

CH₂ Setting a new world standard in green building design

Design snap shot 07: Design Features

Summary

Introduction

This snap shot provides an overview of the design features for Council House 2 (CH₂). It outlines the influences behind the design features chosen, and the final outcomes.



Figure 1. Model of the CH₂ building south-west corner

Drivers and objectives

The main driver was to create an effective building for the staff and a building that would be a lighthouse project locally, nationally and internationally for environmental innovation. A project that informs practice for architects, builders, buildings owners, engineers and users.

The design started with a very simple brief for the building to:

- be greenhouse neutral
- be a 'lighthouse project'
- improve employee wellbeing

Analogous to industry transfer

- World class solutions for inner urban sustainable, integrated commercial building design
- A design model that other projects can learn from
- Lighthouse – to influence other new building developments
- Energy Efficiency will save \$720,000/yr
- Comfortable and stimulating environment for staff, expected to improve staff health and retention, saving a potential \$1.12million/yr
- Retain the equivalent area of greenery to what would have been on the site if there was not building there
- Potential to achieve the aim of zero net greenhouse gas emissions by 2020
- Responsible material selection protecting the biodiversity of the environment, the health of Council staff and minimising environmental impacts wherever practical within the current market and information availability
- Improved indoor environmental quality through responsiveness to natural external climatic conditions, attention to material selection and design for human physiology
- Effective integration to the aesthetic and culture of the city
- Vibrant tangible potential to educate the public and building professionals

Outcomes

The design team was guided by the Council's objectives and inspired by natural systems. There were various design outcomes from this:

- Innovative heating and cooling systems using active and passive systems
- Design for displacement ventilation to create a more productive environment and reduce spread of illness
- Clever interface with the public and outside environment through the use of a semi enclosed stairwell – while providing for the fire rating requirements

(More design outcomes are listed in the table on the last page).

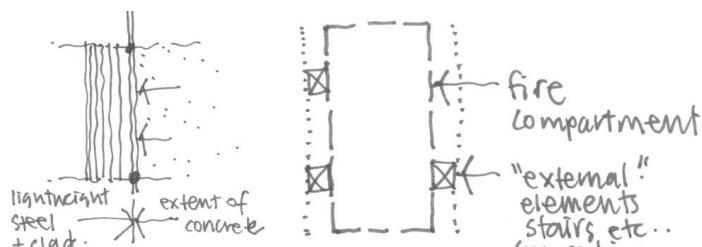


Figure 2. Diagram used in the initial workshop to capture the idea of the building façade as a skin

Lessons

Building design can be a synergy between different principles, ideas and demands. The result of collaboration and communication between all people involved in the delivery of the building and the client can create an innovative design and a building which will be a positive place for people.

More detail

CH2 is to be a landmark sustainable commercial building. The aim is for the building to become a 'lighthouse' design for future central city development in Melbourne. The approach taken towards sustainability is one that incorporates and draws on social, economic and natural aspects.

Design development

The key influences on the design of CH2 were the aims and objectives of Council, the influence of nature, the need to future-proof the design, and, later in the process, the use of the Green Star Office Design methodology. Art was also a major influence in the design. These influences were incorporated in to the design charrette process, which developed the design of the building centring around concepts such as biomimicry.

The charrette process

A charrette is a highly intensive 'workshop' process that involves all members of the project team. Charrettes have set goals and a set timeline in which the goals must be achieved. The advantage of the process is that it allows a greater depth of understanding between project areas, team members and allows holistic idea generation and problem solving. (See Snap shot 3: The Design Charrette for a more detailed discussion of the CH2 Design Charrette).

The CH2 charrette was set over two weeks, with the final output being the building's preliminary design, of which 80–85% remains in the final design. The collaboration of the project team from the earliest possible stage ensured the design addressed the aims of the project. The charrette workshops were pivotal in creating the vision of the building, and in educating the whole team and all the consultants in the breadth of the project. It also created an atmosphere which was creative, stimulating and challenging, resulting in many problems being avoided at an early point in the project. The involvement of all the consultants meant that each discipline was able to understand the demands of the each other. This also had the benefit of bringing different disciplines and approaches to a problem. It should be noted that the Green Star Office Design Rating Tool methodology did not exist at the beginning of the design process. Instead the US Green Building Council's LEED (Leadership in Energy and Environmental Design) Green Building Rating System¹ and the UK based BRE Environmental Assessment Method (BREEAM)² were used as guides.

¹ <http://www.usgbc.org/>
² <http://www.breeam.org/>

There were four key concepts that came out of one of the first sessions in the charrette process, and these were articulated as part of the documentation process by CSIRO Evergen who facilitated this:

- 1 People: provide a healthy, comfortable, adaptable and stimulating working environment for its primary users (staff) and visitors. The building should be welcoming, accessible and easily navigated;
- 2 Eco exchange: the building should respond and interact with its natural environment in a responsible way throughout its life cycle. It should do this through use of natural resources (eg. materials, water), efficiency of form and design, efficiency of construction and operation, the ability for effective reuse, the minimisation of waste, the maximisation of the use of renewable energy sources during its operation and an overall aim to reduce greenhouse gas input to zero;
- 3 Green print: it should also provide at least the same area of green cover as its footprint bearing in mind that this area can be measured vertically as well as horizontally;
- 4 Eco-nomics: the idea of 'more from less' – that is, no longer having a focus on minimising costs but balancing costs with good building construction, optimal operating condition and focussing on people and the environment while maximising value and benefits throughout its life cycle.

All of these ideas, and the design outcomes, were developed within the framework of the building being a light house project – that is making it relevant to industry.

Nature as an inspiration

Biomimicry (from bios, meaning life, and mimesis, to imitate) is a field of study that attempts to apply approaches/processes found in nature to solve human problems. The logic behind biomimicry is that nature has had millions of years to perfect different ways of doing things, and the approaches used have already been 'tried and tested'. Some of the more well known examples of biomimicry include the development of Velcro from the way burs stick to clothing (see Snap Shot 11: Biomimicry).

In the case of CH2, biomimicry was used to help work out how to cool the building in the most efficient manner (the design of a termite mound) and how to design the most effective building form (mammalian skin structure).

The heating, ventilation, and cooling (hvac) system The Termite Mound

The first application of biomimicry on the design came by examining how termite mounds function. 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 in the mound, 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 living and laying eggs, despite the large variations in temperature outside. The termites reside within the air ducts, working within the natural convection currents. This 'design solution' from the natural world has been transferred and applied to the air conditioning system of CH2, as illustrated in Figure 3 and 4.

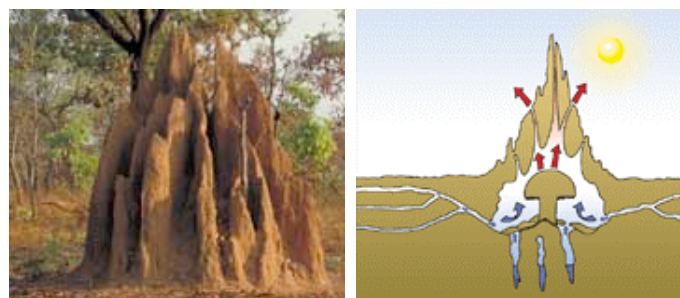


Figure 3. Termite mound and physiology working process

This approach resulted in a heating and cooling system which applies natural air convection, thermal mass, ventilation stacks and the use of water for cooling. These are illustrated below, and many of these are also discussed in greater detail in other snap shots.

Principal Design Architect, Mick Pearce, had previously applied this approach in the 'Eastgate' office building in Harare, Zimbabwe, 1992-1997.

Ventilation

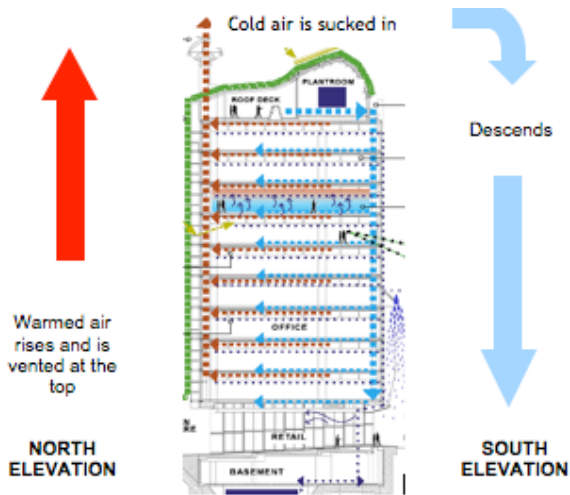


Figure 4. Translation of termite mound ventilation to the CH2 building

Ventilation stacks

Ventilation stacks to channel the air have been designed to the north and south of the building. The north side receives more sun during the day, so the ventilation stacks are black to absorb heat from the sun's rays. This encourages the warm air from the building to rise up and out of the stacks. The south side receives less sunlight, so the cold air is channelled down through the vents, which are light coloured so as to reflect heat, allowing the air to remain cool.



Figure 5. North and South Façades

The ventilation stacks are also angled so that they are larger at the top. This encourages airflow as well as controlling natural lighting levels. The largest windows are at street level (smallest width of stack) where there is the least natural light, gradually reducing window sizes until at the top there is the most natural light and therefore the smallest windows (largest width of stack). The figure below indicates the amount of natural light that enters the building.

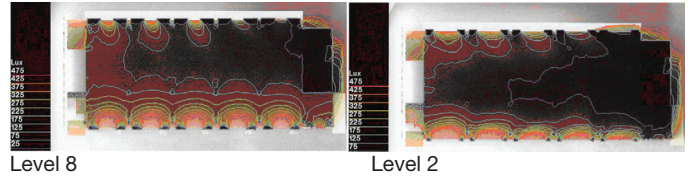


Figure 6. Lighting study depicting the amount of natural light entering the building

Thermal Mass

The ceilings are made from precast concrete which has high thermal mass, and are 'wavy' in shape which increases the surface area and the thermal mass capacity. The ceilings perform the same function as the soil in the termite mounds. The building spaces remain cooler because the thermal mass in the concrete is flushed at night, through a night purge, absorbing coolth from the night air and allowing it to absorb heat from the space during the day. Heated air collected at ceiling height is also channelled out of the building and into the ventilation stacks.

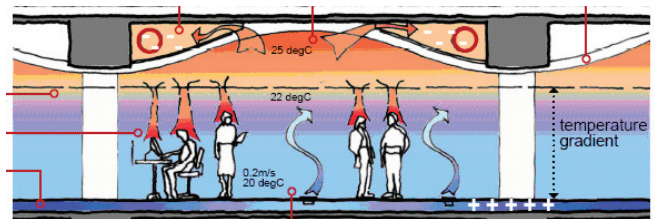


Figure 7. Wavy concrete ceilings help keep the building cool by slowly releasing 'coolth' and absorbing heat

Chilled beams and ceiling panels

Water is used to cool the building. The panels and beams run chilled water through them to providing radiant cooling. The rising warm air is cooled by the chilled panels which then drops, creating a natural convection current.



Figure 8. Chilled ceiling panel providing radiant cooling

Phase change material

The design includes the use of a phase change material to cool the water for the chilled beams and panels. This is often referred to as the 'battery' of the building, i.e. storing the 'coolth'. It efficiently helps to keep the water circulating through the chilled panels and beams at the desired temperature (see Snap Shot 15 Phase Change Material).

Shower towers

Through the shower towers on the southern façade, outside air is drawn in from above street level and is cooled by evaporation from the shower of water. The cool air is supplied to the retail spaces and the cool water is used to precool the water coming from the chilled water panels. This system is also an interpretative element as it demonstrates externally the environmental principles behind the building (see Snap Shot 6 Shower Towers).

The building shell

The Skin

The horizontal form of CH2 was developed by incorporating basic features of mammalian skin, composed of epidermis (outer skin) and dermis (inner skin). That is, the outer skins allows breathing and interaction with the external environment (see the eastern and western facades) while the internal skin protects the internal conditioned space.

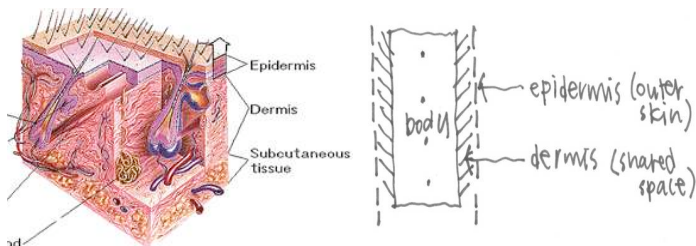


Figure 9. Skin cross section and its adaptation in the workshop to the CH2 plan (DesignInc)

The dermis is the outer zone that houses the stairs, lifts, ducts, balconies, shade screens and foliage with the inner line defining the extent of the 'fire compartment'. All structures within the dermis will 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.

The office space

The workspace was developed with the needs of the staff as paramount. The building needed to be comfortable for those working – supporting their activities, health and wellbeing. The floor plan was divided in two types: shared space and work space. This approach allows darker spaces for computer work, and with shared spaces adjacent to windows to make the most of the natural light. The workspace is primarily open plan, but a lot of thought and consultation was put into the allocation of space for meetings, quiet areas, relaxation and general work. It works well with the rectangular envelope available on the site.

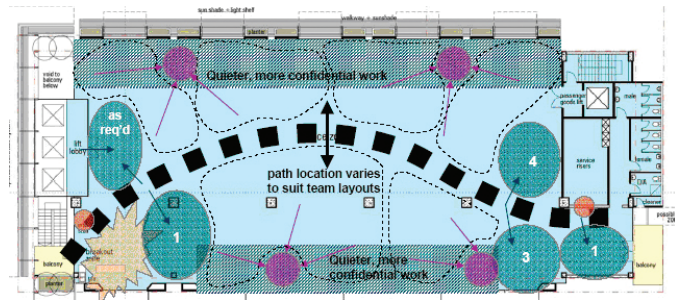


Figure 10. Flexible open plan office design

Working with the rectangular site and the open plan requirement resulted in a 'deep space' office building. This presented many challenges to the designers and engineers for natural lighting and air conditioning, particularly given the objectives of low energy use and high indoor environmental quality. Aiming for a green, deep space provides a more flexible, 'future-proofed' floor plate.

The solution to these challenges is a unique system of air and light distribution: barrel vaults running in north to south direction like waves along the ceiling. This provides space for air distribution ducts as well as enabling light to penetrate deep into the offices.

Art

Artists were commissioned to be part of the charrette process to present their ideas and collaborate with the design team. The artists used examples from nature to create an impressive art landscape. They were inspired by black and white shells of the cockle (waste products of the mussel industry), charcoal (coloured tiles with the imprints of fossilised birch branches for the parking deck), bark, crinkled paper, embroidery patterns and coral surfaces. The study of nature became an important vehicle for the symbiosis between art and architecture. The art provided a link between the physical and psychological, mind and body, the seen and the unseen.

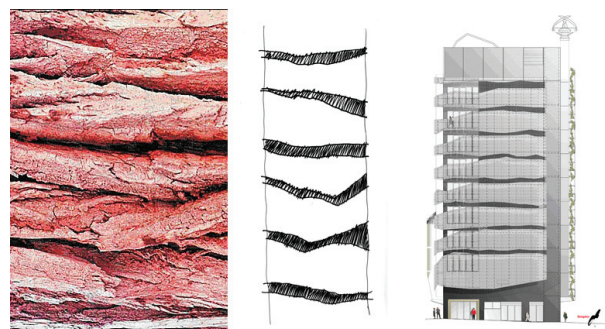


Figure 11. The bark inspired eastern façade (image from charrette, resulting drawing and image DesignInc)

Artists were also involved in creating work that would convey to the public the nature of the CH2 building development, and in the future they will continue to contribute artwork to the interior of the building.

This is a good example of how an artist can add to the artistic vibrancy of the city by working on a feature that is necessary but often uninspiring. With Jones' input, CH2's hoarding has become a 93-metre cultural advertisement for the building and for Melbourne. **Cr Kate Redwood, City of Melbourne**



Figure 12. Art was used in the charrette process and was also integral to the whole building process. Here, the art is a part of the fencing around the project June 2004 (Artist: Cara Jones)

Green star rating system

Another influence on the design was (initially) using the US Green Building Council's LEED (Leadership in Energy and Environmental Design) Green Building Rating System³ and the UK based BRE Environmental Assessment Method (BREEAM)⁴, and later having an awareness of what would meet the Green Building Council of Australia's Green Star – Office Design (v1) rating system for commercial buildings. The tool's comprehensive evaluation process rates the building in relation to its management, the health and wellbeing of its occupants, accessibility to public transport, water use, energy consumption, the embodied energy of its materials, land use and pollution. It therefore highlights these areas for designers and what is the leading edge.

(See Snap Shot 4: Green Star Office Design)

Future proofing

Future proofing is a term used to describe actions that help delay, or even avoid, obsolescence for as long as possible. CH2 is a project that tries to minimise future risk. The project team have tried to forestall the pressures of the next 50 years and have asked the question 'what are the main priorities and risks to the Council?' In summary, they are:

- 1 Responsibility to City of Melbourne constituents
- 2 Increasing costs for water and energy over time
- 3 Providing an advantage in attracting and retaining good staff (often called the 'war for talent')
- 4 Addressing corporate social responsibility issues
- 5 Minimising risk to the Council through comprehensive risk management
- 6 Minimising Indoor Environment Quality (IEQ) risks – in the US this is seen as one of the five main litigation risks facing organisation (i.e. people suing for becoming ill in 'sick buildings'⁵)
- 7 Tools and systems to help identify and categorise IEQ issues – give a more objective basis to a highly subjective area
- 8 Reducing staff turnover ('churn')
- 9 Improving staff satisfaction
- 10 Having standards to allow demonstration of compliance with regulations and standards

I think the industry would change when it realises the risk it runs. Not only environmentally, but health wise, with the buildings we design today. **Rob Lewis, Project Superintendent, City of Melbourne**

The design outcomes of future proofing included a flexible floor plate with displacement ventilation, open plan workspaces, a carpark which can be converted to future lettable area, energy and water use minimisation and backup generators (co generation).

⁵ Insurance and Liability - The past decades' conventional office design, construction, and operational practices have decreased the quality of the indoor office environment, resulting in new health concerns and associated economic costs and liability. The introduction of a multitude of new pollution sources into the workplace, combined with tighter building construction, has intensified air-quality problems. For example, poor indoor air quality can result from such factors as faulty air-conditioning systems, occupant-related pollutants, construction materials that emit high levels of volatile organic compounds, and poor maintenance practices. The U.S. EPA ranks indoor air pollution among the top five environmental risks to public health. Unhealthy indoor air is found in up to 30 percent of new and renovated buildings. US Department of Energy (www.sustainable.doe.gov/pdf/sbt.pdf last accessed 13/07/2004)

The final outcomes

Decision (for more details see snap shots)	Why it was made	Alternatives considered
Sewer mining	Water from site is mainly toilet water and so it is more effective to sewer mine that to treat in house	Black grey water treatment only
Temperature range 21-24°C	Commercial building meeting current industry expectations	18-28°C and the use of no plant and only natural ventilation
Passive night purge	Low cost method for cooling thermal mass, modelling showed passive purging would be sufficient for a majority of the time	Active night purge
Co-generation	Lower peak energy consumption, gas is a more greenhouse efficient fuel, waste heat can be used for heating and cooling	
Chilled beams and panels	Radiant cooling is a more comfortable and effective way to condition working spaces with low flow air movement	Hybrid HVAC system and VAV
Use of water for transferring the 'coolth'	More efficient method of transferring 'coolth' than air	Air cooling
Phase change materials	Most efficient means of storing and transferring 'coolth'	Additional chillers and rack labyrinth
Recycled timber	Durable timber sorts which do not have forest impacts	Victorian ash and other hardwoods
Double skin façade – external permeable internal closed during working hours	Windows are public space work space conditioned with a great deal of passive air cooling	Cheese façade with individual window ownership
Vaulted ceiling	Allow natural light to travel further into the building, provide thermal mass. It also allows for improved stratification of the slow flow air.	Standard drop down ceiling and precast ceiling (if using raised floor)
Raised floor – 200mm low flow air	Effective space management system, allows maximum flexibility and low velocity displacement air delivery system	Standard precast floor with drop down ceiling, 80mm raised floor for data cabling only. 250-280mm raised floor if using air-conditioned air.
Semi enclosed stairwell	Transparency to the street, connectivity to constituents and ability to get fresh air while moving between floors.	Enclosed stairwell
Under floor primary air supply	Health benefits and ability to need less energy for fans	Overhead supply
Wind turbines	Most effective in supporting additional night purging at 6%	Wind cowl Simple stack