Design snap shot 11: Biomimicry

Summary

Introduction

This snap shot discusses the use of biomimicry (from the Greek: bios meaning life; mimesis meaning imitation) in the design of Council House Two (CH2) and what the benefits and final outcomes were.

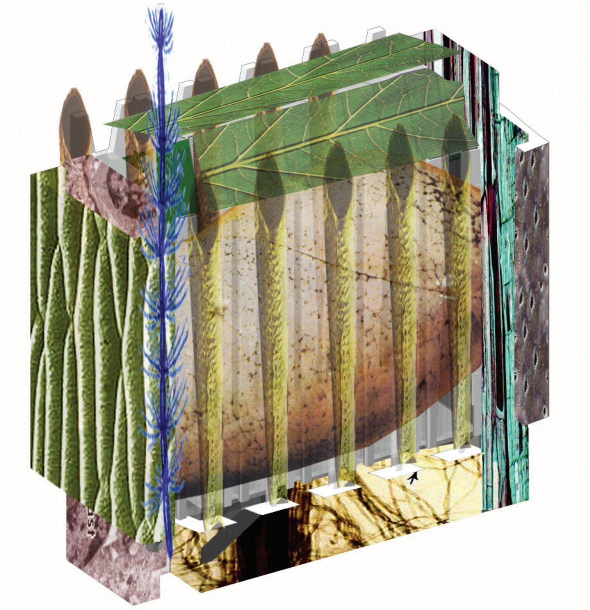

Figure 1. Image of CH2 as representative of its environmental elements (DesignInc)

Drivers and objectives

The main driver was to have the best design possible: one which was energy efficient, comfortable, environmentally responsible, 'future proofed', leading edge and met the Council's commitments to the environment and its staff.

Benefits

- Energy efficient design which successfully integrates various elements to achieve these goals
- Reduction in greenhouse gas emissions
- A comfortable building for users resulting in reduced sick days and potentially aiding in the retention of staff
- A unique building which will be a landmark, lighthouse project and an example of the Council's commitment to the environment
- Education of professionals and public about environmentally and socially responsible design

Outcomes

Inspired by nature and particularly the termite mound, the design includes:

- Use of thermal mass absorbing excess heat and night purging for cooling the building;
- Air displacement which moves the air through the natural process of hot air rising, pulling cool air through the building;
- Use of façades to cool and heat building with shutters that respond to the position of the sun;
- Concept of the equivalent number of leaves or as Professor, Rob Adams, Director Design and Urban Environment, says 'replicate the footprint in greenery on the building' which has resulted in planter boxes and roof gardens which will equal the plant area that the building occupies.

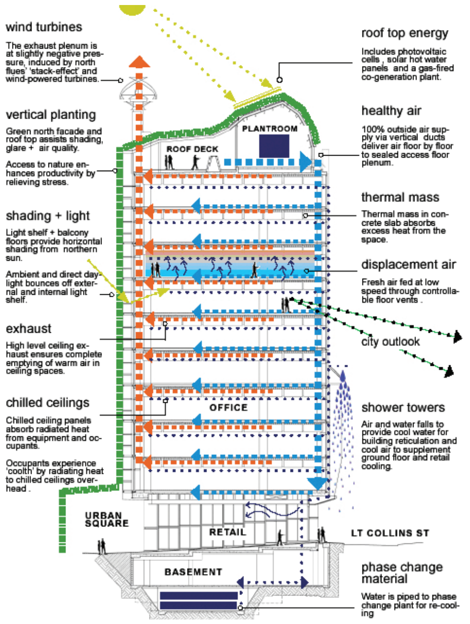

Figure 2. Translation of termite mound concepts into CH2 design (DesignInc)

Lessons

Natural systems function without waste, and within an integrated web of relationships and interdependence, which sustains the system over the long term. There is a lot that can be learned from nature. Using natural systems as inspiration supports the creation of buildings that minimise the need for energy for heating and cooling, and in many cases improves the amenity as well as indoor environmental quality.

More detail

Biomimicry – an introduction

(from the Greek: bios meaning life; mimesis meaning imitation)

One of biomimicry's first proponents was Richard Buckminster Fuller. He studied nature's constructing principles to solve human problems, and introduced synergetics in the 1950s. Synergetics explores holistic engineering structures in nature. Biomimicry draws on how nature deals with situations that can be analogous to human situations and problems. In mimicking these biological designs, processes and laws, biomimicry is about learning from nature, being inspired to create an adapting, evolving sustainable lifestyle.

Biological systems are truly sustainable. They are efficient, drawing all that they need from within the immediate environment. There is balance in a natural biological system in which the plants and animals have adapted over millions of years of natural selection to live successfully. Biomimicry is about drawing on this wealth of information to apply the biological laws to develop equally successful human designs and systems. The principles of sustainable agriculture, green building, environmental design and industrial ecology are based on natural systems. Designers need to further draw on information already gathered by ecologists and biologists.

A simple example of biomimicry is the invention of velcro. It was invented by a Swiss inventor, named George de Mestral. He was walking his dog one day and noticed how cockleburs were sticking to his pants and his dog's coat. He examined the cockleburs under a microscope and noticed the hook-like structure on the burs. This led him to the invention of velcro, now an everyday object.

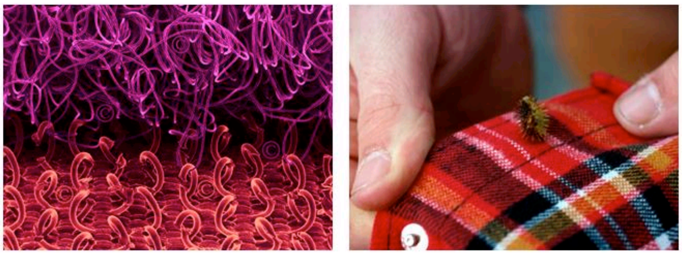

Figure 3. Image of a bur and its attachment to fabric[1]

The building as an integrated system – biological synergy

CH2 has been designed to be a highly energy efficient and sustainable building, with all its systems and spaces forming an interconnected and inter-related whole. Much like a living organism, the building requires all of its limbs and organs to fully function. Below is a brief outline of this biological synergy.

1 http://wetware.hjalli.com/cat_biomimicry.html last accessed 29/09/04

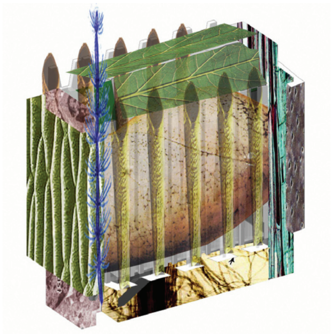

Figure 4. Image of CH_2 as representative of its environmental elements (DesignInc)

1 Leaf structure: air cleaning and processing, combined with collecting energy and dissipating heat.

2 Growth plane: roof terrace supporting living plants and grasses for the enjoyment of building inhabitants.

3 Bronchia: enclosed duct spaces for delivery of vital gases.

4 Root: network of connections to ground, provision of public services, buttressing to the city plane, sewer mining for non potable water.

5 Stem: primary core structure and arterial volume providing network of reticulated fluids, gases and nervous system of building for control of cooling, heating and ventilation.

6 Epidermis: external layer of skin for protection from the elements.

7 Dermis: sub-layer of skin composed of enclosed spaces to filter wind, light and sound.

8 Antennae: vertical mast carrying vegetation and weather monitoring equipment for control of cooling, heating and ventilation.

9 Bark: external ventilation module for waste and toilets, with inhabitable external balconies.

10 Soft body: the internal activity zone of the building where climate is modified for people.

In the case of CH_2, nature has inspired various aspects of the design – from the superficial (the eastern façade is inspired by bark) to the deeper, integrated cooling and heating systems.

The nature inspired systems incorporated into the CH_2 design are:

- The termite mound using thermal mass and natural air movement
- The epidermis or skin (which influenced the facades design)
- Bark inspired eastern façade
- The concept of equivalent number of leaves

The termite mound

Principle Design Architect Mick Pearce had previously used the concept of termite mounds systems successfully in the 'Eastgate' office building in Harare, 1992-1997. He transformed the simple design and system that termites build to control the temperature of a termite mound, into the air conditioning systems of a building. In a termite mound, the cool wind is drawn into the base of the mound via channels and the 'coolth' is stored using wet soil. As the air warms, it flows upwards and out of the mound via vents. The termite mounds are able to keep a stable temperature within, allowing the termites an ideal temperature for harvesting, despite the large variations in temperature outside. The termites reside within the air ducts, working within the natural convection currents.

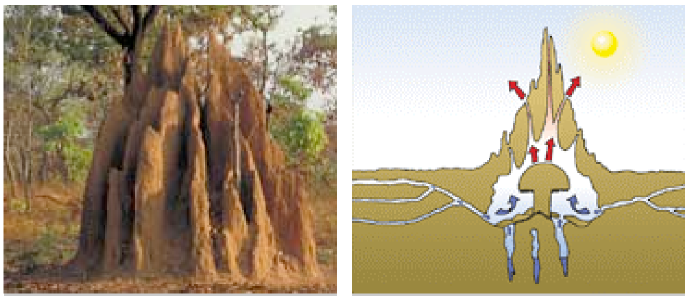

Figure 5. Termite mound and physiology working process (DesignInc Melb)

The elements of the thermally efficient design concept for CH2, stimulated by the termite mound, were the use of natural convection, thermal mass, ventilation stacks and water for cooling.

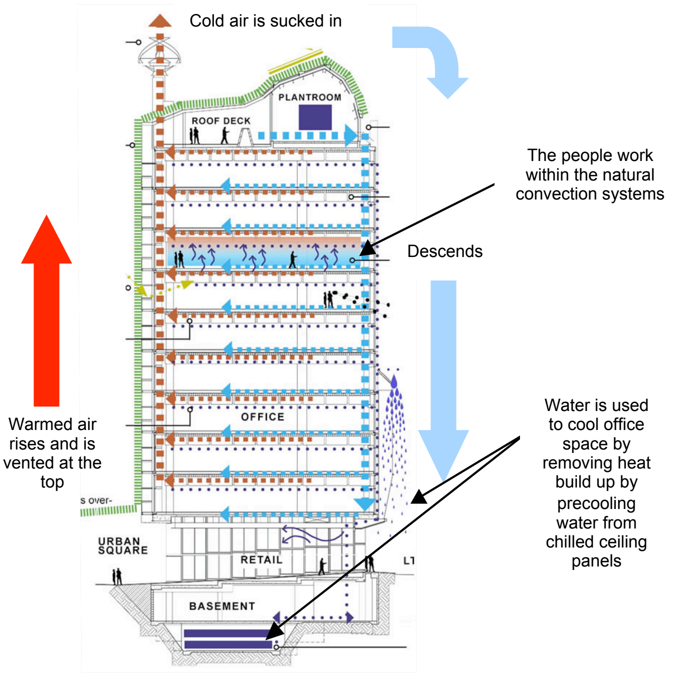

Figure 6. Translation of termite mound concepts to the CH2 building (DesignInc Melb)

The skin

The horizontal as well as the vertical form of CH2 was developed by the example of skin, composed of epidermis (outer skin) and dermis (inner skin). Conceptually, this notion developed into the facade becoming analogous to an 'inhabited skin', or a traditional veranda.

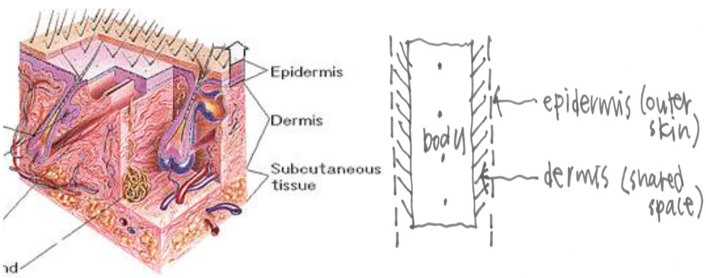

Figure 7. Skin cross section and its adaptation in the workshop to the CH2 plan (Images used in the charrette)

The dermis translated to the outside zone to house the stairs, lifts, ducts, balconies, sunscreens and foliage with the inner line defining the extent of the 'fire compartment'. All structures within the dermis were to remain lightweight and steel framed. The outer epidermis provides the micro–environment including the primary sun and glare control for the building while helping to create a semi enclosed-micro environment for the users' outlook.

Bark facade

Inspired by the aesthetic and function of bark which protects and houses the tree, the eastern façade houses the service core and toilets to the building. The bark façade was conceived as a second skin, or protective layer assisting with the natural ventilation of the wet area spaces. The final solution consists of two overlapping layers of perforated metal with polycarbonate walling and fixed metal louvres.

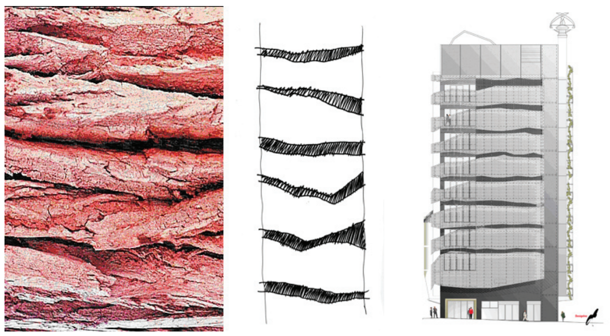

Figure 8. The bark inspired eastern façade (image from charrette, resulting drawing and image DesignInc)

Restoring the site to original foliage levels

Another innovative concept of the design of CH2 is the provision of the same amount of foliage on the building as would have been present if the site was still in its original natural vegetated state. This concept and guiding principle of the design is depicted in the iconic image of the building (see figure 4).

The roof garden, together with the planter boxes on the northern façade, meets this aim and provides a micro climate for various building spaces. The roof garden is a large space for use by the staff in the building as a breakout space and for recreation.

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In the roof garden, we've tried to replicate the footprint in greenery on the building, so we've set as much greenery as we would have taken away had this been a virgin site. We will replicate that on all elevations. We have plants growing up and across the roof. Rob Lewis, Project Superintendent, Melbourne City Council

Figure 9. Roof Garden (DesignInc Melb)

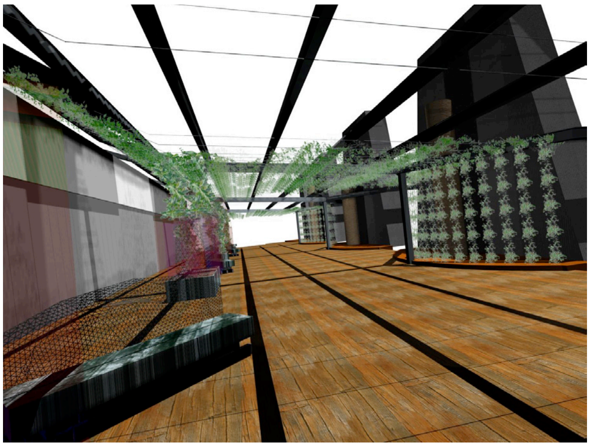

Figure 10. Roof Garden (Phil Edwards, City of Melbourne)

The northern green façade is made up of planter boxes situated to the east and west of each northern balcony. The interesting challenge for these planter boxes was how to get water to the plants. Innovative solutions were developed by the landscape architect involved in the project in collaboration with the architects, hydraulic and structural engineers (see Snap Shot 9: Water Initiatives).

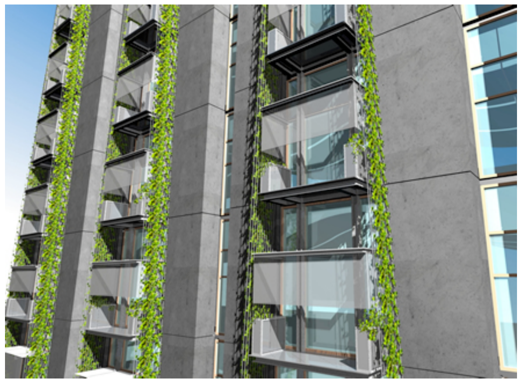

Figure 11. Northern green façade (DesignInc Melb)

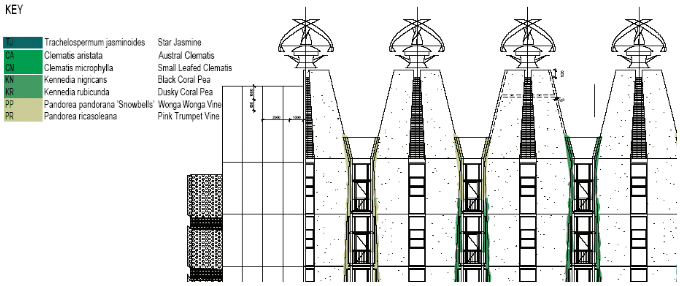

Figure 12. Balcony View showing the range of planting used (Phil Edwards – City of Melbourne)