMS AND PATTERNS and [P10] COMPLEXITY AND ORDER. Each of these patterns and their influence on the experiential qualities within the built environment will be explored in greater detail.

THE EXPERIENCE

[P1] VISUAL CONNECTION WITH NATURE

A space with a good Visual Connection with Nature feels whole, it grabs one's attention and can be stimulating or calming. It can convey a sense of time, weather and other living things.

[P6] DYNAMIC & DIFFUSE LIGHT

A space with a good Dynamic & Diffuse Light condition conveys expressions of time and movement to evoke feelings of drama and intrigue, buffered with a sense of calm.

[P8] BIOMORPHIC FORMS & PATTERNS

A space with good Biomorphic Forms & Patterns feels interesting and comfortable, possibly captivating, contemplative or even absorptive.

[P10] COMPLEXITY & ORDER

A space with good Complexity & Order feels engaging, and information-rich, as an intriguing balance between boring and overwhelming.

Figure 2.29. Visual Sensory Experience (Browning, 2014; Pixel, 2013).

[P1] VISUAL CONNECTION WITH NATURE

Various studies on the Visual Connection with Nature prove that views of nature has the ability to reduce stress, improve concentration and mental engagement, and have a positive influence on a person's mood (Barton & Pretty, 2010). The intention behind introducing a visual connection with nature in the built environment is to relax the occupants and to reduce cognitive fatigue (Browning, 2014).

[P6] DYNAMIC & DIFFUSE LIGHT

According to Mead (2001, 78) light plays a vital role in the perceived atmosphere and experience of a space. It is a highly complex visual element that contributes to the creation of perceptual clarity, spaciousness, relaxation and tension, public versus private space, spatial complexity and pleasantness within a space.

Daylight is the most natural form of lighting and has shown to have physiological and psychological affects on the human body (Browning, 2014). The dynamic and fluctuating colour of daylight from the yellow morning light, the blue midday light and red afternoon/ evening light influences human circadian rhythms, body temperature and heart rate (Kendal et al, 2013). It has also been proven that daylight positively influences a person's mood and well-being (Nicklas & Bailey, 1996).

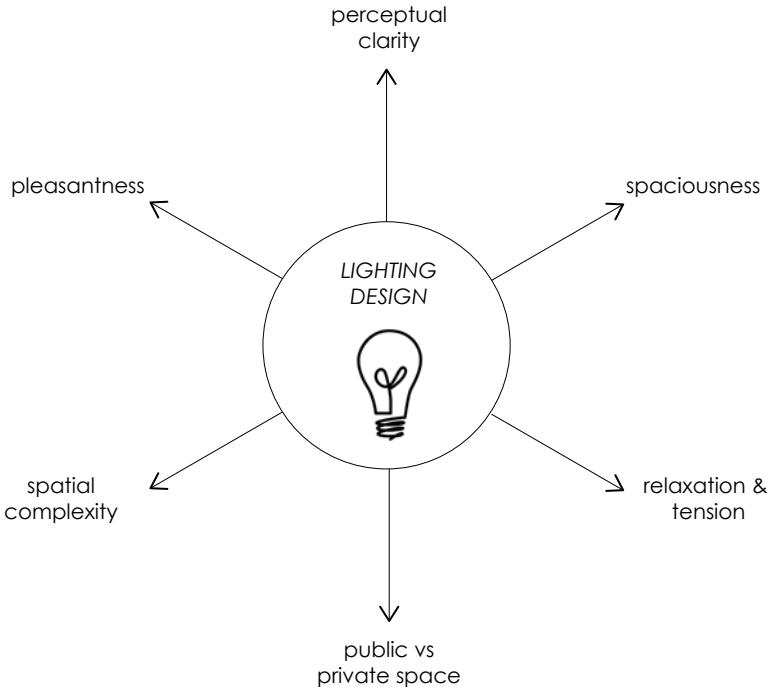


Figure 2.30. Lighting design influences on atmospheric qualities (Author, 2016).

Browning (2014) suggests that introducing dynamic and diffused lighting in the built environment, that mimics the fluctuating patterns of daylight can serve the purpose of capturing the attention of occupants, as well as posing a positive influence on their physiological and psychological well-being. The idea is to introduce layers of diffused, accent and task lighting that creates a visually stimulating and pleasing environment (Clanton, 2014).

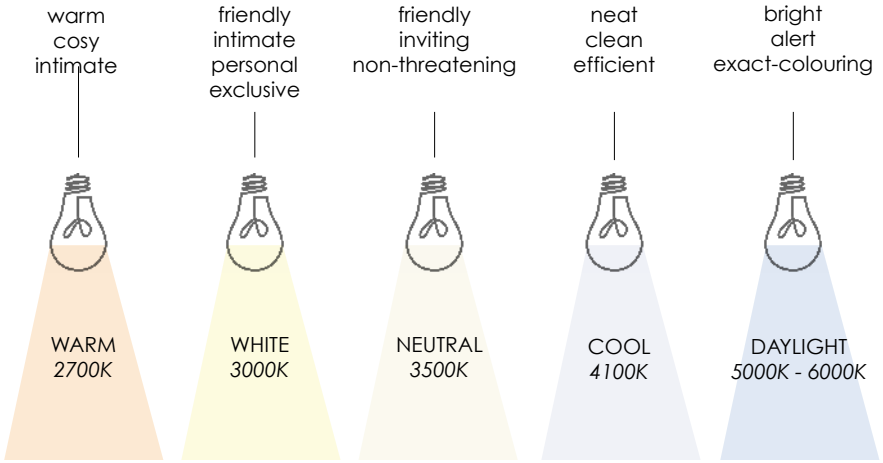


Figure 2.42. Correlated Colour Temperature & Associative Meanings (Author, 2016).

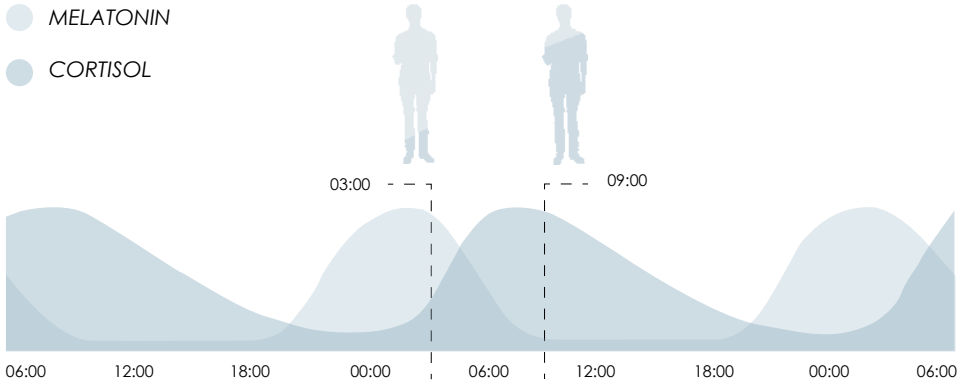


Figure 2.41. Daylight psysiological influences (Author, 2016) compare with (Gombikova, 2014).

[P8] BIOMORPHIC FORMS AND PATTERNS

Form possesses a visual grammar and plays a big role in the way we visually perceive a space. In design, form and shape has the ability to organize information, symbolize different ideas, create movement, texture and depth, convey moods and emotions, emphasize points of interest and leads the eye from one point to another (Bradley, 2010).

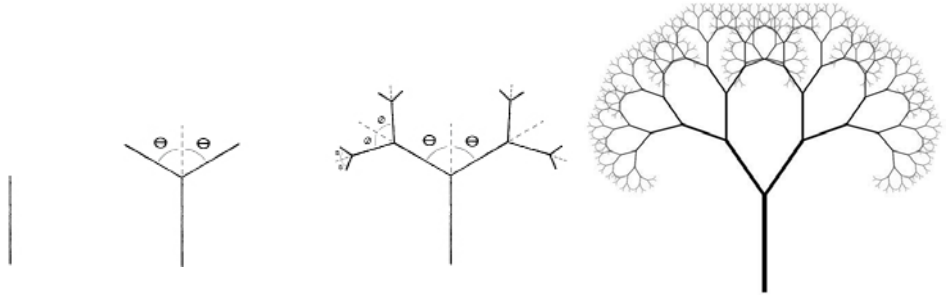


Figure 2.43. Tree Fractal Pattern (Shiffman, 2010)

Fractals is a type of mathematical pattern that is characterized by its self-similarity and is defined in the Oxford English Dictionary as "curves or geometrical figures, each part of which has the same statistical character as the whole" (reference). Fractals are embedded within the patterns of shape found in nature, which creates intricate and beautiful structures that stimulates visual pleasure in human beings.

For this reason, it is clear that shape, and the repetition and variation of shape, has the ability to affect the visual experience of a person and can therefore be used in retail spaces to induce a desired atmosphere.

> *"I wonder whether fractal images are not touching the very structure of our brains. Is there a clue in the infinitely regressing character of such images that illuminates our perception of art? Could it be that a fractal image is of such extraordinary richness, that it is bound to resonate with our neuronal circuits and stimulate the pleasure I infer we all feel?"*
>
> P.W. Atkins (Bourke, 2001)

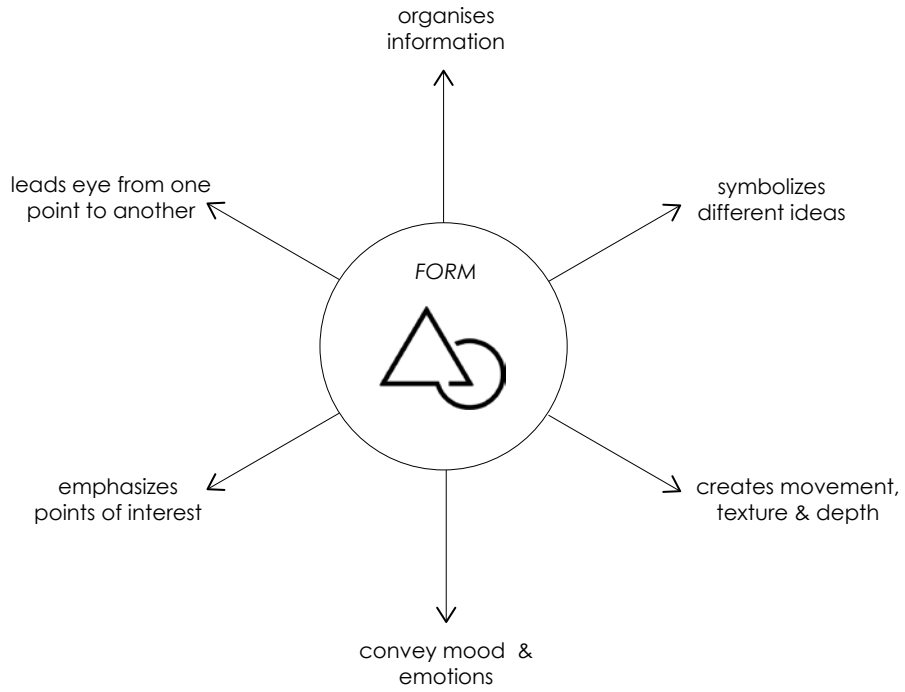


Figure 2.44. Influence of form on atmospheric qualities (Author, 2016).

[P10] COMPLEXITY & ORDER

According to Justema (1978), it is human nature to be drawn to patterns. Patterns are created through repetition of shape, which promotes consistency and familiarity – both of which are important to the human psyche. Repetition of shape creates a welcomed sense of order however, variation in pattern satisfies our need for visual imperfection. Variation relieves the mechanical and monotonous nature of patterns and adds visual interest, which is what makes the pattern pleasing to the viewer (Justema, 1978).

Audio Stimuli

Auditory stimuli and their relative associations prove to have a significant impact on the perceived atmosphere and experience of a space (Hussain, 2014). Soundscaping in a retail setting is the process of controlling noise and accentuating favourable sounds and music to enhance the retail experience.

Music plays a vital role in retail spaces and has the ability to influence shoppers' psychological arousal (Mattila & Wirtz, 2001). Studies have shown that the rhythm and tempo of music can have an affect on the speed at which shoppers move through a space. It has also been proven that the tempo of music has a direct correlation to a person's mood, in which music with a fast tempo will energize and excite whilst music with a slower tempo will calm and relax shoppers.

Kopec (2006: 307) suggests that music can be used to create comfortable and inviting environments that encourage social interaction through reducing the negative effects of silence and by masking unpleasant background noises. It is also proposed that music in retail environments should only be incorporated as background music that adds to the atmosphere on a subconscious level and should not attract attention, but instead encourage shoppers to linger and enjoy their shopping experience.

Furthermore, research has shown that exposure to nature sounds provides positive psychological and physiological affects and can greatly reduce stress, cognitive fatigue and even helps to motivate a person (Alvarsson et al, 2010). The use of nature sounds in an interior space will therefore be most beneficial for creating a relaxing and calming atmosphere.

THE EXPERIENCE

[P2] NON-VISUAL CONNECTION WITH NATURE (AUDITORY)

A space with a good auditory connection with nature provides positive psychological and physiological effects on the user that reduces stress and creates a calming and relaxing atmosphere.

Figure 2.45. Auditory Connection with Nature: Water, wind, birds etc (Kostreva, 2016).

Tactile Stimuli

The patterns in nature that are associated with tactile stimuli consist of *[P2] NON-VISUAL CONNECTION WITH NATURE, [P4] THERMAL & AIRFLOW VARIABILITY* and *[P9] MATERIAL CONNECTION WITH NATURE*. Each of these different tactile stimuli contributes to the atmosphere of a space and can be manipulated to influence the in-store brand experience in a retail space.

[P2] NON-VISUAL CONNECTION WITH NATURE (TACTILE)
Browning (2014) suggests that non-visual connections with nature through touch provides both physiological and psychological benefits that reduces stress, lowers blood pressure and promotes well-being and tranquility. A study showed that this positive response to interaction with plant life was only achieved through touching of real plants and did not show the same positive outcome when subjects were exposed to synthetic plants (Browning, 2014). This suggests that people are very sensitive and tuned in to textures even though it might only be on a subconscious level.

[P4] THERMAL & AIRFLOW VARIABILITY
Various studies have been carried out which investigate the effects of ventilation and temperature on occupants in a space. The research shows that people respond positively to moderate sensory variability of airflow and temperature (Heerwagen, 2006). According to Heerwagen (2006) and Wigö (2005), the natural movement of airflow through a space mimicking the softness of a breeze has a positive impact on the comfort level of occupants and will create a fresh and invigorating atmosphere.

[P9] MATERIAL CONNECTION WITH NATURE
A material connection with nature is manifested through the use of natural and raw materials. Natural materials such as wood, bamboo, cork and stone as well as fabrics such as cotton, linen and wool exude a warm richness that provides a sense of comfort to the human psyche.

Figure 2.46. Tactile Stimuli: Natural textures (Schmidt, 2016)

THE EXPERIENCE

[P2] NON-VISUAL CONNECTION WITH NATURE (TACTILE)
A space with a good Non-Visual Connection with Nature feels fresh and well balanced; the ambient conditions are perceived as complex and variable but at the same time familiar and comfortable, whereby sounds, aromas, and textures are reminiscent of being outdoors in nature.

[P4] THERMAL & AIRFLOW VARIABILITY
A space with good Thermal & Airflow Variability feels refreshing, active, alive, invigorating and comfortable.The space provides a feeling of both flexibility and a sense of control.

[P9] MATERIAL CONNECTION WITH NATURE
A space with a good Material Connection with Nature feels rich, warm and authentic and sometimes stimulating to the touch.

Figure 2.5.8: Non-Visual Connection with Nature: Tactile Experience (Author, 2016)

Olfactory Stimuli

Social learning theory suggests that scents and aromas have strong associations with people, places and ideas and is connected to creating and retrieval of memories (Goldstein, 2002). It is therefore a very powerful tool that can be used in the design of retail spaces to provide non-visual clues about the atmosphere and even branding of the space.

Olfaction is a technique that manipulates the use of scents and smells to attract shoppers into a store (Kopec, 2006). For instance, the smell of freshly baked bread drifting out through the open doors of a bakery will awake appetites and entice people to enter the bakery. Similarly, beauty stores often use the scents of burning candles to release soft floral smells that would attract customers to enter the store and view the products.

The use of natural smells in an indoor setting creates a non-visual connection with nature that has a calming and energizing effect on people. Research has shown that the natural scents of herbs captured in essential oils promotes healing and rejuvenation (Li et al, 2012).

Therefore, the careful use of scents and smells can be manipulated to create a desirable atmosphere and brand experience that will elicit positive feelings and memories in shoppers.

THE EXPERIENCE

[P2] NON-VISUAL CONNECTION WITH NATURE (OLFACTORY)

A space with an olfactory connection with nature creates a calming and energizing atmosphere that promotes healing and rejuvenation.

Figure 2.47. Olfactory Sensory Stimuli: Oil Diffuser (Gardeners, 2016)

Gustatory Stimuli

Gustatory experiences in a retail environment are usually limited to specific sectors that deal with food such as restaurants and supermarkets. However, Leone (2008) suggests that there is value in introducing taste as part of a holistic sensory experience in other retail sectors too – "Food and taste can make a space feel more inviting and welcoming. We recommend creating public waiting rooms that have fresh natural food offerings such as pitchers of water with lemons or cucumber slices and offerings of fresh fruit. It is a way to support health and relaxation" (Leone, 2008).

When consumed, natural and earthy ingredients such as fresh fruit, vegetables and herbs have the innate ability to leave you feeling revitalized and invigorated. Therefore, incorporating a gustatory experience within a retail space can contribute to the perceived atmosphere of the store.

THE EXPERIENCE

[P2] NON-VISUAL CONNECTION WITH NATURE (GUSTATORY)

A space that incorporates a gustatory experience using fresh and natural ingredients has the ability to relax, revitalise and invigorate occupants.

Figure 2.48. Gustatory Sensory Stimuli: Fresh Herbs and Fruit (Cochrane, 2015; Verdina, 2013)