Back to the Future: Heritage buildings, adaptation and sustainability in the Melbourne Central Business District

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Abstract
Humans have adapted buildings for almost as long as they have constructed shelters. With an acceptance of links between energy consumption, greenhouse gas emissions, and climate change, many perceive the built environment as a sector with high potential to reduce overall emissions. The built environment is responsible for around half of all greenhouse gas emissions and could play an important role in mitigating global warming. Many global cities aim to become carbon neutral, Melbourne leads the way with a target of neutrality by 2020 with others following such as San Francisco with a 2030 target. With only around two per cent of new buildings added to the existing stock each year, clearly the scope for emissions reductions lies largely within the adaptation of existing buildings.

Buildings have to meet the needs of users and the wider community. As such, successful adaptation requires stakeholders to address social, technological, environmental, economic, and legislative criteria. Heritage buildings often account well in terms of embodied energy, though they may not be energy efficient. Whilst unlisted buildings present their own challenges and opportunities, heritage stock adds another layer of complexity to adaptation and sustainability practices, given the varied heritage-related restrictions on the nature and extent of retrofit measures that may reduce energy, water, and resource consumption.

Concentrating on Melbourne, Australia, this paper addresses the question: what is the nature of adaptations in relation to heritage and non-heritage office stock in the Central Business District (CBD)? The study analyses 1,548 commercial building adaptation events of heritage buildings, surveys the extent and nature of adaptations between 1998 and 2008, and identifies future considerations for integrating sustainability into heritage retrofits.

Introduction
One option considered by owners to increase the sustainability of existing building stock is to undertake adaptation. Australia, like many developed countries, needs to increase the adaptation of the existing commercial stock to reduce building related greenhouse gas emissions (Garnaut 2007). The City of Melbourne aims to be carbon neutral by 2020 (Lorenz et al. 2008) and a target of 1,200 building adaptations has been established to deliver greenhouse gas reductions through sustainability measures. Some of these emissions reductions could be achieved by adapting heritage buildings, but the question remains as to what is the nature of these adaptations in relation to heritage and non-heritage office stock in Melbourne’s CBD.

There are a plethora of terms used to cover adaptation (such as retrofit, refurbishment, upgrade, conversion, renovation) all of which often exist in a ‘state of happy confusion’ (Markus 1979; Mansfield 2002). For the purposes of this research, the definition of adaptation follows Douglas’ (2006: 1) broad parameters: ‘any work to a building over and above maintenance to change its capacity, function or performance’ or, in other words, ‘any intervention to adjust, reuse, or upgrade a building to suit new conditions or requirements’. This definition encompasses within use and across use adaptations and demonstrates that adaptation can be applied to a whole building or to part of a building – for example, to one or more floors of a high-rise building. The term ‘adaptation event’ is defined to include all activity related to individual building permits on existing buildings. In the case of tenanted buildings, this event could include the alteration, extension, upgrade, change of use, renovation of a site, and as such multi-tenanted buildings will experience multiple events within the one building. High rise buildings therefore experience a greater number of adaptation events, though the value and scope of those events may be smaller. One of the reasons existing buildings are adapted is to meet the requirements of tenants and owners for improved environmental performance. As such, heritage buildings need to adapt to changing preferences if they are to compete with newer sustainable buildings. This paper examines the nature of heritage buildings, the need to adapt existing stock, and the conflicts and connections between sustainability and adaptation of heritage buildings.

The nature of heritage buildings
The notion of a heritage building is typically conceived of as an older building, which is architecturally significant. In Australia, heritage may be protected by Local, State, and Commonwealth Governments (DPCD 2010). The criteria for heritage listing in Victoria are outlined in the Victorian Heritage Act (1995) and are similar to heritage criteria in other countries. To satisfy these regulations, heritage buildings or places typically have to be of cultural or historic significance and/or be included in the Heritage Register and/or on the World Heritage List (DPCD 2010). However, it is a misconception to assume that heritage stock is simply ‘older’ stock, as many city centre buildings constructed in the post-war period have a heritage overlay or listing to protect them from alterations which would otherwise compromise their heritage values.

Construed in Melbourne in 1958 and an example of ‘Modernist’ style, the office building known as ICI House was heritage listed in March 1990 due to its architectural significance to Victoria. Until 1961, ICI House was the tallest building in Australia, and at 84 metres in height it greatly exceeded the previous 40.2 metre Victorian height restriction, setting a new precedent for height
controls in Melbourne. Its height and position on the eastern hill of the CBD, terminating the axis of Lonsdale Street, made the building a landmark. In terms of construction innovation, curtain walling had previously been used to a small degree on facades in Melbourne but its use on ICI House was important as the entire main building envelope is clad in this manner. In addition the garden – with its Lewers fountain and water feature – is of significance due to its role in determining the plot ratio that allowed the breaking of the height limit as well as defining the original formal entry to the building. ICI House makes it clear that buildings become heritage listed for many reasons, and that ‘heritage’ comprises both older and relatively recent buildings in city centres.

The need to adapt heritage buildings

The adaptation of heritage buildings allows us to retain significant cultural and social values embodied in the buildings for future generations (DEH 2005; Bromley et al. 2005). A US study concurred with this view of social and cultural worth when researching adaptation of industrial buildings (Snyder 2005). The adaptation of heritage stock can promote urban regeneration in rundown areas (Ball 2002), however there is a counter-argument that where large numbers of obsolete buildings await adaptation, a region may become socially blighted (Bryson 1997). Economically it is claimed that adaptation is cheaper than new build (Ball 2002; Douglas 2006). However, Bullen (2007) argues that with heritage stock there can be a premium to construction costs because of the additional skills and the quality of the materials required to satisfy statutory controls which can result in higher adaptation costs.

Heritage buildings have additional statutory constraints that create challenges in terms of compliance and meeting contemporary market expectations of commercial stock. For example, where the facades or building envelopes are listed the opportunity to reduce energy consumption through increased insulation to the fabric of the building is limited. Another compliance issue is addressing the social sustainability of access to buildings which is now a matter addressed in building design and legislation. Older stock is unlikely to have ramped access for wheelchair users as part of the original design, and adjusting to access needs – though necessary by contemporary design standards – is likely to be viewed as a major intervention to the building which has to be accommodated in the least obtrusive way possible. In order to comply with best practice in conservation, where possible the measure should be reversible without damaging the original building structure (Brereton 1991).

One of the challenges facing the professional teams adapting heritage buildings is determining the extent of the original features, many of which may have been partially compromised by previous adaptations (GBCA 2010). Lengthy debates ensue to determine exactly what is of significance and what may be changed and how. Thus there are good reasons for adaptation and a number of very specific challenges in executing successful adaptations of heritage buildings before the issues of addressing sustainability are taken into account.

Sustainability and existing buildings

Sustainability has been defined in the context of the triple bottom line (TBL) as having three components of social, economic, and environmental sustainability where each are perceived as equally important. Often with buildings the emphasis is placed on environmental sustainability of its structure and fabric and on the operational phase of occupation, with consideration also given to deconstruction and recycling opportunities at the end of the building lifecycle. Langston (2010) noted that adaptation of buildings can deliver economic, environmental, and social benefits to society, which should be at the forefront of thinking about existing building stock.

Key environmental sustainability measures that can be considered in the adaptation of heritage buildings are much the same as those relevant to non-heritage stock; namely energy efficiency, water efficiency, reduction of waste, introduction of recycling/waste management, specification of low environmental impact materials, and effective building operation and facility management. Energy efficiency and reductions in building-related greenhouse gas emissions may be improved by using high efficiency luminaires, high frequency ballasts, energy efficient lighting controls, and by purchasing ‘green power’ (Arup 2008a). In addition, tenancy sub-metering enables improve management of energy use. Significant improvements can be made with minimal costs through a housekeeping review, energy purchase, improved maintenance, and re-commissioning buildings’ services (Arup 2008b). Water economy measures include the installation of waterless urinals, 3/6 litre dual-flush toilets, water efficient fixtures, and water tanks to collect rainwater for flush toilets (GBCA 2010). Such measures can reduce environmental impact of buildings and are recognised as such by their inclusion in the environmental assessment tools which are used to evaluate the levels of sustainability achieved in green buildings such as BREEAM and Greenstar (Langston 2010).

Other environmental sustainability measures that may be adopted include reusing timber and using timber from renewable certified sources. Furthermore, using carpets, paints, sealants, glues, and adhesives with low Volatile Organic Compounds (VOCs) incorporates sustainable materials into buildings (GBCA 2010). If possible the provision of bicycle storage and shower facilities encourages users to adopt more environment friendly transportation. It is clear there are a range of measures which may be adopted and the list above is not exhaustive, however each building has to be assessed on its merits and with its heritage listing to identify specifically those parts which may be retrofitted with sustainability measures and yet satisfy the relevant statutory controls.

The social sustainability of a building is considered by stakeholders and within environmental assessment tools. ‘Social sustainability’ is a broad concept that relates to society, the community, and /or individual people. An illustration of social sustainability is the notion that sustainable buildings are healthier for people due to the specification of materials that do not contain chemicals which can be detrimental to human health (Clements-Croome 2006). Another example of social sustainability involves building aesthetics, where buildings having pleasing aesthetic qualities that enhance the surrounding areas in which the building is located and the urban environment in which they are sited.

A powerful argument for economic sustainability is the view that sustainable buildings are healthier buildings which result in less employee absenteeism due to sickness and result in higher productivity, thus increasing the overall profitability of business occupiers (Clements-Croome 2006). Lower operating costs within sustainable buildings are a further driver and powerful argument for implementing sustainability within office
buildings, especially given increasing energy costs. Given the examples above it is evident that there can be a close and often overlapping relationship between the three components of the triple bottom line.

In this paper the potential for integrating a broad range of economic, environmental, and social sustainability measures are explored in the context of the type and extent of adaptations that have been undertaken to heritage buildings from 1998 to 2008 in the Melbourne CBD.

**Building attributes in adaptation**

Previous studies have identified building attributes which are either important in adaptation or affect adaptation (Kincaid 2002; Snyder 2005). For a fuller discussion on building adaptation and building attributes readers are referred to Wilkinson, James and Reed (2009). This paper focuses on attributes which were found to be important in the context of heritage buildings’ sustainability and adaptation – specifically, the number of adaptations overall, trends over time, age, location, building quality, aesthetics, plan shape, and building height. Some of these attributes are associated with sustainability such as building quality – as defined by the Property Council of Australia where by office buildings are classified as Premium grade, through A, B, C, and lastly D grade. Premium grade offices typically have the best quality services – for example the fastest lifts and air conditioning – which result in high operating costs per square metre and consequently high greenhouse gas emissions. However, it is also true to say that lower grade offices with older services installations can have higher running costs. Aesthetic qualities are also a measure of social sustainability in the context of this research.

Building age has an important affect on adaptation, since as buildings age they wear out and need certain components to be repaired or replaced (Douglas 2006). Barras and Clark (1996) and Baum (1991) have argued the correlation between time and building obsolescence, establishing that as time passes adaptation of some form is necessary to avert a decline in condition, which otherwise leads to demolition. Previous studies considered location and its affect on adaptation as important. Some properties are sited in favourable locations which enhance the frequency and likelihood of adaptation (Kincaid 2002; Douglas 2006; Highfield 2000). Building location within a geographical area can be interpreted into zones and in Melbourne the city is grouped into five zones – Prime, Low Prime, High Secondary, Low Secondary, and Fringe – where ‘Prime’ is considered the best location, wherein the highest rental and capital values are to be found. There is a view that buildings in better locations are likely to undergo more adaptation (Swallow 1997; Ball 2002). Depending on the condition of the original building, it is possible to increase the overall quality with adaptation (Boyd and Jankovic 1993; Swallow 1997; Snyder 2005; Kersting 2006). Building quality is measured in various ways, relating to either provision of a greater number of amenity features, attributes, and/or a higher standard of services, features, fixtures and fittings. In Australia, offices are graded by the Property Council of Australia (PCA) as Premium (the best quality and highest rental levels), A, B, C, and D grade. Grade D is the lowest office grade with the least level of services and amenity and the lowest rental levels. It is possible with adaptation to increase the quality grade from one band to another and increase the rental and capital value of the building, however the capacity to do this is dependent on the condition and location of the building (Boyd and Jankovic 1993; Swallow 1997; Snyder 2005; Kersting 2006).

In his UK study of 400 building owners, Ohemeng (1996) found that aesthetics was an important attribute in determining whether or not a building was adapted. Plan shape was an important attribute in adaptation and some plan shapes (such as ‘deep’ plan shapes) were easier to adapt than others (such as irregular plan shapes. See also Kincaid 2002; Povall and Eley in Markus 1979). Building height or the number of storeys in a building have also been found to affect adaptation (see Povall and Eley in Markus 1979; Gann and Barlow 1996).

**Research approach**

For this research, a database of Melbourne CBD office buildings was assembled to understand the nature of adaptation and the extent and scope for sustainable adaptation using multiple sources such as the commercial database Cityscope and public databases such as PRISM (Victorian Government) and the Heritage database. In addition, Property Council of Australia (PCA 2007), Google Earth, and Google Streetview were used to gather building-related data. Information relating to adaptation events was derived from the records for building permit applications. Finally, visual inspections and photographic records of CBD buildings were undertaken.

Following validation, the database comprised records for 13,222 adaptation events to commercial buildings within Melbourne’s CBD from 1998 to 2008, with full address details for 6,507 adaptation events. Given the objectives to understand the nature of adaptations to heritage office stock and the extent and scope for sustainable adaptation of heritage office buildings, analysis of the database presents an opportunity to scope the nature of existing buildings using multiple sources. The criteria used to establish the potential for sustainability in the adaptation of heritage buildings were: number of adaptations, building age, adaptation trends by year, location, building quality, aesthetics, plan shape and height. These criteria allow the research to provide an overview of what has happened on a CBD scale with adaptations to commercial heritage buildings.

This exploratory study aims to determine the extent of the potential for the scope of sustainability in adaptations within the Melbourne CBD. As such, details on the individual characteristics of the buildings are not examined or presented here. Langston (2010) showed that the application of models to evaluate a building’s potential for adaptation, such as the adaptive reuse potential (ARP), can assist stakeholders to evaluate the optimum time for adaptive reuse. This paper adds to the body of knowledge of adaptation in respect of analysing adaptations stock between 1998 and 2008 and comparing the similarities and differences to heritage and non-heritage stock.

This paper presents a uni-variate and a bi-variate analysis of its data. The results of this research will enable Heritage Victoria, the City of Melbourne, and other stakeholders to evaluate on a cost-benefit analysis the desirability of developing and pursuing incentives to roll out a programme for sustainable adaptation of heritage office stock. The results allow other municipalities to reflect on the potential of their heritage stock to accommodate a sustainable adaptation programme.

**Defining the CBD area**

The research sought to investigate activity in a well-developed, mature commercial market and a preliminary task was to define the area for the study. The Melbourne CBD was the first area laid out in 1834 by the surveyor Hoddle, has been continuously
buildings that has occurred in the CBD since the 1830s. Figure 3 shows that generally newer stock is adapted across its age profile, however this may be partly the result of the types of heritage and/or overlay buildings within those age groups. That is to say, newer heritage stock is more likely to be sky-rise and high-rise property constructed in the post-war period which tends to experience multiple adaptation events to individual floors as well as on a whole building basis. Given the broad definition of adaptation adopted for this study and the nature of the stock in its database, it is clear that many adaptations occurred to floors within high rise buildings more so than adaptation to entire buildings.

Data analysis
Of the total adaptation events, 23.8 per cent occurred to buildings which are either listed as heritage or hold heritage overlays indicating nearly one in four adaptations has heritage issues (Figure 2). This is a significant minority and signifies that authorities need to pay attention to the opportunities for integrating sustainability measures into heritage stock. Relatively speaking there are more frequent opportunities to do this compared to non-heritage stock.

Contrary to what might be assumed, when the age profile of heritage and overlay stock adapted is examined it is the newer heritage and/or overlay stock which is more frequently adapted to meet changing market and tenant needs. This is also a reflection that the average of all office stock in the Melbourne CBD is only 31 years of age (Jones Lang LaSalle 2005) and demonstrates high levels of demolition and replacement of buildings that has occurred in the CBD since the 1830s. Figure 3 shows that generally newer stock is adapted across its age profile, however this may be partly the result of the types of heritage and/or overlay buildings within those age groups. That is to say, newer heritage stock is more likely to be sky-rise and high-rise property constructed in the post-war period which tends to experience multiple adaptation events to individual floors as well as on a whole building basis. Given the broad definition of adaptation adopted for this study and the nature of the stock in its database, it is clear that many adaptations occurred to floors within high rise buildings more so than adaptation to entire buildings.

Age group
On a year by year analysis the trend lines show adaptions to heritage and non-heritage stock are increasing, however the rates of adaptation to non-heritage stock is increasing at a slightly steeper rate (figure 4). This may be due to the total amount of unlisted stock compared to listed stock and that the unlisted stock is at an age where adaptation is required. The average age of commercial CBD stock was 31 years in 2005 and this suggests that most stock was at age where major adaptations were necessary within the time period covered by this study (Jones Lang LaSalle 2008). Major retrofits on commercial stock are typically performed around the 20–25 year age mark (Duffy in Brand 1994). Overall the results show increased adaptations and increased opportunity for owners to incorporate sustainability measures in heritage adaptations.
Adaptation was also examined in terms of CBD location under Melbourne’s classifications from ‘Prime’ to ‘Fringe’. Most adaptation events occurred in low secondary locations, followed by low prime and prime locations (see Figure 5). The high secondary location was ranked fourth, with the least adaptations in the fringe location. Taken together however, the higher quality locations – prime and low prime – account for 49.6 per cent of all adaptations. Thus, more opportunities for sustainable adaptations occur in higher quality locations.

Significantly, the gap between the amount of heritage and non-heritage adaptations is greatest in the fringe location. Conversely, the least gap occurs in the prime location. This is not unexpected given that buildings in the prime location need to be maintained to retain market appeal and tenants and many heritage buildings are sited in prime locations. Not only are some older lower rise buildings sited in prime locations but also some of the sky-rise office buildings in the Melbourne CBD are now listed or have heritage overlay and these properties are often subject to adaptations to single floors which results in a high total number of adaptations. The proportion of adaptations in low prime and low secondary is similar at 22.7 per cent and 20.8 per cent respectively.

Deep plan buildings tend to consume more energy than narrow plan stock because of the high levels of lighting and air conditioning required to illuminate space and circulate fresh air to all parts of the floor plate. In this respect they offer good potential for improved environmental sustainability. Buildings

With respect to heritage adaptation and the assessment of adaptation proportions according to building quality, the unit of measurement adopted was the Property Council of Australia Building Quality Matrix (PCA 2007). The results showed the highest proportion of adapted heritage/overlay buildings to non-heritage buildings were Premium quality (see Figure 6). Some sky-rise buildings, which are Premium grade PCA, are listed or have heritage overlays and the amount of adaptation of listed to non-listed buildings is least in this category. On a per-square metre basis Premium buildings have the highest levels of energy and water consumption. Thus, there is a more regular opportunity to reduce consumption on an individual tenant basis within Premium heritage buildings (Wilkinson and Reed 2008).

Conversely, the A and B grade stock revealed a wider gap between the amount of adapted listed and unlisted stock. Listed D grade stock was least likely to undergo adaptation followed by A grade buildings. The highest probability for sustainable heritage adaptation lies with Premium stock, B grade followed by unclassified stock. Though the number of B grade heritage buildings adapted is larger than unclassified and Premium, the proportion of heritage to non-heritage adaptation in these groupings is lower. Furthermore, there is a large amount of adapted stock, both heritage and non-heritage, which was not classified by the PCA.

As Figure 7 illustrates, the relationship between aesthetics and adaptation and compares the listed or heritage overlay stock to the unlisted stock. Aesthetics can be considered as an attribute of social sustainability. The stock was graded according to objective criteria set out by Zunde (1989) for judging aesthetic merit in buildings. It is acknowledged that this is a relatively crude method of measuring aesthetic merit, however it does allow some analysis to be made at a large scale. Not surprisingly buildings with heritage overlay largely fell into the categories of having positive aesthetic qualities (86.4 per cent scored 3 or less on a 5 point scale where 1 is the highest and 5 is the lowest aesthetic quality). The trend lines show that non-heritage buildings are proportionally less likely to be adapted if they are less aesthetically pleasing – results which confirm Ohemeng’s (1996) findings. In other words, ‘ugly’ buildings are less likely to be adapted and greater scope for sustainable retrofit lies with buildings which are more aesthetically pleasing – an advantage for heritage buildings which are considered to hold aesthetic appeal.
with deep plan floor plates underwent most adaptations, around a quarter of all adaptations (see Figure 8) and therefore offer potential for reducing energy consumption through the specification of low energy lighting and energy efficiency air conditioning systems. The second highest number of adaptations occurred to buildings with irregular plan shapes and a quarter of these buildings are heritage. Fewest adaptation events occurred to wide plan buildings, with around a quarter being heritage buildings. Narrow plan buildings had the second least number of adaptations and also the least proportion of which were heritage. No heritage buildings had curved plan shapes and were adapted during the time frame covered by the research study. Therefore, most potential for sustainable retrofit lies with the adaptations to deep plan heritage stock followed by irregular shaped buildings. With higher energy consumption in deep plan floor plates there is greater opportunity for reducing building-related greenhouse gas emissions.

Buildings were grouped into four categories – low-rise (up to 6 storeys), medium-rise (7-21 storeys), high-rise (21-45 storeys), and sky-rise (46 storeys plus) – to determine the relationship between heritage, adaptation, and height. Contrary to the notion of heritage stock being low-rise Victorian or Edwardian stock, this research shows that sky-rise stock is most likely to have the highest proportion of heritage adaptations (see Figure 9). This is likely to be due to the early listing of the ground breaking, technologically innovative structures which high-rise buildings tend to be (such as The Rialto Towers in Bourke Street). The highest total number of heritage overlay adaptations by height occurred to medium-rise buildings with 560 events. Low-rise heritage overlay stock had the least number of adaptations. As far as sustainability is concerned high-rise buildings typically consume more energy because of the high speed lifts and services required to meet the tenants and market demands. The finding is that a reasonable number of the sky-rise adaptations are to heritage stock and there is potential to retrofit more energy efficient services at these times.

Conclusions and further research

There are a number of findings from this preliminary study. In particular, this research has determined the nature of adaptations in relation to heritage and non-heritage stock in the CBD and the extent and scope for sustainable retrofits to heritage buildings. The ten key findings are:

1. There is much scope for sustainable adaptation as 23.8 per cent of all events occurred to heritage and/or overlay buildings.
2. There is a growing trend for adaptations and the opportunity for owners to engage in sustainable adaptations is increasing over time.
3. More opportunity for sustainable adaptation occurs in ‘prime’ and ‘low prime’ locations which account for 49.6 per cent of all adaptations.
4. The gap between the amount of heritage and non-heritage adaptations is greatest in the ‘fringe’ location and the least gap occurs in the ‘prime’ location.
5. Some sky-rise office buildings are now heritage listed or have heritage overlay and these properties are often subject to adaptations to single floors which results in high numbers of adaptation events.
6. A high proportion of heritage buildings that underwent adaptation were Premium; the highest consumers of energy and water and the most frequent opportunity for sustainable heritage adaptation is to individual tenancies in Premium heritage buildings.
7. More opportunity for sustainable adaptation lies with aesthetically pleasing buildings and high proportions of heritage stock are aesthetically pleasing.
8. The most potential for sustainable adaptation on the basis of plan shape lies with the deep plan heritage stock followed by irregular shaped buildings.
9. A reasonable number of the sky-rise adaptations are to heritage stock and it is erroneous to assume that heritage buildings are typically low rise.
10. There is potential for sustainable adaptation by adopting more efficient services to sky-rise heritage stock.

The results reveal the nature and adaptation in the CBD and outline the attributes that offer the best scope for sustainable adaptation. The database will facilitate analysis of heritage adaptations on an individual building basis to determine adaptation profiles for typical building types and this is the next stage of this research.
References


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