

# CH<sub>2</sub> Setting a new world standard in green building design

## Design snap shot 20: Lighting

### Summary

#### Introduction

This snap shot discusses the use of lighting in the CH<sub>2</sub> project, the analysis of natural lighting opportunities, and the need for supplementary artificial light.

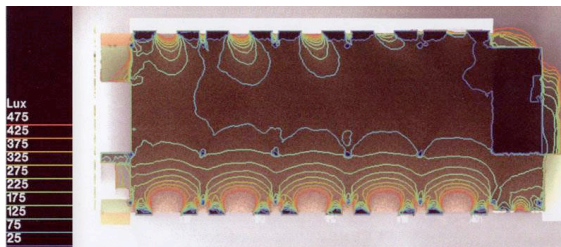


Figure 1. Daylight levels on level 8 of the building (AEC)

The generation of electricity produces heat and in a cogeneration system this heat is used to assist heating and cooling the building - directly for the building's heating hot water system and through an absorption chiller for cooling.

#### Drivers and objectives

To reduce the greenhouse gas emissions of the building, natural gas is used as the fuel source of the generator. This replaces grid electricity which predominately comes from brown coal fired power stations in the La Trobe Valley, east of Melbourne.

In addition to augmenting the energy use of the building the generator acts as a back up power system for critical building systems, in case energy supply from the grid fails.

#### Costs and benefits

Using energy efficient light fittings and using as much natural light as is practicable are cost effective strategies. The final costs cannot be determined until the building is operating, but there are many expected benefits, such as improved staff effectiveness when spaces are adequately lit and when people have access to natural light. Efficiency strategies regarding light switching and appropriate use (more light over work space, less in communal space, the use of task lighting, etc.) add to the whole equation.

### Outcomes

The deep plan floor layout meant that a considerable use of artificial lighting was necessary. Day lighting levels at the perimeter are designed to be compensated with artificial lighting when required (such as on extremely overcast days).

General lighting is used in most areas of the office and supplemented with individual task lighting. Lighting systems were designed so that spaces are lit adequately for the tasks performed in them.

This means that the background lighting component provides an average of 150 lux to the office space and the task lighting component provides 320 lux on each desk.

Further, the system is designed to ensure that a luminance of no greater than 400 lux will be provided anywhere on the office floor.

This was seen as appropriate, as most of the occupants will be working at computer terminals where high background lighting would cause discomforting reflections and glare on screens.



Figure 2. Testing different fixtures in the wave ceiling prototype

The use of the highest efficiency light fittings and clearly legible controls adds to the reduction of the energy used for lighting in the building. Lastly, introducing as much day lighting and connection to the outside as possible, given the building's context, gives a more natural working environment.

## Lessons

Accurate modelling of free natural light should be done before supplementary systems can be designed to avoid over sizing of systems.

By optimising the location of windows at the curves of the ceiling plane daylight can be transferred deeper into the plan.

The use of prototyping space illustrates the light fixtures in context, as well as more practical issues such as the replacement of light fixtures.



Figure 2. Testing different fixtures in the wave ceiling prototype

## More detail

### Lighting

Due to the building's orientation and position in relation to surrounding buildings, and the requirement for a deep open plan office space, adequate provision of daylight is a challenge for the CH2 design team. Daylight design and analysis drove the decision making in regards to building form and façade systems. During the initial two week design charrette process, daylight modelling using radiance software was conducted to assess the most appropriate form for the building (see Snap Shot 3: The Design Charrette).

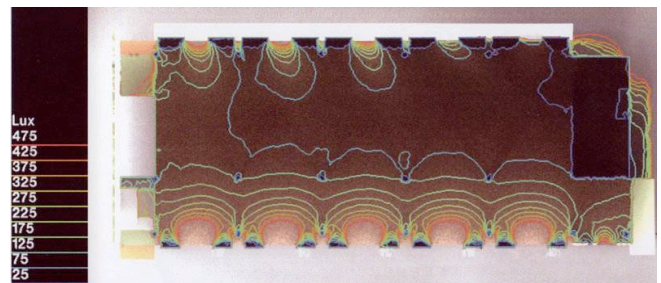
As the design developed, further analysis was undertaken to look at the design of the façade and technologies to further enhance the penetration of daylight. This modelling showed that similar daylight levels could be achieved on each floor by providing larger windows at the lower levels and smaller windows at the upper levels, and the provision of light shelves on the northern façade. However, due to the physical constraints of the building no more than 25% of the building floor area has a daylight factor greater than 2% as measured at the working plane under a standard overcast design sky. Therefore significant levels of artificial lighting is needed.

## Natural Lighting

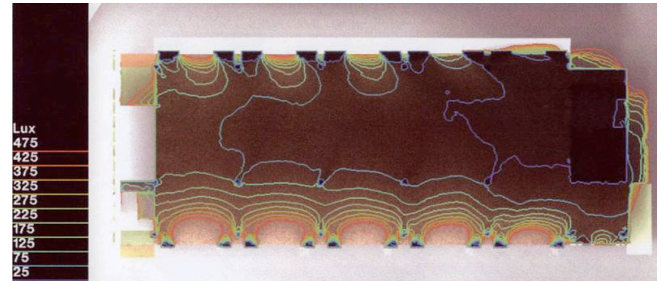
Design techniques to make the most of natural light in CH2 are:

- Synergy between windows size and air ducts
- Light shelves to reflect light into the space
- Vaulted ceilings to allow further light penetration
- Shading on the north, east and west facades
- Timber louvres to control light penetration from the afternoon western sun

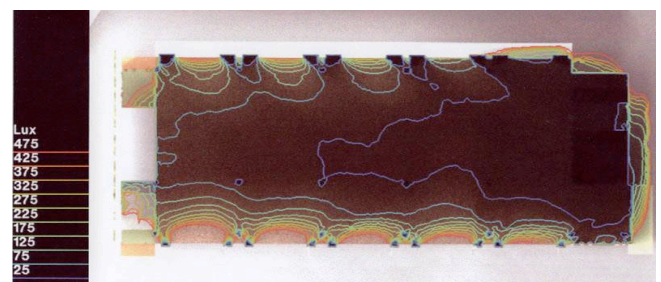
The series of images below shows the analysis of light entering at each level. Lower floors generally receive less daylight than upper floors.



Level 8



Level 5



Level 2

Figure 4. Lighting study (AEC)

The size of the windows was determined by the need for duct size to move air from each floor – larger ducts near top, smaller near the bottom. This allows the total amount of glass to be minimised, thus reducing energy loss, while maintaining desirable natural light levels.

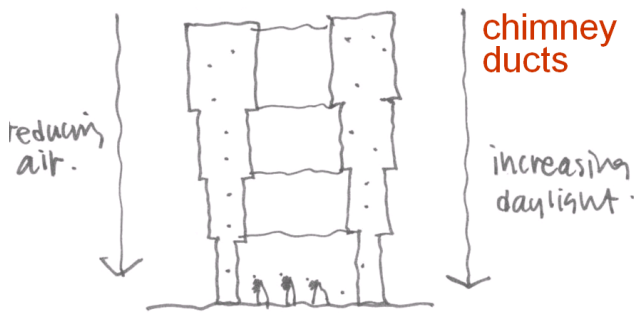


Figure 5. Image from the initial workshop of the stack and window concept- larger windows at the bottom, and smaller windows at the top that work effectively with the larger ducts at the top for ventilation

To further assist natural light to penetrate the floor space (especially on the lower floors), light shelves on the north façade will reflect sunlight onto ceilings and produce a soft indirect light. The light shelves will be placed externally and made of a durable fabric in a steel frame. Initially the shelves were both internal and external but when coordinating this with the chilled beams, it was found that the gain of the internal part of the light shelves did not outweigh the cost to the effectiveness of the chilled beams.

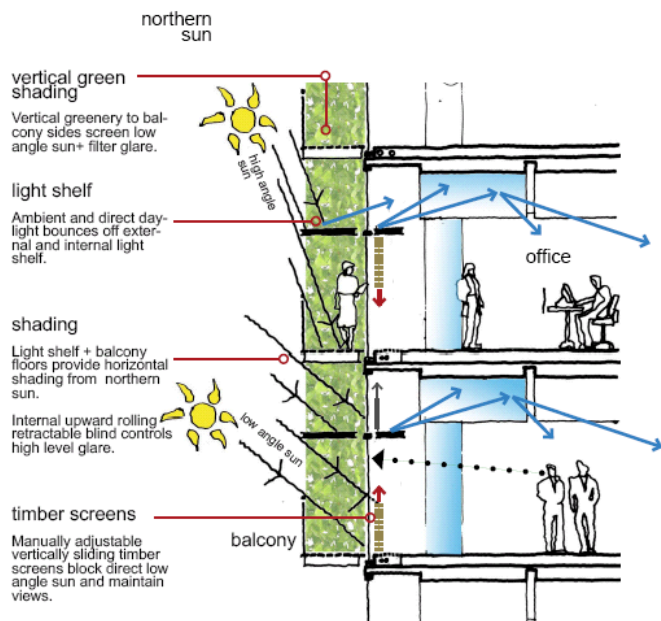


Figure 6. Using natural light and providing shading (DesignInc Melb)

The vaulted ceiling is also a technique to improve the amount of natural light filtering to the deeper parts of the floor plate by locating windows at the highest point of the curve. This reduces the amount of time artificial lighting needs to be used.

Shading to control sun and glare will be used on the north, east and west façades. The east-facing façade uses a perforated metal system, this acts like a thermal chimney, heat rises pulling air through the eastern part of the building allowing it to be naturally ventilated.

The north-facing façade will comprise of steel trellises and balconies supporting a series of vertical gardens nine storeys high. The foliage will help protect the building from the sun and filter sunlight to reduce glare indoors. Further light shelves will be used to both provide shading and reflect natural light into the building as shown below.

The entire west facade of CH2 is protected by a system of timber louvres that pivot to optimise the penetration of natural light and views out, while providing protection for this facade from the harsh western sun. The louvres will normally be in the open position and gradually close in the afternoon when the sun enters the western sky, and open when the sun's rays no longer strike the façade. The louvres will be made from untreated recycled timber and are moved by a computer-controlled hydraulic system, in accordance with the seasonal position of the sun.

Sensors will increase and decrease the artificial lighting according to the amount of sunlight coming directly and being reflected into the building; thus a balance of natural and artificial light will be achieved.

### Artificial lighting

The artificial lighting systems are designed as two components: a background lighting system provided as part of the base building design, and separate task lighting provided as part of the fit-out works. The background lighting will provide an average of 150 lux to the office space and the task lighting 320 lux on each desk. An illuminance no greater than 400 lux will be provided anywhere on the office floor.

Each luminaire can be separately programmed to adjust zoning requirements to suit the future fit-out requirements. Each lighting zone is no greater than 100m<sup>2</sup>.

The prototype office was heavily used for testing various options for the lighting system, the final system was called the glow worm (Figure 8), following the curve of the ceiling.



Figure 7. Trialling different lighting systems



Figure 8. Lighting prototype

The lighting design uses low energy T5 luminaires, which achieve a lighting power density of less than 2.5 Watts/m<sup>2</sup> per 100 lux. T5 lighting incorporates high frequency ballasts that will be provided to all office areas. The T5 fittings are linked to sensors that will reduce the light when sufficient daylight is available. It will be supplemented with individually controlled lamps at workstations to give occupants more control over their environment. Thus the level of lighting on a floor or in an area will reflect the level of activity.

All lighting has been designed so that no beam of light is directed beyond the site boundaries or upwards without falling directly on the surface which it is illuminating.