CH2 Setting a new world standard in green building design

city of Melbourne

Design snap shot 03: The Design Charrette

Summary

Introduction

This snap shot discusses the charrette process used for the development of the concept design of Council House Two (CH2). It briefly outlines the reasons the charrette process was used, its costs and benefits and the final outcome.

Figure 1. Participants at the charrette

'Charrette' is a term used in architectural circles to describe the intensive pooling of ideas. The original meaning of 'charrette' (cart in French) signified the collection of student design projects in a cart at the end of the year. In the case of the CH2 project, the charrette was a two week gathering of the project team which enabled brainstorming of the project design principles. This was followed by further development of ideas in a third week in smaller groups.

Drivers and objectives

The charrette process aimed to build a cooperative, collaborative team where differences could be ironed out early in project design, while providing an opportunity for all of the team to gain ownership of the design through developing and reviewing the whole design at the initial stages of the project.

Hence, the objective was to strengthen the project team and bring all the consultants together in a collaborative environment, allowing them to consider innovations that might turn CH2 into a true lighthouse project.

Costs and benefits

The charrette process was paid for on an hourly rate at a total extra cost of $170,000. It resulted in a 6 months shortening of the design time. There were also numerous other benefits, including:

- Early clarification of goals and objectives
- Resolution of 70-80% of the building design and building systems.
- Reduced total design and tendering time (finished within 12 months – 6 months less than expected).

Outcomes

The team outcomes included holistic team building, clarification of goals, solving of problems based on the knowledge of all the design team, innovation, improved understanding of other disciplines and professions, and improved communication and team bonding. The project outcome was a design driven primarily by the needs of intended occupiers and the minimisation of environmental impact, as well as a coordinated and integrated design at concept stage (not usually achieved in a traditional linear design process).

A major breakthrough at the charrette was the decision to use water instead of air for cooling. Other specific building design outcomes included:

- 100% fresh air
- Use of stack ventilation
- Use of under floor air distribution
- Larger windows decreasing up the building as stacks increased
- Shower towers

Snap shot compiled by Dominique Hes, dhes@unimelb.edu.au from input by the entire design and construction team.

- Cogeneration
- Design elements to minimise heat load
- Natural light for communal spaces
- Chilled water cooling
- Temperature range of 21-25°C in offices
- Primary air at 22l/s/person (twice the Australian standard)
- Use of vaulted ceilings
- Use of thermal mass and night purging
- Use of thermal store (probably phase change)
- Use of wind turbines on top of the stacks
- Low background light with individual task lights
- Potential use of sewer mining and rain harvesting
- Incorporation of horizontal and vertical greenery
- All innovation needed to have high level of risk analysis and mitigation

Lessons

The key lesson from the charrette process is that significant innovations can come out of getting all consultants on a project together early on to discuss the project and pool ideas.

More time could have been spent planning the charrette and most participants wished there had been more time getting to know everyone in the team.

Strong facilitation needs to be provided to manage the various personalities and points of view of a design team. There needs to be a 'visionary' as part of the project to retain the initial intent while the details are finalised.

More detail

The goal of the CH_2 design team was to produce a building that set a new benchmark for ecological sustainability in office development. It also set out to produce a healthy and stimulating workplace that supports cultural change, is economical, and can be used as a model for future development.

The design process was distinguished by the interactive exchange of information and ideas between the consultant teams. Through this process, all parties were able to have an input into the design and to achieve professional 'ownership' of both their particular discipline and the project as a whole. The project team included all consultants, artists, the CSIRO and the Sustainable Energy Authority of Victoria.

The first few sessions of the charrette were facilitated by Dr Greg Foliente. The rest were managed by the City of Melbourne team. All sessions were made up of a series of presentations, discussions and working parties. The documents and outcomes were summarised in a series of internal publications called the Hairy House and the Council House Redevelopment Design Workshop.

The brief for the building needs can be summarised as:

- greenhouse neutral
- a lighthouse project
- prioritise employee wellbeing
- amenable to industry transfer to other projects

The schedule for the charrette is summarised below, showing the type of workshops that took place, space for discussion and group work, etc. A further week involved consultants to a varying degree.

Day one

Discussion and development of:
Set outcomes and objectives

Discussion of major concerns of concept

Design considerations

Preliminary investigations

Sustainability

Education

Presenting a united front

Retail strategy

Technical documentations

Requests, goals and general information and discussion

Day two

Presentations from DesignInc, Bonacci, Evergen, process consultant, Mechanical and environmental engineers – Lincolne Scott/AEC

Development of objectives

Break into groups – people, design, car park and streetscape

Prepare results and present the next morning

Day three

People group presentation

People group – retail strategy

Split into groups

Day four

People group presentation

Split into groups – building, car park streetscape, car park construction and people group

Presentation from Design Inc

Split into design workshop and documentation workshops

Day five

Group presentations – City of Melbourne and Design Inc, Bonacci, artists

Define objectives and goals

Split into design workshop and documentation workshops

Day six

Group presentations – City of Melbourne and Design Inc, design considerations, Bonacci, artists

Split into groups – building, streetcape, construction and people

Split into design workshop and documentation workshops

People group presentation

Design considerations

Skin analogy

Technical considerations

Week one summary

Report on assumptions

Car park feedback

Design feedback

Retail strategy

People feedback

Evergen feedback

Statement of requirements – people, eco-exchange, green print, economics

Day seven

Group presentation – City of Melbourne and Design Inc, landscape

Design and people groups

Day eight

Design day

Day nine

Monash Environment Institute – green office program

Group presentations

Design and people groups

Day ten

Consultant presentation

Artist presentations

Drinks

Over 30 consultants participated in the charrette, and the list below indicates both the people and organisations involved, and the range of their different disciplines, from advisors on climate, to acoustics, to turbine design and geotechnical advisors.

In addition, various people from Melbourne City Council participated in and facilitated the workshops, as well as three artists, who were commissioned as part of the charrette process (See Snap Shot 7 – Design for more information).

Company	Purpose
MCC City Projects, Arts and Culture	Design and holder of the vision Input from council perspective on art and culture
MCC City Strategy and Development	Ensure alignment with MCC strategies
MCC City Assets and Services	Ensure alignment with MCC asset policy
MCC Best Value and HR	Ensure alignment with MCC HR policy
DesignInc	Architectural development and documentation
Lincolne Scott	Building services
Advanced Environmental Concepts (AEC)	Environmental services engineering, design and research
Bonacci Group	Structural engineers
Donald Cant Watts Corke	QS
Andrew O'Brien	Traffic consultant
CSIRO Evergen	Facilitation and materials advice
Carl Mahoney	Climate science
Professor Alan Rodger	Technical advice / sustainability
Simon Perry	Artist
Steve Hope	Artist
Cameron Robbins	Artist

Table 1. The Project and Supporting Consultant Groups – Initial charrette

Costs and benefits

The idea for the charrette was developed late in the process. It came out of a discussion within the City of Melbourne team following the appointment of consultants. It was driven by the need to quickly bring a large consultancy team together in a focussed program to refine and test the initial design idea approved by Council. The key message from City of Melbourne to the consultant team was: "We are happy to pay extra to test the initial design assumptions but your obligation is not to tell us in 12 months time that there was a better way of doing it." Professor Rob Adams, Director City Projects, Arts and Culture

The main charrette cost was the $170,000 in extra consultants' fees to allow for them to be available for the intensive 2-3 weeks period. The charrette was organised so that most of the group would be together at the start of each day, then individuals would pursue various tasks arising during each afternoon. Not everyone was required to be part of the process all the time.

This structure proved very efficient and effective, as issues would be discussed in the morning and any problems raised which could not be solved around the table would be actioned to individuals, who would then research and develop solutions to them in the afternoon, invariably reporting back the following morning with a solution.

This also gave the consultant group the flexibility to continue with other urgent tasks in the afternoon or, if they weren't required in particular tasks arising that morning, they could attend to other matters in the afternoon. The block of time was therefore a very effective way of providing resources for the core project team, including instantaneous peer review by some of Australia's leading building consultants.

A major benefit of the charrette process was that most issues had been resolved, and those that came up afterwards were resolved based on the same trust and cooperative intention which had been built up in the charrette process. In the first week there was team building, developing the project goals and building attributes and establishing a process of logistics for team collaboration, communication etc.

03 The Design Charrette

Target outcomes were developed by the charrette group, then objectives associated with each were developed in a standard format. As a result, through this process most of the issues relating to the concept design were refined and resolved.

Some participants initially felt that the charrette would be a waste of time: why should they take several weeks off from their busy schedule to sit around and talk about design? 'Wasn't that the architect's job?' However, afterwards, all of the consultants expressed how rewarding the experience was and the general feeling was that, if anything, they would have liked it to have been a little longer so that they could have formed even better working relationships and progress on the building detail.

"When I was first asked to attend I thought it was going to be a waste of time …but it became the most rewarding experience – a really emotional, rewarding experience … in those two weeks, virtually the whole building was … sorted out." Nat Bonacci, Director Bonacci Group Consulting Structural and Civil Engineers

Outcomes

In the two weeks of the charrette, the basics of the building where determined (see below). These basic elements were then tested and refined over the following month.

Melbourne conditions

One of the first fundamental discussions which influenced all the outcomes concerned the climatic conditions of Melbourne, and the implications in terms of what would be required for a commercial building to function within 'A' grade parameters. Initial discussion centred around whether Melbourne was a heating climate or a cooling climate. It was shown that, although there is a greater percentage of time that it is below 20°C degrees in Melbourne than above it, office buildings actually require more cooling than heating because of the heat load from lighting, equipment and people.

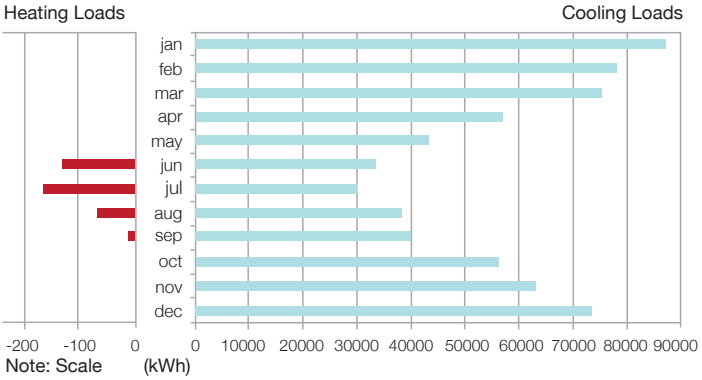

Figure 2. Monthly Heating and Cooling Loads (AEC)

These two factors together point to an opportunity to use the cold air outside to help with the reduction of the heat load inside. The summary below outlines how the related decisions which flowed from this were made by the end of the charrette.

Air

The building occupants will enjoy 100% fresh air, delivered through floor plenum distribution, with a supply diffuser at each desk that can be controlled by each person. Relief air is circulated via a cored vaulted ceiling to ventilation stacks on the north, called blades, which increase in diameter up the building (see Figure 4).

Cooling

The initial idea was to incorporate exposed thermal mass to 70% of the area, with chilled ceilings for the remaining 30%, using a metal pan design that is insulated from the ceiling mass and includes acoustic insulative functions. Later testing and refining of this chilled element concept and its function led to a reduction in the chilled ceiling area to 23%.

Discussion was supported by a focus on indoor environment quality and healthy spaces for occupants. Using water through chilled ceiling elements provides a radiated cooling which increases the perception of comfort to the users, as indicated by reference to international research made available through the charrette.

This led to the concept of the people within the office space effectively occupying the building air ducts, since they were now incorporated into in occupied office area (see figure 3 below).

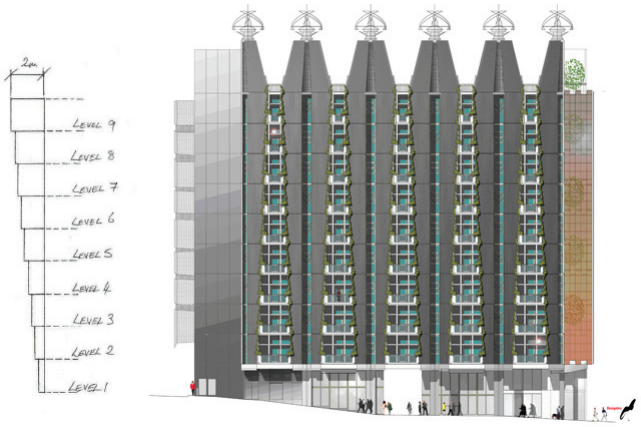

Figure 3. Blades to the North of the Building (AEC/DesignInc Melb)

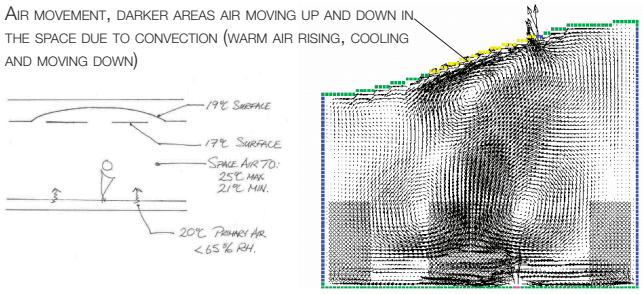

Figure 4. Temperature Stratification Modelling (left) and Testing of the Concept using CFD modelling (AEC)

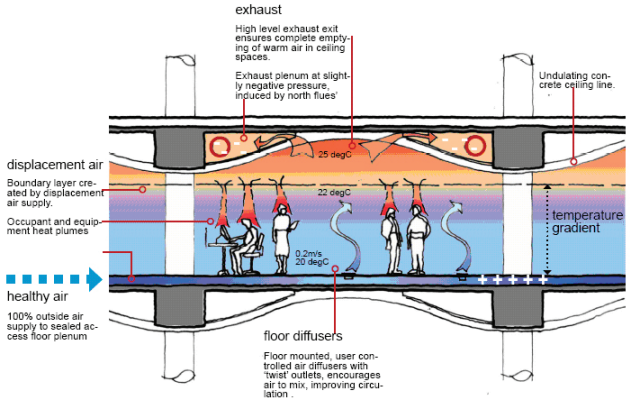

Figure 5. Air Flow in the Offices 'People in the Air Ducts' (DesignInc Melb)

Temperature

One of the most contested discussions at the charrette was around the temperature levels. These were initially set to 21°C min and 25°C max for the office spaces in line with 'A' grade building specifications. The main question was around whether these should be widened to decrease the amount of energy used for conditioning the space. For example, the German levels of 20-28°C were often quoted. The response to this was, firstly, that the German levels reflected individual office layouts, not open floor plans, and, secondly, that if CH_2 was to be a case study to move the industry forward then it needed to meet industry requirements (and for Australia these are 21-25°C).

Mechanical versus natural ventilation

A long discussion was had on the use of natural ventilation in the building, in fact one side argued to try to avoid any heating or cooling plant all together. Below is an extract of an AEC report (SFT30301) with the results of the modelling they carried out to show the impact of full natural ventilation without additional cooling:

During a typically hot summer's day, when the building is fully naturally ventilated the resultant temperature of the office during working hours are at approximately 25°C in the morning and increase hourly until its peak at 33°C at 6pm. We can also see that the maximum temperature experienced in summer is 37°C (see Appendix A. section 1.1). This indicates that during summer, a fully naturally ventilated building is unsuitable and air conditioning is necessary.

Aside from the potential discomfort the other side also argued that if this building was to be a demonstration building analogous to the industry and was meant to support further uptake then it needed to meet current commercial building standards. It was argued that having a building that was completely naturally ventilated and therefore having a much greater temperature and humidity variance would put it outside the Property Council of Australia (PCA) standards for commercial buildings and would alienate it from the property industry. As such, since one of the main aims was diffusion of the green features of the building it was decided to aim for a building that still met PCA 'class A' standards but did so as efficiently as possible.

Thermal plant

A major breakthrough at the charrette was the decision to use water instead of air for cooling. The chilled elements are already briefly discussed above, but it is important to note that this specific decision was made for several reasons. The first was that using water for cooling provided the radiant cooling which studies have found is more comfortable for building users. Secondly, water is a very effective way to transport 'coolth' and allows the 100% fresh air strategy to be implemented. Cooling water can be supplemented by passive techniques such as the shower towers and radiant night cooling. Using water also allows for effective use of the thermal storage capacity of water, rocks or phase change materials.

The thermal storage concept was agreed upon at the charrette but there had not been a decision on which method would be used. The preferred strategy was phase change, but it was recognised as potentially the highest risk strategy, so water, rocks and saline baths were also investigated.

Thermal mass

The idea of using thermal mass to help in passive cooling of the building was flagged from the very beginning. The vaulted ceilings (see Figure 5) were eventually adopted as the central concept for the optimisation of exposure of the thermal mass to the office space.

When vaulted ceilings were first proposed, aside from the benefits (thermal mass, more natural light into the floor plate, etc.), several problems were put on the table. The QS could not give an accurate estimate of the cost, as this was unique system. Indeed, there was uncertainty as to whether it was even possible to precast a system of this nature. Associated issues of cost of transportation, delivery, storage and actually lifting the systems were also raised. Bonacci, the structural engineers took the challenge and contacted precast concrete manufacturers and, within the week, had the information that could be used for a costed solution. This provided the confidence for the team to decide on this as the flooring/ceiling system.

This is an excellent example of how a charrette can deliver solutions to complex problems. The team wanted to use vaults running across the space and Bonacci developed a structural system which addressed all the problems. Hence a single solution, the vaulted ceilings, was adopted that addressed all the complex demands of gravity, light, air, people, heat, services, and energy.

"To have Bonacci, for instance … actually going to precast concreters and getting prices and advice on things that were just ideas at that stage … started the whole process …they had a section of the precast ceiling panels virtually designed in the first month that we started this project."
Stephen Webb, Director, DesignInc

Also it was decided to combine this with a night purge of air washing over the concrete elements and removing the heat collected in the concrete. This was only an effective strategy because of the favourable climatic conditions of Melbourne with its high diurnal range between daily high and nightly low temperatures. Further analysis in subsequent months optimised the thickness of the concrete for heat absorption and release, but the basic concept remained.

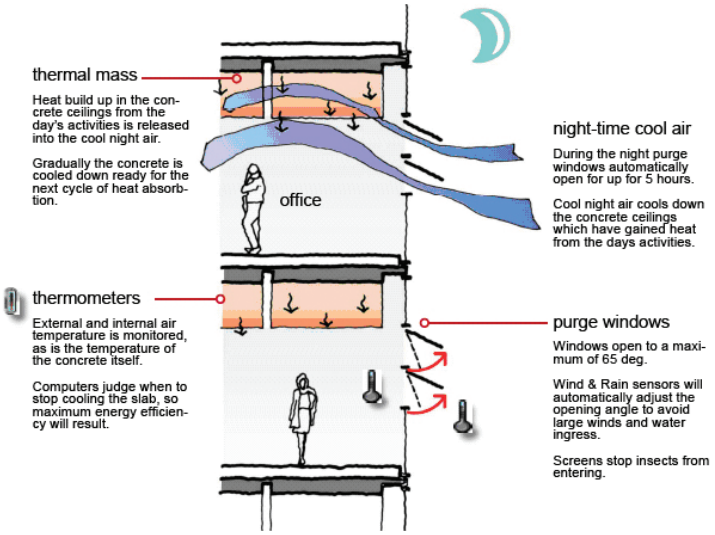

Figure 6. Night Purge and Thermal Mass Elements (DesignInc Melb)

Artificial and natural light

Initially, it was thought that natural lighting was not something which was going to be a useful strategy for the CH2 building because of the strength of the Australian sun. The research presented at the charrette that showed the IEQ benefits of the ventilation strategy also showed the advantages of natural light provision for the space. Thus, the building façade and use of natural lighting were refined looking at various configurations of the floor plate from the shallow space concepts with internal bays, through several other concepts to the square building design.

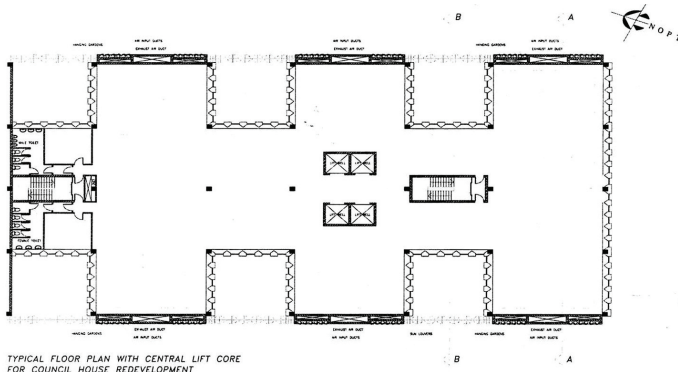

Figure 7. Building Development: The Shallow Space Concepts with Internal Bays

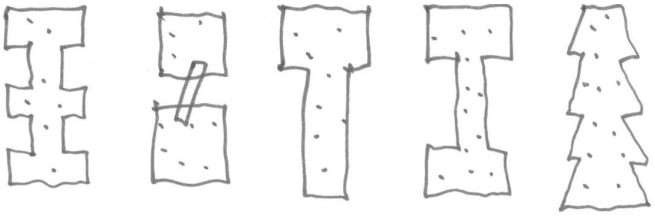

Figure 8. Building Development: Initial Concepts for Discussion (Mick Pearce)

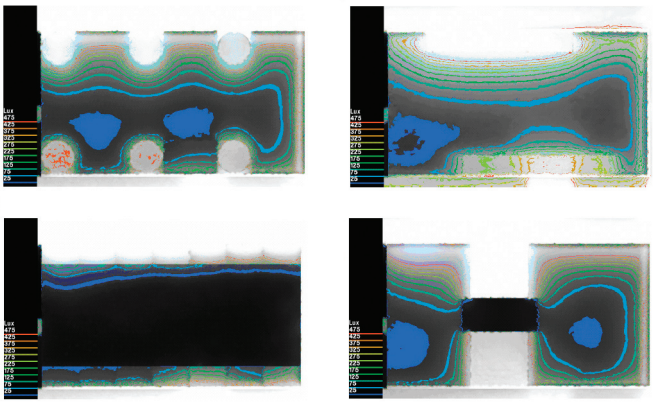

Figure 9. Initial concepts modelled by AEC during the charrette process to identify natural light opportunities using radiance software (AEC)

Access to natural light

Another concept challenged was access to windows and views by individuals – one of the rationales for the cheese design. At the same time, the idea of the skin was talked about and the result was the concept of a rectangular building providing windows as a shared communal space: What is now known as the Australian veranda concept. This also supported information brought to the table by DEHW, who suggested a deep space would facilitate many of the functional requirements. This is a bold step when most countries in the EU are moving away from deep space – in the Netherlands, for example, 1 million m^2 of deep space office lies empty. CH2 is a pioneer in this regard; the first very green deep space building where windows are not owned by individuals. Mick Pearce described the change to the deep space approach as the "the biggest breakthrough that came out of the charrette".

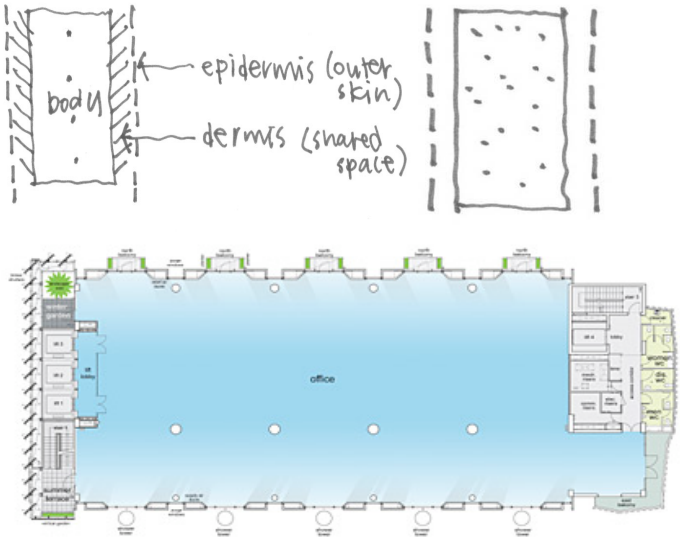

Figure 10. Deep Space Concept with Shared Access to Natural Light (DesignInc Melb)

With the deep space analysis an interesting balance emerged. While the natural light analysis showed that there were different amounts of light available at the various floors; more at the top and less at the bottom, this married nicely with the stack strategy for ventilation, which had resulted in large windows at the bottom and smaller ones at the top (see Figure 11).

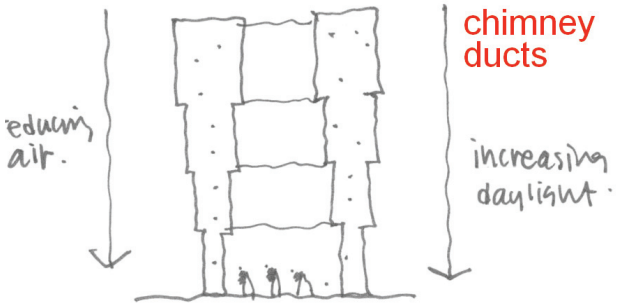

Figure 11. Image from the Initial Workshop of the Stack and window concept (DesignInc Melbourne)

Use of plants

Another decision made at the charrette was to integrate considerable amounts of greenery both vertically and horizontally. This was initially conceptualised as ensuring that the building had as much greenery as if the site was greenfield – or located in the bush. However, like many of the other solutions, it provided numerous additional spin-off benefits in terms of shading, glare reduction and provision of a pleasant space.

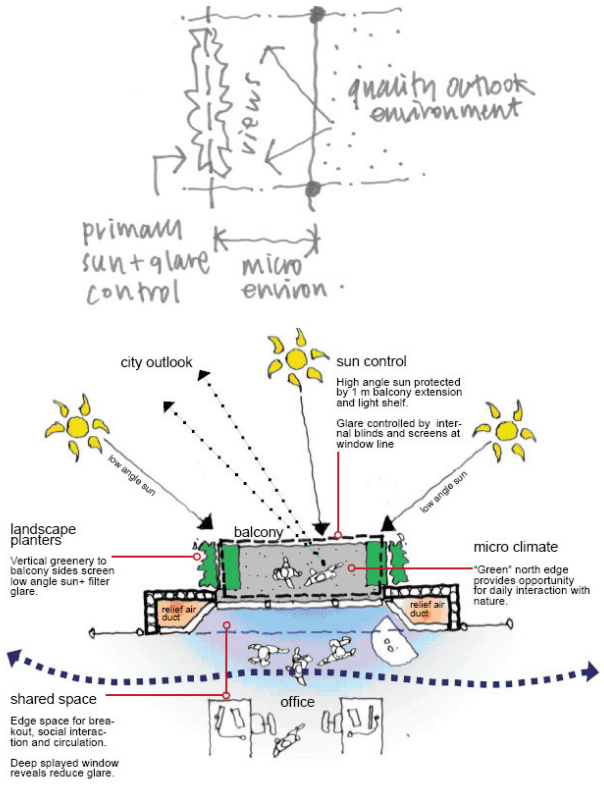

Figure 12. Initial charrette concept of the vertical use of greenery (above) and a developed concept (below) (DesignInc Melb)

Risk minimisation

For every innovative decision and element a rigorous risk assessment was carried out. These were mostly done after the charrette to check assumptions and directions that came out of the two week intensive.

For example, in making decisions on the chilled ceiling elements AEC carried out extensive analysis using computational fluid dynamics (CFD) modelling that the elements would effectively cool the space. This required an understanding of the heat loads expected, thermal mass effects, night purge effects and the effectiveness of the provision of chilled water. There were two main outcomes from this one risk assessment process:

1 It was determined that if a constant source of chilled water was available the elements would work effectively – thus ensuring this constant water source was the main risk and thus the PCM tanks are backed up by an extra chiller

2 It was determined what the expected heat loads would be over one year and then over 10 years of climate data and from this shown that 95% coverage of cooling loads would reduce load by 42% saving around $600,000 in plant and only result in a few hours a year where it would not perform

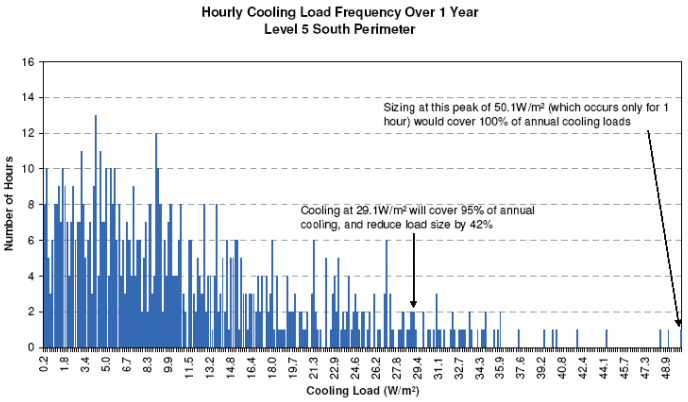

Figure 13. Example of results used to minimise risks and maximise opportunities for lowering energy use (AEC)

Figure 17 shows an example of results used to minimise risks and maximise opportunities for lowering energy use. In this example, implications on cooling load for one section of CH_2 are shown – this was repeated to optimise the entire building. This was done for the sizing of the chilled water panels, the sizing of the chillers and the sizing of the phase change material plant.

Decisions by the end of the charrette

A key decision which came out of the charrette was that the building design should be primarily developed with the needs of occupiers in mind and, secondly, to minimise environmental impact. In terms of the results of the building design process within the charrette, 18 separate elements were incorporated in the design (listed in the Summary on the front page of this snap shot).

Lessons

The success of the charrette was due in part to the strong indication from Council of what they wanted from the building, and their active involvement in the process. Notwithstanding this positive role, some of the participants felt that more planning of the charrette process could have been carried out at the beginning of the project. Rob Adams, Rob Lewis, Mick Pearce and Greg Foliente were in agreement that the charrette process could have been preceded with more concepts, aims and objectives development prior to the intensive design development phase.

"Within the workshop (charrette) itself, things happened very fast, especially in the beginning. We had finalised certain things in December, then there was a break, and then the workshop took place in the first two weeks of January. So there was a problem in that Melbourne City Council and I didn't really have enough time to plan to get the most out of it. Nonetheless, it was an innovative idea to have two weeks rather than two days. I think that most projects throughout the world tend not to devote adequate time to this initial planning." Dr Greg Foliente, Principal Research Scientist, Team Leader EVERGEN, CSIRO

The other, and related, lesson from the charrette process was that more time could have been spent on team building, communication and listening techniques. This would have required professional facilitation from someone outside the project. However, there was no budget set aside for this and the team was very keen to begin the solution and design process, so charrette skills development was left aside.

"The charrette was very hard work, I found. What would have made things easier and with probably better results was group training – what used to be called Organisational Development (OD); training in listening and how to make contributions in groups. Also, understanding role play and group dynamics ... Learning to listen to others is best learned from a "listening-speaking game" A speaks to B in the presence of C – B has to say back to A (in B's own words) what he has heard. Only when he has obtained agreement from A that he has the sense of A's statement can he say what he wants to say. This is the rule kept by the Referee C. A lot of time and confusion could have been saved with a few simple rules and training like this." Mick Pearce, Principle Design Architect, City of Melbourne

A charrette process needs someone who has the vision and keeps the intent in mind. Mick Pearce played this role – after each day he would draw and collate many of the ideas expressed during the day.

Clarification of goals and objectives

Below are a series of diagrams produced after the charrette to summarise the main goals and objectives of CH_2. These where developed by Evergen, from notes and diagrams made at the charrette.

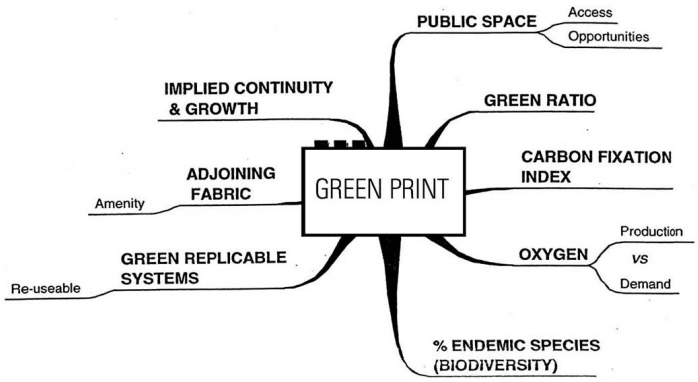

Figure 14. Green print mind map (Evergen)

Green print: CH2 should 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. That is, there should be as many leaves on the building vertically and horizontally as if the land was still under native vegetation. Furthermore, the building should be read as a work of art, including, where possible, inspiring works and influences. Finally, the building should inspire a new relationship between the city and nature.

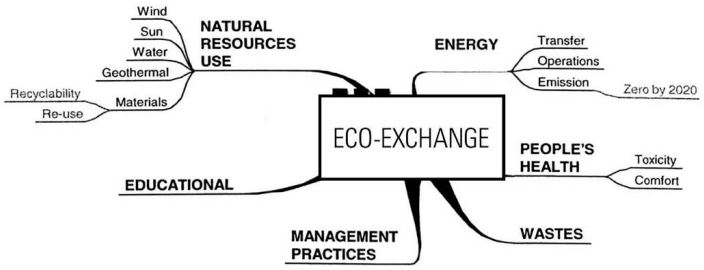

Figure 15. Eco-exchange Mind Map (Evergen)

Eco exchange: CH2 should respond and interact with its natural environment, in a responsible way, throughout its life cycle. It should do this with; its use of natural resources (e.g. materials and 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 carbon dioxide emissions to zero.

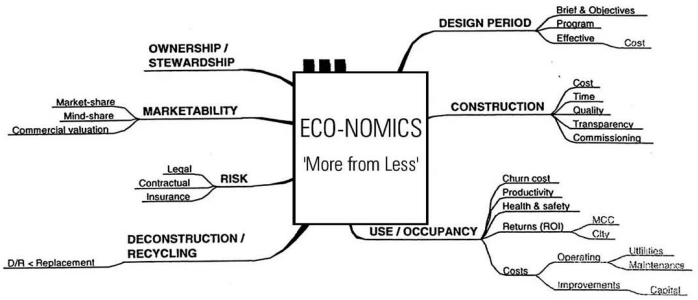

Figure 16. Eco-nomics Mind Map (Evergen)

Eco-nomics: CH2 should demonstrate 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.

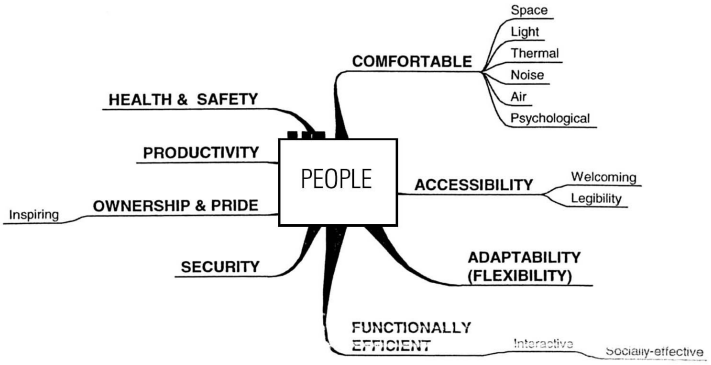

Figure 17. People Mind Map (Evergen)

People: CH2 aims to 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, and should provide a positive social environment.