Technical Research Paper 02
Workplace Environment

Contents

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green star Office Design v1
This rating represents World Leadership

Preface

Council House 2 (CH_2) is a visionary new building that is changing forever the way Australia – indeed the world – approaches ecologically sustainable design.

With its Six Star Design Rating granted by the Green Building Council of Australia, CH_2 is one of the cleanest and greenest buildings on earth.

This paper, one in a series of 10 technical papers, investigates the design and systems of CH_2 prior to occupancy and availability of operational performance data. The papers have been written by independent authors from Australian universities, as 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 CH_2.

The aim of the CH_2 Study and Outreach Program is to raise awareness of sustainable design and technology throughout the commercial property sector and related industries.

While the pre-occupancy research papers are a valuable resource, they do have some limitations. For instance, these studies have been written before operational experience. This means the authors' views are based on existing knowledge, which can be difficult to apply when significant innovation exists.

Many of the innovations in CH_2 have been subject to limited, if any, rigorous or directly relevant research in the academic field, which is reflected in the lack of literature cited for systems such as the shower towers and phase change materials used in the cooling system.

Another major limitation is the exclusion, by academics generally, of industry experience of new technologies. The extensive knowledge gained by industry is often not well documented and can be difficult to access through traditional academic channels.

One example, where industry expertise exists, is the use of phase change materials for reducing peak cooling loads and energy use in commercial and institutional settings, such as offices, hospitals, prisons and factories.

In addition, to enable the authors to complete their task, they have based their study on CH_2 project reports prior to the design being finalised. This means some of the descriptions of systems and findings in the papers are to some extent out dated. In particular, findings related to the wind turbines and the heating, cooling and ventilation systems have changed somewhat as a result of final design decisions.

To reduce the impact of these limitations for readers, the Council has provided additional comment as footnotes in some papers.

It is important to inform readers the target audience for these papers is professionals and academics involved in the research, design, engineering, construction and delivery of high performance buildings. This helps to explain the technical detail, length and complexity of the studies.

Although these papers may be of interest to a range of audiences it's important that readers, who possess a limited knowledge of the subjects covered, obtain further information to ensure they understand the context, relevance and limitations of what they are reading.

For more information or to make comment and provide feedback, readers are invited to contact the Council. The details are available at the end of this document.

We hope you enjoy reading these technical studies and find they are a useful resource for progressing your own organisation's adoption of sustainable building principles and encouraging the development of a more sustainable built environment.

Foreword

In 2000 the City of Melbourne made the decision to embark on a revolutionary new project called Council House 2 (CH_2). The decision was due to a pressing need for office space for its administration and the desire to breathe life into an under-used section of the city.

The project gave the Council the opportunity to exercise its environmental credentials by creating a building that was at once innovative, technologically advanced, environmentally sustainable and financially responsible.

This approach allowed the Council to insulate itself against exposure to rising energy and water prices, the diminishing availability of resources and the uncertain long-term availability, while providing a healthy workplace attracting the best workforce in a labour-constrained market.

CH_2 has been designed to reflect the planet's ecology, which is an immensely complex system of interrelated components.

From the revolutionary cooling storage system in the basement to vertical gardens and wind turbines on the roof, the building has sustainable technologies integrated throughout its 10 storeys.

Although the majority of the technologies and principles adopted in the building are not new, never before in Australia have they been used in an office building in such a comprehensive and interrelated fashion.

This includes innovations such as: using thermal mass for improving comfort; phase change material to reduce peak energy demands and energy use; generating electricity onsite from natural gas; and using waste heat for cooling and heating.

Through CH_2, the Council plans to trigger a lifestyle and workstyle revolution. The building will be used as a living, breathing example, demonstrating the potential for sustainable design principles and technologies to transform the way industries approach the design, construction and philosophy of our built environment.

As with many revolutions, there are sceptics. The Council's response has been to patiently press ahead with the construction of CH_2 while actively and energetically encouraging lively debate.

Some of the papers in this pre-occupancy study and outreach series make compelling points in favour of the case for sustainable development. Others reflect a more subtle or sometimes overt scepticism that may be encountered throughout the community.

The City of Melbourne welcomes all of this debate but in the long term intends to demonstrate the effective performance of CH_2 and prove the doubters wrong. Collectively, the studies demonstrate the enormous value to be gained by researching the case for sustainable development and the scope for much more study and documentation in this field in the future.

The City of Melbourne wants CH_2 to be copied, improved on and enthusiastically taken up throughout Melbourne and far beyond.

Technical Research Paper 02

Workplace Environment

Dr Scott Drake, University of Melbourne

Introduction

The modern office building is arguably the most prevalent and readily identifiable type of architecture in the 20th Century[1]. On one hand, it represents the rise of 'white-collar' administrative work located in urban centres and necessary for the management systems of modern corporations. On the other hand, it marks the rise of construction and servicing systems that enable high-rise stacking of floor plates, elevator access, and controlled environments with air-conditioning and artificial lighting.

The office building emerged primarily to house the administrative departments of manufacturing plants of the Industrial Revolution. Early designs, such as the 1906 Larkin Building in Buffalo, New York, by Frank Lloyd Wright, were connected to the factories they served, and adopted an internalised focus to protect workers from the noise and pollution of the adjacent plant. As companies grew, administration became centralised and moved to inner city locations. This allowed office buildings to adopt a more outward focus, and to access natural light and ventilation using narrow floor plates. But speculative pressures eventually led to larger floor plates serviced by artificial lighting and air-conditioning, all enclosed within a glass curtain wall[2].

The resulting office design, comprising largely of a 'ring' of homogenous space located around a central core, proved highly efficient in a number of ways. The central lift core gave structural efficiency; the open space was flexible enough to suit a variety of uses; the services enabled the internal environment to be precisely controlled; and the generic nature of the space meant it could be easily commodified as part of the market for lettable floor areas.

Today, however, there is increasing interest not only in the efficiency of the building but in the way it facilitates the operations of an organisation housed within. While a central lift core makes for an efficient structure, it can lead to isolation between departments housed on opposite sides of the floor plate. If interaction between those departments is desirable or necessary, then the floor plate can prove inefficient for the organisation.

One of the biggest challenges taking place in business today relates to organisational structure and managerial strategies. While the office tower works well for paper based systems of information exchange and management hierarchies based on authority and surveillance, most modern organisations operate in a dramatically different way. They rely more on worker motivation and participation than management supervision and authority, and on computer-based rather than paper-based forms of communication, storage and exchange. These developments are having an effect on the type of office space needed and how it is used. They also have the potential to dramatically change the requirements of office space, and must be taken into account at design stage.

The design of Council House 2 (CH_2) is typical of a new generation of office buildings that take into account the need to improve environmental performance as well as the need to respond to new developments in workplace organisation and behaviour. Notable examples include ING (NMB) Bank in the Netherlands by Alberts and van Huut (1983); Norman Foster's Commerzbank in Frankfurt, Germany (1997) and Swiss Re headquarters in London (2004). In Australia, recent examples include 30 The Bond, Sydney by Lend Lease (2004) and National Bank, Docklands by James Grose and Bligh Voller Nield (2004). In terms of design, each of these buildings has reconsidered environmental performance in terms of its impact on organisational performance and behaviour. Before considering the design of CH_2, it is important to understand some of the ways building design can impact on the work done by an organisation.

Work and the Workplace

In general terms, the design of any workplace involves the design of a building and its contents in such a way that its occupants can undertake the work for which they have been employed. The way a building 'works' and the way its occupants 'work' are interconnected.

1 Author note: Iñaki Ábalos and Juan Herreros, *Tower and Office: from modernist theory to contemporary practice*, edited by Joan Ockman; translated by Megan McFarland with Stephanie Salomon, Cambridge, MA: MIT Press, 2002.
2 Author note: See for example Carol Willis, *Form follows finance: skyscrapers and skylines in New York and Chicago*, New York, N.Y.: Princeton Architectural Press, 1995.

The way a building works can be understood in terms of 'function'; the way in which it provides suitable spaces for the activities that need to take place within. Function is usually related to the size and shape of the space, its equipment or furnishings, and its proximity to, or connections with, other spaces. Function was a central tenet of the 20th century artistic movement of Modernism, seen as a key determinant of architectural form[3]. The way a building works can also be understood in terms of environmental provision; whether it provides the right amount of heat, light, air and sound for the occupants to be reasonably comfortable when performing their tasks. These two aspects are often connected, so that the size and shape of a space will affect the way air circulates through it[4]. But these factors can also be seen as separate, so that a building that functions well in some ways may be too cold or too dark, or a building that is comfortable may be awkward to work in.

How a person 'works' can also be understood in two distinct ways. Firstly, there is the kind of work undertaken as part of employment, such as writing a report, meeting with a customer or balancing accounts. Secondly, there is the work of physiological performance, much of which goes on unnoticed or at least without conscious effort. This is the work of digestion, respiration, thermal regulation and so on that keeps our bodies operating and able to perform other tasks. These aspects are also connected, so that preparing a report, for example, depends in most cases on reasonable eyesight and ability to manipulate a keyboard or writing implement. As such, there is a connection between the built environment and its human dimension. The functional layout of a building affects the types of work tasks that take place there, while the environmental provision ultimately affects the physiological conditions of its occupants. Taken together, these four aspects are interconnected as follows:

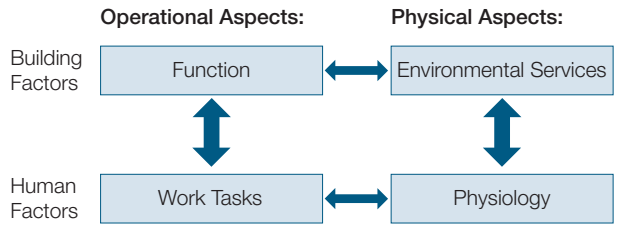

Figure 1: Relation between physical and operational aspects of buildings and their occupants.

While architects are traditionally responsible for the design of buildings in both functional and environmental terms, the widespread adoption of mechanical services throughout the 20th century shifted responsibility for this aspect of design to building services engineers. The development of mechanical and electrical services, especially artificial lighting and air-conditioning, meant that environmental control was no longer dependent upon building fabric[5].

This separation led to great flexibility in building design, with precise control over the indoor environment achievable in almost any situation. But in terms of the figure above, the separation of environmental control from other functional aspects of building design led to a related separation of physiological issues from the design of the workplace. In fact, the idea of precise environmental control was promoted as a means of ensuring worker productivity by minimising distraction[6]. Instead of being considered as an important aspect of workplace design, research into the physiology of worker performance has been dominated by laboratory-based experiments conducted by engineers[7].

Research into the link between physiology and worker performance reached a high point with the experiments conducted at the Hawthorne plant of Western Electric (a subsidiary of AT&T) in the 1920s[8]. In these experiments, workers undertaking repetitive manual tasks (assembling telephone relay devices) were subjected to various changes in work environment and routine to test their effect on productivity. The anecdotal result of these experiments popularised in the so-called 'Hawthorne Effect', in that managerial interest is more important to workers than workplace environmental conditions. Although having little to do with the actual results, this attitude has come to dominate workplace design ever since. Not only has it resulted in most workspaces meeting only minimum environmental standards, it has also limited the amount of further research undertaken in the area of workplace performance.

In other fields of design, most notably industrial design, there has been extensive research into the area of 'product failure'[9], where the failure of an object such as a chair or a desk results in a direct impact on the body of the user due to incorrect ergonomic performance. With the design of built space, however, there is often a 'loose fit' between space and activity, since the spatial boundaries are at a distance from the body. Even in spaces that are less than ideal, such as a cramped or noisy office, many tasks can still be undertaken. As a result, spaces that are poorly designed often go unnoticed, except in cases of extreme discomfort or illness.

3 City of Melbourne note: For example, to ensure maximum performance of the night purge operation consideration must be given to the placement of the demountable partition walls in relation to the south purge windows. In addition, doors of the semi enclosed workspaces must remain open overnight to allow effective air movement across the floorplate.
4 Author note: Stanford Anderson, "The Fiction of Function," *Assemblage* 2, February 1987, pp. 19-31.
5 Author note: Cecil D. Elliott, *Technics and Architecture: the Development of Materials and Systems for Buildings*, Cambridge, Mass.: MIT Press, 1992.
6 Author note: James S. Russell, "Form Follows Fad: The troubled love affair of architectural style and management ideal," In Donald Albrecht and Chrysanthe B. Broikos (eds). *On the Job: design and the American office*. New York: Princeton Architectural Press, 2000, pp. 49-73.
7 Author note: Richard de Dear, "Thermal Comfort in Practice," *Indoor Air* 14 (suppl. 7), 2004; pp. 32-39.
8 Author note: Richard Gillespie, *Manufacturing knowledge: a history of the Hawthorne experiments*, Cambridge; New York: Cambridge University Press, 1991.
9 Author note: See especially Donald A. Norman, *The design of everyday things*, New York: Doubleday, 1990.

Environmental provision is rarely, if ever, correlated with worker performance. Instead an effective workplace is by definition one that elicits a minimum number of complaints. A recent phenomenon that is causing some concern worldwide is sick-building-syndrome, although the principal outcome of research in this area recommends reductions in volatile organic compounds (VOCs) from building materials[10], not changes to building design. With the current interest in productivity research, it is likely the workplace design will increasingly be linked with worker performance[11]. A report on CH_2 by Advanced Environmental Concepts suggested a financial return from a gain in occupant productivity of between one and 4.9 per cent of staff salaries. Since the rationale for these estimates are based largely on findings from European research, it would be beneficial to monitor CH_2 after it is occupied.

One of the main reasons for constructing a building like CH_2 is to bring people together and help them work towards common organisational goals, such as those of the City of Melbourne. The decision to build any building leads to a range of other issues, such as site selection, layout and choice of consultants. There are also subsequent decisions relating to how the building will be constructed; what materials and fittings will be used; what passive and active systems will be employed to ensure adequate and appropriate levels of heat, light, air, and sound; where the energy will be sourced from to power these systems; the provision of water and the collection and treatment of water; how the building will be funded; and what the end result will be in terms of the contribution to the built and natural landscape of the city.

As explored in other studies in this series, every aspect of a new building has an impact on the final workplace. For example, the lighting level at any point is affected by the relative position of artificial lights and windows, as well as the size, shape, layout of the space and the reflectance of its surfaces (see paper six). In addition, the air quality is affected by natural/forced ventilation systems as well as the 'off gassing' from furniture, linings, and finishes (see papers six and nine). This paper will consider the workplace impact of decisions such as floor plate depth and core location as well as specific issues to do with the internal fit-out of fixtures, finishes and individual workstations. The paper will address:

- The use of internal space
- Cultural norms in work place behaviour
- Change and its effect on people's behaviour
- Communication
- Worker morale and attitude
- Fit-out
- Interior design
- Acoustics/noise
- Technology
- Materials (refer paper nine)

Consultation

The design team for the CH_2 floor plate layout and fit-out consisted of the City of Melbourne, strategic design consultants DEGW, and local Melbourne architects DesignInc. Preliminary consultation with DEGW consisted of a briefing strategy that evaluated the degree of fit between organisational structure and the physical environment. This involved a review of organisational issues, such as: the size of the organisation; nature of activities; company culture; size of workgroups; level of technology used; amount of interaction; frequency of visitors; patterns of work/time; support functions and adjacencies. This information was correlated with structural issues such as: size of building; building form; planning grids; depth of space; size of floorplates; floor to floor heights; number of storeys; location; quality of finishes; degree of fit-out and own versus lease. The relationship between organisational structure and physical environment was then summarised in a 'project vision' that aimed to embrace new ways of working, support cultural change, provide a showcase for environmentally sustainable design, and create a healthy and stimulating work environment.

Research also involved walkthroughs, interviews, surveys, and evaluation of the existing workspace. This was complemented by workplace performance surveys assessing: the quality of overall accommodation; individual workstations; filing, storage and reference materials; office equipment; meeting facilities; the indoor environment; and communication with others. The principal finding of this research was that the current buildings did not support staff interaction and visibility of team leaders. Workers expressed a desire for more autonomy and flexibility in their work practices, but also expressed a desire for more interaction and opportunity for collaborative work. It was also found that more interaction should occur between different departments and work areas, and directors and senior managers should be more visible to staff. There should also be places where people could gather inside and outside the building, with traditional meeting rooms kept small to keep meeting times to a minimum[12].

In addition, the research showed there was a perceived need to improve public perception, and provide better interface with clients and increased security. Developing workplace culture was identified as a goal by enhancing collaboration and supporting project teams, and improving staff satisfaction and pride in the office. Improving the amount and quality of natural light was an issue for staff. Likewise evaluation of existing facilities showed poor services (lifts, toilets, kitchens etc.), not enough meeting areas, limited views or outlook, and limited opportunities for interaction across the organisation.

10 Author note: Jack Rostron (ed.), *Sick building syndrome: concepts, issues, and practice*, London: E & FN Spon, 1997.
11 Author note: Derek Clements-Croome (ed.), *Creating the Productive Workplace*, London; New York: E & FN Spon, 2000.
12 City of Melbourne note: The time utilisation study conducted as part of the research, referred to by the author, indicted that the existing meeting rooms were under utilised and staff often chose to meet outside City of Melbourne premises. One of the causal factors attributed to this finding was the adopted practice by staff of booking reoccurring meetings for months in advance and failure to cancel a booking if meeting details changed, which leads to a situation where the room is booked but unused.

The workplace performance survey showed that while quality of office equipment and the location of the building are seen as positive, the quality of the indoor environment was considered in need of improvement, as were the ability to communicate with others, display work related materials, and conduct meetings. In particular, the indoor environment, especially the quality of daylight, décor and air-freshness were seen as poor, while concentration and conversational privacy were also seen as inadequate.

A review of staff numbers at the City of Melbourne suggested the need to accommodate approximately 750 people, with 540 staff required to be accommodated in the new CH_2 building with a gross floor area of approximately 12,500m^2. These accommodation requirements were assessed against the site constraints, including public thoroughfare and access issues, possible connections to the Town Hall, views and solar gains, and the proximity to public transport and other amenities. This resulted in a recommended floorplate size of 1,500m^2 with an ideal width of 18m, depending on environmentally sustainable development (ESD) initiatives, and within a height limit of 40m. The new building was intended to feature key design criteria such as highly effective floorplates, interaction between levels, integration of ESD principles, a friendly public interface along with retail and pedestrian activity at ground level, as well as long-term utility and flexibility.

In addition to the internal parameters addressed above, DEGW also considered a range of external factors that would affect the building design. These included the public perception of the building as sustainable, inviting and accessible, and forward thinking and efficient. They also focussed on the way in which the building would be integrated into the city fabric, and how it could support the new organisational culture being encouraged for the City of Melbourne by being more informal, creative and dynamic, yet still remaining professional in appearance.

DesignInc Return Fit-out Brief

In response to the research carried out by DEGW, architects DesignInc developed a Return Fit-out Brief to ensure the initial design work was in accordance with the aims and requirements of the City of Melbourne. The main principles used to drive design decisions were as follows: space allocation and acoustic screening proportional to the nature of the work process; optimum flexibility to spaces and furniture systems for ease of reconfiguration to minimise 'churn'; increased opportunities for teamwork, autonomy and interaction; shared working environments, informal meeting spaces, quiet spaces etc.; and increased opportunities for cross-divisional teamwork and vertical interaction. The brief took into account the need for an improved customer service experience, changing IT systems, sustainable design and other design elements such as natural light and ergonomic furniture.

The brief also recognised City of Melbourne requirements for the following: an A Grade commercial building with a focus on ecologically sustainable design suitable for a CBD situation; a healthy and user-friendly environment for users; optimum use of space; a model for commercial property developers in terms of sustainability principles; an economically feasible project; compliance with Town Planning Regulations; retail opportunities to expand the immediate precinct.

The fit-out brief was then used to develop the following accommodation requirements:

- a physical environment that provides for general well being of users;
- good lighting (natural and artificial), reduced glare and user operation;
- air quality – reduced toxic emissions from specified materials and use of fresh air air-conditioning and night purging;
- thermal control prevention of direct sunlight and awareness of perceived comfort;
- ergonomic furniture designed for functionality not aesthetics;
- bike storage, showers and lockers to encourage activity amongst staff;.
- recreational roof space to provide an external meeting area;
- design that provides maximum flexibility to enable efficient management of the facility and minimise 'churn' costs;
- 'plug in' options for furniture systems such as modularity, soft wiring for ease of reconfiguration, interchange of colours between levels;
- minimum range of desk types to allow for integration within a range of different general office configurations and development of a workspace menu;
- interchange of functions within enclosed spaces (i.e. an office may become a meeting room);
- multiple use of space, where appropriate; and
- opportunities to improve general communication between staff, in order to break down silos.

Opportunities may include:

- random communication between users within single floor space;
- random communication vertically between floors (i.e. between divisions/branches); and
- functional communication between individuals and groups.

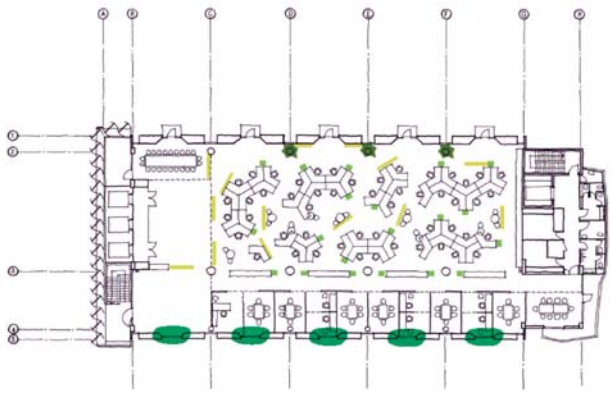

Figure 2: Layout of typical Floor Plate.

The Use of Internal Space

Council House 2 (CH_2) is typical of many recent office buildings that avoid individual cellular offices in favour of a return to an open plan arrangement, with occupants sharing similar work-stations. This shift represents a move away from hierarchical models of organisational power toward more 'horizontal' structures of space allocation. In other words, older models where executives vied for larger and more prestigious space on higher levels, are being replaced by a more democratic attitude to space, where managers share open plan offices with other staff, and 'prestige' space such as that adjacent to windows is reserved for common areas such as meeting rooms or temporary work spaces. The problem with this new approach is that the former model of vertical hierarchy was ideally suited to the office tower, whereas the latter often works best in lower-rise buildings with a high degree of interconnection via atria or other shared spaces. Recent examples include NAB @ Docklands or Lend Lease's 30 The Bond.

CH_2 is a medium-rise tower, with a long east-west floorplate divided into various layered zones. The northern edge of the space, with access to natural light from windows, is reserved as shared open space. The southern edge is allocated to meeting rooms, separated from the workstations by a circulation corridor. Services and other common areas, including toilets, lifts, external staircases, and kitchens, are located in the cores at the eastern and western ends. Where customer service areas are required, a line of security is extended from north to south across the floorplate, allowing visitors to enter the floor from the western end without disrupting staff.

The idea of open plan offices can be traced back to the *bürolandschaft*, or office-landscape, designs of the 1960s, derived from studies of workplace communication in Hamburg, Germany. These designs proved extremely popular, especially in the US, although predominantly for cost reasons. They were cheaper to build and easier to arrange than walled offices, and, deemed as furniture, were more rapidly tax deductible. However, combined with artificial lighting and air-conditioning, 'office landscape' generally meant a loosely planned series of cubicles arranged on a large floor plate interspersed with potted plants. An alternative to the large floor plate also emerged with internal atria, such as the tower and pod arrangement used by Herman Herzberger in the Central Beheer Insurance Company offices in Apeldorn, Holland (1972). This approach allowed a greater degree of interconnection between levels as well as providing a linked common space. The same approach has been used more recently in buildings such as Norman Foster's Commerzbank in Frankfurt, Germany (1997) and Swiss Re headquarters in London (2004).

In CH_2, the open plan arrangement allows a degree of connection to the outside for all workers, while vertical interconnection possible via balconies and external stairs. The architects have noted that the layout of the open plan area has been affected by the curved ceiling, with the low points providing a natural 'edge' to departmental divisions on the same floor.

Cultural Norms in Work Place Behaviour

Every workplace is affected by various forms of organisational behaviour that impact on communication, leadership, decision making, motivation and interaction at both individual and group level[13]. The workplace can affect behaviour to the extent that it supports or represents various work groups, encourages interaction between staff, provides a sense of involvement, and facilitates the range of activities necessary for effective contribution to the organisation as a whole. In CH_2, the design team adopted key accommodation principles intended to create new types of spatial allocation based on work processes instead of worker hierarchy[14], and by increasing autonomy and interaction through a range of reconfigurable enclosure types and flexible spaces. The design is also intended to provide a high level of spontaneous interaction between staff in different divisions via staircases and informal gathering spaces. This interactivity is complemented by flexibility, allowing staff a greater degree of choice about when and where to work, with workstations complemented by informal work areas.

Change and its Effect on People's Behaviour

The notion of change is often invoked as one of the most significant aspects of the modern organisation. Many employees need to deal with conditions and requirements that change on a regular basis, and this is often a source of stress within the workplace. Change can occur through different work tasks, different work teams, different locations, different systems or technologies, and so on. In terms of the CH_2 building itself, the greatest change for the organisation is obviously the entire process of briefing, designing, constructing, moving into, and adapting to the new building.

Recognition of changing work practices is fundamental to principles of 'new office' design. By acknowledging different levels of worker autonomy and interaction, office design can accommodate temporal change as workers move between workstations, meeting areas and other formal and informal spaces.

13 Author note: Stephen P. Robbins, *Organizational Behavior: concepts, controversies, and applications*, Englewood Cliffs, N.J.: Prentice Hall, 1993.
14 City of Melbourne note: During the consultation process some work areas in the organisation embraced the opportunity to inter mix managers and team leaders with their staff, whilst other work groups preferred a more cautious approach, which has resulted in a variety of group arrangements that are reflective of particular managers willingness to adopt an intermixed model.

The idea of change has been fundamental to principles developed by consultants DEGW, and founding partner Francis Duffy[15]. Duffy has extensively explored ideas and issues around workplace design, both in terms of different activity types and different rates of change of building elements. Duffy describes various 'layers of longevity' of a building that are renewed at different rates, consisting of site, structure, skin, services, space plan and what he calls 'stuff'. This model has also been used by Stewart Brand to develop ideas of building adaptation that are fundamental to ecological principles of reuse and recycling[16].

The City of Melbourne's current office accommodation is sometimes inefficient and inappropriate for the functions of the users. There is a tradition of 'owned' spaces, strong territory delineation, and provision of substantial enclosed private office spaces. In tandem with developing a leading edge building, the City was also keen to create an interactive and highly functional working environment (within and across departments) that enhanced performance, provided greater space efficiencies, and achieved an effective public interface. Pivotal to achieving these goals is the desire for the City of Melbourne to be perceived as 'an employer of choice', as this is seen as a key aspect in attracting and retaining high calibre employees. In order to achieve the outcomes described above, it will be essential for the organisation to challenge existing paradigms, investigate solutions and develop policies and procedures that provide for the work style the City of Melbourne wish to create[17]. It must also be recognised that the City of Melbourne is a business that provides a diverse range of services requiring a variety of solutions dependent on the service offering. In order to achieve the above goals, a cultural realignment will need to occur to match the new environment.

Communication

The design of any office building represents a degree of compromise between the need for interaction and autonomy among staff. The way in which staff directly interact with each other is affected by the type of space, while the way they interact indirectly is affected by other means of communication such as telephone, email or internal mail. One of the major advances of recent 'new office' design has been the increased interaction between staff as a result of less hierarchical office arrangements, as well as from increased informal spaces, such as staircases and kitchens[18].

This kind of communication has also been complemented by new media such as email and the increased portability of laptop computers and mobile phones. Within organisations, there is also portability resulting from variable telephone and computer ports, enabling staff to access their own files and extension numbers from anywhere within the office. Internet connections also allow workers to communicate with other staff while working remotely or from home.

Together these changes have reduced the reliance on individually allocated workspaces, and increased mobility of workers within the office. In CH_2, this has facilitated open plan furniture arrangements, and reduced reliance on paper based storage and security systems.

Worker Morale and Attitude

The quality of the workplace has long been recognised as having an effect on worker moral and attitude. The importance of providing for the needs and comfort of workers links back to both early industrial philanthropy and to negotiations between worker groups and employees since the 18th century. Worker morale and attitude is a complex issue, dependent on a range of factors including rates of pay, employment conditions, relations with managers and other staff, and opportunities for promotion, to name just a few. However, the concern of this paper is the extent to which the building itself can influence workers.

Location

While many offices benefit from a central city location, problems with air quality and noise have occasionally led to designs in remote locations intended to take advantage of more natural sites. Examples include the range of 'office parks' such as those by Eero Sarinen in the late 1950s and early 60s or Roche and Dinkeloo in the 1980s[19]. While these buildings offered clean air and picturesque settings, it is still the amenity and convenience of the city that remains most attractive to workers. Moreover, with the dramatic improvements in amenity that have occurred in inner Melbourne in recent years, a central location such as CH_2 has become even more attractive. Workers at CH_2 will enjoy[20] excellent public transport services and immediate access to shops, galleries, parks and gardens, and the general ambience of being in the heart of the city they are responsible for administering.

15 Author note: Francis Duffy, *Design for change: the architecture of DEGW*, Basel: Birkhäuser; Haslemere: Watermark, 1998; Francis Duffy, *The New Office*, London: Conrad Octopus, 1997; Francis Duffy, Andrew Laing, and Vic Crisp, *The responsible workplace: the redesign of work and offices*, Oxford; Boston: Butterworth Architecture in association with Estates Gazette, 1993; Francis Duffy, The changing workplace, London: Phaidon, 1992.
16 Author note: Stewart Brand, *How Buildings Learn: what happens after they're built*, New York: Viking, 1994.
17 City of Melbourne note: Addressing this aspect of the change process is by its nature an ongoing activity and in some respects has not occurred as intended, especially at the deeper level of cultural attitudes, expectations and behaviours. At a practical level, however, certain work functions have had to be separated from existing work groups to fit within the functional constraints of the building, such as for security related to the operation of mail rooms. Another practical example is the deliberately set storage limitations within CH_2, which fits with the organisations overall information management strategy and how this has actively encouraged work areas to review the hardcopy information that is stored at hand, determine what can be moved off-site or converted to digital format.
18 Author note: Duffy, *The New Office*.
19 Author note: Thomas Hine, "Office Intrigues: the interior life of corporate culture" In Donald Albrecht and Chrysanthe B. Broikos (eds). *On the Job: design and the American office*, New York: Princeton Architectural Press, 2000, pp. 129-143.
20 City of Melbourne note: Although the majority of the occupants in the new building will not experience any real change in regard to their location, as their current accommodation is very close, some occupants will experience a change as they are moving from CBD fringe area that is located close to a popular market precinct.

Indoor Air Quality

Although operable windows are highly desirable, one of the principal reasons for designing sealed offices is to protect workers from the noise and pollution generated by city traffic[21]. In CH_2, air intake is 100 per cent filtered outside air, instead of being recycled as it is with traditional air-handling systems in most office buildings. It is therefore likely that the environment inside CH_2 will be a dramatic improvement over that of existing facilities. With this improvement in indoor air quality comes the potential to increase worker health and moral by providing a high quality working environment and reducing incidences of illness (see also paper six). This is further enhanced by the option of accessing external space, such as balconies and winter gardens, to make the office experience more enjoyable.

Identity

The role of CH_2 as a world leading green building has the potential to improve worker morale and attitude through their contribution to environmental measures, and to promote City of Melbourne as an 'employer of choice' that attracts staff by providing the best possible facilities. The greatest advantage of workplace satisfaction among workers is the reduction in 'churn' or turnover of staff. Turnover incurs costs as a result of disruption to remaining staff and the need to train new staff, estimated at between 0.25 and 1.5 times the annual salary of the staff member concerned.

Fit-out

A range of strategies have been implemented by the CH_2 design team to improve the sustainability of the interior fit-out, including design for disassembly; material selection criteria; recycling and recyclability; innovation; dematerialisation; reuse; indoor air quality; indoor landscape; flexible planning; glare reduction; lighting management; user education; and waste management. (See Sustainable Fit-out Guidelines by DesignInc).

As Stewart Brand has identified, one of the key issues involved with recycling of building materials is the design for disassembly by minimising lost fixings and finishing[22]. For the CH_2 project, the design team have attempted to promote reuse by designing or selecting joinery systems that can be easily disassembled. This involves the use of standardised components for ease of repair and flexibility in configuration, as well as the use of free-standing elements[23] to minimise connection to floor slabs and to allow relocation without damage to surfaces.

The selection of materials for internal fit-out has been dominated by environmental aims in accordance with Green Star Rating (see below and also paper six).

This process has involved an awareness of what constitutes a 'green' material, and of industry resources available for their specification (especially ecospecifier). It has also involved the use of local materials and suppliers, where possible, to minimise energy use associated with transport. Selection of materials involved the development of specification clauses to ensure supplier compliance. Care was also taken to avoid materials promoted as 'green' without suitable independent research or certification (otherwise known as 'green wash').

Although design for recycling has been promoted where possible, such as the design for disassembly, this has been done with an awareness of the associated problems. Since recycling is a manufacturing process, it can still produce hazardous emissions and consume other resources, such as water and energy, apart from the recycled material. It can also involve a reduction of quality, known as 'downcycling', which prevents continuous cycles. Due to these problems, the design team promoted a 'cradle to cradle' approach, where possible, as well as a broader understanding of sustainability and innovation in relation to material use.

Another strategy for CH_2 was to use the opportunity of designing and constructing a new building as a way of advancing industry knowledge and improving sustainable building practices. This requires an innovative approach to the use of material and a redefinition of the industry 'standard'. It also recognised that the development of sustainable materials and selection methodology needs to be matched by innovations in design approach. Likewise it involved a recognition that the development of a sustainable 'aesthetic' necessary for future impact will only emerge from a new approach to all phases of design and delivery of the building.

The design of office buildings usually includes high level finishes to emphasise status and differentiate from spaces of industrial production. In contrast, the approach required to achieve sustainability necessitates a 'dematerialisation', where material use is reduced to a minimum. The outcome of this approach is a kind of 'industrial aesthetic', where applied finishes are avoided through creative design that seeks to beautify and expose functional and structural elements. This creative way of thinking also responds to the lifecycles of elements such as structural services and fit-out, by allowing for elements to be replaced without damaging others. It also demands thinking about 'standard' detailing, which involves using available sheet size to reduce off-cuts, or re-using off cuts in other design elements.

21 City of Melbourne note: The point in relation to car exhausts is partly challenged by carbon dioxide measurements, conducted by a group from Cambridge's Martin Centre that found air quality in Swanston Street was far better than on the first floor of Royal Mail House, which indicated greater air quality (lower carbon dioxide levels) outside than inside nearby buildings.
22 Author note: Stewart Brand, *How Buildings Learn: what happens after they're built*, New York: Viking, 1994.
23 City of Melbourne note: While the design team for the building has actively used freestanding elements, there has been the need to connect certain demountable partitions to both the raised access floor and ceiling to provide security control and other services to the semi-enclosed space.

As the occupants of CH_2 are being relocated from existing tenancies, it may be possible to reuse materials and furniture already being used by staff. This has involved an audit of existing furniture to identify reuseable elements and include them in the new fit-out. It has also consisted of an innovative approach for considering reuse of existing materials in different applications. Strategies for staff turnover also include relocation and reuse of furniture for new staff.

The interconnected nature of internal office environments is particularly evident in the relationship between interior fit-out and indoor air quality. The design team adopted a strategy that considered indoor air quality at all phases of project. This included material specification to minimise volatile organic compounds (VOCs); design for indoor planting to absorb pollutants; use of water based paints and coatings; and minimisation of paints and coatings by leaving surfaces exposed where possible.

Indoor plants have been considered as an integral part of the interior fit-out to ensure optimal contribution to indoor air quality. This includes species selection that maximises absorption of pollutants; use of planting for privacy screens instead of partitions where possible; use of planting on perimeter spaces to filter daylight and reduce glare; and implementation of a management plan for maintenance of plants.

The principles of the open plan office have been used to minimise fit-out requirements and maximise flexibility of planning arrangements. The move away from fixed and enclosed offices means greater degree of interaction between staff, reducing isolation of staff housed within a single department. Workstations are located away from windows to allow for shared perimeter space.

A range of strategies have been employed to eliminate glare, including: care in selection of colours and surface finishes; use of perimeter planting; installation of blinds where required; and consideration of workstation layout to avoid incident light on computer screens.

Various management systems have been used to minimise artificial light and rely, where possible, on daylight. These include installation of energy efficient fittings; light sensors to dim lighting in response to natural light levels; possible use of motion sensor switches to operate lights in infrequently used space; and night switches to prevent lights being left on overnight. The overall design strategy includes minimisation of unnecessary lighting and design of lighting layout to respond to workstation modules. This will be achieved using a low base level light, along with highlighting and task or desk lamps rather than high overall light levels.

A key sustainability strategy is to educate users to achieve the best performance from the building and its systems. This includes familiarisation with the operation of facilities to prevent misuse and encourage pride of ownership. It also includes involvement of staff in the design process to promote a sense of ownership and responsibility, as well as in the building assessment to promote understanding of sustainability issues. Waste management processes have been considered[24] as part of the schematic design, especially for incorporation of recycling systems and promotion of staff awareness.

Interior Design

General principles adopted for the interior design of CH_2 include flexible and adaptable spaces, an emphasis on sustainability, and a strong relationship with central Melbourne and its history. The interior of CCH_2H2 is designed to create an optimal working environment for staff that reflects the broader environmental aspirations of the building and the City of Melbourne as a whole.

Flexible and Adaptable Space

As the spatial constraints of CH_2 limit the ability to rearrange furniture, the focus of the building is on flexibility of use. The use of open plan offices, combined with mobile and modular furnishing systems, allows work spaces to be adapted to suit changing work requirements. This is emphasised by a focus on 'skeletal' design that avoids unnecessary fittings for aesthetic purposes and reflects a strategy of minimal material usage with maximum recycling potential. The overall intention is to allow staff to determine the character of the space for themselves. This applies to individual areas as well as to breakout spaces and meeting areas.

Emphasis on Experience

The emphasis on occupant experience in all aspects of the interior fit-out is intended to reflect the broader ambitions of the building as well as provide a healthy and stimulating work environment for staff. Materials, finishes and colours will be selected to provide an 'organic' feel to the space. Natural textures and tactile surfaces will be used to emphasise sensory experiences that are sympathetic to occupants.

The use of open plan offices, with spatial allocation according to project group instead of status, will deliver a more equitable use of space as well as a greater degree of communication between staff. It will also allow staff to share access to natural light and ventilation, with window areas defined as common zones rather than allocated to individual offices. Office areas will also be enhanced by movable planter boxes to bring landscaping inside the offices and further enhance staff wellbeing.

Relationship to the City

A greater degree of contact with the outside environment, such as the external staircase, will allow staff at CH_2 to feel more involved with the city in which they work. Art and memorabilia related to the history of the City of Melbourne will also be displayed in gallery spaces that both differentiate and connect each level.

24 City of Melbourne note: Consideration has been given to City of Melbourne's existing waste management processes in an effort to provide more efficient waste management services.

Acoustics/Noise

One of the major problems with open plan offices is the possible disruption caused by a lack of acoustic isolation between staff. Sources of noise include meetings, conversations, telephone conversations, telephone ring-tones, keyboard 'tapping', equipment such as photocopiers or scanners, and kitchen equipment. Methods of reducing noise in CH_2 include acoustic screens of varying heights between workstations, installation of fully-enclosed and sound isolated (30 to 35dB reduction) meeting rooms at first floor level[25].

The use of an exposed concrete ceiling in CH_2 means the normal method of sound absorption, using suspended ceiling panels, is not possible. Instead, sound absorbent surfaces have been incorporated into the design of the chilled ceiling panels, and carpets are laid in workstation areas. These panels will cover around 25 to 30 per cent of the ceiling area, and additional noise attenuation related calculations will be performed when these elements are finalised.

While the concrete ceiling is highly sound reflective, the curved profile will serve to partially isolate sound within each of the bays. This relates to the use of internal space described above, where the layout of the open plan area has been influenced by the curved ceiling, with the low points providing a natural 'edge' to departmental divisions on the same floor.

With low air-flow rates from the under-floor swirl diffuser ventilation system, there is less sound masking due to the absence of 'white noise' generated by a typical ducted air-conditioning system. Electronic sound masking will be installed to counteract this effect. Another aspect of noise reduction is that of workplace behaviour, with attitudes to both noise generation and tolerance of others requiring some adjustment by staff to suit the new situation[26].

Technology

Technology has long had an impact on the design of the office environment. Throughout the 20th century, office layouts were based largely on the flow of paper based information. The need to literally 'hand-over' pieces of paper from one person to another up the managerial hierarchy gave rise to organisational structures based on information flow instead of effective work practices. The technologies used also had acoustic implications, so that, for example, manual typewriters were often 'pooled' together to minimise disruption to other spaces.

The wholesale change to computer based information systems in the last few decades has led to new forms of information exchange and storage, shorter time frames for communication, and new levels of mobility both within and between offices.

For example, centralised telephone and computer networks can enable staff to access their own files and extension number from anywhere within an office, reducing the need for allocated desk space. Internet connections and home or portable computers also allow workers to undertake work from home while still being in contact with colleagues.

These technological advances have led to changes in managerial practices, reducing the reliance on visual forms of surveillance and security, and instead relying on individual motivation and electronic forms of data protection. Given the cost and time needed for the development of new buildings, spatial responses to these technological innovations have been relatively slow. Even the shift from CRT to LCD computer displays has significant spatial implications, relating to depth of workstations, visibility between staff, and the overall heat load for the space. In CH_2, the installation of access-floor wiring and modular furniture systems will combine with flexible management practices to enable staff to work effectively with new digital technologies.

Materials

Sustainability and 'design for environment' were key criteria for selecting materials for CH_2. In keeping with other design decisions, the interior fit-out was seen as integral to the performance of the building, and the aim of minimising environmental impact.

The process of materials selection started with an EcoAudit of potential materials and suppliers, using a questionnaire to evaluate the environmental impact of various products. The audit also sought to understand impacts at the manufacturing stage, such as embodied energy and water, dust and chemical emissions, use of renewable resources, and efficient use of materials (avoidance of over-specification). The audit also sought to account for disposal impacts, including landfill requirements, toxic waste problems resulting from synthetic materials and chemicals, and reduced resource efficiency for non recyclable materials.

The selection of furniture was also driven by environmental considerations such as life cycle impacts, including off gassing and maintenance issues, as well as waste minimisation at the end of a product's useable life. Strategies included: design for durability; design for easy care and maintenance; design for reuse and re-manufacture; design for disassembly, including component replacement; design for recycling; and design for safe disposal. (See also paper six for material considerations).

25 City of Melbourne note: Sound isolated meeting rooms have been included in the south east area of levels two to nine.
26 City of Melbourne note: Small changes in acoustic qualities are also expected to be highly noticeable to staff moving from the 200 Little Collins Street building, which was recently tested (MABEL July 2005) for its acoustic qualities. Considering that 200 Little Collins Street buildings is an open office, the acoustic quality in terms of noise background environment was found to be practically non-existent. The reason for this may rest with the highly sound absorbing environment that produces virtually no sound reverberation and was consequently identified by the measurement team as one of the lowest observed in their work to date.
27 MABEL Monitoring of the Melbourne Council House 1 Offices Report

Conclusion

By examining workplace environment of the City of Melbourne's new Council House 2 (CH_2), we begin to see how all other aspects of the building – its use of energy and water, its services and systems, its materials and construction – combine to provide a comfortable and productive place for employees to work.

Although there is much interest in the environmental features of CH_2, what is possibly more important is how those features can help improve the quality of the workplace, and assist employees to respond efficiently and effectively to the City of Melbourne's new workplace and organisational goals.

Given the complexity of drivers influencing built form outcomes in the property and construction industry, it is easy to see why the true purpose of spaces created in buildings is often neglected. Buildings are, therefore, often designed according to current industry practices of construction, servicing, and spatial provision without explicit consideration of the buildings ability to produce high performance 'workspace' environments that stimulate and respond to support people as they carryout demanding and ever-changing activities. For that reason, the shift towards designing building that integrally consider the relation between the operational and physical aspects of the building and human factors, is being meet with a degree of industry resistance as the players in this sector come to terms with a new value proposition and design philosophy to create it.

The most likely benefit of the investment in CH_2 is the improvement to staff motivation, welfare and performance resulting from their involvement in designing a leading-edge workplace. As Hawken et al have argued, the relative costs of personnel, building and energy differ by an order of magnitude: that is, 100:10:1[28]. Therefore, minor improvements to worker productivity can easily make up for increased expenditure on building infrastructure. In order to generate valid financial estimates that support this logical rationale a range of methods are being developed internationally to measure productivity benefits[29], although more work is needed, which focuses specifically on the Australian context.

This paper has focussed on the intended benefits of workplace design to workers and the way that internal design can accommodate new work practices. At the time of writing, many decisions relating to CH_2 were still being finalised, including the final design of workstations and the selection of furniture. Some of the ideas being adopted are typical of new office designs, and some, especially the environmental systems, are unique to CH_2. Further research will be necessary after completion and occupation of the building to understand the full benefits of the different innovations, and to benchmark CH_2 against other international demonstrations of sustainable office design.

28 Author note: Paul Hawken, Amory Lovins, and Hunter Lovins. *Natural Capitalism: creating the next industrial revolution*, Boston: Little, Brown and Co., 1999.
29 Author note: Derek Clements-Croome, (ed.), *Creating the Productive Workplace,* London; New York: E & FN Spon, 2000.

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