

rethinking design

biomimetics: lighting design

Andy Florkowski

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What/Why:

include an overview of the issues pertinent to your research section (what is regenerative design, bio-mimicry or appo-tech), and why they are important.

Bio-mimicry is essentially taking inspiration from nature to inspire and solve problems we face, especially as designers. Already, nature has found many solutions to problems we have been trying to solve. It is about looking at nature in new ways; fully appreciating, understanding and then emulating Mother Nature's forms, processes and systems to inspire our own makings. After all, nature must have learned what works and what lasts after 3.8 billion years of evolution (Biomimicry Institute, 2009).

Biomimicry could be particularly important to lighting design for many reasons. The present attitude and approach to this type of design is also very narrow minded; lights (commercial in particular) come in very limited shapes, sizes, colour temperatures and wattages. For decades now, lighting design has always had its share of organically inspired lights. From the 1960's 'cocoon' lights (Figure 1) by Pier Giacomo and Achille Castiglioni to the 2005 'Aloe' designs by Jeremy Cole (Figure 2), nature's forms have always been particularly influential within the lighting design realm. This has however, predominantly existed on a form level and mimicking generally for aesthetic purposes.

The realm of biomimicry has now started to become more influential for lighting designers on more levels than just form. The processes and different lighting systems within the natural world are now being interpreted and adapted for lighting problems.

Energy use and awareness with lighting is a major problem across the board. Incandescent, halogen and even fluorescent lights waste a lot of power, do not have long light hours, output a lot of heat and cost a lot to purchase. Because lights turn on with the flick of a button, they are on a lot of the time when they need not be; people do not appreciate the power they consume.

Light quality and intensity is also a major problem within the commercial and industrial sectors. Prolonged exposure to the same light quality and intensity, such as bright fluorescents, is bad for the well-being of workers. It can strain the retina within the eye causing sleepiness, exhaustion, mood swings and even pain.

Who/How:

Reference people/entities/institutes working to develop policies or designs in these areas,

The mimicry of form and function within lighting design has evolved dramatically over recent times. Lights that have been influenced on this level of 'form and function' have not only been inspired by the physical makeup of the natural world but also the chemical.

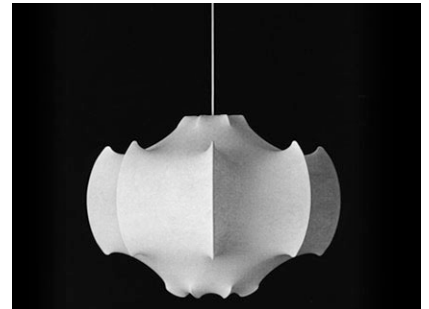


Figure 1



Figure 2

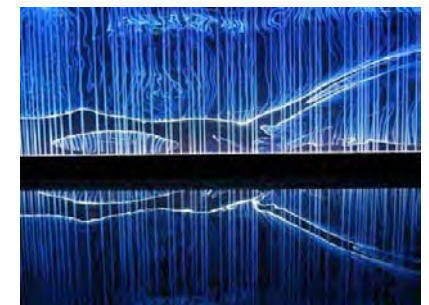


Figure 3



Figure 4

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The ANEMIX (Figure 3 + 4), designed by Ximena Muñoz and Paulina Villalobos, is inspired by bioluminescence, a natural phenomenon that occurs only in the very deep sea, where some species of jellyfish, fish and organisms, produce light to communicate and protect themselves against other animals in an environment where natural light does not exist. This phenomenon is produced by two chemical components: a luciferin (type of pigment) and a luciferase (type of enzyme) that react when they make contact with each other (Anemix, 2009). The 'ANEMIX' took this chemicaluminescent phenomenon as an inspiration to its form and lighting process. It intends to transport the spectator to a deep sea environment, where waves and curves are mixed into organic shapes.

Iguzzini is an Italian architectural lighting company and regarded as one of the best in the world. Their research sector has been exploring the use of biodynamic light (Figure 5) within workspaces over the last decade. Their Photo biological studies have demonstrated the benefits of light and how to effectively manage its effects on our well-being. They are exploring patterns with the intensity of light and the length of exposure as determined by the light-dark cycle (circadian rhythm). By following the circadian rhythms is supposed to guarantee a greater sense of well-being (Iguzzini, 2009). This research of theirs initiated the Sivra Compact project (Figure 6). It is reflective of the gradual change in daylight and colour temperature (Figure 7 – multiple colour tubes). Light also influences important physiological factors such as hormone production, mental alertness and mood. The Sivra compact creates the imitative of the 'passing of time' in artificial environments. By having and using this type of lighting it allows those who live or work in areas with no natural light to regain a natural physiological balance and psycho-physical well-being.

The 'Invisible Streetlight' (Figure 9 + 11) by Jongoh Lee is a project that depicts the process of photosynthesis by using solar energy to create 'streetlight'. Biomimicry is also present on a form and function level; the configuration of light coming from synthetic 'leaves' we are wrapped around the branches of trees on the edge of streetscapes to blend into the surroundings. 'Invisible Streetlight' emits light at night time by saving energy from sunlight during the day, like photosynthesis. The most innovative element of Invisible Streetlight is that it does not require a support because the flexible body in the shape of tree branch is directly installed to the trees lining a street.

Rethinking design:

test out the issues through design, use your design work to critically reflect on current conditions and the potential for design to make radical change. Document your design response/s as a resource for others.

The Protective Pendant – Andy Florkowski

A main influence behind the 'protective pendant' (Figure 12) was the moonflower. The moonflower (Figure 10 – a species) can close and open its petals at different times of the day to protect valuable pollen and the nectar used to attract pollinators. By closing at night, it also prevents nocturnal feeders which do not necessarily

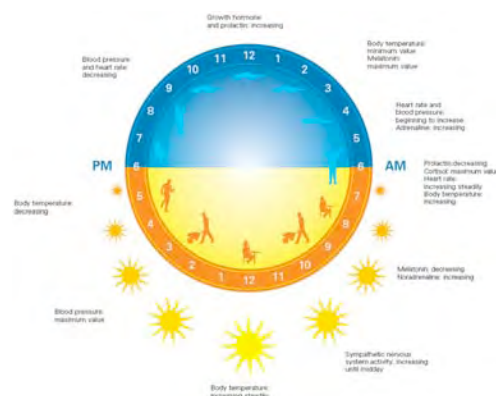


Figure 5



Figure 6



Figure 7

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carry out any cross pollination duties. The plant expends a great deal of energy in the production of pollen and nectar, it is worth protecting it, even at the cost of energy to produce a close & open flower system. The idea of 'protecting' its contents is quite a beautiful design notion and can be applied or related to the protection and importance of energy within lighting.

By having the lighting circuit run through a computer and sensors, we can have the light 'open' and 'close' in tandem with the quality of light around the space it is in. This light design itself is treating energy like a moonflower treasures its pollen. The light shade opens and closes through small mechanisms at the base of the fitting; these are also run off the lighting computer circuit.

The shade itself was derived from the moonflower form. The leaves in this case act as 'reflectors' for the light - like the base of a traditional downlight. The shape of the light helps to disperse lightflow around a space. The light uses 1 watt Light-emitting-diodes (LED). These are arranged in the formation like sunflower seeds arrange themselves on the head of a sunflower. "Patterning seeds in spirals of Fibonacci numbers allows for the maximum number of seeds on a seed head, packed uniformly, with no crowding at the center and no 'bald patches' at the edges (Ask Nature, 2009). Or in other words, the sunflower has found optimal space utilization for its seed head; this allows us to create a decent amount of light from the small fitting space within the design. This is particularly important because LED's do not produce a large amount of light but they are by far the most economical of all lighting available.

Because the light is linked into a computer circuit we also have the ability to control light intensity and even colour depending on the LED's used. However, LED's have recently been developed for colour temperatures 2000 through to 8000; roughly the spectrum that is experienced in natural daylight over the course of a day. This means we can also mimick the circadian rhythms, or colour temperatures, like the Sivra by Iguzzini does.

The Nocturnal flower light – Andy Florkowski

This solar powered street light (Figure 13) emulates the process of photosynthesis by using solar energy to generate light for nighttime use on streetscapes. The head of the light faces towards the sky (and sun) during the day, capturing the solar energy and storing this within itself. Light sensors on the panels detect when the sun has gone and the head mechanically swivels to face the ground; this is similar to that of a sunflower following the path of the sun over the course of the day – the changing light is reflected in its positioning.

The form of the light is taken from that of a moonflower, just like the 'protective pendant'. The solar panles on the light not only act in capturing the suns rays, but also act as light directors and reflectors when the light head rotates to face the ground. The shape of the leaves also helps to disperse and reflect this light across the streetscape. Because the edges are irregular and layered the light does not have a sharp shadow across the ground.

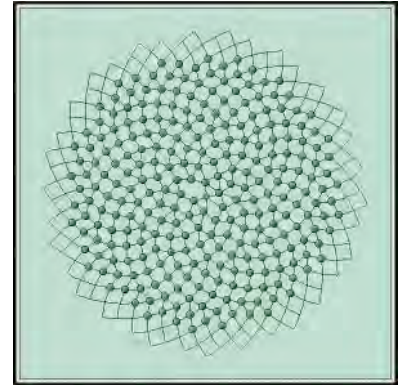


Figure 8



Figure 9



Figure 10

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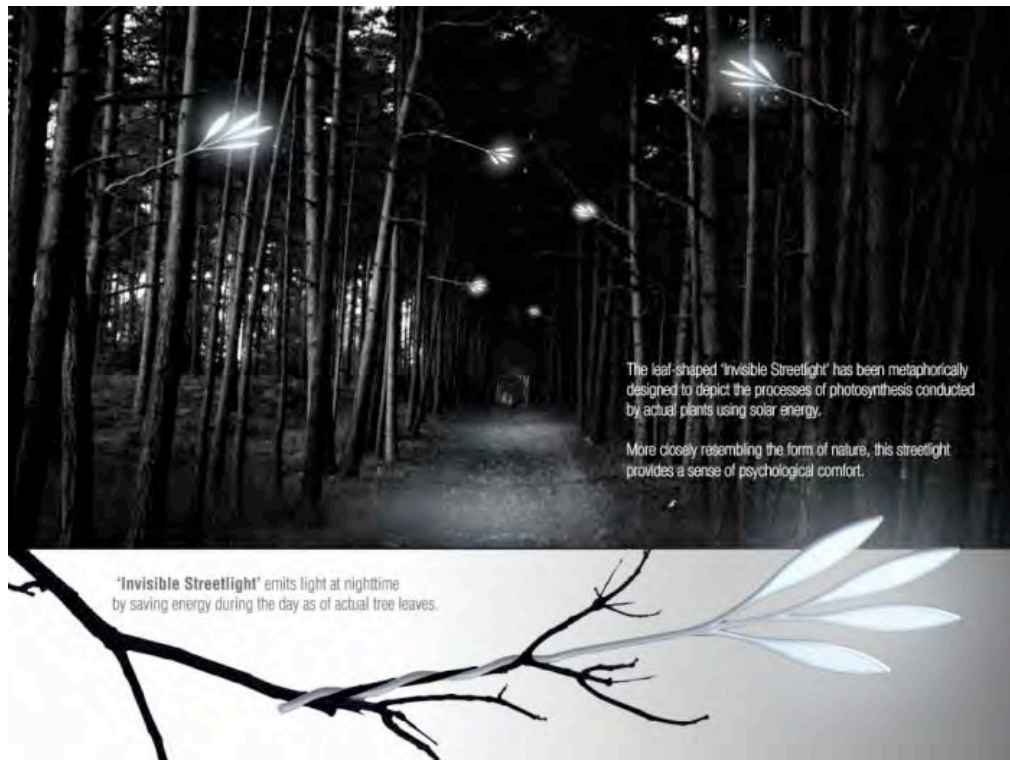


Figure 11

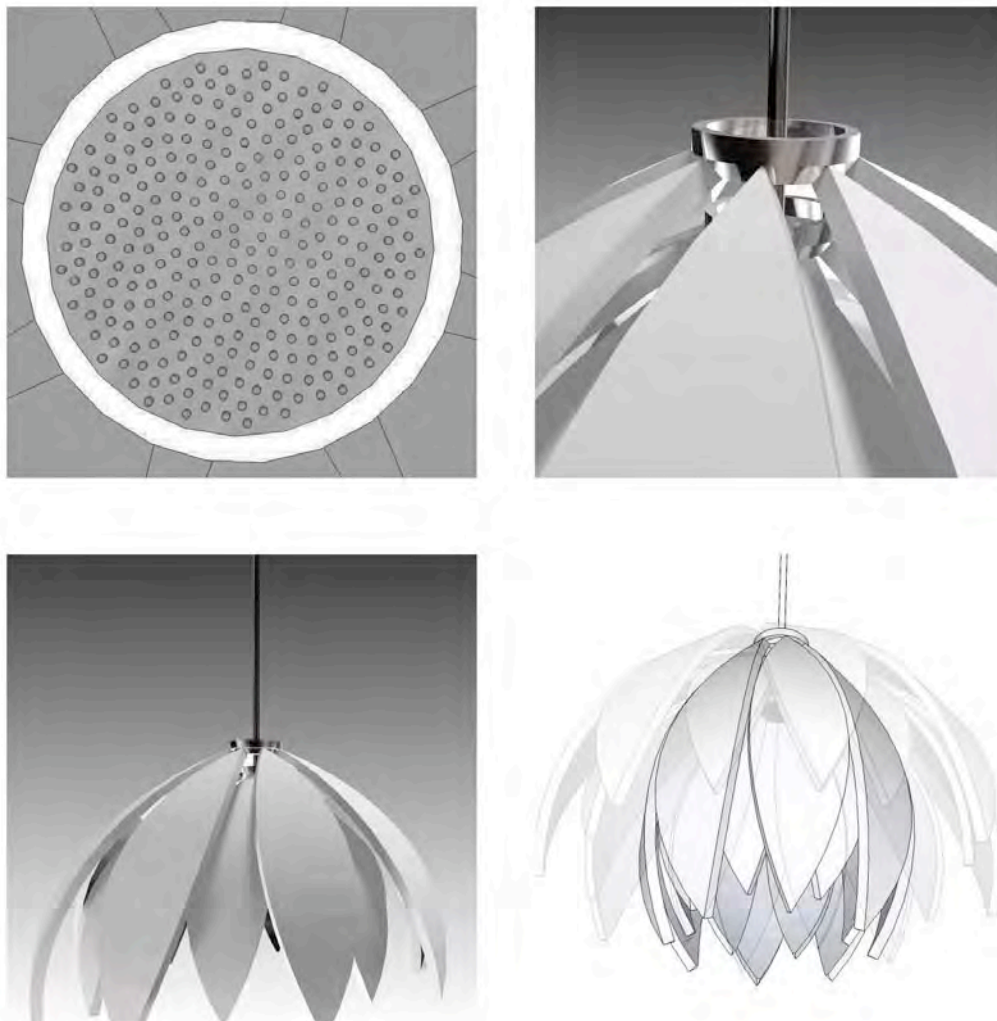


Figure 12

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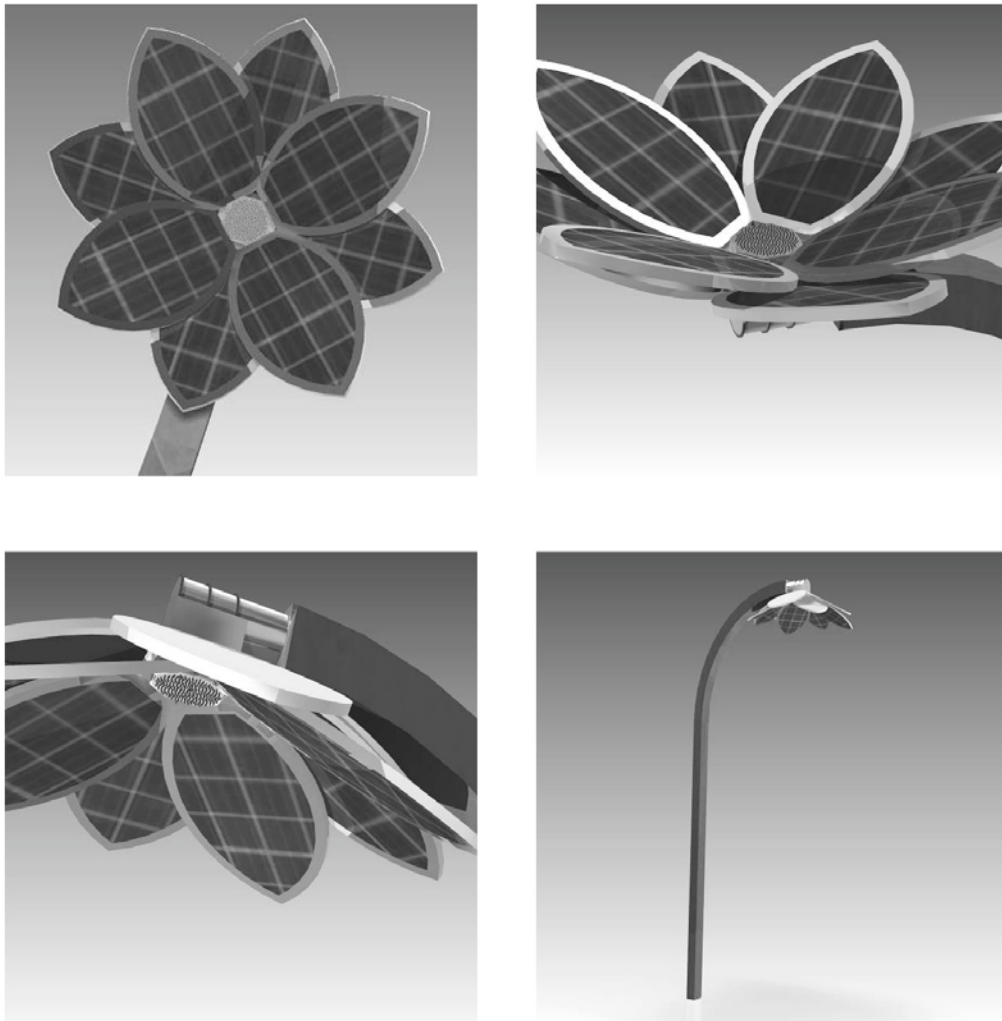


Figure 13

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Biomimicry : Spatial Design

Jenna Lawson

"Nature is my manifestation of God. I go to nature every day for inspiration in the day's work. I follow in building the principles which nature has used in its domain" – Frank Lloyd Wright

"The world will not evolve past its current state of crisis by using the same thinking that created the situation," – Albert Einstein

"What might the human-built world look like if a cherry tree had produced it?" – Cradle to Cradle, William McDonough & Michael Braungart

WHAT IS BIOMIMICRY?

The word "Biomimicry" is derived from the Latin words "Bios", which means "life", and "mimesis" meaning "to imitate".

Biomimicry, also known as Biomimetics, is the study of nature and its processes and systems for the development of technology and engineering in order to contribute to a sustainable future.

It is separated into three main areas of study:

- mimicking natural methods of the manufacture of chemical compounds – An example of this would be the development of organic glues like the ones mussels use to attach themselves to rocks.
- imitating mechanisms found in nature eg Velcro
- studying organizational principles from social behavior of organisms. Flight patterns have been studied and scientists have found that the V pattern birds use is more aerodynamic and uses less energy.

WHO IS INFLUENTIAL IN THIS FIELD?

One of the most influential people involved in the study of Biomimetics and its role in design and engineering is Janine Benyus. She is a fore-runner in helping people realize the important role of Biomimicry in Sustainable Design. She says that "The more our world functions like the natural world, the more likely we are to endure on this home that is ours, but not ours alone" (SustainabilityDictionary). Benyus explains that there are 9 aspects of Nature that re-iterate its sustainable systems and processes. They are:

1. Nature runs on sunlight
2. Nature uses only the energy it needs
3. Nature fits form to function
4. Nature recycles everything
5. Nature rewards co-operation
6. Nature banks on diversity
7. Nature demands local expertise
8. Nature curbs excesses from within
9. Nature taps the power of limits

William McDonough & Michael Braungart are also influential with their book Cradle to Cradle. Although not specifically focusing on Biomimicry, they touch the subject nicely by noting that "We can be humbled by the complexity and intelligence of nature's activity, and we can also be inspired by it to design some positive side effects to our own enterprises instead of focusing exclusively on a single end." (McDonough, 2002). If we take note of the title of the book they have written, 'Cradle to Cradle', they are referring to the way we design as humans, for a one way, use-and-throw-away system, more like Cradle to Grave. Whereas, nature is focused on the life cycle of things. They provide food for themselves and other species and the waste they create is useful in some way, to other organisms, and it is these systems that as designers, architects, engineers and humans, that we need to start taking on as our own.

WHAT IS BEING DONE TO ADDRESS THESE ISSUES?

In this report I am choosing to focus on one aspect of Biomimicry which has been used relatively extensively in design and engineering in the last few years, to aid to a sustainable future.

It is the structure of the Honeycomb in a Beehive. If we look at it closely we can see that it consists of a densely packed matrix of hexagons. This is not only visually pleasing, it is also structurally strong, making it a useful tool in design. The hexagon tiles the plane with minimal surface area. Thus the hexagonal structure uses the least material to create a lattice of cells within a given volume. Another interesting aspects of the honeycomb is its ease of temperature regulation.



There are 3 main areas of Spatial Design that I have researched the use of honeycomb in. They are:

- Architecture
- Interior Design
- The manufacture of products for the Spatial environment

ARCHITECTURE

The development of the Sinosteel International Plaza in Tianjin, China which was designed by MAD Architects.

The hexagonal grid on the exterior facade is the building's main structural support system, meaning that there is more flexibility for the types of use the interior spaces can accommodate.

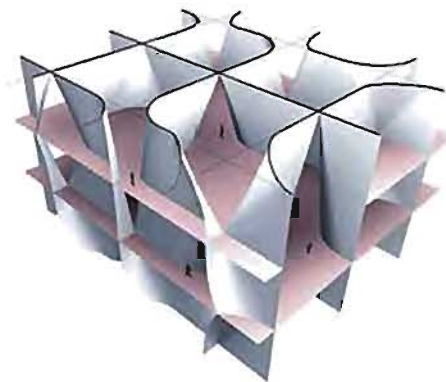
The initial mapping of airflow and the direction of light across the site, has led to the positioning of different sized hexagonal windows to accommodate the needs of different areas. This results in minimal heat loss in winter and minimal heat gain in summer.



Berkeley Art Museum and Pacific Film Archive by Toyo Ito is a good example of how the honeycomb structure has been used to differentiate space. The “interstitial spaces seem to swell open and close up to regulate the movement of people through the building; the self-contained, honeycomblike spaces, by contrast, produce a sense of suspension rather than enclosure” (New York Times, 2009). Ito states that “We want the feeling that nature has - merging and melting”.



from Jeanne Collins PR firm / Digital rendering by Kurami



from Jeanne Collins PR firm / courtesy Toyo Ito & Associates

<http://www.nytimes.com/2008/11/25/arts/design/25ito.html>

Melbourne recital hall by Ashton Raggatt McDougall (ARM). The Honeycomb façade is constructed of steel, concrete and glass and is used as a visual element and structural element of the building.



The Beijing Water Cube for the 2008 Beijing Olympics houses the Olympic Games Swimming pools. The exterior is constructed of 22,000 steel beams constructing a honeycomb frame which support pillows of high-tech plastic inflated onto shimmering translucent bubbles. This skin is based on soap bubbles. At night, the light radiates from the inside out creating a glowing water aesthetic to the surrounding areas.



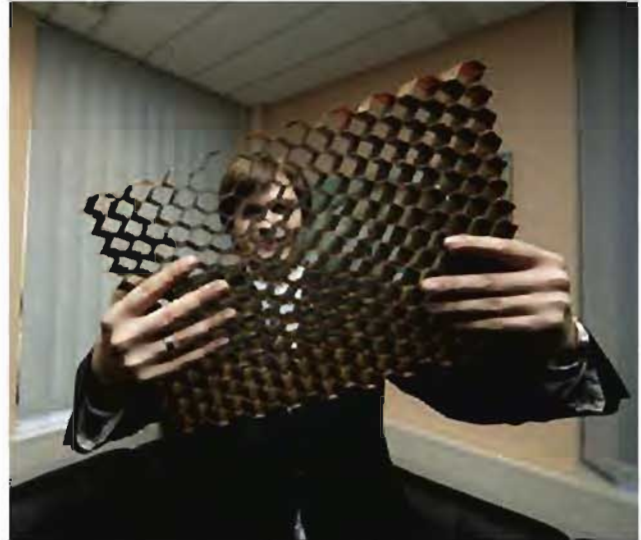
INTERIOR DESIGN

The use of the honeycomb to create an interior space that is both functional and aesthetically pleasing has been shown in the restaurant Honeycomb in Shenzhen, China by Keiichiro Sako of SAKO Architects. The interior walls of the space are made of large pieces of acrylic moulded into the honeycomb-like shapes. These walls help create the private areas of dining without closing them completely off to the other parts of the restaurant.



PRODUCTS

The development of SwissCell walls is a good example of how the structure of the honeycomb has been used in the production of industrial products. Based on the hexagonal structures of honeycomb, the board is made from "a cellulose product, impregnated by synthetic resin" (Anarchitecture, 2009). These boards are lightweight but strong and the materials used make it an excellent insulator.

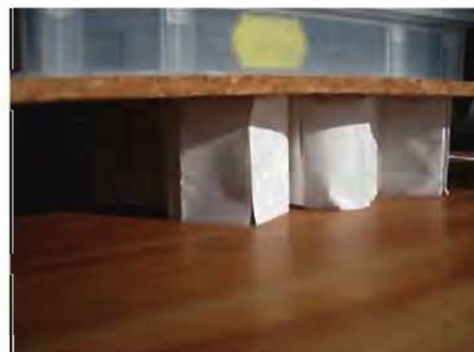
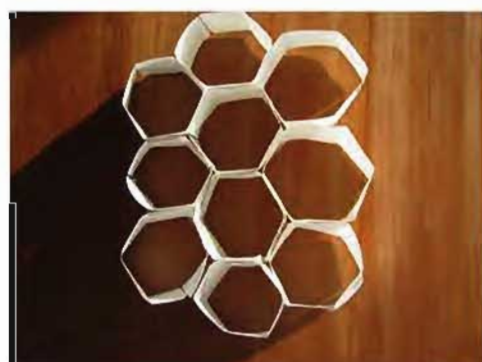
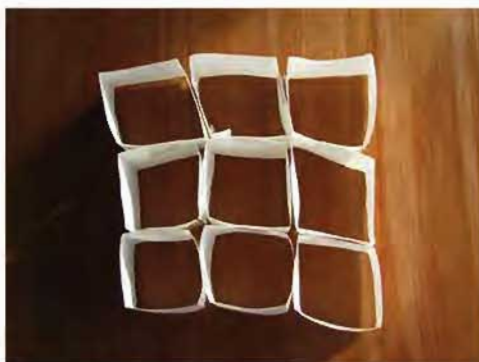


<http://www.an-architecture.com/2009/01/honeycomb-paper->

Architects Stephanie Forsythe and Todd MacAllen of Canadian firm Molo, have developed paper furniture which is expandable and compressible due to its honeycomb structure. These durable inventions can be fanned out to create stools and benches and once finished with, can be flattened again and stored flat.

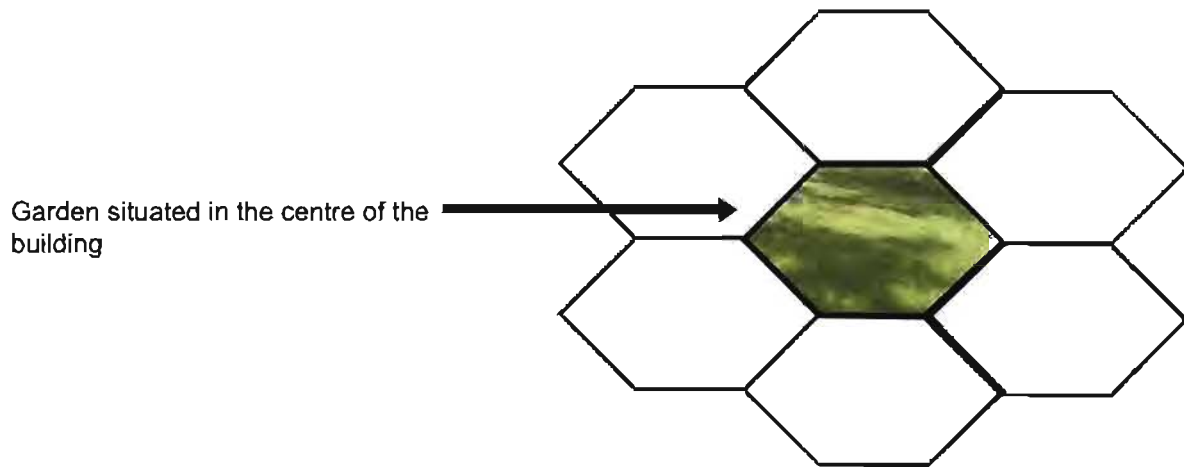
RETHINKING DESIGN...

This initial experiment was to test the strength capabilities of the hexagonal structure in comparison to the square structure. The structures are made of thick paper with each "cell" of roughly the same size, clustered together. The placement of weight onto each structure showed that the hexagonal construction was able to hold a larger amount of weight for longer. This experiment is subjective research, as each of the variables were not controlled.



If we think of Architectural design in the last thousand years or so we begin to see that it is mostly made up of a structure of squares. If we look to nature, almost never can we see a square, everything is organically rounded to fit together. We can understand that the development of the square or rectangle as the main architectural layout is feasible as it fits the capabilities of our logic, it has been easier to create machinery to create these layouts. Yet nature is screaming for us to design organic forms that fit ergonomically with our bodies. To design a house consisting of several spherical rooms is simply not sustainable for us, as we would have to accommodate all our furnishings to fit the walls. So the hexagonal shape is a nice intermediary for the human psyche. In his book *The Enigma of Numbers*, Lance Storm explains that the number six is "identified with the qualities of harmony and balance, mostly due to its associations with complete, and therefore, functional (efficient) systems, or models, or discourses in mythology, science and proto-science, and even nature and technology". It has also been observed that the human consciousness has a limited capacity system which only allows a maximum of six items in attention at one time. Again, the hexagon is sufficient in this theory.

In this design I have arranged a building with an internal garden, so that all rooms in the building receive light on more than one side. There is no room in the building that will not receive light at some point of the day, which is important in regulating light, temperature and airflow into the space. Also, each hexagon is ultimately 'a room with a view', keeping the occupants in touch with the natural world.



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www.sustainabilitydictionary.com

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Bio-mimicry: Water collection or treatment systems of water using systems research

Sarah Brown-Toganivalu

What/Why:

Bio-mimicry or Bio-mimetics is working with solving human problems in a sustainable way, using the relatively new science of modelling techniques, elements and actions from the studies of nature. The elements of nature that are addressed are then imitated and enforced in a process to resolve the present world issues.

The study of bio-mimicry is a learning tool from the natural world. By observing the ways in which nature behaves and understanding the systems of creation, dispersion, resilience or even transformation, scientists can then influence and reshape current systems in the world, in the process of developing a more sustainable environment.

It is a somewhat asking application for the designs, strategies and relationships in nature, to find integrated solutions to all the problems of sustainability.

Adapting to this new technology is proving to be very useful. Some examples of the current use of bio-mimicry include producing fabrics with structural colour, inspired from some butterfly wings and peacocks feathers. This would eliminate the use for strong chemical dyes. Also a lotus leaf and how it has a self-cleaning element, this is then used to influence the manufacturing of paints and other coverings that are self-cleaning.

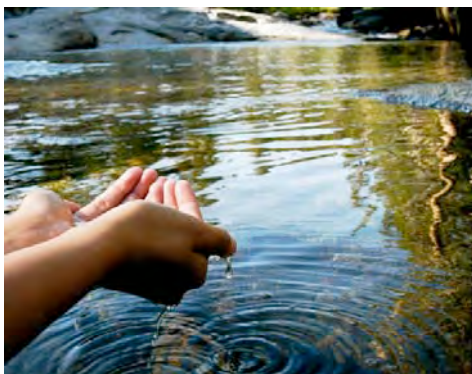
Looking to nature for the simple answers to key world issues is centre to Bio-mimicry.

Water collection or treatment systems of water using systems research.

This category focuses on the substance of water, which is essential to the survival of all known forms of life. The issues of facing water-based vulnerability are becoming more crucial for the world population, as it is estimated that by 2025 more than half of the world's occupants will be exposed to the crises of availability of safe drinking water.

One in eight people in the world don't have access to safe drinking water and many women and children have to spend hours walking kilometres each day to receive water. Once the water is collected, the chances of it actually being safe to drink are very slim, as most of the collection areas are unprotected and polluted.

Diseases can be caused by unsafe drinking water even causing death. So there is defiantly a need for water collection and treatment systems to ensure safe and available drinking water. But for this issue to be resolved, bio-mimicry looks to nature for its answers and explores way of enforcing the natural qualities regarding water in the solution.



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Beetle based water harvesting is a water harvesting system that was inspired from the Namibian desert beetle.

The Namibian desert beetle comes from a location that only receives a small amount of approximately 40 mm of rain a year. In-fact, it lives in one of the driest places in the world. Yet the amazing ability of this beetle is that it is able to harvest drinking water from early morning fogs.

The reason the beetle is able to harvest water is because when the slightest fog blows against its back, water droplets start to cumulate, it is the special bumps on its back that cause this phenomena. Because waxy water-repelling channels surround the bumps, it is able to roll the water droplets down into a channel and then into its mouth.

Researchers have now designed a surface from studying the beetle that mimics the water attracting bumps and water valleys upon the beetles back. They have created synthetic films that can be printed onto polymer sheets and then attached to buildings to harvest water vapour.

This technology has caused trials to be carried out which use the beetle film to capture water vapour from cooling towers. The initial tests have shown that the invention can return 10 per cent of lost water, which usually evaporated and turns into heat. This in turn leads to cuts in energy bills for nearby buildings, it also reduces the cities heat sink effect. Which is an environment that is capable of absorbing heat.



Who/How:

Las Palmas Water Theatre, Or, Teatro del Agua. Is an example of bio-mimicry having a direct influence in inspired architectural submissions. Designed by architect Nick Grimshaw. This was part of a competition for the regeneration of the port of Les Palmas in the Canary Islands. This design was inspired by the properties of water collection from the fog collecting Namibian desert beetle.

The scheme was to benefit from the atmospheres surrounding wind and sun properties, to create large amounts of water for the town of Las Palmas.

The surroundings in Las Palmas provide the ideal conditions for such technology. Having a steady wind direction all year round, and abundant sunshine will assist the project, in the sense that the basic solar thermal panels could be used to heat the sea water going into the evaporators, this could ensure that moisture can be picked up by the wind going through.

The destination is also ideal because the Canary Islands are volcanic, so there are very steep sides below the sea; this cuts costs of constructing pipe systems in the deep-sea water. Among all the other ideal conditions, this proposal has the potential to create a very productive desalination (the removal of salt water) plant, because one thousand metres below the sea the temperature is only 8 degrees centigrade, so the



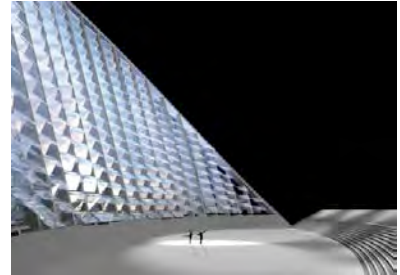
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cold water could be used as a condenser.

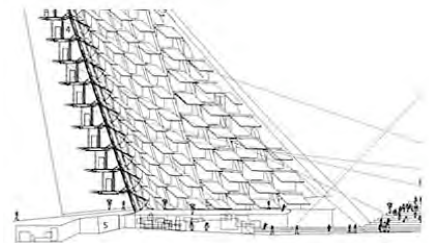
According to Grimshaw, "The essence of the idea is to couple a series of evaporators and condensers such that airborne moisture from the evaporators is then collected from the condensers, which are cooled by deep seawater. This produces large quantities of distilled water" (Grimshaw)

The design will house a public venue for the performing arts, as well as incorporating remarkable desalination methods.

_Performing arts centre



_Evaporators and condensers



Fog Quest, is a non-profit and international organization developed to highlight the environmentally appropriate and beneficial uses of fog and rain.

Dr. Robert Schemenauer is the exclusive director in the project. Along with Sherry Bennett, Schemenauer went out to find water collection solutions for places where conventional sources of water collection are not available, such as pipelines, rivers and wells.

The system works by a process of condensation of the atmospheres water vapour, which is air condensing on cold surfaces into drops of liquid. This process is what happens to plant leaves and blades of grass.

With assistance of 200sqm of netting which was constructed in 2005, the residents of Serra Malagueta are collecting fog to supply their water requirements.

The fog collection screens capture the fog, and then transform it to water, the water then drips into a trough and flows through pipes. Once the water is collected it is then filtered and put into tanks to supply schools and communities.

The potential for fog collection technologies to provide sustainable solutions to water are extremely productive. With many areas able to produce billions of litres of affordable clean water per year, fog capturing is ideal for bio-mimetic solutions to water collection.



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Rethinking design:

Water collection designs using bio-mimetic technology

Australia in recent years has been prone to drought problems and often had to comply with water bans and limitations on water usage. The communities demand on water supply has increased which means the supply of water itself has decreased.

With water bans and limitations, this means people are not able to supply their own gardens with sufficient water in times of drought.

Design proposal: The design is for portable attachable/removable water collection sheets. The water attracting qualities of the Namibian desert beetle, and processes of water collection from fog quest inspired this design.

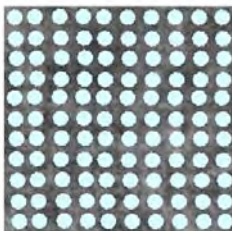
The sheets are to be fastened up in rooms that generate condensation, such as a bathroom. And to be utilised in countries which suffer from droughts. Such as Australia, as it is common for limitations on water usage, Australia provides a good example, because people still use hot water for showers, even in the humid weather, which in turn provides the steam central to this design.

The design proposal is for the water collection sheets to absorb the access moisture from the bathroom when in use by a person using a shower, which generates steam. Once the water is collected it is channelled down a tube into a container.

The idea is for the access water to then be reused to water the residence outdoor garden or domestic plants.

The ability to provide the domestic vegetable gardens with essential water helps with the maintaining of a sustainable household.

_Water collecting screen
which is attachable to
any surface



_ Attachable-absorbing sheet, size: 500mm by 500mm

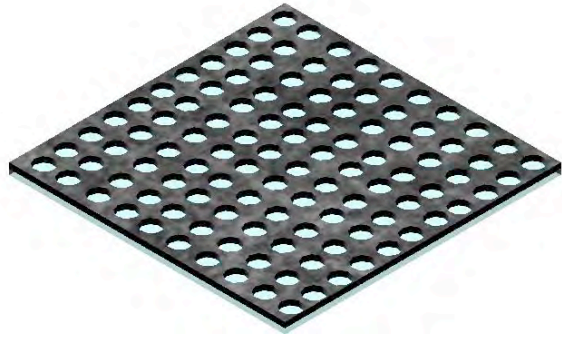
_Water attracting bumps



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_Attachable brackets
which can also be removed



By using this design in a household, there is more potential for maintaining a sustainable environment.

The water-collecting screen is best utilized when consecutive showers are taken.

So if a household holds more than one occupant, the best way to get the most out of this screen is by having their showers one after the other, so that strong flow of moisture and condensation to get absorbed into the collection screen.

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rethinking design

biomimetic design: materials design exterior

Gemma Loving-Hutchins

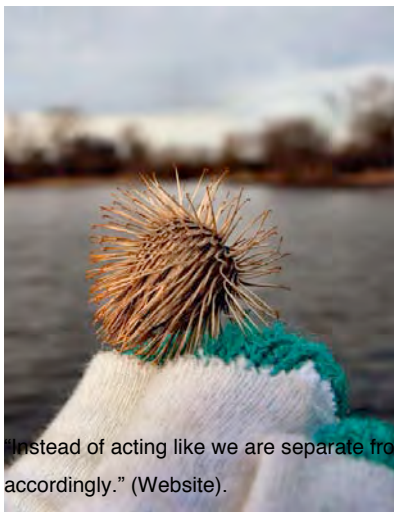
What

Biomimetic design

Biomimicry takes inspiration from nature and apply's the knowledge to the fields of engineering, science and technology to produce and enhance new materials, processes and devices.

The solutions that animals and nature have come up with have been tried and tested for millions of years (certainly longer than humans have been designing), so why reinvent the wheel? Why not learn from nature to make our designs more efficient, elegant, and sustainable?

Remember Velcro? George de Mestral, a swiss engineer, created Velcro after going on a hike with his dog in the Alps and coming home covered in burs. He fashioned Velcro after how the burs had hooks on them and could catch on anything with a loop. You may have also used an idea from nature to help you solve a design problem. Many designers and architects are now using these design principle in order to create elegant solutions to every day pressing problems - like how can we more easily filter salt from water, or how animals naturally medicate themselves against disease. Biological materials are more advanced than man-made materials. They represent elegant and highly refined structure compositions, which can aim to mimic or enhance or design strategies. (inhabitat.com)

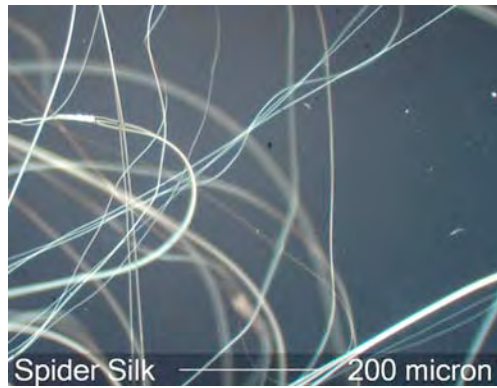


"Instead of acting like we are separate from nature, we need to accept that we are part of it and we should be behaving accordingly." (Website).

Material: Spider Silk

Silks are fibrous protein polymers spun into fibres by arthropods such as silkworms, spiders, scorpions, mites and fleas. Used in nature for protective shelters, structural support, reproduction and capturing their food. Silk of engineering interestingly spun by orb weaving spiders, as it is mechanically superior to any other known insect's silk, the fibres are -5um diameter compared to human hair, which is -6um. Spider silk is currently being analysed to

develop a technology that replicates the benefits of this material, why silk is so superior to other materials (other than its scale) is its high strength, high ductility, high toughness, low density, it is thermally stable at low and high temperatures (suitable for bioengineering, it is recyclable and finally insoluble in water and most solvents.



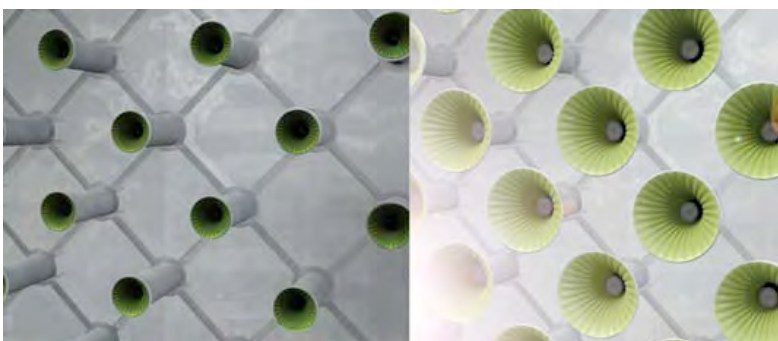
(www.mircolabnz.com)

Who:

Habitat 20:20: Future Smart 'Living' Architecture

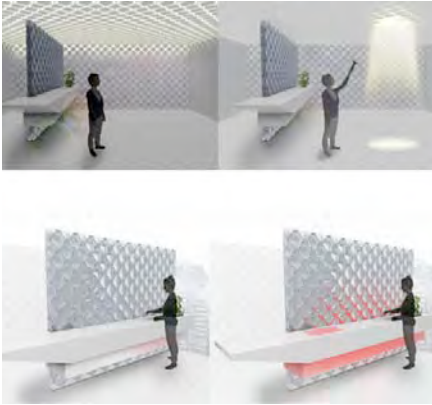


One of the most effective ways to cut down the ecological footprint of buildings is to follow the lead of nature through Biomimicry. Habitat 2020 is a future forward example of Biomimetic architecture that fuses high-tech ideas with basic cellular functions to create 'living' structures that operate like natural organisms. This nature-inspired approach to city living looks at the urban landscape as a dynamic and ever-evolving ecosystem. Within this cityscape, buildings open, close, breath and adapt according to their environment.



The Habitat 2020 building is envisioned for China, and radically alters our perception of a structure's surface. The exterior has been designed as a living skin, rather than a system of inert materials used only for construction and protection. The skin behaves like a membrane, which serves as a connection between the exterior and interior of the habitat. Alternatively, the skin may be considered as the leaf surface having several stomata, cellular openings involved in gaseous exchange and transpiration in plants.

Phillips Design Probes



The surface would allow the entry of light, air and water into the housing. It would automatically position itself according to the sunlight and let in light; thus electricity for lighting would not be needed during the day. The air and wind would be channelled into the building and filtered to provide clean air and natural air-conditioning. The active skin would be capable of rainwater harvesting where water would be purified, filtered, used and recycled. The skin could even absorb moisture from the air. The waste produced would be converted into biogas energy that could be put to diverse uses in the habitat.



(<http://www.inhabitat.com/2008/07/09/habitat-2020-off-the-grid>, July 9, 2008)

An elegant intervention: successful exterior material

Design team: peter Richardson

Firm : zmarchitecture

Project Name : lillies

Description:



In cities all over the world there are disused waterways, canals and rivers. Often they become the focus for regeneration and for most people offer an improved quality of life and environment. Our project proposes to stimulate river activity and change by proposing that the surface is used to harness the power of solar energy on a large scale. The energy created can be easily transformed and exported to the grid and will reduce the carbon footprint of the city. The idea references large lily pads that are optimised for efficient photosynthesis, so the design is inspired by nature. They can be moved and dismantled and are simply tethered to the riverbed, integrated motors can rotate the discs so their orientation to the sun is maximised throughout the day.



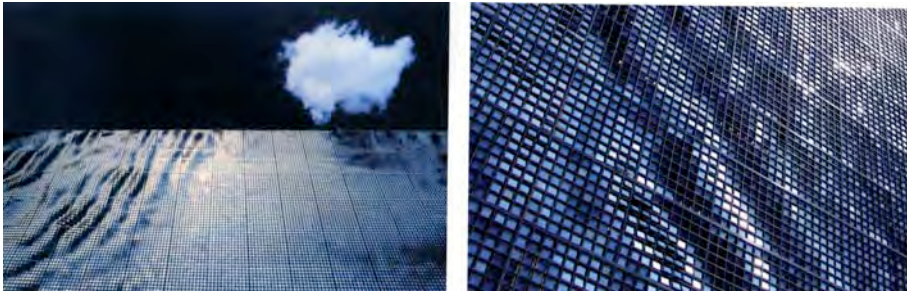
[Http://www.inhabitat.com/2008/05/12/solar-lily-pads-planned-for-glasgows-clyde-river/](http://www.inhabitat.com/2008/05/12/solar-lily-pads-planned-for-glasgows-clyde-river/)

<http://idesignawards.com/winner>

Dynamic Thermal Wind Wall- Ned Kahn

Wind Veil, Mesa Arts Center, Technorama Façade, Winterthur, Switzerland

The Façade becomes a hybrid of sky, light and wind, dissolving the building into the landscape and converting a solid building skin into an amorphous and liquid like substance. Both screens were also designed to reduce solar gain in the lobby of the building. The screens are placed 3Ft (0.9m) from the glass curtain wall to allow natural air currents to cool the building. As the shingles warm in the sun, they create convective air currents which draw cooling air up against the glass. (see image).



As the vertical landscape, these screens explore realm relatively uncontested compared to the ground but increasingly valued in dense urban conditions. (Living systems).

Envirogrid – Stratify/Fluid

Three dimensional cellular soil confinement- Envirogrid is a flexible and expandable cellular soil confinement structure that combines compaction resistance with drainage to provide slope and stream bank erosion control, as well as ground and retaining wall stabilization. (Living systems).



By testing these issues through a 'low tech' design process – it reflects upon the standard conditions in which retaining walls are developed, I created these experiment to reflect upon and try to begin to understand exterior construction and how they might be enhance or altered slightly, by using environmental product that are biodegradable.



How

Exterior Material

Photosynthesis in plants converts solar energy to chemical energy by splitting water to release hydrogen.



"The light reactions are the steps of photosynthesis that convert solar energy to chemical energy. Water is split, providing a source of electrons and protons (hydrogen ions, H) and giving off O₂ as a by-product. Light absorbed by chlorophyll drives a transfer of the electrons and hydrogen ions from water to an acceptor called NADP⁺ (nicotinamide adenine dinucleotide phosphate), where they are temporarily stored. The electron acceptor NADP⁺ is first cousin to NAD⁺, which functions as an electron carrier in cellular respiration; the two molecules differ only by the presence of an extra phosphate group in the NADP⁺ molecule. The light reactions use solar power to reduce NADP⁺ to NADPH by adding a pair of electrons along with an H⁺. The light reactions also generate ATP, using chemiosmosis to power the addition of a phosphate group to ADP, a process called photophosphorylation. Thus, light energy is initially converted to chemical energy in the form of two compounds: NADPH, a source of electrons as 'reducing power' that can be passed along to an electron acceptor, reducing it, and ATP, the versatile energy currency of cells. Notice that the light reactions produce no sugar; that happens in the second stage of photosynthesis, the Calvin cycle." (Campbell 2008:188-189) (www.asknature.com).

Rethinking design – the relationship of photosynthesis and design

"The equation for photosynthesis is a deceptively simple summary of a very complex process. Actually, photosynthesis is not a single process, but two processes, each with multiple steps. These two stages of photosynthesis are known as the **light reactions** (the *photo* part of photosynthesis) and the **Calvin cycle** (the *synthesis* part).

<http://www.asknature.org/strategy>

Delicate intervention proposal

By taking inspiration from plant and mimicking the nature processes that occur around photosynthesis we are able to develop an elegant system that echo's these ideas from nature. Defined as plant- inspired solar cells, taking a closer look at the micro cells that each plant operate- they naturally use photosynthetic dyes and processes to generate energy. We can develop a strategy that mimics theses dyes artificially that when a building is constructed it can be integrated with a building skin. The conventional solar panels (silicon-based) are often designed around a bulky infrastructure to support the rigid panels; this requires a large amount of energy and toxic solvents. "Alternatively, dye-sensitive solar cells use a variety of photo-sensitive dyes and common, flexible materials that can be incorporated into architectural elements such as window panes, building paints, or textiles." (Ask nature).

However the silicon-based cells often have a higher solar energy conversion- these dye-sensitive solar cells argue to have a higher over power collection potential due to low-cost operability under a wider range of light and temperature conditions, also there application is very flexible it can be added to any light receiving surface.

Design response/gesture (see image):

Design proposal – Using photosynthesis as an exterior material to generate energy, (Artificial photosynthesis- dye sensitive solar cells), a delicate intervention that can operate in any conditions to store and generate the sun's energy, elegantly transparent in their form they offer a light enhancing system for any household or even work space.

Plant inspired system - blood red



Artificial photosynthesis

Appendices

Biomimetic –

The study and development of synthetic systems that mimic the formation, function, or structure of biologically produced substances and materials and biological mechanisms and processes.

Chlorophyll -

The green coloring matter of leaves and plants, essential to the production of carbohydrates by photosynthesis

Infrastructure -

The basic, underlying framework or features of a system or organization

Stomata –

Also, stomate. Botany. any of various small apertures, esp. one of the minute orifices or slits in the epidermis of leaves, stems, etc., through which gases are exchanged.

Photosynthesis-

(esp. in plants) the synthesis of complex organic materials, esp. carbohydrates, from carbon dioxide, water, and inorganic salts, using sunlight as the source of energy and with the aid of chlorophyll and associated pigments.

Photophosphorylation -

That utilizes light as a source of energy, as in the formation of ATP from ADP and phosphorus during photosynthesis.

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www.rmi.org

www.massivechange.com

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www.worldchanging.com

www.projecthdesign.com/manifesto

Useful Books:

Living Systems. Innovative materials and technologies for Landscape Architecture, Liat Margolis/ Alexander Robinson

Cradle to Cradle - Remaking the ways we make things. William McDonough & Michael Braungart.

rethinking design

biomimetics: energy generation

Morgan Terry

rethinking design

What/Why:

Biomimicry (from bios, meaning life, and mimesis, meaning to imitate) is the science that studies nature, their design successes and processes and then imitates these to help solve human problems¹. The key word in this is that biomimicry imitates. Biomimicry does not take physically from nature; it learns from what nature can do and implements this in the design processes of the human environment.

In today's society we have a process referred to as heat, beat and treat. This process is used in the manufacturing of basically everything. The object is put under enormous amounts of heat, is shaped and then treated with chemicals. However the environment produces the same products without any of these energy intensive systems, in a shorter time and every time the product is more efficient, longer lasting and of course it is sustainable, the end product returning back to the environment without any waste.

The earth is populated millions and millions of species, each individually developed with unique talents and abilities. These species have had over 400 millions years of field testing, their survival highlighting the success of their designs. The more that we emulate the natural world the more likely we are to survive as a species in a home that is not ours alone.

The issue in today's society has been noted is not the knowledge, not understanding what nature can do, but the integration between different fields of study. By integrating the knowledge of the biologist with the designer, our human environment, our lifestyle and our products can begin to function like the earth around us.

Biomimicry can be applied a three different levels.

'The first level of biomimicry is the mimicking of the natural form'². This can be explained through the example of imitating the bumps on the humpback whale as a way to decrease the turbulence of a fan blade, increasing its productivity and saving energy.

The second level mimics the natural process, such as how the object is made. A shell is created through a build up of carbon that is aligned and hardens into an extremely strong material, in low temperature with no heat, beat and treat.

The third level is the ability to mimic the natural ecosystem. This is the idea that the object is part of a wider system that includes how it is made, how it is used and what happens to it when its life ends. In the natural world every single item is put back into the system to become a fuel, material or mineral for something else. Nothing is wasted.

Biomimicry and the integration with energy generation design are still in the early stages, at the moment most ideas are still in the prototype phases. When it comes to nature, each individual tree, plant etc generates their own energy, they do not rely on anyone else, and they do not produce waste. If this was applied to the human environment, every house and building would power itself, we wouldn't need large power stations that when fails stops electricity to large sections of communities not just one house.

¹ <http://www.biomimicryinstitute.org/about-us/what-is-biomimicry.html>

² <http://www.biomimicryinstitute.org/about-us/what-do-you-mean-by-the-term-biomimicry.html>

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Who

In 1997, Janine Benyus first coined the term biomimicry from the Greek “bios,” meaning life, and “mimesis” meaning “imitate”³. Since writing her first book on biomimicry, *Biomimicry: Innovation Inspired by Nature*, Janine has been sought after as a consultant to some of the world’s biggest companies in order to harvest her ideas on how they can improve their business, products and design issues through the application of biomimicry as sustainable design. Basically Janine has become the biologist at the design table, fixing design issues that have already been solved by nature. Janine is currently writing her second book, and consults through her firm The Biomimicry Guild, which was built after the extensive need and want for her knowledge.

The Biomimicry Institute (<http://www.biomimicryinstitute.org/>) is developed as a not-for-profit organization. It aims to develop a ‘global community of people who learn from, emulate and conserves life’s genius to create a healthier, more sustainable planet’⁴. The Institute believes that basically the more we look and function like the natural world, the more likely we are to survive on a planet that is not ours alone.

The Biomimicry Institute is working on a project called AskNature, (<http://www.asknature.org/>), which gives examples of works inspired and designed from nature. It gives an example of how plants absorb light and energy, and then allows the viewer to look at related, applied or application ideas of this design. This website can be used as a database for people from all disciplines to explore or submit ideas, questions or designs. If you enter in a search for ‘how would nature store energy’, at the moment you can get 374 results for how nature achieves this, this incredible database means that anyone can come and learn from biologists and nature, and apply to the human environment.

Alongside the Biomimicry Institute is the Biomimicry Guild, (<http://www.biomimicryguild.com/indexguild.html>). The Guild has been up and running since 1998 helping companies and communities understand and emulate ‘life’s time-tested strategies’⁵. The Guild aims to integrate the study and application of biomimicry into the design environment. It offers services and help to companies that request how nature may help them by doing comprehensive research into how nature has already solved their challenges.

³ <http://edition.cnn.com/2008/TECH/science/07/04/janine.beyusbio/index.html>

⁴ <http://www.biomimicryinstitute.org/>

⁵ <http://www.biomimicryguild.com/indexguild.html>

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How

BioPower Systems

BioPower Systems has begun work on a series of biomimetic inspired energy generation ideas, the BioWave, BioStream and the BioBase⁶.

These designs are modelled on marine life that live within a near shore environment with high flow waters. The BioWave is inspired by the design of kelp. Through kinetic movement these structures are able to store energy created by their movement in the waves. During rough weather, these kelp inspired designs fold flat against the sea bed in order to protect themselves from being damaged.

The BioStream is mimicked from a shark's tail. The design simply flows with the waters current, again storing the kinetic energy that is produced by the currents. The great thing about both of these designs is that they are low visual impact, submerged below the surface, but also make use of an energy source that currently is not being fully taken advantage of.

The BioBase will be the system they use to attach these structures to the sea bed. It works on an anchor, root type system that improves the installation, and reduces maintenance. It is reported that by inserting a graphite rod into marine sediment has the potential to prevent corrosion of marine metal structures⁷.

<http://www.biopowersystems.com/>

Grow

'GROW is a hybrid energy delivery device that provides power via the sun and wind, and draws inspiration from ivy growing on a building' SMIT⁸.

The Grow system is based on the idea of ivy leaves growing up the side of a building. They are attached in a modular system, meaning that when one breaks, only a small part needs to be replaced and fixed. This beautiful idea works as all plants do, not using large panels, but small, delicate leaves.

GROW aims to use recycled and reclaimed materials when possible, reducing the effect this design will have on the environment. This design effectively works on all three levels of biomimicry: they mimic the shape, they then mimic the way that a leaf is made, (as they are designed to absorb the sunlight), they then also consider what will happen to the materials after their user life is over, recycling what they can, reducing the environmental footprint they will create.

The manufacturing of these bricks could happen in a roll to roll printing process where PV, conductive ink, and piezo generators can be layered quickly and efficiently⁹.

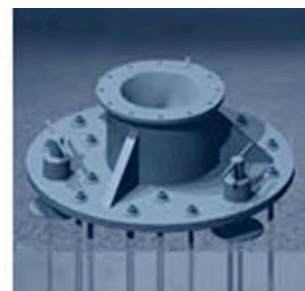


Fig 1

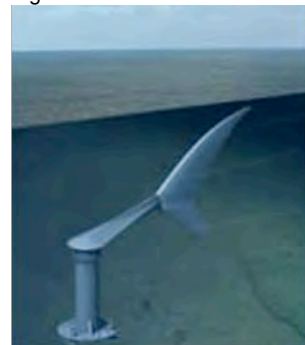


Fig 2

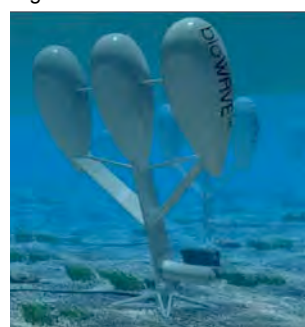


Fig 3



Fig 4

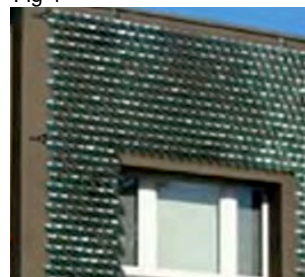


Fig 5

⁶ <http://www.biopowersystems.com/>

⁷ http://www.treehugger.com/files/2006/10/biologically_in.php

⁸ http://s-m-i-t.com/#grow_target

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Solar Lily Pads

Scottish firm ZM Architecture have developed a solar energy idea that mimics the lily pad. Designed for the Glasgow River, they will float, soaking up the sun's rays during the day to send electricity to the city, while during the day the design will attract waterfront attention.

This design is still in the proposal stage like many other biomimicry energy generation ideas. At the moment the Glasgow council has been considering a small test pilot with the Glasgow Science Centre¹⁰. This design allows solar panels to take on a more aesthetic approach to the standard application as panels to the roofs of houses.

<http://idesignawards.com/winner/07/zoom.php?eid=1007-08&uid=3072>



Fig 6



Fig 7

WhalePower Corp

The shape of the Humpback Whales fin is being studied at the moment in order to design a better fan blade, and also a better wind turbine. Scientists have discovered that the tubercles on the Humpbacks fins, result in 32 percent less drag when compared to a smooth fin. this results in the fan blade moving through the air with a lot less energy needed for the rotation¹¹.

WhalePower is continuing work to apply the idea to wind turbines, but the process at the moment is slow because of certification and testing, but when they are put in use, the blades will produce more energy than other wind turbines¹².

<http://www.whalepower.com/drupal/>



Fig 8



Fig 9

⁹ http://s-m-i-t.com/#grow_target

Fig 1,2: http://www.treehugger.com/files/2006/10/biologically_in.php

Fig 3: <http://www.biopowersystems.com/>

Fig 4,5: http://s-m-i-t.com/#grow_target

¹⁰ <http://www.inhabitat.com/2008/05/12/solar-lily-pads-planned-for-glasgows-clyde-river/>

¹¹ <http://www.treehugger.com/files/2008/03/biomimicry-fan-blades-mimic-humpback-fins.php>

¹² <http://www.whalepower.com/drupal/>

Fig 6,7: <http://idesignawards.com/winner/07/zoom.php?eid=1007-08&uid=3072>

Fig 8,9: <http://www.whalepower.com/drupal/>

rethinking design

Biomimicry and energy generation is constantly being tested and developed, new ideas are coming from all around especially within solar energy generation. There are numerous ongoing studies that are looking into the design and production of solar panels. At the moment the process to create traditional solar panels requires a lot of energy, a time intensive process that in the end makes the price of the solar panel quite a lot.

Sea Sponge

One of the ideas being tested at the moment is the sea sponge, which could lead to a more efficient method of making solar cells¹³. Sea sponges have the ability to form silicon structures within the energy that solar panels require. This process can be implemented as a way to create cheaper solar cells.



Fig 10

Butterfly Wings

Butterflies is another species being tested for their ability to inform the way that we can create solar panels. Butterfly wings helped to inform the idea of dye-sensitized solar cells and the ability to make them more efficient and less expensive. These solar panels are able to be produced in a thin film instead of the traditional large panels. Tests have shown that the butterfly wing solar collector absorbs light more efficiently than conventional ones¹⁴.

<http://www.treehugger.com/files/2009/02/biomimicry-breakthrough-butterfly-wings-solar-panels.php>

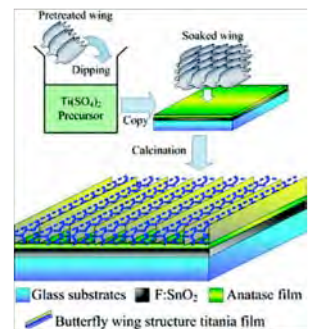


Fig 11

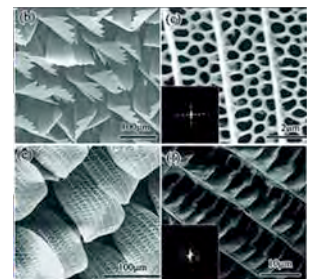


Fig 12

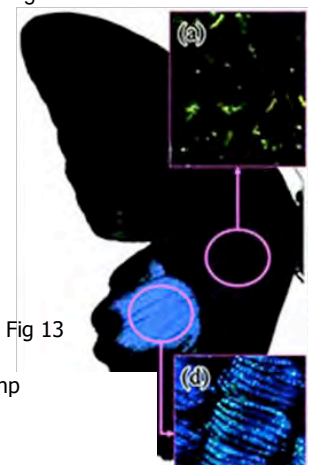


Fig 13

¹³ http://www.treehugger.com/files/2007/03/sea_sponge.php

¹⁴ <http://www.treehugger.com/files/2009/02/biomimicry-breakthrough-butterfly-wings-solar-panels.php>

Fig 10: http://www.treehugger.com/files/2007/03/sea_sponge.php

Fig 11-13: <http://www.treehugger.com/files/2009/02/biomimicry-breakthrough-butterfly-wings-solar-panels.php>

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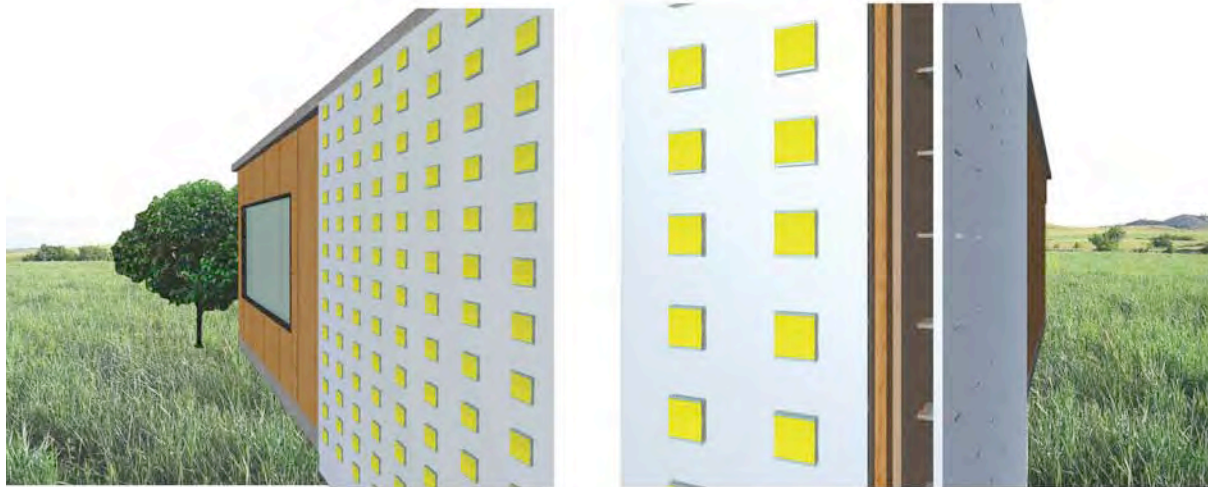
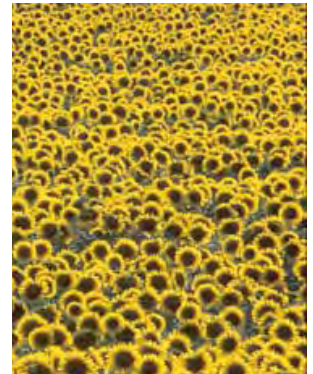
From the research gathered, one of the main ideas that I have taken from biomimicry and energy generation is that in nature, each individual species has their own way of obtaining energy. As humans we rely on one or two very large systems that power our area of living, when these are down due to technical faults etc, we have no power. This would mean implementing different systems that power different needs.

SUNFLOWER

The sunflower has been known for many years as the plant that tracks the sun's movement. At sunrise, the faces of most sunflowers are turned towards the east. Over the course of the day, they follow the sun from east to west, while at night they return to an eastward orientation. This motion is performed by motor cells in the [pulvinus](#), a flexible segment of the stem just below the bud. As the bud stage ends, the stem stiffens and the blooming stage is reached.

As a design implementation, we can mimic the way that the sunflower tracks the sun, to achieve the maximum harvesting of the sun. However as a design aesthetic, no one wants their whole house to be covered in solar panels. Basically situated around the house are 'seed facades', walls attached to the exterior of the building with slits cut into them. As the sun moves around the house, a sliding wall hidden behind the 'seed façade' pushes forwards allowing hundreds of solar panels to literally begin to bloom and begin to harvest the sun's energy. As the sun moves over the house, these panels will respond, opening and closing during the day. During bad weather the panels are able to be protected reducing maintenance, and due to the module design, when it comes to replacing or fixing a piece, it will mean only a small job not a complete overhaul.

The panels will be designed with the same techniques as the SMIT GROW Ivy leaves, reducing waste with reusing the left over or recycled materials



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BUTTERFLY

With the research into creating new solar panels, implementing the design and style of the butterfly will prove for some beautiful aesthetics. This Butterfly design takes into consideration the butterfly's ability to absorb sun more effectively, and also its relationship between its wings and the wind.

The design consists of a landscape of flags, attached to large 3-4m poles. The flags will be designed from laminated plastic solar panels allowing it to move in the wind, using the SMIT Grow technique for its flexibility and ability to be recycled and reused. During the day the panels will absorb solar energy through the very thin panels laminated into the plastic. However the design also implements the use of wind or kinetic energy. As the flags pull against the poles with the wind this movement will also store energy, so on a day when there is less sun and more wind, there is still a large amount of energy being generated.

As a very simple design, this could be implemented in many other ways, by reusing the plastic surface as a billboard or advertising space, they could be used within urban areas by companies as a way of both advertising and generating electricity. Designs could be placed upon street lights etc and the great idea would be that when the advert needs to be replaced, the plastic can be recycled and reprinted for the next advert.

In Wellington this design could be seen as a productive wind sculpture set along the waterfront. The energy produced from the flags could then be used to power the lighting in public areas at night around the cities waterfront. As stated earlier nature has multiple ways of producing energy, with each tree generating their own, not relying on their neighbours. The Butterfly flags work in the same way; they can be placed where energy generation is needed, such as public walkways and accesses.



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biomimicry: interior design

jasmin yee

Jane Benyus (1997) coined the term 'biomimicry' which derives from the Greek *bios*, *life*; and *mimesis*, imitation. It is "innovation inspired by nature."

Nature as model: Biomimicry is a new science that studies nature's models which emulates it's forms, processes, systems and strategies to solve human problems - sustainably. The Biomimicry Guild have developed a practical design tool, called the *Biomimicry Design Spiral*, for using nature as model, for example; a solar cell inspired by a leaf.

Nature as measure: Biomimicry uses an ecological standard to judge the sustainability of our innovations. After 3.8 billion years of evolution, nature has learned what works and what lasts. Nature as a measure is captured in Life's Principles and is embedded in the evaluate step of the *Biomimicry Design Spiral*.

Nature as mentor: Biomimicry is a new way of viewing and valuing nature. It introduces an era based not on what we can extract from the natural world but what we can *learn* from it.

Benyus, J.M. (2002). *Biomimicry: Innovation Inspired by Nature*. HarperCollins Publishers.



Interior design accommodates conditions which are functional, enhance the quality of life and culture of the occupants, and are aesthetically attractive.

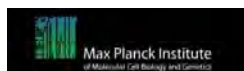
Interior designs are created in response to and coordinated with the building shell, and acknowledge the physical location and social context of the project.

Interior design is a branch of architecture dealing with the selection and organization of furnishings for the interiority of a space. - NCIDQ, 2004.

http://www.ncidq.org/pdf/id_definition_07-2004.pdf

Thinking of biomimicry – interior design as a *wall lining or shelter*:

Systems, forms and processes inspired by nature can provide the necessity for which we are able occupy space in a structural manner.



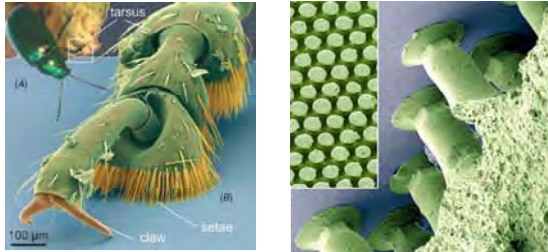
Max Planck Institute are developing adhesives based on biomimicry of beetles' feet.

Inspired by the microstructures of beetle feet a team from the Max Planck Institute (MPI) in Stuttgart, Germany, and Case Western Reserve in Cleveland, US, has developed an "insect tape", a powerful sticky patterned adhesive, twice as sticky as flat tapes. The novel glue-free product adheres better to dusty surfaces, and can be re-employed multiple times after being washed with water and soap. The design enables the materials to stick to smooth walls without any adhesives. The researchers say the technology, which uses microhairs "reminiscent of tiny mushrooms", could someday allow robots to climb vertical glass walls and refrigerator magnets to be replaced by non-magnetic objects.

In rigorous tests carried out by the Max Planck Institute researchers with measuring instruments developed especially for the purpose, the artificial adhesive system gave an impressive performance and demonstrated many benefits. It lasts for hundreds of applications, does not leave any visible marks and can be thoroughly cleaned with soap and water," reads media release from the Max Planck Institute for Metals Research. "The researchers found that five square centimeters of the material can hold objects weighing up to one hundred grams on walls." – Stanislav Gorb (co-author of MIP).

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Microscope image of the biomimetic surface structure of the new adhesive material. The material (green), which was inspired by the soles of insects' feet sticks to the glass (blue). Image courtesy of the Max Planck Institute for Metals Research The researchers said smooth structures, like glass, are good bases for the adhesive material but that wallpaper and other rough surfaces do not work well.



(A) Chrysomelid beetle with
(B) a close-up of the tarsus
with a hairy adhesive system

<http://news.softpedia.com/news/New-Super-Adhesive-Mimicks-Beetle-Feet-70080.shtml>



Columbia Forest Products learned about natural adhesives from the blue mussel. This ocean species attaches itself firmly to underwater structures without use of toxic chemicals. Columbia's PureBond® is a soy-based formaldehyde-free technology used in the construction of hardwood plywood products. Inspired by the sticky proteins serve as glue by blue mussel. Byssus threads of the blue mussel attach to a wet, solid surface due to catechols on adhesive proteins that overcome the surface's affinity for water molecules.

Blue mussels – bivalves that attach to rocks in wave-battered seashores produce adhesives comparable in strength to human-made glues but without carcinogens such as formaldehyde and which can cure under water.

A key feature of the blue mussel's unique adhesive chemistry are the presence of the amino acid 3,4-dihydroxyphenylalanine, with its reactive catechol functional group (two hydroxyl groups sticking out from a benzene ring) that forms strong bonds with catechols on adjacent molecules and with metal atoms present in the surface of most natural solid substrates. Another key feature is the ability of catechol chains to overcome a solid surface's otherwise strong preference for water molecules (which is why conventional adhesives fail on wet surfaces).

New mussel-inspired adhesives, which have wide-ranging applications from surgical to wood composites, currently use soy as an inexpensive, accessible feedstock, and work by blocking certain amino acids in soy proteins that are not present in mussel proteins, such as glutamic acid, so that the resulting compound bears a closer resemblance to that of mussel proteins.



<http://www.asknature.org>

video material: http://www.sciencedaily.com/videos/2005/0601-wood_glue_inspired_by_mussels.htm

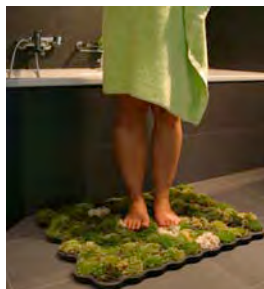
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Thinking of biomimicry as an *interior object*:

A piece of furniture or an object which can be found in the interior has characteristics borrowed from biomimicry itself. The two examples below utilise nature in which they mimic a process over time through an eco-conscious design.



Living Moss Carpet by Nguyen La Chanh echoes the notion of “there’s nothing like the feeling of fresh cut grass under the toes, especially when stepping out of the shower.” Moss Carpet brings the outside indoors in an unconventionally natural way by placing it underfoot. The lush green lawn thrives in humid environments, which makes your bathroom a perfect place to grow. This ingenious design is made from a decay-free foam called plastazote, and populated with three varieties of moss: ball, island, and forest. Maintenance required for this little patch of green is limited, as the moss thrives off of the humidity released from daily bathroom rituals.



www.inhabitat.com



Mushrooms Ate My Furniture by designer Shinwei Rhoda Yen is of garden furniture that is made with natural wood, embedded with mushrooms' spawn. after a time of exposure to the weather. Mushrooms will grow out and live with the furniture for a few more years. As the nutritional material from the wood is eaten by the mushrooms, the furniture will start to break down, eventually dying while giving its life to the mushrooms. In the case of this mushroom bench, an inanimate object sustains life and automatically biodegrades as it reaches the end of its lifecycle.



<http://www.designboom.com/weblog/cat/8/view/5492/mushrooms-ate-my-furniture-by-shinwei-rhoda-yen.html>

Design meets shelter and furniture:

Examples where these two conditions can inter-cross one another as a means of interior design.



MAProject1 in partnership Philips in the UK have come up with a dream of eco-conscious wallpaper for the year 2030 called the *Constellation Wallpaper*. It is an energy storage wallpaper, this means that the wallpaper produces and stores electricity into his surface thanks to photovoltaic technology. The wallpaper is made of two layers of paper. The first layer transforms the sunlight into electricity, whereas the second one works as a battery and stores the electricity produced so far. Flaps into the wallpaper surface indicate the level of electricity stored. They open up when the wallpaper is accumulating energy and reveal a new poetic aesthetic. How is it sustainable ? This wallpaper works with the only renewable energy susceptible to provide all the energy we need at a global level, as the sun provides, every two

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minutes, to the Earth, all the energy we need annually. It is not only a self-energy sufficient product that transforms wasted space into an energy's production place but also support people in becoming producers rather than just consumers. The beauty of the pattern revealed by the stored electricity is a way to reward good energy use and to create a situation where it is socially desirable to show that you are an eco-conscious consumer.



Details of wallpaper opening at various times of the days.

<http://www.textilefutures.co.uk/exchange/bin/view/TextileFutures/MAYear1Project>

abstracta Decorative and functional and sound absorbing screens by Swedish design company, Abstracta divide space to add a more intimate feel, or simply fixed to the wall as an artistic touch. The *Airflake Wall Coverings* are moulded fibre felt panels. The materiality of these screens are cheap and accessible and come in four distinctive patterns, all in a hexagonal snowflake shape designed is by Stefan Borselius.



A multi-purpose screen

<http://www.trendir.com/archives/002518.html>

Rethinking design through biomimicry:

The plasterer bee protects its nests from water by secreting a natural polyester.

"The plasterer bees (*Colletes*) and yellow-faced bees (*Hylaeus*) are among the most primitive bees; they build their breeding chambers in hollow twigs or holes in the ground, lining the walls of their nest cavity with wallpaper made of an oral secretion. This fluid hardens into a waterproof film resembling cellophane; the lining both prevents their collected nectar from leaking into the surrounding material and keeps away dampness and mould." – Pallasmaa, 1995.

Colletidae is a family of bees, and are often referred to collectively as plasterer bees, due to the method of smoothing the walls of their nest cells with secretions applied with their mouthparts; these secretions dry into a cellophane-like lining. There are 5 subfamilies, 54 genera, and over 2000 species, all of them evidently solitary, though many nest in

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aggregations. Two of the subfamilies, Euryglossinae and Hylaeinae, lack the external pollen-carrying apparatus (the scopa) that otherwise characterizes most bees, and instead carry the pollen in their crop. These groups, and in fact most genera in this family, have liquid or semi-liquid pollen masses on which the larvae develop.

Cavities in the ground



http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WNH-4TRK0P0-1&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=3e130d212ab3ea685ca04388325dcd0f

Design proposal:

The new *Plasterer Wallpaper* can be described as wax-like, varnish-like or cellophane-like. This wallpaper is not only designed as an aesthetic addition to the interior but is also practical in purpose. The density of this product creates a lining between interior and exterior, it provides protection between inner and outer with waterproof and anti-moisture elements.

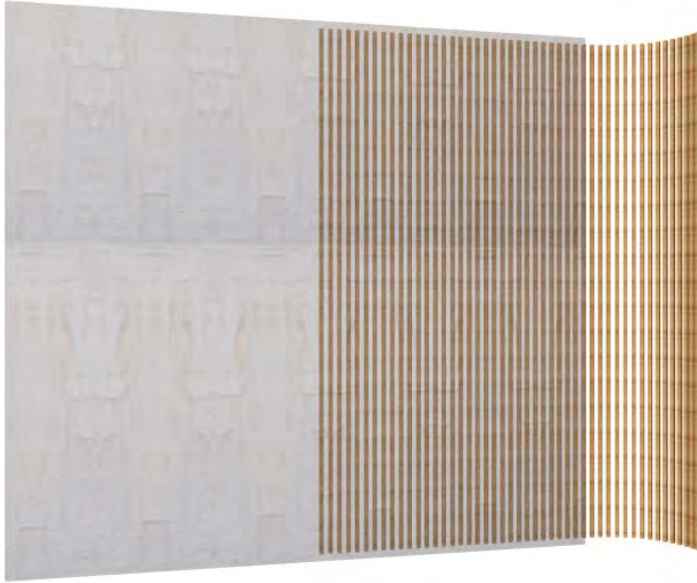
The oral secretion process performed by the female bee is defined by a basic type of cell lining: the silk-like which is insoluble in ether and chloroform and does not melt under heated conditions.

The “plaster wallpaper” is made from a class of organic compounds in which two hydrocarbon groups are linked by an oxygen atom. Chloroform is a clear, colourless, heavy, sweet-smelling liquid, CHCl_3 , used in refrigerants, propellants and sometimes as an anaesthetic. However, the “plaster wallpaper” will not put you to sleep, nor will it put your home asleep. With the design of this wallpaper, your home will be alive at all times.

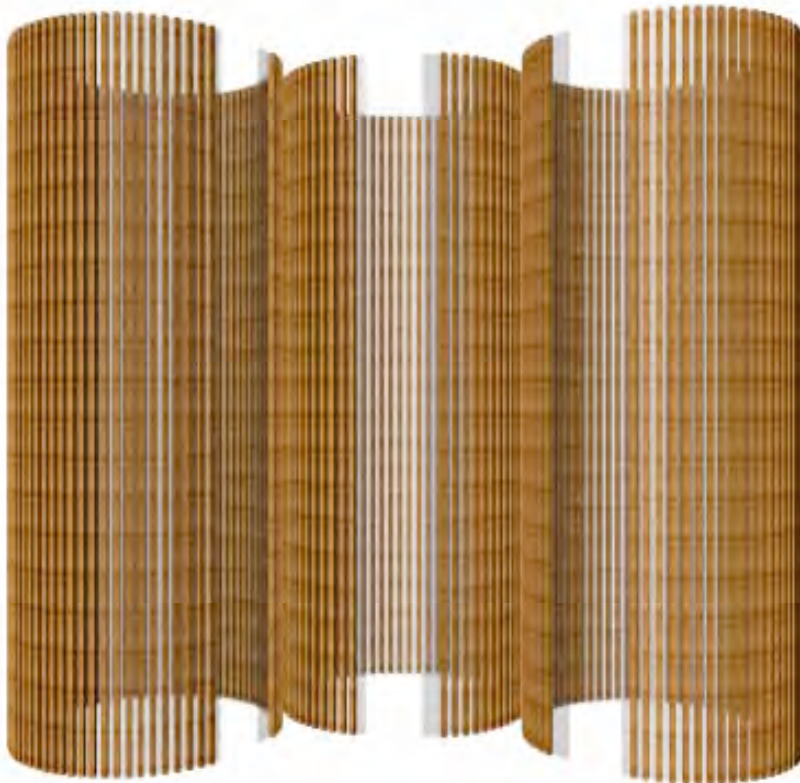


The 'secretion lining' provides a shell for wooden framework.

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Timber framework is wrapped in a film inspired by the oral secretion Process involving hydrocarbon groups linked by an oxygen atom and secondly, chloroform. The development from a lining for framework to a system of lining which creates an interior space and essentially leads to a series of spaces.



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biomimetic: food generation design

Katherine M. Wilkinson

WHAT/WHY

“Innovation inspired by nature.”

In biomimicry, we look at nature as a model, measure and mentor; it is a new way of considering and appreciating nature. It introduces an era based not on what we can extract from the natural world but what we can learn from it. Biomimicry is the new science that studies nature, its models and systems, operations and principals. It solves the problems we as humans have sometimes, but not always, created ourselves. It takes creative inspiration from nature; it does this by studying the best ideas and then echoes its designs and processes. It is a survival strategy for humans, a path to a sustainable future. When biomimicry is used we are imitating the best-adapted organisms because what surrounds us is the secret to survival. Nature has lead to the development of products such as hypodermic needles designed on snake fangs. We have learnt to self medicate like a chimp, create protective clothing or coverings for cars inspired by crocodile skin, looked at fish antifreeze to find new ways of freezing human transplant organs without injury, created non-marking adhesives and closures for rock-climbing gloves inspired by Gecko toes. By necessity nature is imaginative. Animals, plants and microbes are the engineers of biomimicry. With the demand being high today for a sustainable future, the science of biomimicry is producing more and more opportunities for the world to create a better future using sustainable, organic properties.

WHO

The Japanese have developed a system of growing more of their prized melons within the small area that they have available to grow. Instead of taking up lots of precious space growing all over the ground they have developed a way to train them to grow vertically. Enabling more to be grown in one area. This also means that fewer blemishes will cover the fruit, as they are not lying in one position throughout their whole stage of growth. Because of this they are able to sell more of the fruit and get a better return for their work.



Aquaponics is the system that involves both aquaculture and hydroponics. This process involves fish, plants and bacteria. The cycle consists of fish by-products being pumped into growing beds that are filled with gravel. The beauty of the

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system is that a balance occurs in the eco-system where the water is filtered by the plants, which in turn obtain all the necessary nutrients from, the fish. This system allows you to eat both the fish and the plants in a totally safe way, as only chemicals that are harmless to fish, can be used to control any pests on the vegetables.



Japanese rice farmer Furuno Takao has developed a system that integrates ducks into rice cultivation. The ducks provide impeccable pest control by eating insects and weeds that otherwise would harm the crops. The duck manure provides many nutrients for the rice. Furuno has also incorporated fish into the rice paddies. His farm is a model ecosystem, which can feed 100 people on a very small amount of land. It does this without the use of any toxic chemicals and with very few outside inputs.



HOW

Aquaponics



Aquaponics is the combination of aquaculture, which is fish farming and hydroponics, which is soil-less plant culture. It mimics every natural waterway on earth. It is essentially organic gardening without the dirt.

Some advantages of having an Aquaponic system commercially and non-commercially are that it utilizes the nutrient rich water from aquaculture, which would normally have been a waste product or would have needed to be filtered in an expensive way. It uses a fraction of the water that traditional crops do because there are no weeds to deplete the water. With aquaculture, water circulates through fish tanks, and then filters through growing beds and flows back out to the fish tank. Both fish and plants grow in the same body of water using one infrastructure.

Aquaponics takes away the cost and time involved with mixing traditional hydroponic nutrients. It provides a completely natural and organic form of food for the plants. Because it has no soil, soil borne diseases don't occur. The microbial process keeps both the fish and

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plants healthy and helps sustain an environment, which they can both survive in. Fertilisers aren't required as the fish waste provides all the nutrients. As plants consume the nutrients they help to purify the

water the fish live in. More than 50% of the waste produced by the fish is in the form of ammonia, secreted within the urine and in small amounts



through the gills. The rest of the waste is excreted as faecal matter, which then goes through a process called mineralisation. This occurs when heterotrophic bacteria consume the fish waste, decomposed plant material and un-eaten food, transforming all three into ammonia and other compounds. However, in certain quantities ammonia is toxic to plants and fish. The bacteria provide the plants with a useable form of nutrients. Removing these nutrients through plant growth, the plants help clean the water the fish live in.



By using aquaponics a large volume of food crops can be grown using a lot less space compared to growing crops in a field. It is also adaptable as it can be used in extremely small areas, perfect for urban living. It grows crops in a concentrated yet sustainable manner.

Aquaponics can provide local food markets with produce in regions with poor soil; it can be beneficial in developing countries and rural communities, as you can eat both the fish and the plants that grow. It is an ideal answer to a fish farmer's problem of disposing of the nutrient rich water and a hydroponic growers need for rich water using expensive high-energy fertilisers. Because plants can be grown very close together you can grow more in a given space. Plants will grow extremely quickly and develop fast in an aquaponic system. The resulting food is much healthier because there are only limited pesticides for fungi and insect control, but no herbicides used. Growing all year round can happen if the climate permits or greenhouses are used. Plants such as leafy lettuce, pack choy, spinach, arugula, basil, mint, watercress, chives and a lot of common houseplants can also be grown if they are heavily stocked and in a well established system. Other plants grown are; tomatoes, peppers, cucumbers, beans, peas and squash. Melons and flowers can also be grown. The breeds of fish that can be grown in an aquaponic system are tiapia, crappie, brim, bass, carp, and goldfish; koi carp also thrive in aquaponic systems.



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Tenkei melons

For the Japanese food not only has to taste perfect, it has to look perfect. Beauty and art are part of the culture of food. With such a high population the Japanese have designed methods of food cultivation to utilize the amount of land available for horticulture to the maximum extent. That is why the rice paddies are seen on terraced hillsides, in between buildings in towns and right up to the edges of greenhouses in the country. Within these greenhouses are the traditional crops of lettuce, tomatoes, capsicums etc but to increase the yield per square meter they have developed techniques of growing to utilize the space even more effectively.



Melons are one of the Japanese' most prized fruits for their appearance, scent and taste; they are often given as high quality gifts. Traditionally, the plants are grown in a similar way to pumpkins, sprawling all over the ground and covering a large area per plant.

However, within the limited space that Japan has due to its ever-rising business districts and rising population, training plants to grow vertically up strings within greenhouses enables greater production per square meter. The Tenkei melon is a favourite to grow in this manner. Not only can Tenkei melons be grown in large quantities in small areas, but they can also be trained to grow fruit of different sizes, enabling them to be able to cater for a range of different uses and situations. These melons also adhere to the Japanese standard of food and catering as they add form, function and innovation to their table.



Each melon grown has an average weight of 1.5kgs. The space saving is proven in the fact that the melons grow at about 2.5 plants per square meter. Although with the restriction of only being able to grow two-three melons per plant so that they don't put too much strain on the stalk. The amount grown in tiny spaces is very economical,

safe and sustainable. To ensure that the stems the melons grow on is strong enough to hold them, the string is tied from the plant to the ceiling of where they are growing, to keep the stem strong; also all the fruit below waist height are taken off. Being at waist height also means that the melons are easily harvestable as they are easy to reach, unlike some crops that grow right to the ground or are mainly grown over the ground.

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Tenkei melons mimic the way a vine grows naturally up a tree or other solid natural object in a forest situation. The process of growing the melons is very labour intensive, as it requires daily pruning of the plant and restricting the fruiting capacity of the plant, so that only the perfect fruit are selected at an early stage of their development. This means that the fruit at harvest time will be of a predetermined size and of a perfect shape, resulting in the potential to market every fruit produced with the maximum amount of return per square meter, compared to growing 'traditionally' outside. When growing outside along the ground there is the possibility of more insect and disease problems, this causes damage to the fruit and the fruit not looking as 'clean' with marks where it sits on the ground resulting in a less appealing end product, which would downgrade the fruit to a lower value.



As Tenkei melons greatly benefit from growing in greenhouses, it is also possible to grow them in other external or internal spaces. Because a lot of care is needed when growing them it provides the opportunity to make the melons truly organic, which in turn heightens their price and value. It also really emphasises the sustainability of this vertical crop.

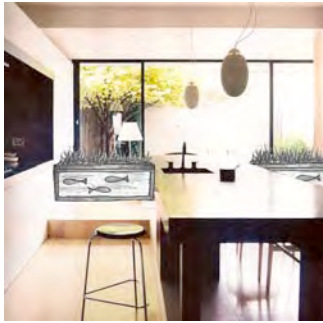
RETHINKING DESIGNS

For urban environments all over the world, as well as rural communities and people in diverse living situations, there is a big demand for organic, sustainable food sources. Urban Aquaponics and Tall Tenkeis are two examples of food that have been adapted to cope in all environments. These designs have provided the different communities with an opportunity for healthy living.

Urban Aquaponics

The process of aquaponics is a complicated but manageable one; it involves both fish and plants. The cycle that happens in aquaponics consists of fish by-products being pumped into growing beds filled with gravel. A balance occurs in the eco-system where water is sufficiently filtered by the plants that in turn obtain all the necessary nutrients from the fish. This process is very economical for everyone as very little water is used and there is no effluent to dispose of.

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Urban aquaponics allows people living in urban situations to grow their own food and know exactly what they are eating. Nothing goes to waste in this system as both fish and plants are edible. This process also avoids chemicals in the growing process as anything poisonous used on the plants will kill the fish.

The idea of having a fish tank in the home is an old one but now with Urban Aquaponics it is possible to have a fish tank in the home that holds both edible fish and vegetables. The tanks with these living things in them provide an interesting feature in any room and because they can be situated in any urban environment it means people have access to organic, sustainable living all year round. The tanks can be built into wall units, provided they have space at the top for the vegetables to grow. They can be free-standing and situated in almost any room within the chosen environment.

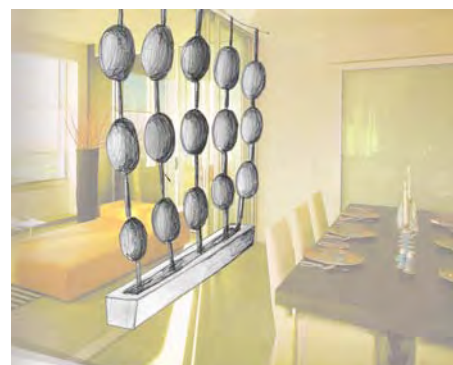


Tall Tenekis



Tall Tenkeis incorporates the Japanese Tenkei melons and internal and external living. What they provide in urban environments is a living, edible artwork. As the Tenkei melons can be trained to grow vertically it is now possible to put them in any part of your home. The vertical garden is a highly efficient growing system. This vertical gardening reduces backaches and sore knees of stooping and kneeling to cultivate and harvest; because of this the growing system could also benefit the elderly and disabled.

All that is needed to grow this system in your home is a small bed of soil for the roots to grow in. They also need string from the ceiling of the environment that they are situated in, so they can be supported when growing vertically. The Tall Tenkeis system is a system that has been designed to create an edible screen within your home. Within each screen there are up to six melon vines growing vertically. The upside of this screen is not only that the melons are edible but they are also organic due to the early care they receive when they are growing. When the melons



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aren't growing the green vines are still aesthetically pleasing and interesting to look at. They capture the sunlight of a large garden while being contained in a small area. Depending on the size of the internal and external spaces these are to be grown in, the melons can be grown to the required size. The Tall Tenkei screen adds form, function and innovation to any given space.

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Biomimetic Design: Design of heating and cooling systems

Kanae Murakami

Why:

Today, global warming is one of the main issues that the world has to consider.

Considering the use of materials, such as energy resources and trees is very important. Since the Industrial Revolution in the 1700's, the amount of CO2 emitted has increased. The amount of CO2 emitted in 2005 was 35% higher than before the Industrial Revolution. The largest source of CO2 in the world is caused by the combustion of fossil fuels, oil, coal and gas. The process of generating electricity, for things such as air conditioning, also produces a lot of CO2. Today, people all around the world use air conditioning and heaters. The energy used for air conditioning can be a huge amount in places such as urban areas in some countries. Air conditionings are units are used to cool down spaces inside because the outside temperature is hot, but air conditioning also heats up the outside air by emitting warm air from inside. The use of electricity for air conditioning can affect global warming and also costs a lot of money. Designing space which uses natural heating and cooling system can reduce the use of energy and can also people and a large amount of money for the long term. (Climate Change (2008))

What:



Biomimetic Design

Engineers and scientists are inspired by the incredible mechanisms of nature to create efficient ecological designs. **Biomimetic design** is one kind of the ecological design techniques is still not well known. Biomimetic design is the method that uses systems that have been found in nature and applies them to the study of design, engineering and technology. There are

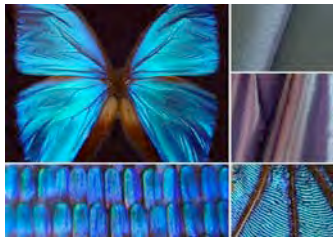


Whale Turbines
biodesign.wordpress.com



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quite few things that have been designed using Biomimetic method. For example, whale turbines, which transferred the shape of whale flipper to increase the speed of wind turbines. Another example is morphotex fibre. Morphotex fibre is the first material which creates a mysterious colour illumination with no pigmentation. This fabric was designed from the shininess of the wings of Morph butterflies. Gathering the idea from living organisms can create simple but more effective design which is harmless to environment. Biomimetic design can also be applied in architectural design. (Biomimetic Design (2009))



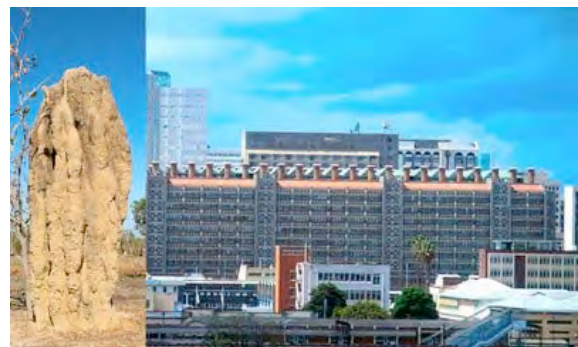
Morphotex and the
Butterfly
Biodesign.wordpress.com

Design of Heating and Cooling system

Heating and cooling systems of buildings are often considerable. We also have to consider the amount of CO₂ emitted every day by using power, the cost of power and the amount of power we use. There are a number of architects who have already started to design the ecological architecture, which have natural heating and cooling systems.

Who/How:

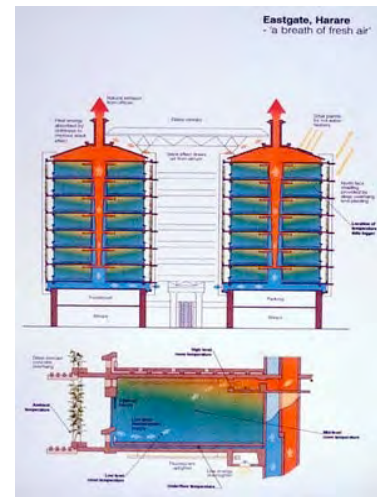
The architect Mick Pearce designed Eastgate centre in Zimbabwe. Eastgate centre is the largest commercial and shopping centre in Zimbabwe, which uses the same heating and cooling system as a termite mound. This building was modelled on African termite mounds. This is one example of sustainable architecture design which successfully used a system from a natural organism in order to use less energy. Termites farm a fungus inside their mounds, which is only their food. The mound must keep at exactly 30°C. The



Eastgate centre in Zimbabwe
nat-envir-sun.blogspot.com

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temperature outside in Africa ranges from 1°C at night to 40°C during the day. The architect Mick Pearce managed to design an office building, which uses no air conditioning and almost no heating systems. This building manage to have no air conditioning by using fans, which suck air in from the atrium then blow the air through the hollow space under the floors. The air also goes through the vents on baseboard. The warm air will rise and exits though chimneys once the cool air come into the rooms. The building also has an unusual form of sunshade to avoid the harsh sunlight from heating the interior. The owner of Eastgate centre saved almost \$3.5 million because an air conditioning plant was unnecessary. The use of energy in this building is 10% less than the usual energy usage of a building tyhis size. (ArchiEnvironmental (2007))

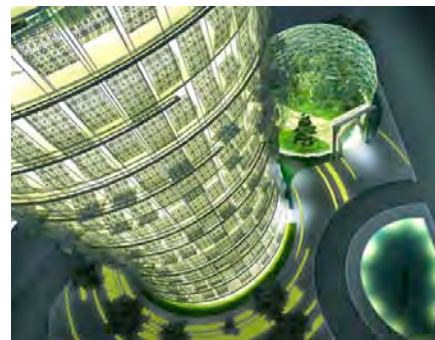


nat-envir-sun.blogspot.com

Current design



Another example of Biomimetic design is Qatar Sprouts a large cactus shaped Skyscraper designed by Bangkok-based



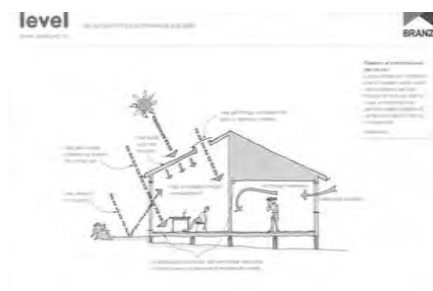
Qatar Sprouts Towering cactus Skyscraper
Inhabitat.com

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aesthetic architects. The design of this modern office building was inspired by the cactus, which survives in a hot and dry environment. The surface of the building is covered by controllable shades, which can open, or close depending on the weather. This design is similar to the way cactus behave during day and night to retain water.

(Inhabitat (2009))

Passive Design of heating and cooling system

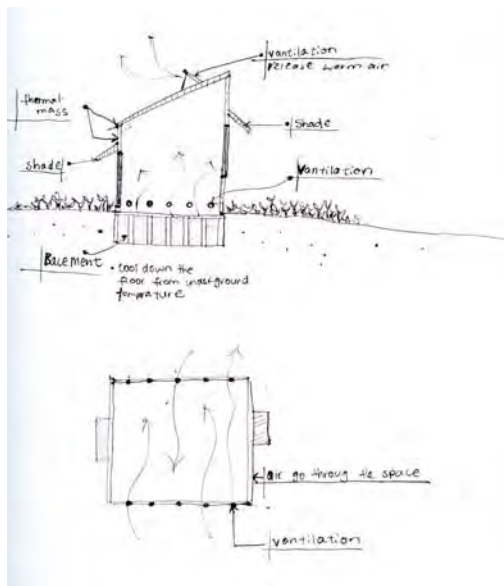


Reasons why some house get too hot/ level.or.nz

Like Biomimetic design, Passive design is one of the methods of sustainable building design. The aim of Passive design is to get the maximum comfort for people living in a house while minimizing the use of energy and impact on the environment. To achieve this,

the design uses free and natural sources of energy such as for example, sunlight and wind to provide heat and cool air for the house. The temperature

which humans are comfortable to live in is between 19 – 24 degrees. Also humidity and air quality is important. The shape of a house such as ceiling or shading and the amount of thermal mass used in the house can control the temperature inside. Lack of sunlight, air gap and lack of thermal mass make a house cold in winter. On the other hand, lack of shade, ventilation and lack of insulation can make a home too hot. (passive Design(n.d))



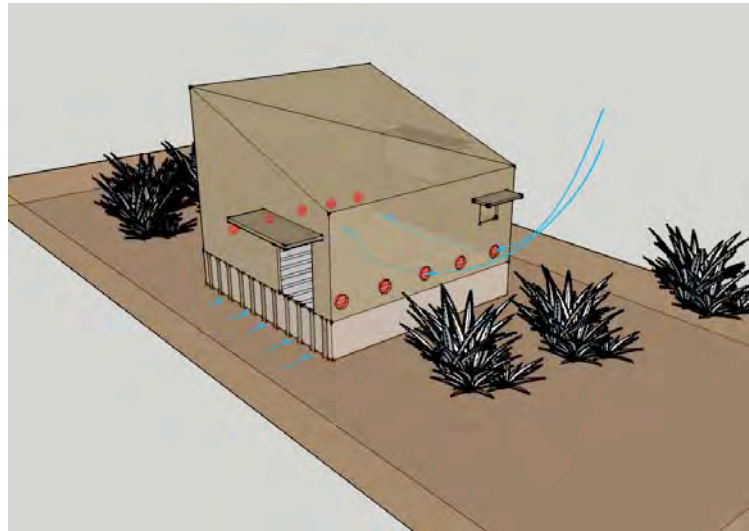
Rethinking Design

Ecological design can have a large effect on the environment. Ventilation, windows and shadings can be very useful to control internal temperature, especially in hot places like deserts. Windows are good to provide sunshine to the inside, but, at same time, that cause the

rethinking design

inside to heat up quickly. The house uses the idea of fans from termites mound for air conditioning system through all season to control air quality and temperature. This ventilation is controllable so it is able to shut or open depending on the weather. The sunlight can produce warm air which comes through the windows. Sunlight also hits the ground is reflected into the house. The shades and planted vegetation block direct sunlight and reflection from the ground. The basement is constructed under the

ground. The idea was inspired by how desert animals survive in a hot area and cool down their body temperature. They often make their nest under the ground where it is dark and cool. The cool air comes through



basement to ground floor and it cools down the house while fresh air comes through the ventilation on the walls. The design also incorporates a thermal mass system to keep the living space comfortable. The thermal mass absorbs the heat created by the sunlight during day and releases the heat when the outside temperature drops at night. The house will be kept cool and have good air quality all day.

Today, the great invention that humans have made and the rapid increase of using energy resources are effecting the environment that we live in by damaging living organisms, the air and even our own health by pollution. Thinking about how natural organisms live and applying their systems of living to develop ecological designs can protect the environment from getting damaged by our technology.

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biomimicry: furniture design

Maraka R. Van Grinsven Saunders

Biomimicry, by definition, is the mimicking, or coping of biological organisms to create form. Although, if we separate the word out, bios means life and mimesis means to imitate, therefore biomimicry means to imitate life. Biomimicry in closer relation to design relates to bio-assisted technology, where designers use an organism to enhance design ideas. Janine Benyus speaks at a T.E.D presentation about the 12 ideas from biology. Starting, in order, with self-assembly, Co^2 as feedstock, solar transformations. Fourth was the power of shape. For example, the bumps found on whale's fins improve the efficiency of speed in which they swim through the water. In relation the design world today, designers are mimicking this idea to increase the fuel efficiency of planes by introducing bumps onto their wings. Fifth, quenching thirst, some bugs pull water out of the air. Designers want to capture this idea and use it in design. Sixth, metals without mining. Seventh, green chemistry, we eventually want to replace all industrial chemistry and natural chemistry. Time degradation, this one has already been seized in many designs, its when something dissolves with time. Biodegradable. Ninth, resilient and healing. Finally, sensing and responding; designers have started to respond to this by design architecture and forms, which do what they do without destroying the environment around it. Benyus did not discuss all 12 ideas although she did state that "if it can't be found in nature, there is probably a good reason for its absence." (Benyus, T.E.D). "Mode, Measure, Mentor." (biomimicry.com). The three words that make up biomimicry. Mode is the form in which it takes, in architecture or object. Measure is the extent or quantity it is produced in. Finally, mentor which is the planning and process, and the way in which the project is carried out. If our every aspect of the world could encapsulate these 12 ideas of biology to inform their biomimetic design, then we could create are very green, healthy, eco-friendly, efficient environment to live in.

Although not many furniture designers have caught on to the idea of biomimetic furniture design, there are designers that have been experimenting or responding to issues and starting to incorporate areas of green design. For example, recycling. The Droog design exhibition in Milan 2008, 'A Touch of Green', exhibited many green furniture design concepts. One of which is titled 'One Day Paper', by artist Jens Praet. Using left magazines Praet responded to "his concerns over document waste." (Inhabitant.com/Milan). His aim was to get the viewer to re-enter the space in which the original document was used.

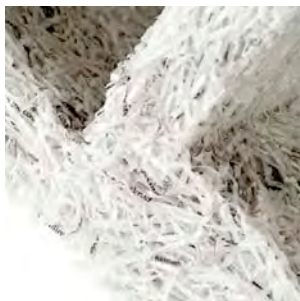


Image 1: detail



Image 2: exhibited at One Day Paper



Image 3



Image 4: Plaited Fence, Martin Azua



Image 5: Cosy Chair, SMAQ

In response to green design, Martin Azua creates a plaited fence, which relates to the plastic bag problem. SMAQ's cosy chair. Is made from stainless steel and argues that, "heat is only necessary when it is actually used ... the Cosy chair is an inhabitable radiator space." (Inhabitat, Milan).



Image 6: Peter on Pooktre chair

In 1986, Peter and Becky harness the art of growing furniture, and they had a well established garden of furniture in which they named Pooktre. In the years since then they have discovered how to slowly create tables and chairs the way they wanted them to grow. By repeating these ideas many times although it takes longer than usual furniture to create, they manage to duplicate this to create a business for themselves.



Image 7: Table in progress



Image 8: in workshop



Image 9: Finished Product

Self-assembly, first on the list of the 12 ideas of biology influencing the world of biomimetic design. Self-assembly is a term "used to describe processes in which a disordered system of pre-existing components forms an organized structure or patterns...without external direction." (Wikipedia, self-assembly) For instance, imagine holding a box with puzzle pieces inside. When you were to shake the box, and then opened it up to look inside to find it is now assembled puzzle. On a more personal level, humans cut or injure themselves, all the time. As well as healing this could be considered, in some form, to be self-assembly. Our skin layer by layer reassembles in self back into an ordered molecular structure, making it strong and durable again.

A living organism, which acts in a similar phenomenon, is the nacre, or more commonly known as 'Mother of pearl'. Nacre is made up of multiple layers; composed of hexagonal platelets aragonite (which are calcium carbonate crystals), and between these layers are sheets of organic matrix composed of organic biopolymers. "This mixture of brittle platelets and the thin layers of elastic biopolymers makes the material strong and resilient." (Wikipedia, nacre) Due to the how it is arranged, it becomes almost as strong as silicon. When the mollusc shell interior breaks down it self-assembles layer by layer, becoming strong and resilient again.



Image 10: (Wikipedia, Nacre Shell)



Image 11: Gunpowder flask



Image 12: decorative wall



Image 13: Altarpiece

Mother of Pearl is also used in architecture and objects for iridescence, " an optical phenomenon in which hue changes from which the angle it is viewed." (Wikipedia, iridescence), as well as its strength and resilience. In interiors, doors countertops and ceilings.

In relation to furniture design, by definition self-assembly is the "construction of materials, especially furniture, from materials sold in kit form" (dictionary.com). Furniture, such as chairs and tables which we sit on, need to hold a lot of weight. By mimicking the phenomenon of Mother of pearl, using its strength and resilience, also its beauty we can incorporate it into furniture design. Using the layering technique to create a strong piece of furniture created.

" When two hydrophobic surface come in contact and remain in contact, they bond." (Maths.udel.edu/MECLAB). Using this idea of self-assemble bonding as a means to adhere two materials together, and the layering technique and material of the nacre shell, a very natural piece of self assembled furniture can be created.

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