Technical Research Paper 03

Lighting and Physiology

city of Melbourne

Study Outline

This study outline summaries key points raised in one of the 10 technical papers in the pre-occupancy study series that investigates the City of Melbourne's world leading Council House 2 (CH_2) office building. Each technical paper has been developed by independent authors from Australian universities as part of the CH_2 Commercial Green Building Technology Demonstration Project. To obtain copies of the full technical papers visit www.ch2.com.au

This project forms a major part of the CH_2 Study and Outreach Program – a coordinated effort to consolidate the various opportunities for study, research, documentation and promotion generated by the CH_2 office building. The primary aim of this program is to raise awareness of sustainable design and technology throughout the commercial property sector and related industries.

The target audience for these papers is professionals involved in the design, engineering, construction and delivery of office buildings, which explains the technical detail, length and complexity of the studies. Although these papers may be of interest to a wider audience, readers who possess a limited knowledge of the subjects covered should obtain further information to ensure they understand the context, relevance and limitations of what they are reading.

Significant funding for the technical papers was provided through an AusIndustry Innovation Access Program grant and supported by cash and in-kind contributions from the City of Melbourne, Sustainable Energy Authority Victoria, the Building Commission of Victoria, the Green Building Council of Australia and the CH_2 Project, Design and Consulting Team. The Innovation Access Program is an initiative of the Commonwealth Government's Backing Australia's Ability action plan.

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CH_2

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Study Outline – Lighting and Physiology

The design of the City of Melbourne's new office building, known as Council House Two (CH_2), is based on sound ecologically sustainable design principles and green building technologies.

The project design is strongly influenced by the needs of the organisations employees, and the initial brief specifies 'a landmark building that will provide a healthy and stimulating workplace'.

The following is a summary of the Lighting and Physiology paper on CH_2, commissioned by the City of Melbourne. The paper investigated the impact of the proposed lighting design on the performance and productivity of people working within the new building.

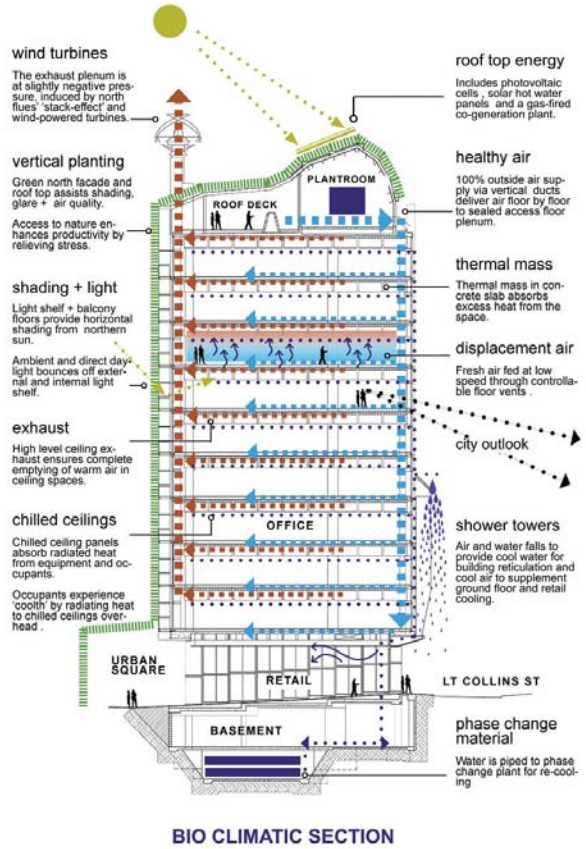


Figure 1: North-south bio climatic section.

The Importance of Light

Light is essential for maintaining human biological rhythms during work, play and sleep. It adds to our sense of wellbeing, mental health and vitality. Most people spend a significant amount of waking time inside artificially lit buildings. We also work to 'mechanical time', which is often unrelated to our body's real needs. The alternative is to work in a well-lit office space, one that balances natural and artificial light and is not only desirable and aesthetically appealing but can improve staff health, efficiency and productivity.

In order to create an optimum lighting environment that meets varying occupant needs, a good lighting strategy is required that responds to ecological issues, tasks and activities, systems integration, human experience and aesthetic considerations.

Figure 2: Prototype curved ceiling showing artificial and natural lighting.

Figure 3: Natural light penetration during construction.

The Impact of Artificial Light on Human Health

One of the central principles of the Ecologically Sustainable Development (ESD) framework is to reduce energy consumption. Using daylight effectively as a primary light source in office spaces goes a long way towards meeting this goal.

Based on recent medical and scientific research, it is reasonable to suggest that most indoor lighting standards and regulations are limited in relation to healthy indoor light requirements. In the longer term working predominantly under artificial light can have negative physiological and psychological impacts on our biological clock and natural health. The link between visual comfort and direct stimulation of the brain for health and wellbeing are also being explored in the latest scientific literature.

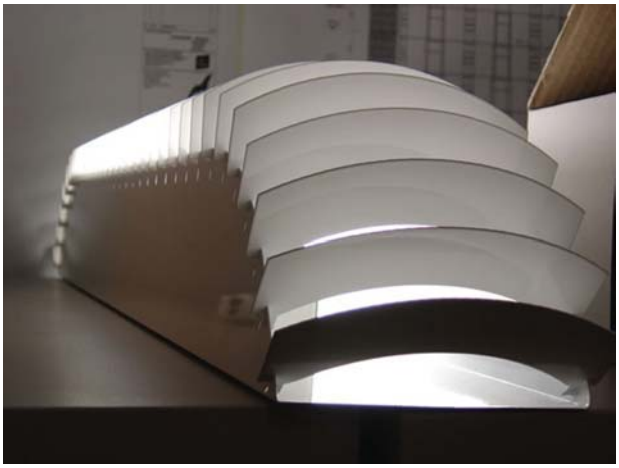


Figure 4: Close up of artificial light.

Figure 5: Light fitting mounted on ceiling.

Managing Daylight

Daylight poses a design challenge inside the office work environment. Glare reflecting off computer monitors and walls, for instance, is unacceptable. The Daylight Glare Index modelling with sophisticated software programs is often used to predict the degree of glare in interior spaces.

A combination of daylight and artificial light, controlled by automatically movable elements, is currently recommended as the most efficient daylight system. When only manually controlled shading such as blinds are used, it is important that individual employees are able to operate blinds to suit their preferences and that blinds do not remain closed at all times, which can lead to a significant reduction in the benefits of daylight penetration under favourable conditions.

Daylight quality can be manipulated in various ways. For instance, the type of glazing used, interior finishes on walls and floors, colour variations, colour temperatures (warm and cool), using green plants and choosing artificial and natural lighting, all have an impact on light quality. Good integration and a combination of the two types of light, including several adjustable lighting systems combining diffuse and direct light, creates optimal light conditions for office tasks. Ensuring optimum light distribution saves energy and increases employee satisfaction. However, managing artificial light via dimming control is not recommended because it is twice the cost of using sensors to switch from daylight to artificial light, which reduces cost effectiveness.

…people would know I'd come from CH_2 because I'd be on a high and start talking about – we could have natural light here, and if we use x we can save energy, and y we can save water. I looked into what I can do at home – I'd like to look at solar panels and some retrofitting… CH_2 has really inspired me. It's a fantastic project …

[a few months later]

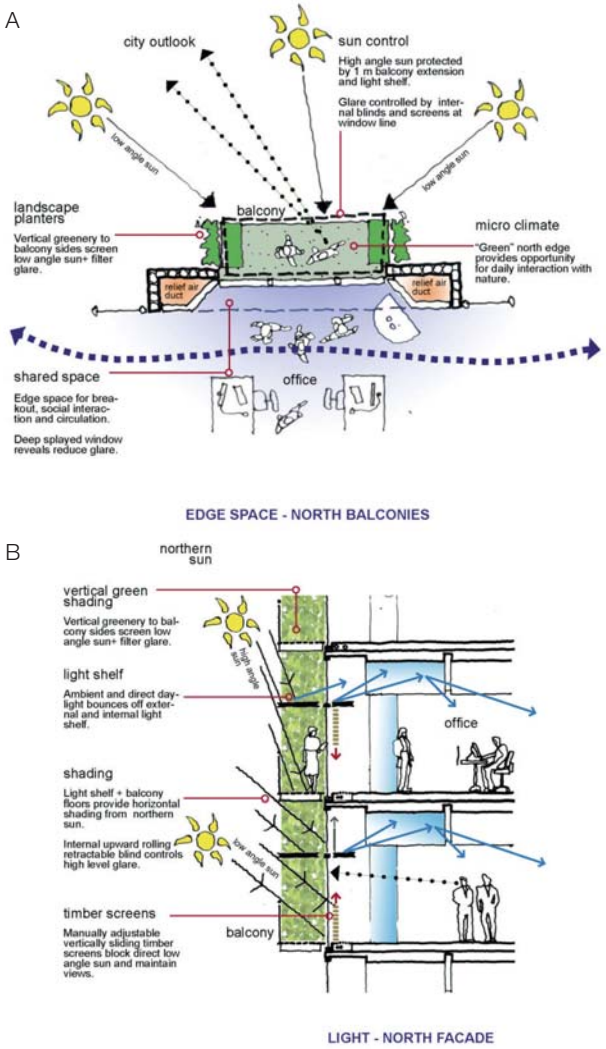
… Easy being green have come to look at our house and when I get back from holidays, we will be installing a solar hot water system, a water tank and their energy pack … All this thanks to CH_2 …

Liz Hui, Acoustic Engineer, Marshall Day Acoustics.

Best Practice Lighting Design

The Lighting and Physiology paper also considers international best practice, with the CH_2 project comparing favourably, and having a number of design elements in common with other leading designs. One such leading international project is the new British Research Establishment (BRE) headquarters, built in Garston (UK) by Feilden Clegg Architects in 1996. Under the Building Research Establishment's Environmental Assessment Method (BREEAM) rating system, the BRE building has an energy performance of 'Excellent'. In the case of CH_2, all consultants were involved from initial design stages, and the main building contractor joined the team during the production information stage.

The daylight strategy adopted in the CH_2 building was designed with occupants' health and comfort as a foremost design determinant. The constrained nature of the site, open floor plan design and strict energy saving requirements have resulted in a unique lighting system that also plays a fundamental role in the air conditioning and ventilation system – a symbiosis of design solutions.



Figures 6: Plan and section of North balcony with circulation, green balcony and space usage.

Site constraints were used positively to enhance CH_2 design solutions. Site orientation and overshadowing from adjacent buildings, direct solar illumination on the facades and the lower angle of the sun during winter months all contribute to the aesthetic and functional appearance of CH_2.

A. Diagramatic North Elevation.
B. West Elevation showing timber louvres.

Figures 7: Both elevations show how the bio climatic design response has determined the design resolution.

Overcoming Glare

Glare and luminous discomfort have been addressed in CH_2 by internal shading devices and vertical gardens planted with fast growing and hardy vines. Using plants in this way results, not only in an acceptable Daylight Glare Index, but also has a positive physiological impact on workers due to a green presence in the office environment.

For CH_2, ecological, economic and psychological objectives largely determined the final lighting system, which guarantees a high level of visual comfort for all occupants. The lighting system meets all of the requirements of the Australian Standard 1680.1-1990[1] and is extremely flexible. It can be controlled from separately switched zones as well as from individual work stations. Every employee has access to a local control switch linked to their personal computer.

Conclusion

The innovative design characteristics of CH_2, including the lighting strategy, mark it out as an excellent example of international best practice in sustainable design. The integration of function and design, particularly in the area of integrated building services, fulfil a number of functions throughout the building simultaneously.

The CH_2 building and procurement process demonstrate a central lesson about sustainable architecture. Sustainable buildings must be conceived of, and operated as, 'living' systems rather than a simplistic collection of separate services and elements.

A building that provides a healthy place of work and that harvests sunlight, cool night air, water, wind and rain to create a lasting landmark for one of the world's most liveable cities.

1 As per Australian Standard AS 1680.1-1990, Clauses 3.3.4., 3.3.5 and 6.2, *Interior Lighting-Part 1: General Principles and recommendations*.

Other Studies in this Series:

1. **Nature and Aesthetics in the Sustainable City** – form, function, flora, fauna and art;
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www.CH2.com.au

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