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Designing for Future Building Adaptive Reuse

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Designing for Future Building Adaptive Reuse

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DECLARATION

This thesis contains no material that has been accepted for the award of another degree at a university or other educational institution. To the best of my knowledge and belief, it contains no material previously published or written by another person or persons except where due reference has been made.

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SHEILA CONEJOS, Institute of Sustainable Development and Architecture, Bond University, Gold Coast, Australia, April 2013

ABSTRACT

(350 words)

Adaptive reuse of existing buildings can play a significant role in mitigating climate change by reusing embodied energy and resources in place and acting as a viable alternative to demolition and landfill. It also offers social benefits by revitalising familiar landmarks and preserving cultural and heritage values. Further, it is important that designers should explicitly consider maximising the adaptive reuse potential of new buildings at the time that they are designed and anticipate their future uses aside from its original use.

Reviewing the design principles implemented in the past, this research identifies a knowledge gap pertaining to an absence of clear criteria for future adaptive reuse and the lack of consensus as how to maximise adaptive reuse potential. Thus, this research is an explorative study and retrospectively analyses successful adaptive reuse projects with a view to establishing and testing a multi-criteria decision-making model that can be applied to new design projects. This research develops and applies a new rating tool known as adaptSTAR, which offers holistic and unified design criteria suitable for assessing the adaptive reuse potential of future buildings.

The research study has adopted a sequential mixed mode research methodology carried out in three stages. Stage 1 is qualitative and involvesmultiple case studies, where primary data is assembled alongside a thorough investigation of secondary data. Stage 2 develops from the outcome of Stage 1 and evaluates a list of potential design criteria to determine their weighted importance via an anonymous online survey sent to selected architects in Australia, and evaluates the case studies including proposing ways in which their original design could have been enhanced. Finally, Stage 3 validates the adaptSTAR model by testing it against Langston's ARP model.

The findings of this research show that design criteria can be identified and weighted according to seven categories to calculate an adaptive reuse star rating, as well as proving that both the adaptSTAR and ARP models have strong relationships and produce results that are positively correlated. The research demonstrates that by applying adaptSTAR to future building projects, it will contribute to the objective of delivering greater sustainability of the built environment.

KEYWORDS: Adaptive Reuse, Sustainability, Design Principles, Obsolescence, Rating Tool, Australia

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To God be the Glory!

Sheila (Selah & Maris)

ABBREVIATIONS

Abbreviation	Definition
AIA	Australian Institute of Architects
ARP Model	Adaptive Reuse Potential Model
BESt	Building Environmental Standard
BIM	Building Information Modelling
BMS	Building Management System
BOMA	Building Owners and Managers Association
BREEAM	Building Research Establishment Environmental Assessment Method
BUHREC	Bond University Human Rights and Ethics Committee
CBD	Central Business District
CNYDDC	City of New York Department of Design and Construction
EBOM	Existing Building Operations and Maintenance
GBCA	Green Building Council of Australia
GGE/ GHG	Greenhouse Gas Emissions/ Greenhouse Gas
GPO	General Post Office
HMSO	Her Majesty's Stationery Office
ICC	Intraclass Correlation Coefficient
IEQ	Indoor Environmental Quality
IPCC	Intergovernmental Panel for Climate Change
LCA	Life Cycle Analysis
LEED	Leadership in Energy and Environmental Design
NSW	New South Wales
RAIA	Royal Australian Institute of Architects (now AIA)
UDIA	Urban Development Institute of Australia
UNFCCC	United Nations Framework Convention on Climate Change
USGBC	U.S. Green Building Council

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PUBLICATIONS ARISING FROM THIS THESIS

The results of this thesis are published in peer reviewed journals and conference proceedings:

1. Conejos, S, Langston, C & Smith, J 2013, 'AdaptSTAR model: A climate-friendly strategy to promote built environment sustainability', *Habitat International*, vol. 37, no. 1, pp. 95-103.

2. Conejos, S, Langston, C & Smith, J 2011a, 'Designing for future building adaptive reuse as a strategy for carbon neutral cities', *The International Journal of Climate Change: Impacts and Responses*, vol. 3, no. 2, pp. 33-52.

3. Conejos, S, Langston, C & Smith, J 2011b, 'Improving the implementation of adaptive reuse strategies for historic buildings', paper presented to Le Vie deiMercanti S.A.V.E. HERITAGE: Safeguard of Architectural, Visual, Environmental Heritage, Aversa and Capri, Naples Italy.

4. Conejos, S & Langston, C 2010, 'Designing for future building adaptive reuse using adaptSTAR', paper presented to International Conference on Sustainable Urbanization: ICSU 2010, Kowloon, Hong Kong.

5. Conejos, S, Langston, C & Smith, J 2013, 'Validation of adaptSTAR Model: towards sustainable and adaptable future buildings', Habitat International (under review).

6. Conejos, S, Langston, C & Smith, J 2013, 'Benchmarking future building adaptive reuse for built environment sustainability', Facilities (under review).

7. Conejos, S, 2013, 'Optimization of future building adaptive reuse design criteria for built environment sustainability', Journal of Design Research (under review).

CHAPTER 1

INTRODUCTION

1.1 MOTIVATION

Damaging climate change that is brought about by greenhouse gas emissions is the most significant environmental, social and economic challenge faced by humanity today (Impey, 2008). Further, Lehmann (2012) confirms that global climate change, excessive fuel dependency and the growing demand for energy and materials among cities are the greatest problems and major challenges of the 21st Century. The built environment is a major contributor to global greenhouse gas emissions (GGE), with 45 per cent of all global carbon dioxide emissions directly or indirectly connected to construction and building operation (UNEP, 2009).

Buildings are property assets that cater to basic needs, such as providing shelter from weather, and are spaces that provide comfort, security and safety for a range of human endeavours. They also underpin wider economic, social and environmental objectives. However, gains in one area can become losses in another; for example as buildings become better suited to human needs, they also use more resources and have a greater impact on the natural environment. The striking of an effective balance between these losses and gains is called sustainable development. The demand for energy, land and materials resulting from new developments needs to be tempered by taking better care of existing buildings, extending their life expectancy and using less energy.

Building adaptive reuse is defined as "a significant change to an existing building function when the former function has become obsolete" (Douglas, 2006:p.1) and it is an alternative to traditional demolition and reconstruction that entails less energy and waste. Adaptive reuse is relevant to the current climate change adaptation agenda because of its ability to recycle resources in place. This chapter makes the case for the development of an adaptive reuse rating tool targeted to new buildings that will support informed decisions about future building design in order to maximise the embedded adaptive reuse potential of existing buildings. It includes a clear statement of the research problem, the identified aim and objectives, a brief overview of the methodological approach, the expected significance of this research to the field of knowledge and identifies the limitations of the study.

1.2 BACKGROUND

Buildings are responsible for between 40-50 per cent of total energy use worldwide, with approximately 80-90 per cent of the energy a building uses during its entire life cycle devoted to heating, cooling, lighting and powering other appliances (Cheng et al., 2008; Tobias & Vavaroutsos, 2009; Yudelson, 2010). These high levels of usage encourage building professionals to produce more energy-efficient buildings and renovate existing stocks according to modern sustainability criteria (UNEP, 2007). However, the remaining 10-20 per cent energy use is embodied energy implicated during mining, material manufacture, transport and construction, and this percentage can increase to higher proportions where the useful building life is short (Cheng et al., 2008).

In the US, it is reported that for every four commercial buildings constructed, one is demolished and for every six houses built, one is demolished (Fornier and Zimnicki, 2004; Tobias and Vavaroutsos, 2012). Such demolition is costly, wasteful and has a considerable cost to environment as well as bringing with it higher energy impacts than if the buildings were adaptively reused. Yudelson (2010) claims that 75% of the buildings expected to be operating in the year 2040 are already built or adaptively reused/renovated. Therefore, upgrading existing buildings to achieve substantial cuts in GGE is considered a more climate-friendly and immediate strategy than producing new energy-efficient buildings (TEC, 2008). Jacobs (1993) notes that based on embodied energy considerations, the greenest buildings are the ones that we already have.

The recycling of building function, known as adaptive reuse, came into "mainstream architectural parlance during the 1960s and 1970s in the US due to the growing concern for the environment" (Cantell, 2005:p.3). The protection and maintenance of existing buildings, especially ancient monuments, is encouraged through conservation, preservation and adaptation practices that have evolved under different heritage laws such as the UK's Ancient Monument Act in 1882 (Curry, 1995), the Antiquities Act in the US in 1906 (Harmon et al., 2006), the Hague Convention in 1954 (ICOMOS, 1994), the Venice Charter in 1960 (Jokilehto, 1996), Australia's Burra Charter in 1979 (Marquis-Kyle and Walker, 1994) and Asia's Hoi An Protocols in 2005 (UNESCO, 2009).

The adaptive reuse of existing buildings is one of the highest forms of sustainable design. The existing building stock contains a large amount of embodied energy that should not be lost through demolition. Demolition and equivalent new construction of energy-efficient buildings require decades to equal the energy savings of rehabilitating and reusing existing buildings. Adaptive reuse is an emerging and significant design strategy that supports the objectives of the Kyoto Protocol for global climate protection and emissions reduction. Building adaptive reuse is a viable alternative to demolition and replacement that will minimise energy consumption and the cost of new construction works (Langston, 2008). Thus, Lehman (2012) suggests that there is a need for a better package of solutions for effectively upgrading older building stock and that there is also a need to focus on the low consumption of resources and materials, including the future reuse of building elements and design for disassembly, when designing new buildings.

In more recent times, communities have preserved old buildings and neighbourhoods out of a desire to retain their historical, social and aesthetic cultural contribution. Rodwell (2007) states that cultural heritage is an essential component of promoting national identity and as a cornerstone of sustainable development. The world's built heritage plays an important role in the shift towards a low carbon society (Lehmann, 2012). Impey (2008) emphasises that historic buildings and places have always existed in a changing climate and that their resilience or capacity to adapt must not be underestimated. With this scenario, the historic environment plays a creative role in forging a sustainable and cohesive low-carbon society.

The Adaptive Reuse Potential (ARP) model (see Appendix G)identifies and ranks opportunities for existing building reuse and enables the timing of any interventions to be predicted(Langston, 2008). Through this model, seven obsolescence categories are conceptualised and measured using surrogate estimating techniques. The ARP model evaluates a building's current age and expected physical life. It then assesses the expected physical, economic, functional, technological, social, legal and political obsolescence and uses the combined value as a discount rate applied to physical life to determine useful life. It also identifies when planning should start or when adaptive reuse is not worthwhile.

As a proven indicator for identifying the potential for adaptive reuse in existing building stock (Langston, 2012), this research makes use of the ARP model to help develop and validate a new design rating tool called adaptSTAR, which is a weighted checklist of design strategies that assists in the development of buildings that can be successfully reused in the future. The development and testing of this checklist is the focus for this research.

1.3 PROBLEM STATEMENT AND RATIONALE

Adaptive reuse has been successfully applied to many types of facilities, including defence estates, airfields, government buildings and industrial buildings, and the adaptive reuse of historic buildings is seen as fundamental to sound government policy and sustainable development in countries such as the United States, Canada, Hong Kong, North Africa and Australia (Langston et al., 2008), as well as in Europe and the United Kingdom (Hein & Houck, 2008; English Heritage, 1997, 2008, 2013). Noteworthy also, are the number of prestigious adaptive reuse projects of heritage buildings in most states in the US, Australia and across the Asia Pacific region (DEH, 2004; NSW Department of Planning and RAIA, 2008; UNESCO, 2007). Furthermore, the linking of adaptive reuse, heritage conservation and sustainability in urban regeneration initiatives around the world- from Asia to North and Latin America, to the Middle East, Europe and UK (Cohen, 1998; Rojas, 2002; Parlewar & Fukukawa, 2006; Peiser & Schmitz, 2007 Rodwell, 2007; Evans & Jones, 2012; Yung & Chan, 2012;).

Despite evidence of the importance and benefits of adaptively reusing existing buildings, it is a challenging task for building designers to resolve the complex set of issues that need to be considered during the design process. This includes, but is not limited to, making design decisions that maximise the opportunity for future adaptive reuse at the outset. A body of literature now exists on the subject of adaptive reuse of existing buildings, as well as a multitude of theoretical approaches, design strategies and technical solutions for the designing new buildings. However, there is a lack of consensus about the most suitable design criteria to use for maximising the future adaptive reuse potential for new buildings. Even more significantly, the relative weighting of criteria in various contexts is unknown. This is seen as a critical gap in current understanding.

1.4 RESEARCH AIM AND OBJECTIVES

Adaptive reuse is a well-documented strategy to breathe new life into obsolete buildings without unnecessary and premature destruction (Conejos et al., 2011a). The success of this activity is predicated on the particular context of the building and its original design. Most buildings are not designed to maximise future adaptive reuse, and hence the opportunity for doing so is often serendipitous. It is in this light that the aim of this research is to create and validate a design evaluation tool that leads to purposeful design decision-making for future adaptive reuse at the time buildings are designed, or put simply, planning for reuse as a key design principle.

The research suggests that the embedded adaptive reuse potential of a future building can be represented by measurable critical design factors. Such measurement or evaluation can lead to better design decisions that maximise the adaptive reuse potential of future buildings when their original designed function becomes obsolete.

The objectives of the research are to:

1. identify and investigate the critical design factors needed in a design evaluation tool by translating the ARP model (Langston, 2008) into a set of contemporary design strategies that maximise the opportunity for the optimal adaptive reuse of buildings in the future;

2. discover and apply individual design criteria and appropriate weightings for each strategy that are informed by a combination of case study analysis, expert interview and practitioner survey; and

3. develop and validate a star rating system, adaptSTAR, that is aligned to best practice and describes predicted adaptive reuse potential in a quantitative manner at the outset of a new project.

1.5 RESEARCH METHODOLOGY (OVERVIEW)

Contemporary literature pertaining to obsolescence, adaptive reuse potential and design principles forms the basis for a proposed conceptual framework and detailed methodological approach. The approach of this research study is divided into three parts that were closely related to the planned three years of the project (see Figure 1-1). The main deliverable of this research is the creation and validation of the new adaptSTAR model, which is a weighted checklist of design decisions that lead to best practice outcomes. It is similar in concept to the Green Building Council's Green Star or LEED methodology, where performance is assessed using a standard five-star rating approach.

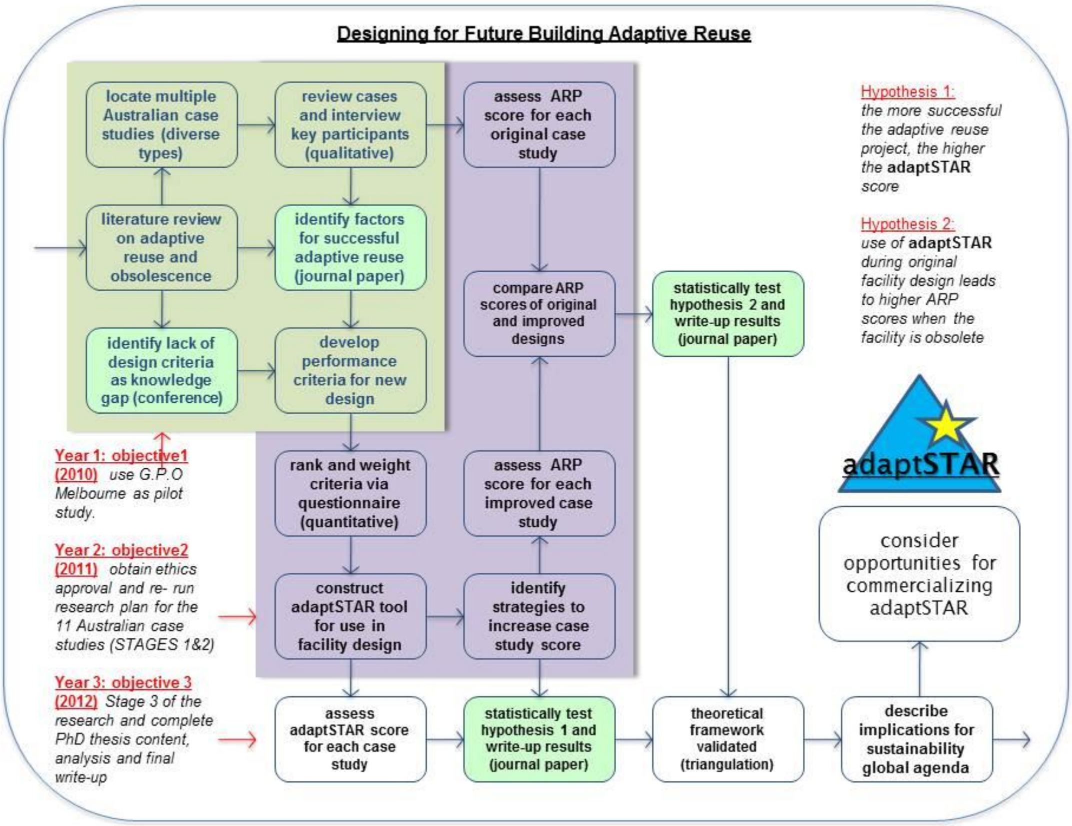


FIGURE 1-1 RESEARCH PLAN LOGIC

The research is an explorative study and retrospectively analyses existing successful adaptive reuse projects to establish a list of design factors (design criteria) evaluated independently by members of the architectural profession. A sequential mixed mode research methodology (qualitative and quantitative) is used to collect relevant data and enable the findings to be triangulated and validated. This approach consists of a combination of case study analysis, expert interview and practitioner survey. The research study involves three stages.

Stage 1 addresses the first research objective. Using a qualitative approach, Australian practitioners involved in twelve successfully completed adaptive reuse case studies are interviewed to solicit their views on key design criteria derived from an analysis of their projects and underpinning literature. The case studies comprise eleven award-winning adaptive reuse conversions with varied typologies throughout New South Wales, as reported in NSW Department of Planning and RAIA (2008), plus a further pilot study of the GPO Melbourne project in Victoria.

Stage 2 addresses the second research objective. Using a quantitative research methodology, a concise structured anonymous electronic survey is sent to selected registered architects in Australia. This survey is used to rank and weight the list of design criteria by assessing the relative importance of each strategy and their contexts.

Stage 3 addresses the third research objective, and tests the new adaptSTARmodel against Langston's ARP model. Two underlying hypotheses emerge from this work:

H1: There is a positive relationship between the ARP model and the new adaptSTAR model: the more successful the adaptive reuse project, the higher the adaptSTARscore.

H2: The use of the adaptSTAR tool during the original facility design leads to higher ARP scores when the facility is obsolete.

1.6 RESEARCH SIGNIFICANCE

Langston (2012b) strongly points out that in an era when sustainability and climate change mitigation are paramount, it is important that the built environment professionals make robust and transparent decisions regarding future development. The significance of this research lies in the empowerment of building designers to make critical design decisions that will contribute to the sustainability of the built environment through the development and construction of new buildings with greater adaptive reuse potential.

The innovation of this research is the reverse engineering of Langston's (2008) ARP model, so that design pathways can be readily evaluated and building proposals optimised and more aligned to long-term national interests. In the future, using the model developed from this research, designers will be able to receive guidance on the effectiveness of their proposals towards achievement of true resource efficiency, taking into account the impact of embodied energy, churn, retrofitting, refurbishment and renewal over the entire life cycle of a building, and benchmark this against best practice. The development of the new rating tool for future building adaptive reuse will make a real contribution to the goal of reducing the impact of climate change upon the built environment.

1.7 SCOPE AND LIMITATIONS

This research is based on selected Australian adaptive reuse case studies and evaluated independently by Australian practitioners. The projects chosen are all award-winning conversions located within New South Wales, plus one pilot study from Melbourne, Victoria. While it is expected that the results of the study will have global application, this aspect of the research is not tested. Furthermore, case study experts were drawn from consultant teams based on willingness and availability to assist.

Unsuccessful projects were not sought, even though obviously they would contain lessons for what not to do during original design, and the study of failed projects may be a worthy area of future research. This research deals only with buildings and does not involve other built structures such as bridges, roads, canals and civil infrastructure. Not all building typologies are covered. Issues of geographic location and climate have also been removed from the study given the case studies largely reside in one Australian state.

1.8 STRUCTURE OF THE THESIS

This thesis is divided into seven chapters. The following paragraphs provide a brief summary of the thesis structure.

Chapter 1 introduces the motivation and background of the research study, the problem statement and rationale, the research aim and objectives, the significance of the research as well as its scope and limitations. Additionally, an overview of the selected methodology is provided.

Chapter 2 establishes the theoretical underpinnings of this study based on a review of the literature related to sustainability and the concept of reuse. These topics comprise adaptive reuse and sustainability, adaptive reuse, obsolescence, the ARP model, design principles and future design directions. The literature review provides the important empirical and theoretical foundations for this thesis. The chapter also identifies gaps in existing knowledge.

Chapter 3 describes the three stages of the research methodology including the research design, selection of the sample, data collection tasks, data analysis procedures and the setting for the study.

Results obtained from the three stages of the research are presented in Chapters 4, 5 and 6 respectively. Chapter 4 features a discussion of the GPO Building in Melbourne as the pilot study and most importantly highlight the results of Stage 1, which identifies the list of design criteria. Chapter 5 presents the results of Stage 2 and the development of the new adaptSTAR rating tool. This also includes testing the ARP model on the twelve case studies, as well as the identification of design strategies to further improve their performance. This leads to the comparison of ARP scores for both original and improved designs of the case studies. Chapter 6 validates adaptSTAR by testing it against the ARP model and the two hypotheses of the study, representing Stage 3 of the research. This also includes the application of the adaptSTAR model to the twelve selected case studies.

Chapter 7 provides the conclusion and recommendations of this research. The significance of the adaptSTAR model is argued as an integral part of future decision-making processes in sustainability and architecture. This chapter also contains a discussion of the implications of this research and suggests further research possibilities.

The next chapter will discuss the underpinning literature that supports the research proposition.

CHAPTER 2

LITERATURE REVIEW

2.1 THE PURPOSE OF THIS CHAPTER

The purpose of this literature review is to investigate existing and relevant research on building sustainability, adaptive reuse, building obsolescence and design principles in order to improve the implementation of building adaptation strategies in the design of future buildings. This review provides insights into how building designers approach the design process, solve problems, make decisions, address potential complexity and value conflict when undertaking building adaptive reuse projects. This leads to an understanding of how designers can best be assisted in these activities in order to increase the likelihood of achieving design solutions that offer better future building adaptive reuse opportunities during the conceptualisation process. This chapter also includes a critical discussion of the ARP model and existing sustainability rating tools that will assist in the development of the new adaptSTARmodel. A knowledge gap pertaining to the lack of clear design criteria for future adaptive reuse is identified.

2.2 THEORETICAL AND CONCEPTUAL FRAMEWORK

In developing a theoretical framework, Kumar (2005) suggests that when reviewing literature it is important to set parameters in relation to the main themes and theories relevant to the research study, as well as identifying the literature's direct and indirect bearing on the research topic. He states that this process highlights agreements and disagreements among authors and helps to identify unanswered questions or gaps. The theoretical framework developed in this research builds on the literature review on building sustainability and adaptive reuse.

The theoretical framework begins by discussing sustainability and the concept of reuse that applies to any form of artefact, such as the 3Rs strategy which is promoted by many governments in the world and encourages sustainability through 'reusing, recycling and reducing'. It is followed by a review of the literature on sustainability tools and their relationship to adaptive reuse. Next, the empirical studies on adaptive reuse, obsolescence and the ARP model are reviewed to ascertain best practice and the possible inadequacies of the case samples. Lastly, the literature on design principles and design futures is reviewed to provide directions for future design and future building adaptive reuse paradigms. The literature selected for review was able to address the characteristics identified for this exploratory and retrospective study.

Kumar (2005) states that the conceptual framework places emphasis on one section of the theoretical framework that becomes the basis of the research study. The conceptual framework developed in this research study is based on an exploration of the relationship between obsolescence and adaptive reuse, design principles and sustainability tools. These three strands of literature provide theories in addressing the research aim of the study and connect to the problem statement. Future building adaptive reuse is a new term or concept that pertains to the designing of new buildings so that their adaptive reuse potential later in their lives is maximised in order to reduce the impact of building and development on the environment, thus helping to mitigate the effects of climate change.

2.3 SUSTAINABILITY AND THE CONCEPT OF REUSE

Responding to, or addressing, the pressing issues of climate change is unavoidable. The IPCC (2007) defines climate change as any change in climate over time due to natural variability or as a result of human activity. To respond to climate change, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 and the Kyoto Protocol was approved in 2005. The goal of the Kyoto protocol was to reduce greenhouse gas emissions to 1990 levels by the year 2000; however, this aim was not met (Jones, 2008).

Jones (2008) further adds that the concentration of greenhouse gases increases due to human activities and that there are many environmental problems that can be attributed to buildings globally. This is a concern in relation to climate change because "the US Green Building Council reports that the built environment is growing globally at a rate three times faster than the growth rate of the population" (Jones, 2008:p.92). Buildings account for around one-third of energy use, produce 30 per cent of the annual greenhouse gas emissions and 40 per cent of all landfill waste comes from building materials (Toepfer, 2007; Jones, 2008).

As "an outcome of the sustainability debate, as ideas of recycling and reuse begin to filter through to all extremities of the built environment...the raised political awareness of sustainability and the 'brownfield' debate has clearly spread to the property arena" (Ball 2002:p.94). Thus, addressing the need for built environment sustainability is an important strategy for achieving sustainable development.

Sustainable development is defined as meeting the needs of the present without compromising the ability of future generations to meet their needs (Brundtland/UN Commission, 1987). Sustainable development leads into/requires the concept of sustainable building design to ensure a more sustainable future and a low carbon environment.

According to Lehmann (2012), sustainable building design is the practice of creating structures and using processes that are environmentally responsible and resource efficient throughout a building's life cycle, from concept to design, construction, operation, maintenance, renovation and demolition. Bergman (2012)also notes that although life cycle considerations have traditionally been applied frequently to products; the same principles also apply to buildings and materials.

When life cycle is considered, the life of the product is examined 'from cradle to grave': that is from the origin of its raw materials to the manipulation of these materials during manufacturing, to the consumption of energy and resources during its useful life to the impact of its eventual end of life. This is similar to what Caroon (2010) mentions, describing the life cycle assessment (LCA) as the holy grail of environmental evaluation as it can evaluate the impacts of a product or process from the first acquisition of materials through to the end of life.

Walker (2012:p.147) states that designing more sustainable products and buildings starts with the introduction of life cycle thinking approaches at the beginning of the design process. He further explains that "sustainable design seeks to use materials, energy and water efficiently while minimising waste and negative impacts on the natural environment and on the quality of human life as well as, considers environmental impacts at every stage of a product or building's life cycle and seeks to address key environmental issues at their source, by locking in positive environmental attributes such as durability and water and energy efficiency and locking out negative environmental attributes such as toxic or hazardous substances, waste and obsolescence".

Jones (2008) points out that sustainable design often implies a macro perspective that has the enhancement of the global environment and protection of the world's ecosystems as the underpinning rationale for design decisions. She further affirms that the life cycle analysis process is the analytical basis for design decisions that are environmentally responsible and it is currently the most effective measure of sustainability.

A sustainable world values stewardship, repairability and durability, which is the opposite of what is practiced in societies where there are 'throw away cultural norms' that support new over old and replacement over repair (Caroon, 2010). Jones tracks attitudes towards consumption and sustainability over time, noting that generation that lived through the Great Depression in effect practiced the 3Rs that are the basis for many contemporary sustainability campaigns: reducing, reusing and recycling their goods wherever possible. However, by the end of the 20th Century the throw away generation was rejecting 'reduce and reuse' in favour of rampant consumerism. Not until the beginning of the 21st Century did the 3Rs regain favour with a significant percentage of the population.

Bergman (2012) argues that the basic 3Rs of environmentalism: reduce, reuse and recycle, are inexpensive and worthwhile solutions that are important for sustainability. Ward (2012) also mentions that, through recycling or reuse, building construction waste can be minimised and the embodied energy of the materials are retained. It is the sustainable designers' responsibility to reduce the quantity of materials used, to reuse materials whenever possible and to recycle in order to produce zero waste.

Wilson (cited in Caroon, 2009) notes that whenever a product is reused instead of producing a new one, resources and energy are saved. Tobias and Vavaroutsos (2009:p.49) also state that "the greenest materials are the ones that do not have to be extracted, manufactured, transported and reinstalled". Additionally, Ward (2012) advocates that the principles of reduce, reuse, recycle, conservation and adaptive reuse are ways of describing the process of adapting a disused item for another use with different purpose. Adaptive reuse is a process that also supports the principles of sustainable development and it "offers advantages over the use of recycled, reprocessed and reassembled demolition waste… while changing the building's use provides an opportunity to retune it, to make use of its existing elements and services where appropriate and also to supplement them with more efficient ones" (Ward, 2012:pp.260-262).

Lastly, Caroon (2010) stresses that since existing buildings outnumber annual new construction by a factor of one hundred, a change in the resource consumption of existing buildings is necessary and important. Both renovation and replacement are resource-intensive. Thus, as Caroon (2010:pp.261-262) points out, the "immediate reduction of greenhouse gas emissions is essential … if the environmental benefit of new green buildings is 10 to 20 years away because of the construction impacts then seeking to avoid these impacts and limit carbon emissions now through building reuse should be the highest priority."

2.4 ADAPTIVE REUSE AND SUSTAINABILITY

The United Nations Environment Programme (Worldwatch, 2008) identifies the United States, Australia and Canada as the three countries with the largest carbon dioxide emissions from buildings per capita. Yudelson (2010) states that in 2010, the total building stock in the United States equals approximately 300 billion square feet (27 billion square metres)and that approximately 1.75 billion square feet (162 million square metres) of buildings are torn down while approximately 5 billion square feet (464 million square metres) are renovated and/or newly built facilities every year.

Yudelson (2010) also predicts that the pace of building energy retrofits and green upgrades will accelerate dramatically in 2015 because there are nearly five million existing buildings in the United States and Canada that are suitable for retrofit into energy-efficient structures. In 2009, the Urban Land Institute (Tobias & Vavaroutsos, 2009) identified that new construction accounts for merely 1-1.5% of existing building stock each year in most developed countries.

Adaptive reuse or retrofitting plays a critical role in reducing emissions since the built environment is the world's largest user of energy, emitter of greenhouse gases and arguably has the largest potential for efficiency given the number of buildings suitable for adaptive reuse. UNEP (2009) argues that adapting and retrofitting existing buildings to the optimal energy efficiency standard must be given more focus by the building sector. Gorse and Highfield (2009) assert that there is no better example of the environmental benefits of effective sustainability in practice than the recycling of buildings. This is supported by Rabun and Kelso's (2009) statement that extending a building's useful life is almost always more sustainable than demolition and reconstruction.

Additionally, the reuse materials and assemblies salvaged from the building being adaptively reused or other buildings is a positive sustainable choice. However, the Urban Land Institute (cited in Tobias & Vavaroutsos, 2009) report that green building practices have under-emphasised the importance of sustainable retrofits of existing building stock globally and that environmentally sensitive and energy-efficient sustainable new construction by itself cannot significantly change the environmental impact of the built environment unless green design and construction technologies are applied to the existing building stock.

Atkinson et al. (2009) demonstrate that there is a rapidly growing appetite for rating methodologies that can be used to define the environmental performance of our activities, ranging from personal carbon footprint tools to complex sustainability assessments and standards of components, buildings and entire cities. These sustainability tools allow designers and owners to compare the sustainable performance of their buildings with best practice (Rabun and Kelso, 2009).

Further, Reed et al. (2009) argue that a common set of criteria and targets that are embodied in design guides to aid professionals to design, construct and manage property in a sustainable way should be the overall goal of sustainability tools. Sustainability tools developed in the United Kingdom, the United States of America, Australia and Canada are discussed briefly in the following paragraphs to give an overview of existing methods of assessment as gathered from the literature. The Green Building Council of Australia's Green Star is given more attention since the new rating tool proposed in this research will be similar to Green Star.

Regarded by the UK's construction and property sectors as the measure of best practice in environmental design and management, the Building Research Establishment Environmental Assessment Method (BREEAM) is a certification scheme which assesses the environmental performance of buildings at construction or refurbishment. Credits are awarded in each area according to performance. A set of environmental weightings then enables the credits to be added together to produce a single overall score. BREEAM can be used as an environmental assessment tool for any type of building, either in the United Kingdom or internationally. This system can be applied to single buildings or entire portfolios and can also be tailored for use at various stages in the life cycle of a building.

Both BREEAM and the US's Leadership in Energy and Environmental Design (LEED) methodology are intended to provide a framework for assessing building performance and meeting sustainability goals. LEED aims to be the means of promoting the development and refurbishment of green buildings through the education of developers and construction professionals. The U.S. Green Building Council (USGBC) introduced the LEED Green Building Rating System in Version 2.0 in 2000. Since its inception the system has evolved and expanded and is now considered the leading method of measuring and rating building performance in many countries of the world. There are nine different rating systems that apply to particular building market segments or project types.

In calculating the weightings between various credit points, the USGBC uses an environmental weighting method developed by the U.S. Environmental Protection Agency. The King Sturge Report (2006) argues that the BREEAM offers a more comprehensive assessment of a building's environmental impact than the LEED scheme. BREEAM provides an assessment against a range of criteria, of which energy is just one important component. While LEED also assesses against criteria in addition to energy, the energy criterion has a more dominant focus than with BREEAM.

In Australia, the Green Building Council of Australia (GBCA, 2010) operates Australia's only national voluntary comprehensive environmental rating system for buildings, known as Green Star. The GBCA established Green Star as a rating system for evaluating the environmental design of buildings in 2002 and it evaluates the green attributes of building projects in nine categories, including energy and water efficiency, indoor environment quality and materials. The GBCA promotes green building programs, technologies, design practices and operations. Rating tools are currently available or in development for most building market segments, including commercial offices, retail, schools, universities, multi-unit residential buildings, industrial facilities and municipal buildings.

The goal of this rating system is to assess the current environmental potential of existing buildings. It is a useful tool for property managers when identifying upgrade and retrofit priorities. The rating system also assists corporate sustainability and environmental reporting efforts. Every Green Star rating tool is organised into eight environmental impact categories and an innovation category. Credits are awarded within each of the categories, depending on a building's environmental performance and characteristics. Points are achieved when specified actions for each credit are successfully performed and/or demonstrated. Table 2-1 outlines the categories and weightings within the existing building rating system.

TABLE 2-1 GREEN STAR EXISTING BUILDING CATEGORIES AND WEIGHTINGS

Environmental Impact Category	Weights
Management	20%
Indoor environment quality	20%
Energy	25%
Transport	10%
Water	12%
Materials	4%
Land use and ecology	4%
Emissions	5%
Total	100%

Source: Yudelson (2010:p.280)

The number of credits for each category is totalled and a percentage score is calculated as follows.

Category score (%) = (total number of points achieved/total number of points available) ×100

Environmental weighting is applied to each category score, which balances the inherent weighting that occurs through the differing number of points available in each category. The weights reflect issues of environmental importance for each state or territory of Australia and thus differ by region. The weighted category score is calculated as follows.

Weighted category score (%) = category score (%)×weighting factor (%)/100

The sum of the weighted category scores, plus any innovation points, determines the project's rating. Only buildings that achieve a rating of four stars and above are certified by the GBCA. The rating levels and their respective scores are listed in Table 2-2.

TABLE 2-2 GREEN STAR: OFFICE EXISTING BUILDING CERTIFIED RATINGS

Score	Rating	Star Rating
10-19	Acceptable	*
20-29	Average practice	**
30-44	Good practice	***
45-59	Best practice	****
60-74	Australian excellence	*****
75-100	World leadership	******

Source:Yudelson (2010:p.281)

A study conducted in Perth observes that there are a number of recent "five and six Green Star new buildings with limited attention being given toward their future adaptive reuse" (Bullen & Love, 2010:p.220). Noting this limitation, Ward (2012) emphasises that functional obsolescence can be avoided by designing buildings with a view to later adaptation and that the potential benefits of adaptive reuse must be considered when designing of new construction. Although progress toward the adoption of sustainable building practices across the globe is encouraging, the green movement in the building industry was initially focused on transforming building practices for new construction (Tobias & Vavaroutsos, 2009).

There are two major certification programs in the US for building operations: LEED and ENERGY STAR. ENERGY STAR assesses buildings according to their relative energy use among similar buildings nationwide, assigning a score based on the percentile ranking and awarding a label only for buildings in the top quartile. It is based on actual energy usage for a given building type, adjusted for climate zone and building type. It differs significantly from LEED because LEED certifies buildings partly based on projected future energy use, using a model that calculates energy use reduction from a code or baseline building of the same size at the same location.

In Canada, the Building Environmental Standards (BESt) enables participants to develop action plans for energy, water and waste reductions, which also help building owners and managers to evaluate a portfolio of buildings and identify the strengths and weaknesses of each building. BOMA BESt is a Canadian national environmental recognition and certification program for existing commercial buildings. There are four levels of certification in the program that incorporate BOMA Go Green best practices and the Go Green Plus assessment framework.

The Canada Green Building Council seeks to transform the built environment by developing best design practices and guidelines for green building. The Council has adapted the US Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) rating system to Canadian climates, construction practices, and regulations.

As a counterpart to BESt, the LEED for Existing Building Operations and Maintenance (LEED EBOM) rating system was developed to help building owners and operators measure operations, improvements and maintenance on a consistent scale, with the goal of maximising operational efficiency while minimising environmental impacts. LEED EBOM helps building owners and operators measure the impacts of operations, improvements and maintenance on a consistent scale. The goal for project teams employing this rating system is to maximise operational efficiency while minimising environmental impacts. This rating system also allows for ongoing certification for buildings throughout their lifetime. Buildings can be recertified every one to five years under this system.

The LEED EBOM is the most widely used rating system in the world for existing buildings while the UK's BREEAM In Use and Australia's Green Star Office Existing

Building schemes are used for rating and certifying existing buildings (Tobias & Vavaroutsos, 2009; Yudelson 2010).

This literature review demonstrates that the existing sustainability rating tools are focused mainly on new built developments and existing building operations and maintenance (King Sturge, 2006; Schultmann et al., 2009; Reed et al., 2009; Tobias & Vavaroutsos, 2009; Caroon, 2010; Yudelson, 2010; Appleby, 2011; Barndon & Lombardi, 2011).This section on adaptive reuse and sustainability also illustrates and confirms the lack of a rating system that considers or predicts the adaptive reuse potential of new buildings and future buildings (see Table 2-3) .

TABLE 2-3 SUMMARY OF SUSTAINABILITY ASSESSMENT METHODS

Versions	Location	Title	Type	Link
Estidama	Abu Dhabi	Env assessment	Under development	www.estidama.org/Default-en-g b.aspx
Green Globe 21	Australia	Benchmarking tool	Companies, communities, ecotourism, design and construct	www.ec3global.com/about/who-is-ec3/Default. aspx#
EC3 Earthcheck	Australia	Environmental Compliance check		ditto
Green Star	Australia	Env assessment	Office design and as built, education, residential, healthcare, retail, office interiors	www.gbca.org.au/green-star/rating-tools/
NABERS	Australia	Env assessment	Existing offices, homes, hotels, retail	www.nabers.com.au/
BASIX	Australia	Energy/water rating	New dwellings	www.basix.nsw.gov.au/information/about.jsp
AQUA	Brazil	Env assessment	New offices, school buildings, hotels	www.vanzolini.org.br/conteudo.asp?cod_Site_0&id_menu=493
LEED Brasil	Brazil	Env assessment	As LEED US	www.gbcbrasil.org.br/in/index.php?pag=certificacao.php
Green Globes	Canada	Env assessment	New and existing buildings, fit-out, emergency management, automation	www.greenglobes.com/
GBTool		Research tool		www.iisbe.org/
LEED Canada	Canada	Env assessment	As LEED USA	www.cagbc.org/leed/what/index.php
Evaluation Standard for Green Buildings	China	Evaluation tool	New dwellings, buildings, offices, shopping malls, hotels	www.risn.org.cn/Norm/xxbz/ShowCalib1.aspx?CaliblD=60043&lsEdit=False).
BEAT	Denmark	Env profile tool	New buildings, products, materials	www.en.sbi.dk/publications/programs models/ beat-2002
Promis E	Finland	Env assessment	New and existing offices, retail, dwellings	http://virtual.vtt.fi/virtual/proj6/environ/ympluok_e.html
HQE	France	Env assessment	New offices, education, healthcare	www.assohqe.org/documents_ certifications_ hqe.php
qualigreen	France	Env assessment	New buildings	www.greenlogic.fr/qualigreen.php

DGNB Certificate	Germany	Env and socio- economic assessment	New offices and admin buildings	www.dgnb.de/en/certification/methodical-principle-certification-system/index.php
BREEAM Gulf	Gulf States	Env assessment	New multi-use buildings	www.breeam.org/page.jsp?id=196
HK-BEAM	Hong Kong	Env assessment	New offices, retail, hotels, healthcare	www.hk-beam.org.hk/general/home.php
CEPAS	Hong Kong	Env assessment	New buildings	www.bd.gov.hk/english/documents/index_CEPAS.html
GRIHA	India	Envassessment	New offices, retail, hotels, healthcare	www.grihaindia.org/index.php?option=com_content&task=view&id=13
TGBRS	India	Envassessment	New and existing commercial and residential	http://teriin.org
LEED India	India	Envassessment	As LEED US	www.igbc.in:9080/site/igbc/tests.jsp?event=22869
ProtocolloItaca	Italy	Env profile	New and refurb residential	www.itaca.org/valutazione_sostenibilita.asp
SICES	Mexico	Env assessment	New commercial and low-income housing	www.mexicogbc.org/certificacion.ph p
LEED Mexico	Mexico	Env assessment	New construction, interiors, existing, pilots for shell and core, new homes and housing developments	www.cadmexico.com.mx/fundacion/noticias/01/ diseno/03/dis_ 01_03.htm
Eco-Quantum	Netherlands	Env profile	New buildings and energy systems	www.ivam.uva.nl/?18
Green Star NZ	New Zealand	Env assessment	New offices, interiors, industrial education	www.nzgbc.org.nz/main/greenstar
Ecoprofile	Norway	Env profile	New and existing buildings	www.byggsertifisering.no/PortalPage.aspx?pageid=142
LiderA	Portugal	Env and socio-economic assessment	New and existing commercial, tourism and residential	www.lidera.info/?p=MenuContPage&MenuId=15 &ContId=29
BCA Green Mark	Singapore	Env assessment	New and existing residential, non-residential, interiors, infrastructure, district projects, parks	www.bca.gov.sg/GreenMark/green_mark_ buiIdings,html

Green Star SA	South Africa	Env assessment Env and socio-economic assessment	New offices, retail pilot New and existing Commercial, tourism and residential	www.gbcsa.org.za/greenstar/ratingtools.php www.lidera.info/?p=MenuContPage&MenuId=15.&ContId=29
BREEAM-ES	Spain	Env assessment	Residential and commercial, communities, existing offices - all under development	www.breeam.org/index.jsp
Ecoeffect	Sweden	Env profile	New building	www.ecoeffect.se
UK BREEAM	UK	Env assessment	New offices, retail, HE, education, industrial, healthcare, fire stations, multi-residential, bespoke, prisons, courts, data centres, communities, existing offices, healthcare and residential	www.breeam.org/index.jsp
Code for Sustainable Homes	UK	Env assessment	Residential	www.communities.gov.uk/planningandbuilding/ buildingregulations/legislation/codesustainable/
SpEAR	UK	Env and socio-economic assessment Env assessment	New buildings	www.arup.com/Services/Sustainability_ Consulting.aspx
CEEQUAL	UK	Env assessment	New civil engineering projects	www.ceequaLco.uk
BFF	UK	Lifestyle indicator	Personal carbon footprint	http://old.bestfootforward.com/tools/
Envirowise Indicator	UK	Assessment tool	Businesses	www.envirowise.gov.uk/uk/Our- Services/TooIs/ Envirowise-lndicator.249257.ht ml
LEED US	US	Env assessment	New construction, commercial interiors, core and shell, schools, retail, healthcare, neighbourhood, residential	www.usgbc.org/DisplayPage. aspx?CMSPageID=222
Green Globes	US	Env assessment	New construction, existing commercial buildings	www.greenglobes.com/

NAHB	US	Env assessment/ standard	New homes	www.nahbgreen.org/Guidelines/ansistandard. aspx
PLACE3S	US	Planning tool	New development	www.energy.ca.gov/places/
SCALDS	US	Planning tool	New development	www.fhwa.dot.gov/scalds/scaIds.html
BREEAM	Europe	Env Assessment	Offices, retail and industrial, new development	www.breeam.org/index.jsp
SPARTACUS	Europe	Planning tool	New development	http://virtua!.vtt.fi/virtual/proj6/yki4/spartacus.htm

2.5 ADAPTIVE REUSE, OBSOLESCENCE AND THE ARP MODEL

Building adaptive reuse has a major role to play in the sustainable development of communities, limiting potential demolition and reconstruction wastes (DEH, 2004). It also provides the benefits of conserving green space, improving the micro-climate air quality and maintaining existing habitats, ecosystems and water quality (Giles, 2005). Siddiqi (2006) proposes that new construction approaches are needed to move from LEED certification to architectural reuse since architectural reuse provides the opportunity to recycle and manage the deconstruction process in a more responsible manner than LEED allows. Adaptive reuse as an effective strategy is essential for improving the sustainability of existing buildings and this trend is gaining recognition throughout the world.

Nevertheless, adaptive reuse is perceived by some as expensive and requiring substantial and costly refurbishment (Bullen, 2007), Gorse and Highfield (2009), however, assert that only 50 to 80 per cent of the costs of new construction are incurred during adaptive reuse of existing buildings, resulting in considerable financial benefits to developers. Siddiqi (2006) confirms that higher initial costs for reuse are likely due to the mechanical and electrical engineering systems embedded in the structures. One additional factor to consider with adaptive reuse is the challenge of blending current sustainability standards with out-dated features of old buildings. Despite some concerns about adaptive reuse, it is still considered by most as a superior alternative to new construction in terms of sustainability (e.g. Douglas, 2006; Bullen, 2007; UNEP, 2007; Langston, 2008).

Adaptive reuse is commonly linked to building preservation (Luther, 1988). Building refurbishment is also associated with adaptive reuse, where there is a need to refurbish/renovate a building when its life cycle ends in order that its maximum earning potential can continue to be achieved (Gardner, 1993). Heritage development consists of building renovation or adaptive reuse and its success is determined in terms of factors such as building type, architectural and marketing approach, financing and the regulatory environment, public policy recommendations and effective citizen involvement (Shipley et al., 2006). Browne

(2006) considers that adaptively reusing a landmark building bolsters economic urban revitalisation and that public private partnerships are a necessary element to the economic success of large-scale adaptive reuse ventures.

Ward (2012:p.251) explains that "successful adaptive reuse means more than just recycling of a building – by improving its value, use and performance, it is effectively being up-cycled…and therefore acts as a catalyst for urban regeneration". Furthermore, social sustainability is encouraged through adaptive reuse and contributes to the development (and retention) of traditional skills and knowledge at the local level, as careful repair and reconstruction are required in conserving heritage buildings.

Buildings are major assets and form a critical part of facility management operations. Although buildings are long lasting, they require continual maintenance and restoration. Eventually, buildings can become inappropriate for their original purpose due to obsolescence or can become redundant due to changes in the demands for their service. When this happens, change in regards to the building is likely: either demolition to make way for new construction or some form of refurbishment or reuse (Langston & Lauge-Kristensen, 2002).

Buildings, like other assets, can become obsolete over time. Buildings both deteriorate and become obsolete as they age. A building's service life, which may be interpreted as its structural adequacy is effectively reduced by obsolescence, resulting in a useful life somewhat shorter than its expected physical life. Obsolescence is defined as being obsolete, antiquated, old fashioned, outmoded or out of date (Building Research Board, 1993; Pinder & Wilkinson, 2000). Burton (1933) identifies obsolescence as a factor that is not considered as normal physical wear and tear while Jacobs (1941) states that the under improvement or over improvement of residential buildings affects the value of land and therefore causes obsolescence. Bryson (1933) also agrees that obsolescence causes the gradual devaluation of buildings while Dixon et al. (1999) demonstrate that obsolescence is one of the factors that affect property assets and value depreciation.

Aikivouri (1996) states that obsolescence is an important basis for refurbishment, noting that the identification and improvement of factors causing early obsolescence will help maximise the structure's use. Douglas (2002) shows that obsolescence pertains to the degree of the building's usefulness which varies over time based on its condition. Lemer (1996) indicates that obsolescence is brought about by the change in demands and technologies. For Nutt et al. (1976), obsolescence has evolved historically in three ways: originally viewed as a process of physical deterioration, then as an economic phenomenon and, thirdly, emphasis has shifted toward behaviour interpretation.

Obsolescence may be described as constituting one or more of the attributes discussed by different authors in Table 2-3. For example, Allehaux & Tessier (2002) identify functional obsolescence as a major parameter that affects the technical installations and influences the value of an office building. Mansfield (2000) suggests that functional, configuration, technological, economic, environmental, locational, regulatory and aesthetic factors are categories of obsolescence that affect a building's structure. Baum (1994) also defines aesthetic, functional, legal and social aspects as different forms of building obsolescence.

TABLE 2-4 TYPES OF OBSOLESCENCE (BASED ON UNDERPINNING LITERATURE)

Types of obsolescence	Research studies
Physical	Aikivuori (1996); Rojas (2002)
Design	Berg (1991)
Structural	Tiesdell et al. (1996)
Economic	Mansfield (2000); Aikivuori (1996); Kalligeros (2003); Salway in Dunse and Jones (2005); Building Research Board (1993); Williams (1996); Canary (2002); Downs (1995); Weber (2002); Rojas (2002); Tiesdell et al. (1996)
Financial	Tiesdell et al. (1996)
Locational	Mansfield (2000); Bryson (1997); Aikivuori (1996); Williams (1996); Downs (1995); Tiesdell et al. (1996)
Site	Downs (1995)
Functional	Allehaux and Tessier (2002); Mansfield (2000); Bottom et al. (1999); Baum (1994); Aikivuori (1996); Chaplin (2003); Kalligeros (2003); Salway in Dunse and Jones (2005); Building Research Board (1993); Smith (2006); Downs (1995); Weber (2002); Rojas (2002); Tiesdell et al. (1996)
Configuration	Mansfield (2000)
Technological	Mansfield (2000); Aikivuori (1996); Downs (1995)
Technical	Kalligeros (2003)
Environmental	Mansfield (2000); Aikivuori (1996); Salway in Dunse and Jones (2005); Williams (1996)
Social	Bottom et al. (1999); Baum (1994); Aikivuori (1996); Building Research Board (1993)
Aesthetic	Mansfield (2000); Bottom et al. (1999); Baum (1994)
Aesthetic and visual	Aikivuori (1996); Salway in Dunse and Jones (2005)
Image	Chaplin (2003); Tiesdell et al. (1996)
Legal	Baum (1994); Aikivuori (1996); Tiesdell et al. (1996)
Legislation	Salway in Dunse and Jones (2005)
Regulatory	Mansfield (2000); Kalligeros (2003); Downs (1995)
Temporary	Klaasen (1989)
Circumstantial	Klaasen (1989)

Chaplin (2003) identifies that the major threats to heritage properties and sites are functional obsolescence and image obsolescence. However, Klaasen (1989) argues that obsolescence is not necessarily the result of age and he proposes two new type of obsolescence: temporal and circumstantial, which cover issues such as property predicaments like foreclosures, rent control, preservation easements and stalled projects.

Until now experience and intuition have often been the only guides to making decisions about adaptive reuse (Gorse & Highfield, 2009). However, using the ARP model (Langston et al., 2008) existing buildings can now be ranked on their adaptive reuse potential at any point in time. The ARP model predicts useful life as a function of (discounted) physical life and obsolescence and allows for the calculation of the adaptive reuse potential of a building's life cycle at any time so that the right timing for intervention can be applied.

The model has generic application to all countries and all building typologies. It requires an estimate of the expected physical life of the building and the current age of the building, both reported in years. The useful (effective) life of a building or other asset in the past has been particularly difficult to forecast because of premature obsolescence (Seeley, 1983). Based on Seeley's (1983) work, the seven obsolescence categories used in the ARP model are physical, economic, functional, technological, social, legal and political.

Attempts to assess building obsolescence based on these attributes were initially developed by Langston and Shen (2007), who illustrated the application of surrogate estimation techniques to help quantify each obsolescence category. This model has been shown to reasonably simulate reality based on a large number of case studies (Langston, 2008) and the surrogates for each obsolescence category have been demonstrated to be both measureable and practical. There is still opportunity for improving this approach in terms of adjusting category scales and weighting, especially to better cater for different building typologies and, at the time of writing this thesis, this work is still ongoing.

The seven categories of obsolescence from Seeley (1983) are expanded in Langston's ARP Model (2008) as the underpinning framework for a design evaluation framework:

- *Physical obsolescence* can be measured by an examination of maintenance policy and performance. Useful life is effectively reduced if building elements are not properly maintained. A scale is developed such that buildings with a high maintenance budget receive a 0% reduction, while buildings with a low maintenance budget receive a 20% reduction. Interim scores are also possible, with normal maintenance intensity receiving a 10% reduction.

- *Economic obsolescence* can be measured by the location of a building in terms of its proximity to a city centre, central business district or other primary market or business hub. Useful life is effectively reduced if a building is located in a relatively low-density demographic. A scale is developed such that buildings sited in an area of high population density receive a 0% reduction, while buildings sited in an area of low population density receive a 20% reduction. Interim scores are also possible, with average population density receiving a 10% reduction.

- *Functional obsolescence* can be measured by determining the extent of flexibility embedded in a building's design. Useful life is effectively reduced if building layouts are inflexible to change. A scale is developed such that buildings with a low churn cost receive a 0% reduction, while buildings with a high churn cost receive a 20% reduction. Interim scores are also possible, with typical churn costs receiving a 10% reduction.

- *Technological obsolescence* can be measured by evaluating the building's use of operational energy. Useful life is effectively reduced if a building is reliant on high levels of energy in order to provide occupant comfort. A scale is developed such that buildings with low energy demand receive a 0% reduction, while buildings with intense energy demand receive a 20% reduction. Interim scores are also possible, with conventional operating energy performance receiving a 10% reduction.

- *Social obsolescence* can be measured by examining the relationship between building function and the marketplace. Useful life is effectively reduced if building feasibility is based on external income or if the service for which the building is intended is in decline. A scale is developed such that buildings with fully owned and occupied space or with an increasing market presence receive a 0% reduction, while buildings with fully rented space or with a decreasing market presence receive a 20% reduction. Interim scores are also possible with balanced rent and ownership or steady market presence receiving a 10% reduction.

- *Legal obsolescence* can be measured by studying the quality of the original design. The rationale for this is that higher quality leads to higher compliance levels against future statutory requirements. Useful life is effectively reduced if buildings are designed and constructed to a low standard. A scale is developed such that buildings of high quality receive a 0% reduction, while buildings of low quality receive a 20% reduction. Interim scores are also possible, with average quality receiving a 10% reduction.

- *Political obsolescence* is a less publicised concept and can be measured by the level of public or local community interest surrounding a project. Useful life is reduced if there is a high level of (restrictive) political interference expected. A scale is developed such that buildings with a low level of interest receive a 0% reduction, while buildings with a high level of interest receive a 20% reduction. Interim scores are also possible, with normal public and local community interest receiving a 10% reduction. Where a project can receive a significant benefit from political interference, rather than a constraint, it is feasible to extend the assessment scores into the positive range (i.e. -20% to +20%). If the potential political interference is seen as an advantage, it may extend a building's useful life and help offset other obsolescence considerations, which are all negative or neutral. Examples of a positive influence include government funding opportunities or enhanced tax concessions that can be accessed when pursuing an adaptive reuse strategy (Gardner, 1993).

Environmental obsolescence is very relevant to today's society with its increasing focus on sustainability. However, in this study environmental issues are subsumed within technological obsolescence considered as an energy intensity surrogate. As the marketplace continues to become more sustainability–conscious, social, legal and political obsolescence will increasingly reflect an environmental agenda.

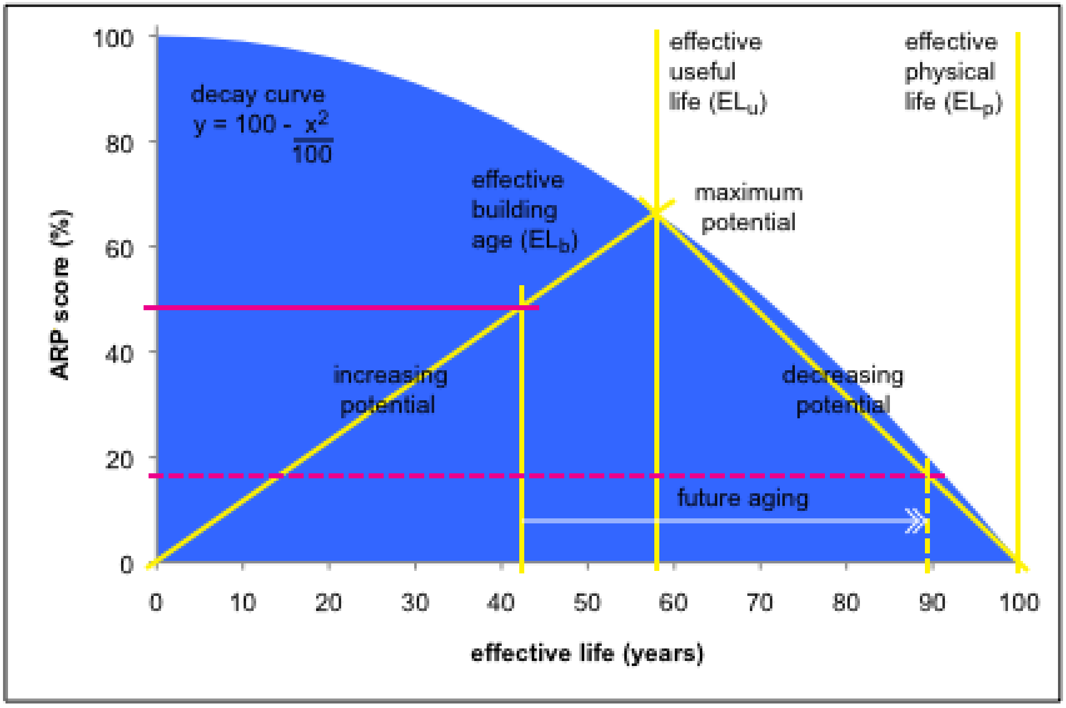
In the ARP model, obsolescence is considered as a suitable concept to objectively reduce the expected physical life of a building to its expected useful life. A discounting philosophy is adopted, whereby the annual obsolescence rate across all criteria is the 'discount rate' that performs this transformation. An algorithm based on a standard decay (negative exponential) curve produces an index of reuse potential (known as the ARP score) and is expressed as a percentage.

Existing buildings in an organisation's portfolio or existing buildings across a city or territory can therefore be ranked according to the potential they offer for adaptive reuse at any point in time. The decay curve can be reset by strategic capital investment during a renewal process by the current owner, or a future developer, at key intervals during a building's life cycle.

ARP scores in excess of 50% have high adaptive reuse potential, scores between 20% and 50% have moderate potential, and scores below 20% have low value and represent approximately one-third of the area under the decay curve in each case.

Potential means that there is a propensity for projects to realise economic, social and environmental benefits when adaptive reuse is implemented. ARP is conceptualised as rising from zero to its maximum score at the point of its useful life, and then falling back to zero as it approaches physical life. Where the current building age is close to and less than the useful life, the model identifies that planning activities should commence.

The ARP model is summarised in Figure 2-1. Its application was first demonstrated for a real case study in Hong Kong in Langston and Shen (2007). It provides a conceptual framework for the assessment of adaptive reuse potential in existing buildings at a strategic management level.



$$\text{ARP (increasing)} = \frac{100 - \frac{EL_u^2}{100}}{EL_u} \cdot EL_b \qquad \text{ARP (decreasing)} = \frac{100 - \frac{EL_u^2}{100}}{100 - EL_u} \cdot (100 - EL_b)$$

FIGURE 2-1 ADAPTIVE REUSE POTENTIAL MODEL

Source: Langston (2008)

The adaptive reuse model identifies and ranks adaptive reuse potential in existing buildings and therefore can be described as an intervention strategy to ensure that collective social value is optimised and future redundancy is planned(Langston, 2008). The ARP model has been widely published and is considered robust as it has been tested in hindsight against 64 adaptive reuse projects globally (Langston, 2008) and was recently validated by a new multi-criteria decision analysis tool called iconCUR (Langston & Smith, 2010; Langston 2010).

2.6 ADAPTIVE REUSE AND DESIGN PRINCIPLES

An array of design principles, strategies, approaches and solutions have evolved from proven existing design solutions (Skurka & Naar, 1976). Design ideas from Vitruvius' canonical architecture criteria of "commodity, firmness and delight" (Pitt, 2008) up to Alex Gordon's design for adaptability criteria which he coined the terms: "long life, loose fit, low energy" (Fulton & Johnson, 2004; Vale & Vale, n.d.; Gordon, 1974 cited in Remoy, 2011) were considered in the literature review. However, there is still a lack of consensus as to what design criteria would best maximise the adaptive reuse potential of future buildings. Multi-criteria assessment also has its challenges (Langston, 2013).

The UNEP (2007) claims that the local climate, transport distances and the availability of materials and budget balanced against the known embodied energy content should be considered. Rabun & Kelso (2009) suggest that the structural character and service systems of an existing building must form as basis for creative solutions when adapting existing buildings, while Milne (2005) emphasises that the single most important factor in reducing the impact of embodied energy is to design long life, durable and adaptable buildings. Caroon (2010:p.262) also added that "durability and repairability are common to many historic buildings and their component parts". Further, he states that "low maintenance materials are also a goal because they reduce added environmental impacts from cleaning requirements".

Siddiqi (2006) observes that the updating of existing buildings to meet current code requirements and ensuring structural integrity for the building's intended use are major hurdles to adaptive reuse. Campbell (1996) considers physical aspects such as location, landmark and ceiling heights, and regulatory issues such as zoning, environmental issues and restrictive covenants affect speed and cost in the adaptive reuse process. Adaptive reuse strategies should also consider the organisational and managerial aspects alongside the technical and architectural matters in order to be able to implement successful building reuse projects (HMSO, 1987). Gorse and Highfield (2009) affirm that to be suitable for refurbishment, buildings should be well built and structurally sound.

For Zushi (2005), successful adaptive reuse projects require not only good design for the buildings but also careful planning that considers the surrounding environment. Browne (2006) also demonstrates that adaptive reuse of landmark buildings should be conducted so that factors such as economic success, friendly public policies, courting public opinion and marketing, potential breadth of economic impact, multi-use programs, themed redevelopment, design continuity or common design elements that offer a lasting impression and draws a bigger market for their use are guaranteed.

Heath (2001) confirms that planners have an important role to play in controlling the stock of new offices through good locational choice for a variety of land uses along with transportation and communication infrastructure. These should be adaptable and flexible to maximise their potential different uses and roles in the future, thereby mitigating potential obsolescence. Furthermore, he points out those flexible and positive planning policies can help to turn a perceived negative situation into an opportunity.

For Fournier & Zimnicki (2004), sustainable design principles that encourage maximum reuse of the existing building components, restoration of passive aspects of the original design and preservation of the micro-climate created by the historic plantings and site usage should be included in the adaptive reuse of historic buildings. In this way, the adaptation will enhance the built environment while preserving the nation's cultural endowment.

Nakib (2010) argues that architecture must embrace adaptability and flexibility to create a symbiotic relationship between buildings and their users. Further, architecture calls forth a combination of many interrelated key factors such as social, professional, economic, spatial, functional, technical and structural as well as some aspects related to facade adaptability.

Architectural adaptability cannot be achieved without suitable adaptation of technical building components and servicing, and technical installations are key factors in adapting buildings (Kronenburg, 2007). Habraken (1998) develops the open building concept as a design strategy which offers flexibility. Zeiler & Quanzel (2010) support that concept by using open building principles that allow flexible energy flow connections and exchanges of supply to heating, cooling, ventilation, lighting and power demand within a building and between buildings and the surrounding environment.

Osbourne (1985) identifies the factors involved in the creation of a building, such as materials and technical ability, functional requirements and performance requirements. However, Prowler (2008) emphasises that the economics of building have become as complex as its design since buildings are expensive to build and maintain and must constantly be adjusted to function effectively over their life cycle. Thus, the 'Whole Building Design' (Prowler, 2008) concept was developed to meet the demands of present and future high performance building projects. It consists of two components, integrated design approach and integrated team process, and draws upon the knowledge pool of all stakeholders across the life cycle of the project, from defining the need for a building, through planning, design, construction, building occupancy and operations.

A positive aspect of the Whole Building Design process is that it deviates from the conventional planning and design process where the designers work in their respective specialties isolated from each other and allows for collaborative design evaluation among stakeholders and the design team for cost, quality-of-life, future flexibility, efficiency, overall environment impact, productivity and how the building occupants will be enlivened. The Whole Building Design concept evolved from 'High Performance Buildings' (CNYDDC, 1999), whose guidelines outline strategies and techniques for best practices for planning, designing, constructing and operating healthier and more energy-and resource-efficient facilities. High Performance Buildings also considers the city and design process as well as the technical aspect, which includes site design and planning, building energy use, indoor environment, material and product selection, water management, construction administration, commissioning, operations and maintenance.

In regards to climate change adaptation by design, Shaw et al. (2007) provide guidelines on how to implement adaptation through design and development. They suggest learning lessons from vernacular architecture and design that suits local climates and reflects the customs and surrounding natural landscape of a community. Fealy (2006) illustrates that redeveloped historic sites in city areas showcase the benefits of proximity to the city and its services and the recognition of being a historical landmark. The advantages derived from lower construction costs and utilising infrastructure that is already in place can outweigh those of construction and land costs of new projects being introduced into an existing urban fabric. He also relates how the established identity of both community place and individual buildings affect the progress and success of the city.

Kincaid (2000) argues that buildings need to be adaptable since changes in uses for buildings affect their demand factors. Thus, aspects of adaptability should also consider factors such as redundancy, ambiguity, constraint, design and flexibility in order to incorporate the uncertain technologies of the future.

According to Caroon (2010), operations and maintenance costs are responsible for 60 to 85 per cent of total expenditure over a building's lifetime. Therefore, he advocates the practice of regular maintenance and the incorporation of products that allow repair rather than replacement as the greenest and most important part of resource management. This practice reinforces holistic sustainability since building repairs offer an ongoing source of revenue and therefore direct more money to the local economy.

A summary of the collected list of design criteria together with its underpinning literature is presented in Tables 4-1 to 4-7 in Chapter 4 of this thesis, and illustrates that there are currently no common design criteria for designing future building adaptive reuse.

2.7 FUTURE DESIGN DIRECTIONS

According to Kincaid (2000), important change in the use of buildings and infrastructure arises because of the development of certain technologies. Therefore, it is important to know how to meet these new needs in existing buildings and how new buildings are designed to allow sustainable adaptability to occur in the future. Fournier & Zimnicki (2005) support this and have developed specific guidelines to provide information and guidance for adaptive reuse of buildings consistent with the goals of historic preservation and sustainable design. The guidelines integrate concepts of sustainability into the adaptive reuse of historical buildings in a way that will enhance the built environment while preserving a region's cultural endowment.

Snyder (2005) examines the potential of adaptive reuse projects in sustainable design and integrates 'green design' into structures that were previously at odds with natural processes. He also notes that adaptive reuse and sustainable design have a significant role in the future of architecture. According to Langston (2010), green adaptive reuse extends the lifespan of the building and reduces its carbon footprint while preserving its cultural heritage values.

Additionally, Horvath (2010) argues that sustainable architecture will emerge as a new architectural style in the future and will focus on the expansion, flexibility and energy efficiency of buildings associated with its maintenance cost separately from ensuring good architectural and structural design. The use of biomimicry to influence building and materials design and innovations in building technology such as Building Information Modelling (BIM), the development of new materials and systems, advances in nanotechnologies and information management will drive the future for sustainable building construction and renovation. Moreover, the development of commercially viable zero energy office buildings is a key component of the effort to reduce GHG emissions (Tobias & Vavaroutsos, 2009).

Another future direction in architecture is eco-physiological architecture, where intelligent homeostatic integrated architecture treats physiological design into building form, fabric and aesthetic. The process integrates building design with ecological features, which serve to enhance performance and sustainability through free cooling, filtration, oxygenation, carbon sequestration, whilst promoting biodiversity and considering a whole life cycle approach (Farrell, 2010). This is also supported by Gilder (2010), who suggests that with intelligent architecture, intelligent flexible design using smart technologies and contemporary materials could be the next wave in the future of architecture. Further, he emphasises that bio-inspired intelligent designs in the future will look into the psychological and physiological comfort of the users and focus on the development of innovative skins for existing buildings for energy efficiency, thus leading to a low carbon footprint.

Knaack & Klein (2009:p.142) reports that appropriate climate orientation is a necessity for future buildings and that in the future building facades will be more adaptable to changing environmental conditions. He notes that in the future, "architecture will increasingly depend on products such as sunshading systems and facade integrated heat exchangers, on which the architect has limited architectonical influence". These ideas are also evident in the works of Koenigsberger et al. (1974), Drew and Fry (1976), Breheny (1992) and Yeang (2006), where architectural design is reconnected to climatic conditions.

2.8 KNOWLEDGE GAPS

The review of the literature in this chapter has demonstrated that there is a need to focus on the importance of sustainable retrofitting of existing buildings and understanding that building adaptive reuse is a vital strategy for climate change adaptation. Existing sustainability rating tools are most suitable for rating new construction and existing building operation and maintenance. The adaptive reuse potential of a building can be identified and ranked through Langston's ARP model. However, two knowledge gaps remain based on the review of literature:

- Firstly, this chapter has demonstrated that design principles are diverse and that some consensus is needed to come up with a holistic and unified set of design criteria for measuring the embedded adaptive reuse potential of future buildings.

- Secondly, there is a need for an evaluation tool that will enable design for future building adaptive reuse from the outset.

2.9 CONCLUDING REMARKS

This chapter reviewed the literature concerning building sustainability, obsolescence and adaptive reuse in particular. It illustrated the different concepts, theories, successful undertakings, lessons learnt and the combination of potential design principles applicable to future building adaptive reuse to support built environment sustainability. Architects and designers can create buildings with either low or zero carbon emissions and also use the concept of reduce, reuse and recycle in the practice of architecture.

A reduction of material consumption and construction waste can be achieved through the adaptive reuse of existing buildings. Although some buildings are not suitable for retrofitting, the demolition of existing buildings should be carefully considered before this choice is made. Building adaptive reuse recognises the economic, socio-cultural and environmental value of the building stock and encourages the reuse rather than the waste of what is available. It is more than recycling building components, as the reuse occurs in place. The adaptive reuse of future buildings must be ensured to achieve sustainable built environments.

CHAPTER 3

RESEARCH METHOD

3.1 THE PURPOSE OF THIS CHAPTER

Designing buildings with significant potential for adaptive reuse is a useful criterion for sustainability. By extension, planned adaptive reuse is an emerging and fundamental design consideration for all new projects in the context of climate change and emission reduction strategies. The reuse of obsolete buildings without extensive demolition or destruction provides a significant benefit in terms of the conservation of resources and the associated energy embedded in new material manufacture and assembly. It is important that the provision for future building adaptive reuse be taken into consideration in new-build schemes. There is a need for an evaluation tool that will help architects maximise the future adaptive reuse potential of their buildings at the time they are designed.

This research involves twelve successfully completed award-winning Australian adaptive reuse case studies that demonstrate the successful blending of modern technology and design with respect to their historic character. These case studies illustrate rich and diverse architectural solutions in terms of conserving and adapting existing buildings to sustainable new uses (NSW Department of Planning and RAIA, 2008). The investigation and assessment of these case studies will help in the development and understanding of the design process for the future adaptation of new buildings.

This section describes the mixed-mode methods used in this research by relating the qualitative and quantitative approaches employed: case studies, expert interviews and practitioner survey. A discussion of the GPO Building in Melbourne as a pilot study is also highlighted as part of the research method.

3.2 RESEARCH DESIGN

Based on a review of the literature, it is clear that there is a lack of consensus on which design criteria lead to successful future adaptive reuse projects. The approach used in this research study is a sequential mixed mode research methodology (qualitative and quantitative). This is divided into three stages which are closely related to the three years of the project. The overall research logic is illustrated in Figure 3-1.

The first stage uses a multiple case study approach and explores twelve completed Australian adaptive reuse projects to understand, with hindsight, what factors related to the project's original design led to its successful adaptive reuse transformation. This step involves a detailed case study of each project, supported by interviews from key stakeholders who are experts in the field and have specific case study knowledge, including representatives from the architectural team, the heritage architect consultant, the structural engineer, the services engineer, the quantity surveyor, project directors and the project manager.

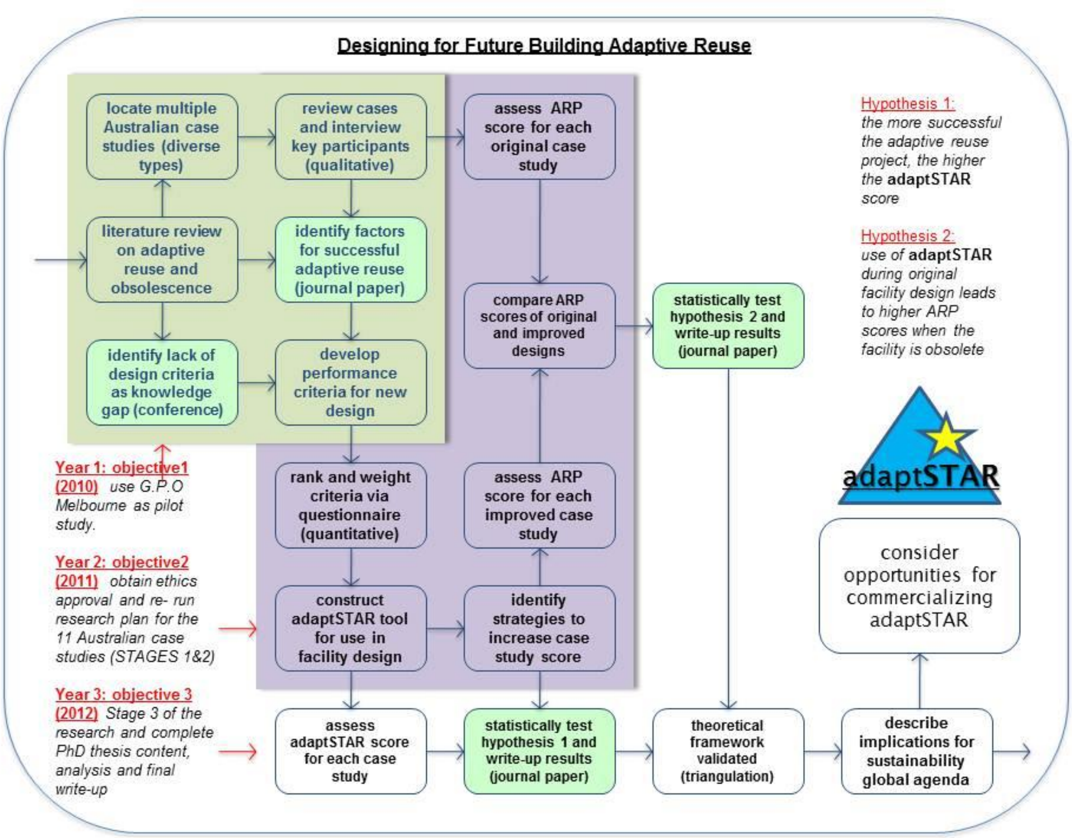


FIGURE 3-1 RESEARCH PLAN (METHODOLOGY)

The first stage of this research (see Figure 3-2) involves the analysis of eleven award-winning Australian adaptive reuse conversions in New South Wales (NSW). These conversions were chosen by the architectural profession from over 20,000 heritage-listed buildings in NSW because they represent excellence, different types of building use and how adaptation guidelines work in practice (NSW Department of Planning and RAIA, 2008). A pilot study of the GPO Melbourne project in Victoria was used as a twelfth case study.

The case studies represent quite different building typologies and each case study has different latent characteristics, thus the list of design criteria that lead to successful outcomes is expected to be reasonably diverse. The identified factors are collated into groups representing physical, economic, functional, technological, social, legal and political obsolescence and the assembly of these factors forms the base criteria to be used and scored in the adaptSTAR model. For the purpose of this research there is no benefit, other than for model calibration, to investigate unsuccessful examples of adaptive reuse, as the goal is to discover what factors lead to favourable outcomes rather than unfavourable ones, so only successful reuse conversions have been examined.

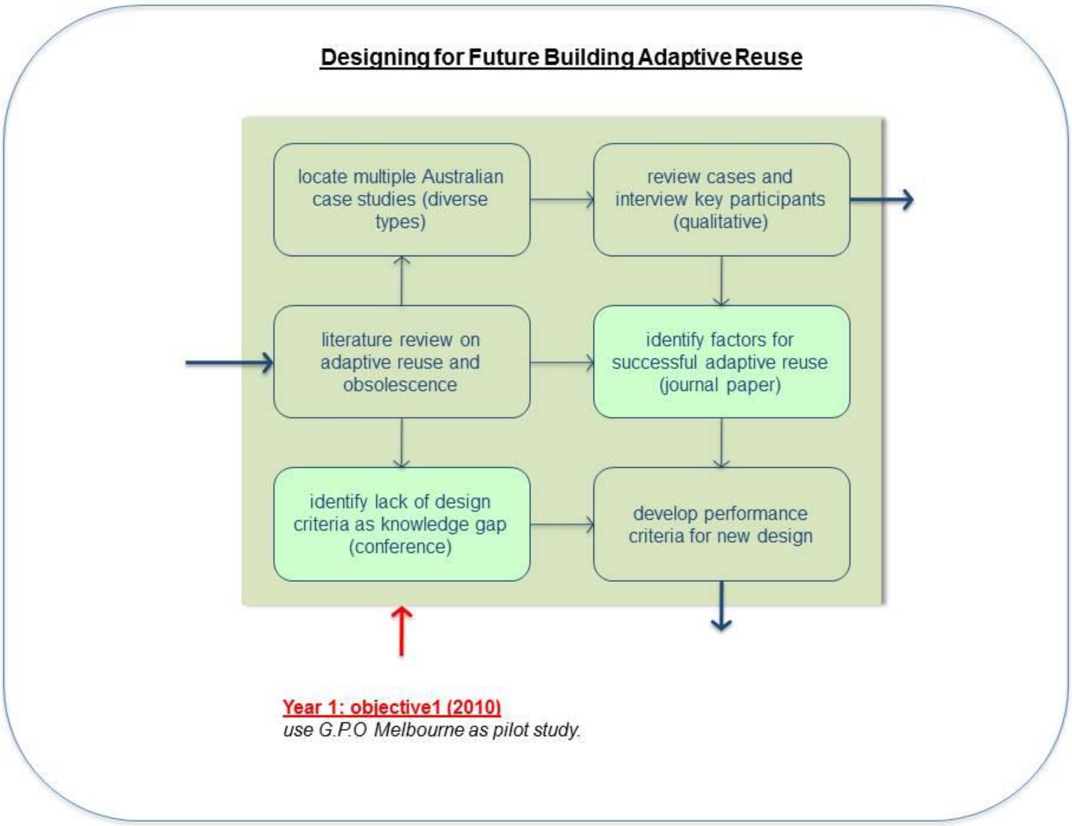


FIGURE 3-2 STAGE 1 OF THE RESEARCH METHODOLOGY

Stage 1 is a qualitative approach that adopts a multiple case design to allow the researcher to fully understand the adaptive reuse of buildings by using several independent case studies. Creswell (1998) suggests that a qualitative approach is most suitable for this exploratory research, encompassing theory-building and enabling the researcher to build a complex, holistic picture, analyse the words, report detailed views of informants, and conduct the study in a natural setting. Yin (2009) points out that the use of evidence from multiple cases is essential to the robustness of the overall research study. Stake (1995) and Yin (1994) further state that case study research is a qualitative methodology that allows for the inclusion of quantitative evidence.

The case study method has also proved successful in researching a variety of issues in terms of adaptive reuse with a large number of authors in this crowded field (HSMO, 1987; Park, 1998; Ball, 1999; Scadden & Mitchell, 2001; Henehan & Woodson, 2004; Johnson, 2004; Velthuis & Spennermann, 2004; DEH, 2004; Snyder, 2005; Giles, 2005; Cantell, 2005; Rothrock, 2005; Siddiqi, 2006; Browne, 2006; Langston & Shen, 2007; Langston, 2008; NSW Department of Planning &RAIA, 2008; Bullen & Love, 2009a; Wang & Zeng, 2010; Langston 2010a). Therefore, the case method is confirmed as an appropriate research strategy for this thesis. It is a suitable strategy for this research because it allows the exploration of the following elements/aspects/areas:

1. The concept of future building adaptive reuse is still relatively new and needs further development;

2. The experiences and expertise of the professionals involved in the project are important;

3. The study of issues, events and situations are in natural settings;

4. There is no involvement of experimental control or manipulations of variables since the research adopts an exploratory study that is retrospective in nature; and

5. There is little or no prior knowledge about what the design principles needed for a design evaluation tool are, and how the adaptive reuse potential of future/new buildings will be measured.

Tellis (1997) states that a case study is potentially a triangulated research strategy since it allows various methods and/or multiple sources for the collection of empirical material. These methods include interviews, direct and/or participant observations and the analysis of artefacts, documents and archival records.

The second stage takes this list of design criteria and assigns weights to them (see Figure 3-3). This is achieved using an online questionnaire to selected practitioners of the Australian architectural profession, asking them to rate the importance of the factors based on using a five-point Likert scale). It is unlikely that all factors are of equal importance, but it may be that each obsolescence category is approximately equal weight. This was a key assumption in the ARP model and the calculation of ARP scores (Langston, 2008). Based on the results of the surveys, the factors with low importance were discarded. These judgements are independent of the twelve case studies examined in this research and so the approach is not merely self-serving.

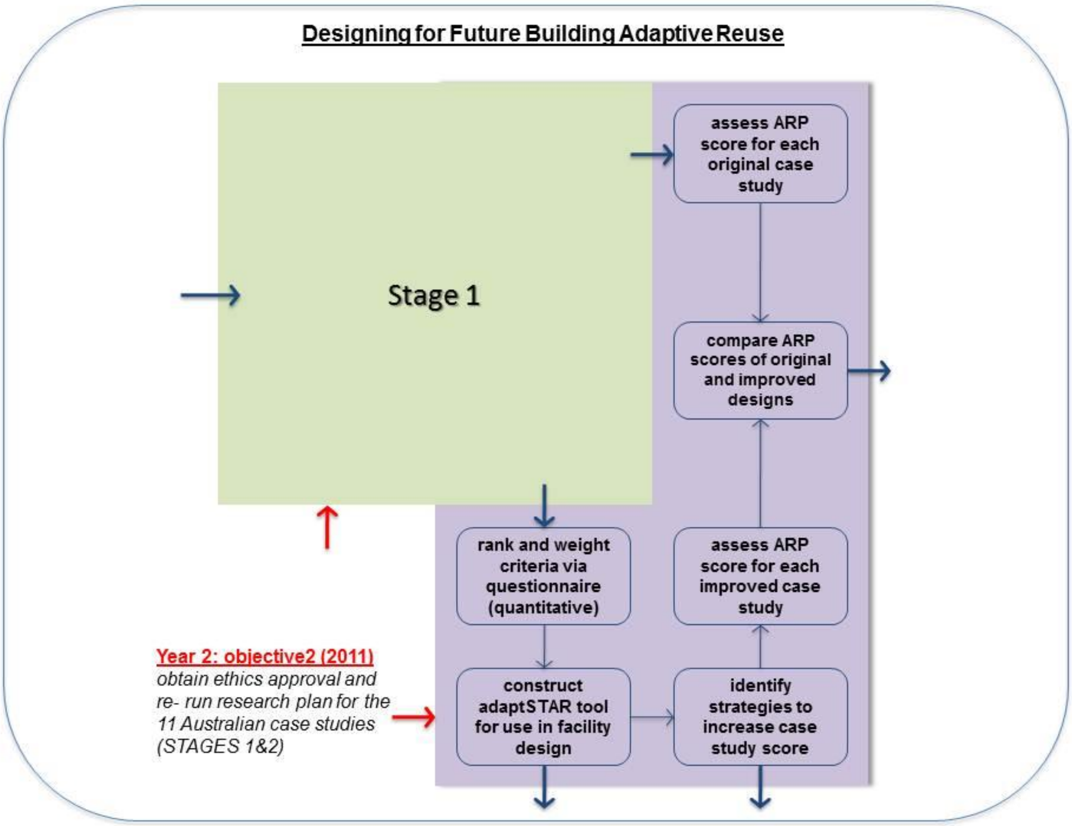


FIGURE 3-3 STAGE 2 OF THE RESEARCH METHODOLOGY

The third stage evaluates the performance of the derived model in a number of ways (see Figure 3-4). The relationship between adaptSTAR and the ARP model is tested in this stage to determine if the respective scores from both models are correlated. The relative weights for design criteria determine if the seven obsolescence categories are indeed equally weighted, as assumed in ARP. Points are used to define a user-friendly star rating scheme similar to the Green Star system currently used by the Green Building Council of Australia. Each of the twelve case studies is then assessed using adaptSTAR to determine their performance, and the ARP model to determine their potential for reuse at the time of their redevelopment.

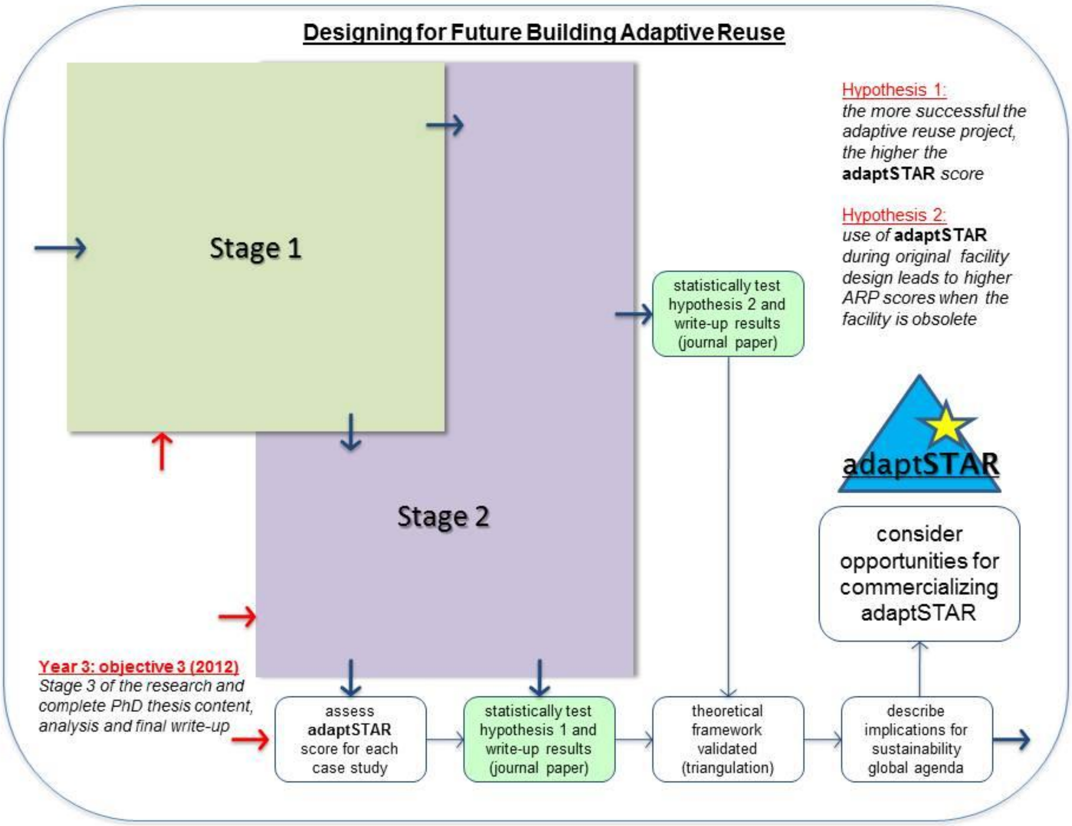


FIGURE 3-4 STAGE 3 OF THE RESEARCH METHODOLOGY

Based on the expert interviews and reflections with the benefit of hindsight, theoretical improvements to each of the twelve case studies are identified. These are assessed to determine alternate performance and potential scores. Two underlying hypotheses are developed from this work:

H1: There is a positive relationship between the ARP model and the new adaptSTAR model: the more successful the adaptive reuse project, the higher the adaptSTARscore.

H2: The use of the adaptSTAR tool during the original facility design processes leads to higher ARP scores when the facility is obsolete.

Only if both of these hypotheses are supported will the adaptSTAR tool be validated and of practical merit. By comparing the change in ARP score with the change in adaptSTAR score, the use of adaptSTARas a strategy to realise more successful adaptive reuse outcomes can be undertaken with confidence. The innovative mix of methodologies, comprising case study analysis, expert interview and practitioner survey, enables the triangulation of results.

The adaptSTAR scores of each of the twelve case studies at the time they were designed are computed and alternative decisions based on unrealised opportunities for enhanced adaptive reuse potential are explored to see whether higher adaptSTAR scores may have been achieved.

3.3 SUBJECT, PARTICIPANTS, POPULATION AND SAMPLE

Within the case study approach, participants in the projects are a rich source for data collection. In the first stage, participants are selected from the key stakeholders who were involved in twelve successfully completed Australian adaptive reuse projects, eleven of which were located in NSW, and one in Victoria. The participants in the Stage 1 of the research were professional consultants responsible for key design decisions and have all been involved in successful adaptive reuse projects. These are experts in the field and include representatives from the architectural team, the heritage architect consultant, the structural engineer, the services engineer, the quantity surveyor, project directors and the project manager.

As this is a retrospective study, it required participants who were willing to discuss their past projects. The research study was explained both in telephone calls and in written form before the interviews commenced. Each participant was provided with a formal letter informing them of their selection and participation in the interview. The letter explained that they were assured of confidentiality and anonymity and they were given the right to withdraw from the project without prejudice at any time. Once each selected participant agreed to be part of the research, a face-to-face meeting in their office at an agreed time took place and the research purpose and process was explained to them in person prior to the start of the meeting.

The selected participants for Stage 2 of the research were active members of the Australian Institute of Architects (AIA) and were involved in undertaking heritage conservation, adaptive reuse and green building projects. A purposeful sampling approach was used in determining the survey participants. The sample size was 93 practising architects. These architects were chosen based on their knowledge and expertise, range of projects undertaken (medium to large scale mixed use development and not limited to residential units), length of professional practice (not less than 10 years) and project turnover per year. The assistance of the Professional Development Manager of the AIA offices especially in Queensland were considered valuable in the identification of the survey list of participants. In this second stage, the selected participants were asked to weight and rank the identified list of factors through an online survey.

3.4 UNIT OF ANALYSIS AND RESEARCH VARIABLES

The unit of analysis is the main entity of a study: the 'what' or 'whom' that is being analysed. Miles & Huberman (1984) believe that the importance of the unit of analysis lies in its identification of where the case starts and where it finishes. The unit of analysis can be individual(s), event, entity, decisions, programs, implementation process or organisational change (Yin, 1994). Yin (1994) further suggests that the unit of analysis should be the focus of the study to avoid the collection of unnecessary data.

The unit of analyses in this study are the key professionals involved in twelve successful adaptive reuse case studies in NSW and Melbourne and selected architects (priori determined sample), who are active members of AIA and are closely involved in heritage conservation, adaptive reuse and green building projects across Australia. The independent variable in this study is the ARP score as the predictor of the overall performance of the future building adaptive reuse project, while the dependent variable is the adaptSTAR score of the future designed building.

3.5 RESEARCH INSTRUMENT AND DATA COLLECTION PROCEDURES

The research study involved three stages, each of which used a mixed-mode approach (qualitative and quantitative). These can be described as:

- Stage 1 (the identification of the list of factors);
- Stage 2 (the rating and weighting of the list of factors through an online survey);
- Stage 3 (testing of the model using two hypotheses that will be used to validate the research work by triangulation).

In the Stage 1 research study, open-ended semi-structured in-depth interviews are the primary mode of the data collection. Yin (1994) emphasises that value of open-ended questions is due to its flexibility and ability to adapt from person to person, whilst maintaining a focus on the issues being studied. A semi-structured open-ended interview questionnaire guide is prepared to minimise bias and encourage respondents to reflect and expound on their experiences. The literature on design and adaptation principles is used to focus the interview and ensure that the issues of interest are being discussed, ensuring that it does not elicit a biased response by providing too much information. The interviews ranged in duration from 30 minutes to 2 hours. This length was guided by the case study protocol with the guide interview questions.

The main instrument in this research is the interview protocol guide with corresponding questions related to the themes of the research. The interview protocol functions as a guide to steer the conversation to the issues pertinent to the investigation. An open-ended interview style was chosen because it was more important to allow the conversations to flow freely to allow the participants to tell their stories.

The interview protocol is divided into three parts. Part 1 consists of questions relating to the background and history of the project before the adaptive reuse was undertaken. Part 2 poses questions that relate to the design and technical considerations of the project, while Part 3 questions are centred on the design process as a whole and what other strategies or design interventions could have been provided to improve building performance. The semi-structured interview questions, with a list of the relevant themes addressed, are:

1. History of the project:

- A brief background of the project from its original and existing use to its newly adaptive use or building function;
- Major decisions and/or events that led to its reuse;
- Major considerations before undertaking the project; and
- Any latent conditions.

2. Design and technical aspects:

- Impediments encountered during the design process, how modern and green design features (if any) were incorporated or blended to the existing facilities;
- Structural and utility challenges; and
- Legal and building code considerations.

3. Design process:

- Design principles and criteria applied or implemented;
- Design consultations conducted with stakeholders;
- Adaptive reuse strategies identified or applied; and
- Critical factors that affected the success of adaptive reuse projects.

The in-depth interviews were recorded and transcribed and supported with secondary empirical material. These included observations, archival data and other documentation (e.g. drawings, plans, reports, press articles and websites). Patton (2002) indicates that gathering data from multiple sources demonstrates the extent of congruity and consistency between key informants' evaluations and permits triangulation over given facts. The collected data in Stage 1 and their interpretations were scrutinised, synthesised and a generalisation was constructed through the use of the *NVivo* software (see Appendix C for the sample *NVivo* application to the experts' interview).

NVivo (QSR, 2008) is qualitative research software that helps manage, shape and make sense of a researcher's data collection. With *NVivo*, the analysis includes data classification, reduction, data display, theme identification and drawing of meaningful conclusions. Through the use of the case study protocol as a guide and the creation of nodes in *NVivo*, the Stage 1 case study analysis was organised and presented in two steps:

1. *The construction of each case study profile*: individual and in-depth case profiles are created based on comprehensive documentation, such as published literature, approved building plans and maps, architect's conceptual schemes, news clippings, articles, and public reports, that have been published about the twelve case studies.

2. *Addressing the research objective*: the key design criteria identified based on the in-depth expert interviews of the selected professionals involved in the case studies' design and construction implementation are pattern coded. This also includes the coding of key design criteria informed by the experts' interview results and relevant underpinning literature.

With regards to sample saturation, theoretical saturation is reached when themes and sub-themes related to data analysis begin to repeat themselves such as when the researchers observe that no new themes are emerging from the data (Strauss & Corbin, 1998). In the Stage 1 research study there were fifteen key experts interviewed and the interviews lasted a total of almost 30 hours. They were supplemented by the review of data from other sources such as websites, newspaper articles, company documents, master plans, architectural drawings and email correspondence. The issue of possible bias is low in this case since triangulation of gathered data from different sources were found consistent and through the use of NVivo software, their interpretations were also scrutinized, synthesized and generalized.

To identify the themes and sub-themes from the interview results, pattern coding was used. Kaplan (1964) emphasises that the bedrock of inquiry is the researcher's quest for repeatable regularities. Pattern codes are explanatory or inferential which identify an emergent theme, configuration or explanation. Pattern coding is a way of grouping summaries into smaller sets, themes or constructs. Miles & Huberman (1994) assert that pattern coding for multiple case studies lays the groundwork for cross-case analysis by surfacing common themes and directional processes. They further state that pattern codes usually concentrate around four often interrelated summarisers: themes, causes or explanations, relationships among people and more theoretical constructs.

Based on the underpinning literature and the interview guide, the analysis is done in an organised manner per case. The data is sorted by themes (into seven categories) and sub-themes (the corresponding design criteria). The interviews are conducted at the offices of the key experts and digitally recorded and transcribed. The interviewees' details are coded to allow anonymity, although all of them are made aware that it might be possible to identify them from the content of their response. As the transcriptions are coded, relationships are set and then fitted into categories and sub-categories, according to the list of design criteria. As each theme and pattern are matched with each design criterion, similarities and differences in key words and phrases are identified, concepts on how and why the respondents perceived and identified certain design criteria are analysed, as well as the number of respondents who agreed to a certain theme or design criterion are noted. The outcome of Stage 1 is the identified list of design criteria needed for the implementation of successful adaptive reuse.

In Stage 2, the list of design criteria is rated and weighted by creating an online survey using *Survey Monkey*. In the survey, a five-point Likert scale determined the level of importance of each design criteria listed on the online questionnaire (see Appendix D). Survey Monkey is a web-based commercial product that allows researchers to create their own surveys using custom templates (Creswell, 2009). It can generate results and report them back as descriptive statistics or as graphed information whilst results can be downloaded into a spreadsheet or database for further analysis. After this process, the weighted list of design criteria is constructed using *Microsoft Excel*: a simple and easy tool for managing data and producing weighted scores. The statistical analysis of the data then shows the level of confidence in the weights and their robustness.

3.6 ETHICAL CONSIDERATIONS

In every research undertaking, the rights and well-being of the research subjects must be acknowledged and looked after. In any research involving human subjects, the preparation of an informed consent form is an essential requirement in procuring ethical clearance. According to the guidelines of the Bond University Human Rights and Ethics Committee (BUHREC), an informed consent includes the title of the research study; a full identification of the researcher's identity; a brief description of the research study; an assurance that participation is voluntary and that the respondent has the right to withdraw at any time without penalty; an assurance of confidentiality; an outline of the benefits and risks associated with participation in the study; and the contact details of the BUHREC Officer in case the participants have any complaints or comments regarding the study and how it was conducted.

The ethical clearance permission was sought from BUHREC prior to the commencement of the data collection for both stages of the research study. In both stages, letters are prepared and sent to the key stakeholders or selected survey respondents. The letters together with the informed consent are read by the respondents before acceptance of their consent to participate in the interview and survey. The participants are required to sign the consent before the one-on-one in-depth interview takes place in the participant's office (for details see Appendix A).

3.7 SETTING AND ENVIRONMENT

The case studies selected were heritage buildings because the researcher believes that the most sustainable building is the one that already exists. Furthermore, heritage buildings were able to adapt to climate change and the changing demands of time. An initial testing of the research plan is conducted using the GPO Building in Melbourne. This involves an in-depth interview with architect Peter Williams of Williams Boag Architects, a follow-up building site survey and interview with the project manager and the thorough investigation of archival documents, photographs, illustrations and blueprints. A series of initial findings based on the pilot study are described in Section 4.2 in the next chapter.

Although, Australia has been using the Burra Charter for building conservation projects, the adaptation guidelines set by the Heritage Council of NSW (NSW Department of Planning and RAIA, 2008) was the main factor in determining the suitability of the case studies selected in this thesis. The Heritage Council of NSW has endorsed the policies in the adaptation guidelines as best practice for the conservation and adaptation of heritage items of either local or State significance, and uses the guidelines when assessing development applications for adaptation projects. Local councils should use the guidelines for the same purpose. The seven principles for the adaptation of historic buildings and sites to new uses are:

1. *Understand the significance of the place:* understanding what is important about a place is the first stage of any project. The analysis of the heritage values and the fabric should result in a clear statement of heritage significance, and identify significant fabric.

2. *Find a use which is appropriate to the heritage significance of the place:* retain the existing use when it is integral to the heritage significance. A new use should be compatible with heritage significance and involve minimal changes to significant fabric, layout and setting.

3. *Determine a level of change which is appropriate to the significance of the place:* minimise impact on significant fabric, significant interiors, interior planning (circulation patterns and use of rooms) and decorative schemes and finishes.

4. *Provide for the change to be reversed and for the place's future conservation:* adaptation and development should not prevent the future conservation of a heritage item. New additions and adjacent or related new construction should be undertaken in such a way that, if they are removed in the future, the essential form and integrity of the historic place is unimpaired. Non-reversible changes to a heritage place will only be considered when there is no alternative way of retaining the place as a viable asset. Existing fabric, use, associations and meanings should be recorded and archived before changes are made, according to Heritage Council of NSW guidelines.

5. *Conserve the relationship between the settings and preserve significant views to and from the heritage place:* where the relationship between the heritage item and its setting contributes to its significance, this relationship should be preserved. Views that have been identified as contributing to the significance of the place should also be retained.

6. *Provide for the long-term management and viability of the heritage place:* secure ongoing funds to maintain the heritage place in the future as part of the project. The benefits from the project will then offset the change of use. Link conservation works and proposed new works together by conditions of approval, a heritage agreement, or other appropriate mechanism, so that the conservation works are integral to the project. Prevent fragmentation of the management of the heritage place in large-scale adaptations. Where there is a fragmentation of ownership through lease or sale, a legally binding overarching management framework should be put in place (such as a heritage

agreement). This will ensure that the heritage values of the place are appropriately managed.

7. *Reveal and interpret the heritage significance of the place as an integral and meaningful part of the adaptation project:* interpretation communicates the history and previous uses of a building to its occupants and visitors and helps to explain how and why the adaptive reuse changes have been made. Retaining historic signs, the layout of internal spaces and the physical evidence of past uses contributes to greater understanding of the significance of the place.

Table 3-1 presents the attributes of the eleven case studies, highlighting the solutions and strategies used to address the adaptation principles, making them successful award-winning projects. This also confirms the suitability of the case studies, since it is evident that they were heritage buildings with different typologies and have undergone different types of conversions or adaptive reuses.

TABLE 3-1 THE SELECTED ADAPTIVE REUSE CASE STUDIES IN NSW, AUSTRALIA

Project name and location	Former use and new use	Application of the adaptation principles
1. Units at Egan Street, Newtown	Industrial to residential building	Local significance of the building was understood. Industrial character was retained. External and internal features were respected and conserved. New works do not prevent alternative future use. Streetscape quality of the building was noted and conserved. Building now put to new sustainable uses. Building's significance and past use was celebrated in the architectural design solution.
2. Babworth House, Darling Point	Grand city house to apartments	Conservation plan identified significance and translated it into policy. Residential use retained and garden was conserved; new houses on the grounds retained original use. Garden features and views from house to harbour were retained. Apartment layouts maintained original relationship between significant rooms. New configuration does not prevent future reconversion. House views of garden areas and harbour were retained. Community title instead of strata title was used. Significant fabric was conserved and restored.
3. Tocal Visitor Centre, Tocal	Rural agricultural building to function centre	Conservation management plan informed the site masterplan. Other farm buildings were retained and the new use provides facilities to support the visitor and tourism function of the homestead complex. The barn form and character and significant interior fabric were conserved and materials have been recycled or sourced locally. New use does not prevent future reconversion to barn. New works did not affect the settings or views. Provides viable use for the building and supports the overall complex. Significant elements and fabric have been conserved.
4. Toxteth Church and Hall, Glebe	Local church and hall to residential building	Thorough significance analysis of the fabric was completed. New use doesn't preclude future function. Significant fabric was conserved and led the design solution; interior features were conserved and used as a new design feature. New work can be removed easily without requiring reconstruction. Relationship between the building and the street was conserved. New use secures the building's use in an ongoing way. Significant features and architectural elements provided inspiration for the new design.
5. Bushells Building, The Rocks	Inner-city industrial site to office building	Conservation management plan identified the building's significance and guided the work. New use as offices has retained the building's spatial qualities and remnant artefacts. Significant features and artefacts including interior features were conserved. The partition system and services can be removed. Landmark signage has been retained. New use and its overall management system provide for holistic building management. Significant building fabric has been conserved and artefacts, including signage, retain the building's historic character.

6. Sydney Harbour Federation Trust Offices, Georges Heights	Defence buildings to office buildings	A conservation management plan (CMP) for the precinct identified the building's significance and developed policies to guide adaptation. New uses for administration purposes entail minimal impact on spaces. The original fabric has been retained wherever possible. Reversibility has been incorporated in different degrees according to heritage significance. The relationship between the original building groupings, access roads and the surrounding open space has been carefully maintained, with restrained new landscaping. The Trust structure allows for overall site and tenant management. Tenant fit-outs are approved by the Trust to achieve compliance with the CMP guidelines Conservation work has revealed the original volumes and character of the Army hospital buildings
7. Sully's Emporium, Broken Hill	Commercial building to art gallery	Thorough significance assessment and fabric analysis was completed. Some commercial use was retained; the gallery use retains some commercial functions and provides public access. Significant fabric was carefully conserved; interior features that survived were retained. New works have been simply undertaken, minimising their impact on the building fabric. The streetscape character and veranda were conserved. The gallery use provides ongoing viability for the building. The light touch of the conservation works and architectural intervention has let the building speak for itself.
8. The Mint, Macquarie St., Sydney	Coining factory to Historic Trust head office and library	Conservation management plan guided the design process. New use continues a 200-year history of the site's use as public offices. Thorough site analysis completed before detailed design and documentation which enabled the conservation and integration of significant fabric; energy-efficient 'tempered air' ventilation system minimised changes to the interior environment. Majority of new work sits separately from the heritage fabric, allowing future change or reversibility with minimal impact. Scale and form of the new buildings has enhanced the nature and use of the central courtyard of the site. Overall design concept separated public and cultural activity areas from head office and business areas, allowing these operations to run independently and concurrently, thus increasing options for use and long-term viability. New use provided the conservation of historic buildings and fabric, and public access and site interpretation through displays, signage and public activities.
9. Forum Health and Wellness Centre, Newcastle	Railway workshop to health and wellness centre	Conservation management plan informed the site masterplan. Health centre use demands were compatible with the former workshops' use. Main building features were conserved in the adaptation. Industrial building is now part of a major regeneration area that has been converted to mixed and residential uses. The new use is an insertion into the building and can be removed later if required. Building's character and role within the revived precinct retains it as an important urban feature. New use provides for the future viability of the building in a single ownership.

10. George Patterson House, Sydney	Warehouse building to hotel complex building	A study was done prior to and after the fire to establish the heritage significance of the building. Key fire-damaged spaces were left to reveal the story of the site: existing spaces and their finishes have been retained and the eastern end of the original showroom wing has been retained as an open space, complete with its fire-damaged finishes. This space and the basement below are now signature spaces for the identity of the place. All repair and stabilisation work to the remaining fabric was done using traditional materials and techniques; some reconstructed elements were carried out using modern materials and significant sections of the fire-damaged interiors were conserved, including finishes. Existing structure and elements were left in place, with new elements and services fitted around them. The adaptive reuse and redevelopment has created one of the most popular gathering places in Sydney. The site has a mix of viable new uses. The finished project interprets the significance of the place and its unique history and identity.
11. Prince Henry, Little Bay	Government health facility to mixed-use develop-ment	Conservation management plan informed the site masterplan. Health care facilities and community uses were retained; museum and chapel uses continued; public access to the site and its beaches was retained; wards and nurses' accommodation were converted to residences. The Flowers Ward 1 was conserved as a representative building from the site's period of greatest heritage significance. Heritage significance was set and linked to masterplan. The highly significant geological site has been conserved. Setting has been recognised as integral to the site's heritage significance and views were conserved. The Reserve Trust and community management schemes provide overarching management frameworks. Heritage significance drove urban design and design solutions for the site and the location of buildings and new uses. An interpretation plan was developed for the site and integrated into the masterplan. Each element/project includes interpretive measures.

Source: NSW Department of Planning& RAIA, (2008). New uses for heritage places: Guidelines for the adaptation of historic buildings and sites.

3.8 CRITERIA FOR EVALUATING RESEARCH

Leedy & Ormrod (2013:p.103) suggest that, when considering the validity of research, the basis should be on whether the "conclusions are valid and meaningful only to the extent that they are warranted based on the data collected and have applicability beyond the specific research situation itself". They state that there are nine general criteria used to evaluate a qualitative research study, namely:

purpose; explicitness of assumptions and biases; rigour; open-mindedness; completeness; coherence; persuasiveness; consensus; and usefulness.

For Guba and Lincoln (1985) the four criteria through which validity can be assessed are credibility, transferability, dependability and conformability. These are mainly associated with qualitative research and these terms collectively evaluate the trustworthiness of the research. King & Horrocks (2010) note that there are universally recognised criteria in assessing quantitative research but there are no similar agreements for qualitative research. However, Yin (1994) shows that the criteria used to evaluate quantitative research are equally applicable to evaluating qualitative research, although Denzin& Lincoln (1994) suggest using a different set of criteria, with credibility, transferability, dependability and conformability, to replace the usual criteria of internal and external validity, reliability and objectivity.

Aside from the four criteria mentioned (internal and external validity, reliability and objectivity), Leedy & Ormrod's (2013) suggestion for validating mixed-methods research by drawing upon Cresswell & Plano Clark's list of potential threats to validity in mixed-methods research is noted. This list addresses the following questions:

- Are the samples for the quantitative and qualitative aspects of the study the same or sufficiently similar to justify comparisons between the quantitative and qualitative data?
- Are the quantitative and qualitative data equally relevant to the same or related topics and research questions?
- Are the quantitative and qualitative data weighted equally in drawing conclusions? If not what is the rationale for giving priority to one type of data over the other?
- Can specific statements or artefacts from the qualitative element of the study be used to support or illustrate some of the quantitative results?

- Can apparent discrepancies between the quantitative and qualitative data be reasonably resolved?

This list of questions was considered and incorporated into the discussion of the four validity criteria in the following section.

3.8.1 CREDIBILITY (INTERNAL VALIDITY)

Maxwell (1992) relates credibility to the factual accuracy of the documentation of the research as well as the degree to which a theoretical explanation developed from the research findings fits the data. To demonstrate this study's validity, triangulation of both qualitative and quantitative data gathered is conducted. Triangulation is a qualitative process that tests the consistency of findings garnered through different methods and sources of data, including field notes, artefacts and transcripts (Calabrese, 2006). Calabrese (2006) further states that triangulation is possible where multiple sources of data are collected that converge to support the research objectives.

The researcher also triangulates data by engaging in repeated site observations in the field and conducting in-depth interviews before looking for common themes that appear in the data garnered from both methods. A detailed profile of each case study is completed and feedback is obtained from the key experts through email correspondence in every stage of the research as well as pattern coding and matching into key themes and sub-themes. The patterns are also matched and compared to the existing literature reviews on design principles. Likewise, the researcher listens to the participants with an empathetic ear while taking notes in order not to bias the conversations.

3.8.2 TRANSFERABILITY (EXTERNAL VALIDITY)

Transferability is the counterpart to the notion of external validity (or generalisability) used in quantitative studies. In qualitative research transferability determines whether or not the case(s) described can be transferred to other settings (and not the whole population as in the notion of external validity in quantitative research). Yin (1994) suggests that a multiple case design based on replication logic is a means of increasing the generalisability of a case study. Guba & Lincoln (1985) propose that providing rich detailed descriptions of cases, participants and study settings help inform the reader about transferability. The transferability of this research is not an issue since the study is conducted in two Australian states, New South Wales and Victoria, thus the same procedures could be used in other states of Australia and to other cities in developed countries that support low-carbon environments.

3.8.3 CONFORMABILITY AND DEPENDABILITY (RELIABILITY)

Conformability and dependability correspond to the reliability of research. Miles & Huberman (1994) point out that the goal of reliability is to reduce errors and biases in a study, thus it is about ensuring that the process of the research is consistent and reasonably stable over time and across researchers and methods. In measuring reliability, the researcher must provide evidence that the instrument used produces consistent results over time and that the various methods used to test reliability are identified. A further indication of the reliability of the study is its ability to be replicated and produce similar results (Hefner, 2004; Walonick, 2005 cited in Calabrese, 2006). A detailed description of the procedures and results of the study is provided in order to meet the criteria for both credibility and dependability. The study's reliability is further enhanced through the consistency of interview questions asked to all key experts and the trial run of the online survey questionnaires to selected PhD colleagues. A rich and detailed description of the methodology is prepared and extensive documentation of records and data stemming from the case study for an audit trail is maintained.

An audit trail can be used to accomplish dependability and conformability simultaneously (Guba & Lincoln, 1985). Additionally, the use of a case study protocol and the development of a case study database, such as suggested by Yin (1994; 2009), to address reliability problems, is used in this study.

3.9 CONCLUDING REMARKS

This chapter discussed the methodological approach used in this research study, which consists of three stages and comprises a mixed-mode research methodology (i.e. both qualitative and quantitative). Stage 1 is qualitative and involves multiple case studies where in-depth interviews of key experts are conducted in addition to building site surveys and a thorough investigation of archival documents, photographs and architectural drawings. The outcome of Stage 1 is a list of potential design criteria for successful adaptive reuse. The list of potential design criteria is then evaluated to determine the weighted importance of corresponding design elements, which is done in Stage 2 of the research study. Lastly, Stage 3 comprises refinement and validation of the new adaptSTAR model via a comparison with post-design decision tools such as Langston's ARP model. The results for both Stages 2 and 3 are discussed in detail in Chapters 5 and 6 respectively.

This chapter also included the procedures on data collection, case study protocol and the guide interview questionnaires. The use of statistical analysis and *NVivo 8* for quantitative and qualitative approaches was discussed. Highlights from the pilot study and the importance of ethics in research were also included. Finally, this chapter considered the evaluation of the research in terms of internal and external validity. The results of Stage 1 as well as, a featured discussion of the pilot study are discussed in detail in the next chapter.

CHAPTER 4

LIST OF DESIGN CRITERIA

4.1 THE PURPOSE OF THIS CHAPTER

Chapter 3 outlined the research methodology for Stage 1 of this study while the pilot case study of the GPO building in Melbourne, Victoria is discussed in section 4.2 of this chapter. This chapter presents the results of the Stage 1 investigation involving the Melbourne GPO Building together with the eleven NSW case studies. The outcome of Stage 1 is the formation of an unweighted list of potential design criteria needed for the implementation of successful adaptive reuse. This chapter discusses the design criteria in detail, together with the initial development of the adaptSTAR model, showcasing the design elements grouped according to the seven obsolescence categories of the ARP model. A sample application of the model is then presented to demonstrate how the model can be applied.

4.2 THE PILOT STUDY

Yin (2009) explains that completing a pilot case study helps refine the data collection plans with respect to both the content of the data and the procedures to be followed. Further, he states that a pilot is not a pre-test; it is more constructive and assists in developing relevant lines of questions or even provides conceptual clarification for the research design. Yin (2009) identifies three considerations for selecting a pilot case: convenience, access and geographic proximity.

The GPO Building in Melbourne (see Figures 4-1 to 4-4) is the pilot study for this research. This study supports the first stage (year 1) of this research study, and is a trial run the data collection and research plan for the main study. This project is selected for reasons of convenience and access. It is also a landmark adaptive reuse project in Australia. The pilot study was completed in 2010 and its analysis was funded by a Bond University Vice Chancellor's Research Grant.

Melbourne's GPO building is one of the most prominent and well-known adaptive reuse case studies in Australia and was awarded the RAIA National Award for Commercial Buildings and the Sir Osborn McCutcheon Commercial Architecture Award. Melbourne's GPO was constructed on the corner of Bourke and Elizabeth Streets in 1859. Between 1859 and 1867, a much grander, two-level building was developed. After a few major renovations it was completed in 1919 with its new sorting hall. In 1992, Australia Post announced plans to sell the building and end the GPO's major postal role in favour of decentralised mail centres.

A shopping mall was proposed in 1993 but its permit later lapsed and, in 1997, there was a proposal to convert the site to a hotel which did not proceed. In early 2001, plans for a retail centre were again announced but experienced a major setback when the building was almost gutted by fire in September of that year. Finally, the Melbourne's GPO Building opened for trade as a retail centre in October 2004. As one of the CBD's premier boutique shopping destinations, the GPO building houses over 50 stores across its three floors. The redevelopment of Melbourne's GPO symbolizes a new era for the revitalisation of significant public spaces provides an outstanding architectural solutions for building use. A photo collection of the redevelopment of the GPO, showcasing its inherent built fabric from 1867 and the intricacies of design solutions applied to it while it was undergoing adaptive reuse procedures, is shown in Figures 4-3 and 4-4.

The pilot study aids the research by determining the nature of the case study protocol, improving the guide questions per theme, as well as providing the researcher with the opportunity to prepare for the data collection process. Additionally, some design criteria taken from literature reviews are confirmed based on the interview conducted with the key respondents of the pilot study. The results of the pilot study are incorporated into the remaining case studies.

FIGURE 4-1 THE FACADE OF THE GPO BUILDING, MELBOURNE

Source: Key expert's photo collections

When asked about the adaptive reuse of the GPO Building in Melbourne, the principal architect has valuable insights to share such as "listening to the building and understanding the linking process of the existing fabric" and not going "against the fundamental settings of the building". What he meant is that the design process in converting existing heritage buildings into another use is very important because you are not designing out of a blank sheet. The designer has to think of the building, understand the building's problem and finding an opportunity for its transformation without losing the integrity of the original structure. Before the adaptive reuse project commenced, a Conservation Management Plan was prepared to guide the designer and other allied professionals to carefully respond to what is the existing needs before introducing some new works. Also, strict conservation control and consultations with Heritage Victoria are mandated.

Some intervention challenges are shown in Figure 4-2, such as the inclusion of a sprinkler system by making use of the decorative rose mouldings of the ceiling of the arcades while transforming the arcade into a small café with ledges that complements the existing pilasters. Another example is the insertion of new stairs that are concealed from the public areas and the provision of the escalator while retaining the existing Victorian columns and exposing the beams which were not affected during the fire incident as exhibits. Existing staircases are retained and used as fire exits and most of the materials used as railings, shop windows or partitions are made of glass so that they do not interfere with the existing fabric.

As can be seen in Figure 4-3, the iconic Melbourne GPO Building shows structural integrity where the façade, envelope, corridor and its original fabric are relatively sound and have stood the test of time. Most of the adaptive reuse transformations were done in the interior areas especially in the area where it was affected by fire as shown in Figure 4-4.

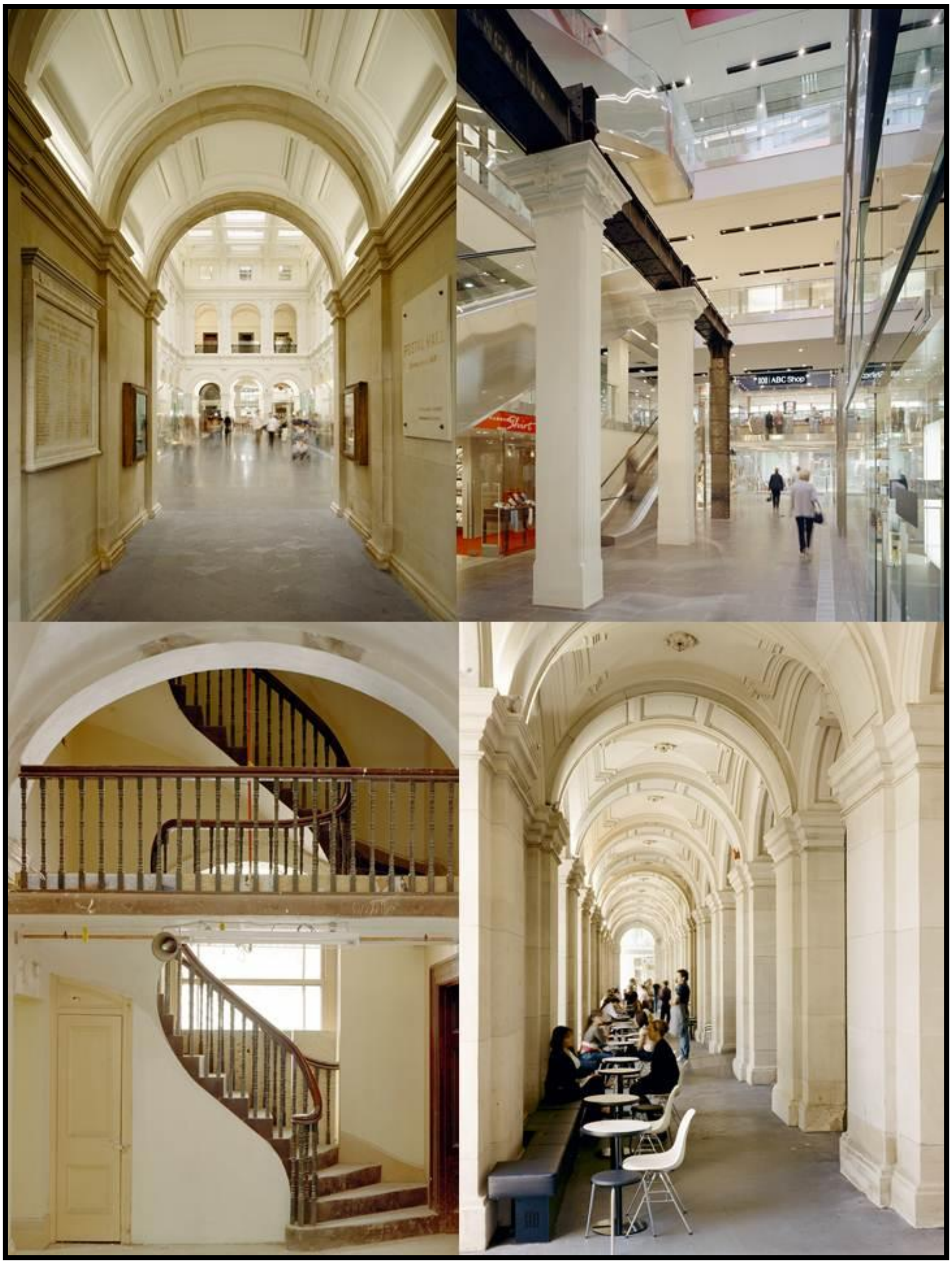


FIGURE 4-2 THE INTERIORS OF THE GPO BUILDING, MELBOURNE
Source: Key expert's photo collections

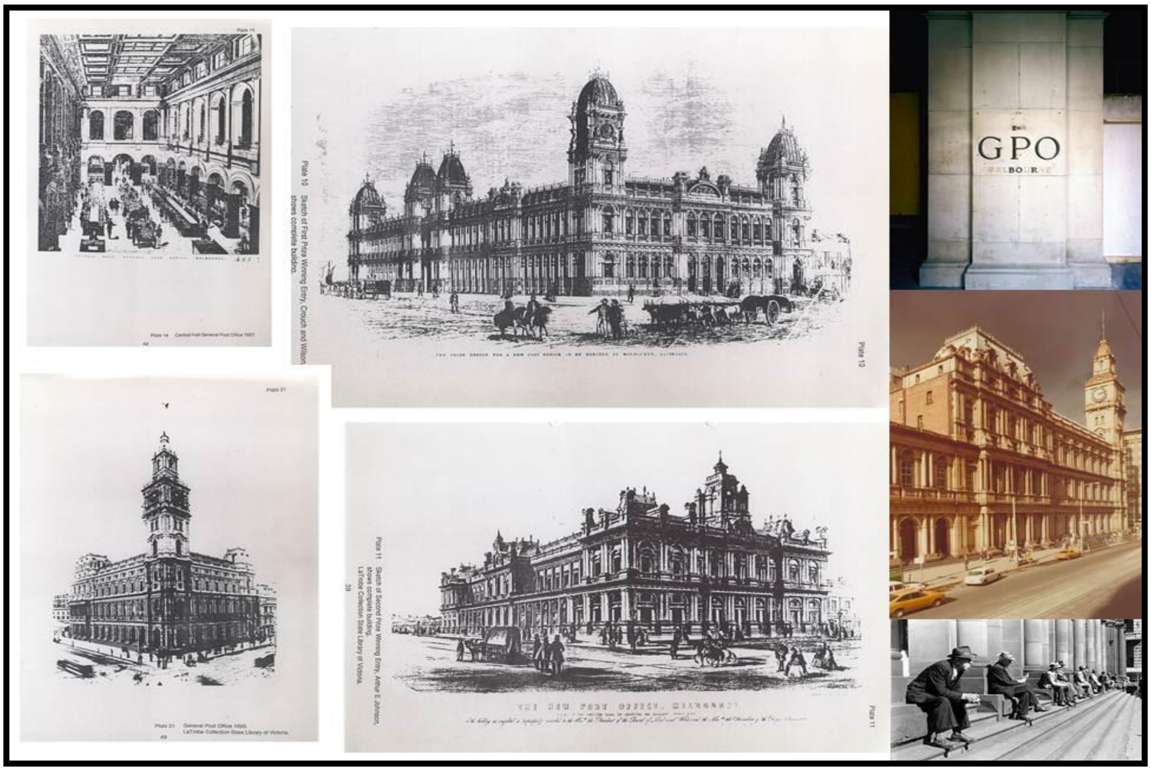


FIGURE 4-3 GPO BUILDING, MELBOURNE (1867-1900)
Source: Key expert's photo collections

FIGURE 4-4 GPO BUILDING, MELBOURNE (ADAPTIVE REUSE PROCESS)
Source: Key expert's photo collections

4.3 LIST OF DESIGN CRITERIA AND THE UNDERPINNING LITERATURE

The list of design criteria with the underpinning literature includes the adaptation principles developed by the Heritage Council of NSW and on the initial findings from the pilot study's in-depth interview with the Principal Architect and his design team. This list of design criteria are again supplemented through the conduct of the eleven case studies as discussed in section 4.5 of this chapter.

The list of design criteria were classified into seven design principles as discussed per sub-sections. They are the design strategies that address the seven obsolescence categories which the design principles are derived from. This satisfy the research objective 1 of this thesis, which is to identify and investigate the critical design factors needed in a design evaluation tool by translating the ARP model (Langston, 2008) into a set of contemporary design strategies that maximise the opportunity for the optimal adaptive reuse of buildings in the future.

4.3.1 LONG LIFE (PHYSICAL)

The design criteria identified for the long life theme comprise structural integrity, material durability, workmanship, maintainability, design complexity, prevailing climate and foundation. The structural design of the building is an important factor to take into consideration when looking at future uses and loads. The durability of the building asset and the quality of craftsmanship of the structure and finishes also lead to building longevity. Low maintenance and design complexity are mentioned by authors in relation to building adaptation and changing climatic conditions, and the building's foundations are essential in ensuring the physical stability of the buildings (see Table 4-1).

TABLE 4-1 LIST OF DESIGN CRITERIA (PHYSICAL CATEGORY)

Category	Criterion	Relevant Research Studies
Long life (Physical)	*Structural integrity* – structural design and ability of the building to cater for future uses and loads	Grammenos& Russell (1997); Russell &Moffat (2001); Davison et al. (2006); Osbourne (1985); Douglas (2006); Siddiqi (2006); Horvath (2010); Gorse &Highfield (2009); Yudelson (2010); Wittkower (1988); Wilkinson et al. (2009); Pevsner (1975); Graham (2005); Bullen & Love (2011)
	Material durability – durability of the building asset	Milne in UNEP (2007); Prowler (2008); Osbourne (1985); Douglas (2006); Vakjli-Ardebili (2007); Grammenos& Russell (1997); Prowler (2008); Queensland Government (2000); Caroon (2010)
	Workmanship – quality of the craftsmanship of structure and finishes	Osbourne (1985); Whimster (2008)
	Maintainability – building's capability to conserve operational resources	Prowler (2008); Vakili-Ardebili (2007); Osbourne (1985); Douglas (2006); Horvath (2010); Carter & Fortune (2008); City of New York Department of Design and Construction (1999); Nakib (2010); Caroon (2010)
	Design complexity – various geometries associated with the building's design and innovation	Grammenos& Russell (1997); Russell &Moffat (2001); Browne (2006)
	Prevailing climate - changing climatic conditions	Wilson & Ward (2009)
	Foundation – differential settlement and substrata movement	Milne in UNEP (2007); Osbourne (1985)

4.3.2 LOCATION (ECONOMIC)

In terms of the location theme, design criteria such as population density, market proximity, transport infrastructure, site access, planning constraint and plot sizes are considered. The density of the area is one factor that contributes to successful adaptive reuse, as Langston et al. (2008) propose. Campbell (1996) and Fealy (2006) also suggest that the distance to major cities or central business districts or primary marketplaces is a design criterion for sustaining adaptive reuse developments.

Other factors that contribute to urban regeneration and adaptive reuse projects are transport and communal facilities, transport access and availability, proximity to access roads and secure parking, exposure to good views, and privacy (see Table 4-2).

TABLE 4-2 LIST OF DESIGN CRITERIA (ECONOMIC CATEGORY)

Category	Criterion	Relevant Research Studies
Location (Economic)	*Population density*–geographic location within major city, CBD, etc.	Langston et al. (2008); Carter & Fortune (2008)
	Market proximity - distance from major city, the CBD, etc.	Campbell (1996); Fealy (2006); Prowler (2008); Wilkinson et al. (2009); Caroon (2010)
	Transport infrastructure - availability and access	Prowler (2008); UNEP (2007); Heath (2001); Peiser& Schmitz (2007); Horvath (2010); Carter & Fortune (2008)
	Site access - proximity or link to access roads, parking and communal facilities, etc.	Prowler (2008); UNEP (2007); Heath (2001); Wilkinson & James (2009); Peiser& Schmitz (2007); Horvath (2010); Carter & Fortune (2008)
	Exposure - views, privacy	Campbell (1996); Fealy (2006); Browne (2006)
	Planning constraints - site selection, planning, neighbourhood and building design, etc.	Langston et al. (2008); City of New York Department of Design and Construction (1999); Carter & Fortune (2008); Prowler (2008)
	Plot size - built area, spatial proportions, enclosure, etc.	Campbell (1996); Heath (2001); Prowler (2008); Solomon (2008); Wilkinson et al. (2009)

4.3.3 LOOSE FIT (FUNCTIONAL)

The design criteria that promote a building's function comprise flexibility, disassembly, spatial flow, convertibility, atria, structural grid and service ducts. Many of the authors interviewed confirm that flexibility is needed for a building to be adaptively reused; followed by the propensity for buildings to be deconstructed, demountable or divisible, exhibit open flow and modularity. Whimster (2008) identifies that 19th Century buildings commonly featured open areas, while structural grid and service ducts and corridors are factors that provide ease in the refurbishment and adaptation of buildings (see Table 4-3).

TABLE 4-3 LIST OF DESIGN CRITERIA (FUNCTIONAL CATEGORY)

Category	Criterion	Relevant Research Studies
Loose fit (Functional)	*Flexibility* - space capability to change according to newly required needs, plug and play elements, etc.	City of New York Department of Design and Construction (1999); Russell &Moffat (2001); Arge (2005); Graham (2005); Prowler (2008); Vakjli-Ardebili (2007); Douglas (2006); Horvath (2010); Langston et al. (2008); Milne in UNEP (2007); Habraken (1998); Grammenos& Russell (1997); Carter & Fortune (2008); Wilkinson et al. (2009); Tobias &Vavatrous (2009); Nakib (2010); Zeiler&Quanjel (2010); Caroon (2010); Lehmann (2010); Remøy (2009)
	Disassembly - options for reuse, recycle, demountable systems, deconstruction, modularity, etc.	City of New York Department of Design and Construction (1999); Russell &Moffat (2001); Graham (2005); Vakili-Ardebili (2007); Queensland Government (2000); Prowler (2008); Rabun& Kelso (2009); Tobias &Vavatrous (2009); Nakib (2010); Prowler (2008); Caroon (2010); Ness & Atkinson (2001)
	Spatial flow - mobility, open plan, fluid and continuous	Davison et.al. (2006); Zeiler et al. (2010); Horvath (2010); Nakib (2010)
	Convertibility - divisibility, elasticity, multi-functionality	Russell &Moffat (2001); Blakstad in Nakib (2010); Arge (2005); City of New York Department of Design and Construction (1999)
	Atria - open areas, interior gardens, etc.	Whimster (2008)
	Structural grid - ideal and economical limit of span and fully interchangeable	Grammenos& Russell (1997); Russell &Moffat (2001); Arge (2005); Rabun& Kelso (2009); Remøy (2009)
	Service ducts and corridors - vertical circulation, service elements, raised floors, etc.	City of New York Department of Design and Construction (1999); Grammenos& Russell (1997); Davison et al. (2006); Russell &Moffat (2001); Prowler (2008); Rabun& Kelso (2009); Gilder (2010)

4.3.4 LOW ENERGY (TECHNOLOGICAL)

All sustainable design criteria essential to building technology are identified, such as orientation, glazing, insulation and shading, natural lighting, natural ventilation, building management systems and solar access(see Table 4-4).

TABLE 4-4 LIST OF DESIGN CRITERIA (TECHNOLOGICAL CATEGORY)

Category	Criterion	Relevant Research Studies
Low energy (Techno-logical)	*Orientation* - micro-climate siting, prevailing winds, sunlight	Prowler (2008); Douglas (2006); GBCA (2010); Park (1998); UNEP (2007); Dittmark (2008); Shaw et al. (2007); Carter & Fortune (2008); Knaack& Klein (2009); Appleby (2011)
	Glazing - sunlight glare control, regulation of internal temperatures, etc.	City of New York Department of Design and Construction (1999); Douglas (2006); GBCA (2010); Appleby (2011)
	Insulation and shading - thermal mass, sunshades, automated blinds, etc.	Osbourne (1985); Douglas (2006); UNEP (2007); Levine et al. (2007); Prowler (2008); GBCA (2010); Holborrow (2008); Knaack& Klein (2009); Carter & Fortune (2008); Wilkinson et al. (2009); Tobias &Vavatrous (2009); Lehmann (2010); Farrel (2010); Appleby (2011)
	Natural lighting - inclusion for natural daylight, efficient lighting systems, et cetera	Osbourne (1985); City of New York Department of Design and Construction (1999); Queensland Government (2000); Douglas (2006); GBCA (2010); Park (1998); Holborrow (2008); Shaw et al. (2007); Davison et al. (2006); Levine et al. (2007); Tobias &Vavatrous (2009); Caroon (2010); Appleby (2011)
	Natural ventilation - optimise airflow, quality fresh air, increase ambient air intake, etc.	City of New York Department of Design and Construction (1999); Queensland Government (2000); Ness & Atkinson (2001); Wilson & Ward (2009); Osbourne (1985); Douglas (2006); GBCA (2010); Park (1998); Prowler (2008); Holborrow (2008); Shaw et al. (2007); Tobias &Vavatrous (2009); Horvath (2010); Caroon (2010); Appleby (2011)
	Building management systems - monitor and control building operations and performance systems	Grammenos& Russell (1997); City of New York Department of Design and Construction (1999); Russell &Moffat (2001); Levine et al. (2007); Prowler (2008); Tobias &Vavatrous (2009); GBCA (2010); Langston and Shen (2007); Gilder (2010); Caroon (2010)
	Solar access - measures for summer and winter sun	City of New York Department of Design and Construction (1999); Wilson & Ward (2009); Douglas (2006); GBCA (2010); Park (1998); Dittmark (2008); Shaw et al. (2007); Appleby (2011)

4.3.5 SENSE OF PLACE (SOCIAL)

Image/identity, aesthetics, landscape/townscape as well as history/authenticity, amenity, human scale and neighbourhood are the design criteria identified that support the sense of place or social aspects of buildings. Social attributes and values coupled with beauty, proportion and timelessness, original fabric and the visual coherence and organisation of the built environment enhances the socio-cultural attributes of the building as a whole (see Table 4-5).

TABLE 4-5 LIST OF DESIGN CRITERIA (SOCIAL CATEGORY)

Category	Criterion	Relevant Research Studies
Sense of place (Social)	*Image/identity* - social and cultural attributes, values, etc.	NSW Department of Planning& RAIA (2008); Bond & Charlemagne (2009); DEH (2004); Curry (1995); Harmon et al. (2006); ICOMOS (1994); Jokilehto (1996); Marquis-Kyle & Walker (1994); UNESCO (2007 and 2009); Fournier &Zimnicki (2004); Orbasli (2008); Rodwell (2007); Wittkower (1988); Bond & Charlemagne (2009); Yung & Chan (2012)
	Aesthetics - architectural beauty, good appearance, proportion, etc.	ICOMOS (1994); Prowler (2008); Farrel (2010); GBCA (2010); Bond & Charlemagne (2009); Yung & Chan (2012); Carter & Fortune (2008)
	Landscape/townscape - visual coherence and organisation of the built environment	Davison et al. (2006); NSW Department of Planning& RAIA (2008); Fournier &Zimnicki (2004); Zushi (2005); Shaw et al. (2007)
	History/authenticity - original fabric, timelessness, socio-cultural traditions, practices, historic character or fabric, etc.	Prowler (2008); NSW Department of Planning & RAIA (2008); Bond & Charlemagne (2009); DEH (2004); Curry (1995); Harmon et al. (2006); ICOMOS (1994); Jokilehto (1996); Marquis-Kyle & Walker (1994); UNESCO (2007 and 2009); Fournier &Zimnicki (2004); Orbasli (2008); Wilkinson et al. (2009); Bond & Charlemagne (2009); Yung & Chan (2012)
	Amenity - provides comfort and convenience, facilities	Browne (2006); Zushi (2005); Fealy (2006); Graham (2005); Peiser& Schmitz (2007); Prowler (2008)
	Human scale - anthropometrics and fit to average human scale	Campbell (1996); Grammenos& Russell (1997); Russell &Moffat (2001)
	Neighbourhood - local and social communities	HMSO (1987); DEH (2004); Browne (2006); Carter & Fortune (2008); Prowler (2008); Yung & Chan (2012)

4.3.6 Quality Standard (Legal)

The design criteria identified under the quality standard theme are standard of finish, fire protection, indoor environmental quality, occupational health and safety, security, comfort, disability access, energy rating and acoustics. These criteria are based on the building codes, compliance and regulations stipulated by the governing body to ensure the building's total performance (see Table 4-6).

Table 4-6 List of Design Criteria (Legal Category)

Category	Criterion	Relevant Research Studies
Quality standard (Legal)	*Standard of finish* - provision for high-standard workmanship	Holborrow (2008); Park (1998); Osbourne (1985); Whimster (2008)
	Fire protection - provisions for fire safety	City of New York Department of Design and Construction (1999); Queensland Government (2000); Davison et al. (2006); NSW Department of Planning& RAIA (2008); Douglas (2006); Solomon (2008); Horvath (2010)
	Indoor environmental quality - provisions for non-hazardous materials, natural fabrics, etc.	Prowler (2008); City of New York Department of Design and Construction (1999); GBCA (2010); Rabun& Kelso (2009); Tobias &Vavatrous (2009); Graham (2005); Caroon (2010)
	Occupational health and safety - special needs of occupants, health and safety risks, building hazard and risk management plan	Prowler (2008); NSW Department of Planning & RAIA (2008); Queensland Government (2000); City of New York Department of Design and Construction (1999); Douglas (2006); Levine et al. (2007); Carter & Fortune (2008); GBCA (2010); Horvath (2010); Caroon (2010)
	Security - provision of direct and passive surveillance designs	Prowler (2008); NSW Department of Planning& RAIA (2008); Osbourne (1985); Douglas (2006); Solomon (2008); Carter & Fortune (2008)
	Comfort - hygiene and clean environment, et cetera	Prowler (2008); Osbourne (1985); Gilder (2010); Levine et al. (2007)
	Disability access - provision for disability easement, facilities, etc.	Queensland Government (2000); NSW Department of Planning& RAIA (2008); Douglas (2006); Prowler (2008)
	Energy rating - environmental performance measures	NSW Department of Planning & RAIA (2008); Douglas (2006); Tobias &Vavatrous (2009); GBCA (2010); Yudelson (2010); Reed et al. (2009); Atkinson et al. (2009); Schultmann et al. (2009); Appleby (2011)
	Acoustics - noise control, sound insulation, etc.	Osbourne (1985); City of New York Department of Design and Construction (1999); Douglas (2006); Davison et al. (2006); Levine et al. (2007); ULI (2009); Wilkinson et al. (2009); Caroon (2010); Appleby (2011)

4.3.7 CONTEXT (POLITICAL)

The design criteria that are included in the context theme (political category) are adjacent buildings, ecological footprint, conservation, community interest/participation, urban masterplan, zoning and ownership, and are often opportunities for designers in an adaptation process (see Table 4-7).

TABLE 4-7 LIST OF DESIGN CRITERIA (POLITICAL CATEGORY)

Category	Criterion	Relevant Research Studies
Context (Political)	*Adjacent buildings* - adjacent enclosures, vertical and visual obstacles	Davison et al. (2006)
	Ecological footprint - appropriate measure of human carrying capacity	Cantell (2005); Tobias &Vavatrous (2009); UNEP (2007); Langston & Shen (2007); Giles (2005); Gilder (2010); Balaras et al. (2004); Prowler (2008)
	Conservation - principles, guidelines, charters governing tangible and intangible heritage protection	Curry (1995); Harmon et al. (2006); ICOMOS (1994); Jokilehto (1996); Marquis-Kyle & Walker (1994); UNESCO (2007 and 2009); Fournier &Zimnicki (2004); Prowler (2008); Yung & Chan (2012)
	Community interest/participation - stakeholder relationship and support	Langston et al. (2008); HMSO (1987); Browne (2006); Peiser& Schmitz (2007); Prowler (2008)
	Urban masterplan - integrated skyline, urban landscape, built environment design and management/practice	Wilson & Ward (2009); Douglas (2006); Heath (2001); Peiser& Schmitz (2007)
	Zoning - land uses and land patterns	City of New York Department of Design and Construction (1999); Wilson & Ward (2009); Douglas (2006); Campbell (1996); Browne (2006); Peiser& Schmitz (2007); Wilkinson et al. (2009)
	Ownership - collaborative commitment, sense of community or ownership, etc.	HMSO (1987); Whimster (2008); Peiser& Schmitz (2007)

4.4 THE AWARD-WINNING AUSTRALIAN CASE STUDIES

The adaptive reuse case studies in this research are real-life Australian projects and demonstrate the successful blending of modern technology and design with respect to the building's historic character. They are award-winning projects as showcased in NSW Department of Planning & RAIA (2008), selected from over 20,000 heritage-listed buildings in NSW because they represent different types of use and illustrate how the adaptation guidelines work in practice. Information on the case studies are drawn from experts' in-depth interviews, experts' personal collections and other supporting literature reviews (e.g. Archer, 2002; NSW Department of Planning & RAIA, 2008; Australian Heritage Database, 2011). Further information on the case studies can be found in Appendix B.

4.4.1 EGAN STREET APARTMENTS

A small industrial warehouse was adapted to create three affordable contemporary apartments and a studio office space for a collective of architects, while still retaining its heritage significance of the place (see Figure 4-1).

FIGURE 4-5 EGAN STREET APARTMENTS
Source: NSW Department of Planning & RAIA (2008)

Located in the O'Connell Town Estate Conservation Area, it is an example of a 1920s light industrial development and makes a positive aesthetic contribution to the streetscape. The project won the 2006 NSW Royal Australian Institute of

Architects ESD/Energy Efficiency Award, the Multiple Housing Award, the President's Award and the 2006 National Trust Adaptive Reuse Award.

4.4.2 GRAND BABWORTH HOUSE

The grand 93-room Sydney mansion Babworth House was adapted to five apartments and ten new houses were constructed within its grounds. The house and its garden setting are listed on the State Heritage Register. Designed in the Federation Arts and Crafts style, the house displays an eclectic mix of Classical Revival, Arts and Crafts and Art Nouveau styles. Magnificent oak-panelled walls, decorative plasterwork and an imposing timber stairway characterise the interior. The Babworth House adaptation was the recipient of the Woollahra Conservation Award in 2004 and was short-listed for the RAIA and National Trust 2004 awards.

FIGURE 4-6 GRAND BABWORTH HOUSE
Source: Key expert's photo collections; NSW Department of Planning & RAIA (2008)

4.4.3 TOCAL VISITOR CENTRE

The Tocal Visitor Centre was adapted from an early 20th-century hayshed within the State Heritage-listed Tocal Homestead precinct. It still maintains the appearance and feel of an Australian rural shed. The adaptation contains a multi-purpose visitor centre for both Tocal Homestead and Tocal Agricultural College. It is capable of seating 100 guests, has a 60-seat theatrette, exhibition areas, and provides modern and comfortable amenities for visitors. The converted shed won the 2007 Ten Carat Award for Best Wedding Reception– Hunter Valley.

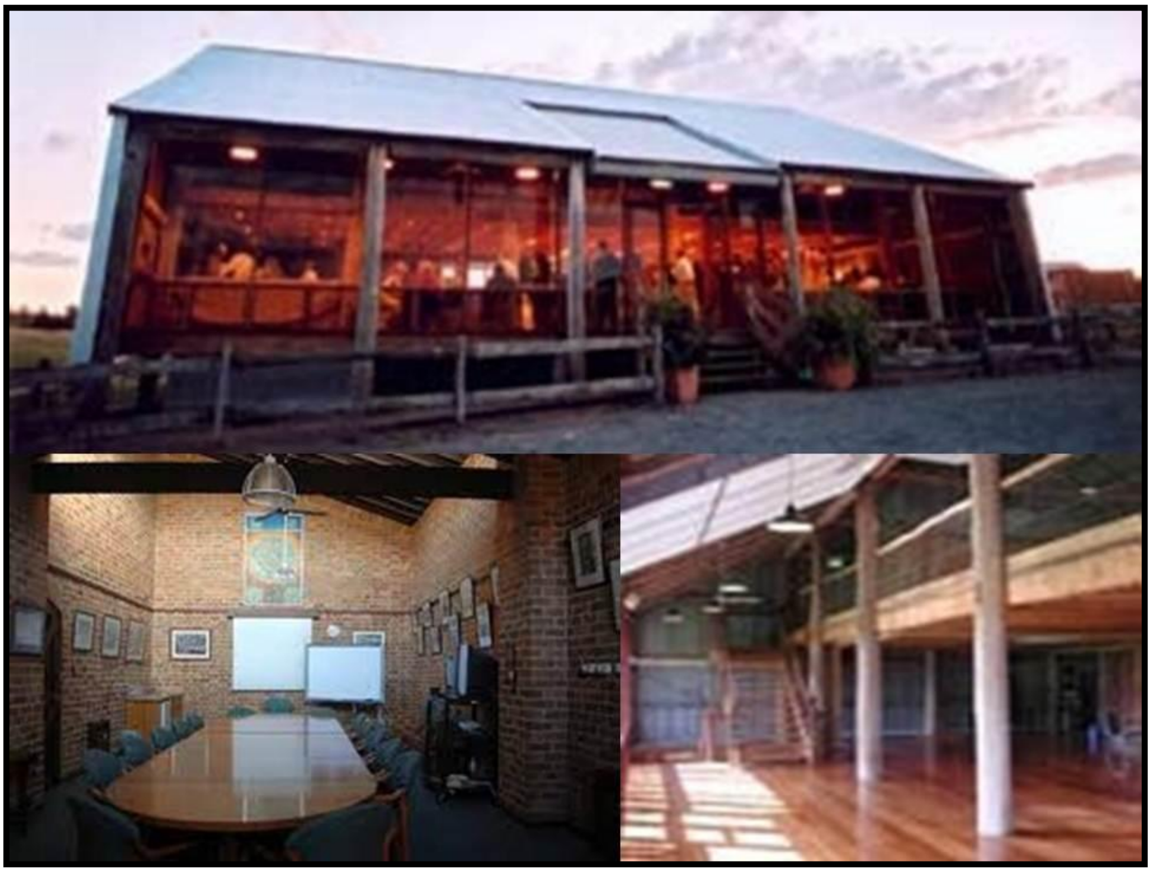


FIGURE 4-7 TOCAL VISITOR CENTRE
Source: Key expert's photo collections; NSW Department of Planning & RAIA(2008)

4.4.4 TOXTETH CHURCH AND HALL

A former church and church hall were adapted as two residences. The principal elevations, roofs and overall forms of the buildings were retained and conserved. The church and hall are located in the Toxteth Estate conservation area. The streetscape of predominantly Victorian houses has a mixed residential character, with single and two-storey terraces and some single dwellings. The conversion was a finalist for the Greenway Award in the 2007 RAIA NSW Chapter Awards.

FIGURE 4-8 TOXTETH CHURCH AND HALL
Source: Real Estate Website; NSW Department of Planning & RAIA(2008)

4.4.5 BUSHELLS BUILDING

This former factory building was adapted to modern offices in a way that preserves the structural clarity of the warehouse spaces, conserves and incorporates a number of significant artefacts, and provides a rewarding and unique work environment. The Bushells Building is a landmark within the historic Rocks area of Sydney and is listed on the State Heritage Register. The building is important because of its industrial character and its historical association with the Bushells Company, once synonymous with Australia's cultural identity through prolific and successful marketing campaigns over the last century.

The project was awarded the Master Builders Association Excellence in Construction Merit Award for the Restoration or Renovation of an Historic Building and the UNESCO Award for conservation and adaptation in 2001 and was highly commended for both the Australian Property Institute Award for Best Development (heritage refurbishment) and the Property Council of Australia Rider Hunt Award for conservation and adaptation in 2002.

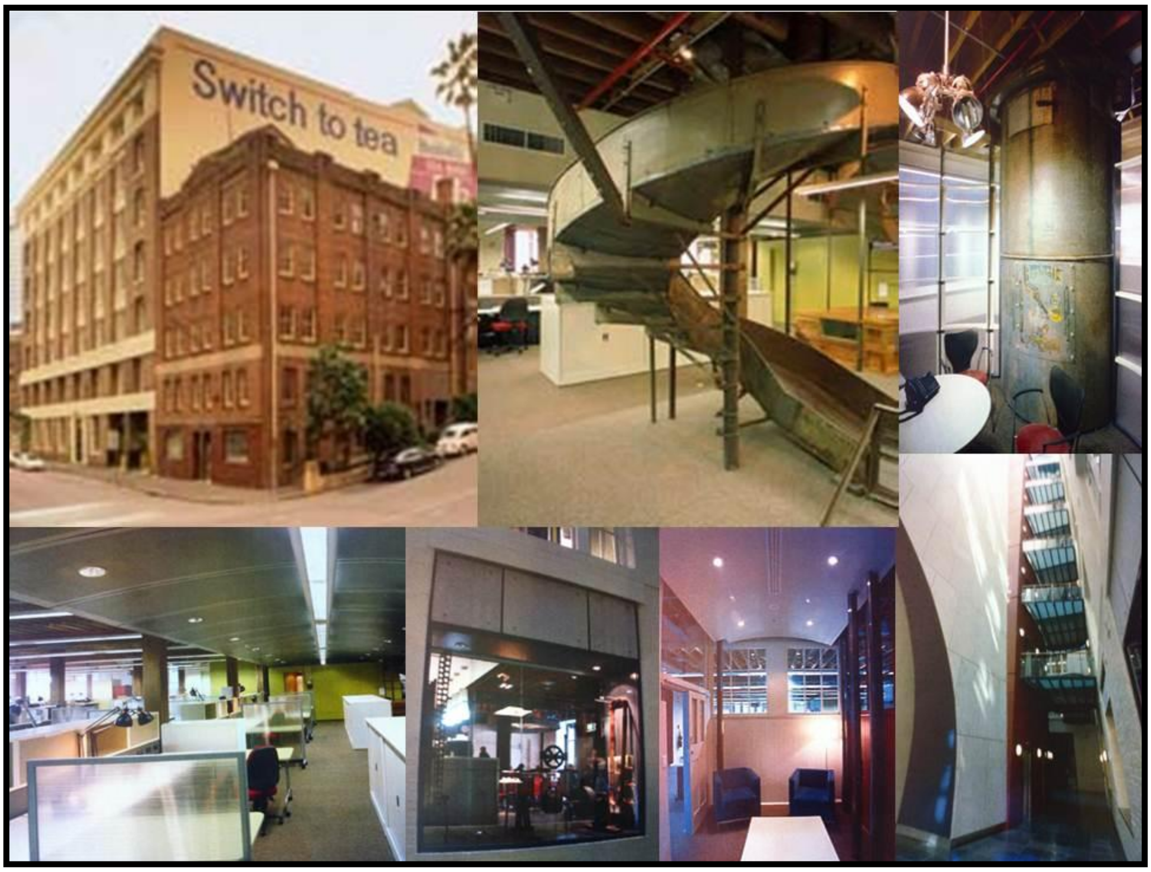


FIGURE 4-9 BUSHELLS BUILDING
Source: Key expert's photo collections; NSW Department of Planning & RAIA (2008)

4.4.6 DEFENCE BUILDINGS

A group of former WWI hospital buildings was adapted by the Sydney Harbour Federation Trust as part of an overall plan for a headland park development extending from Rawson Oval to Middle Head. Three former hospital buildings were converted into a linked office space and headquarters for the Sydney Harbour Federation Trust. These buildings are on the Commonwealth Heritage List. They sit on a prominent knoll on the ridgeline, with excellent views to the east across Sydney Harbour. Two of the buildings were part of a 1915 Army Auxiliary hospital and are considered unique. All three buildings had been converted to other uses by the Army.

FIGURE 4-10 DEFENCE BUILDINGS
Source: Key expert's photo collections; NSW Department of Planning & RAIA(2008)

4.4.7 SULLY'S EMPORIUM

The Broken Hill Regional Art Gallery was adapted from a nearly ruined former mining hardware building in the main street of Broken Hill. The building now exhibits the extraordinary art of the Broken Hill region, including contemporary art and the local council collection, which dates from the council's establishment in 1886. Interpretative design was used to tell the history of the building and the story of the development of Sully's Emporium as an important mining enterprise. It has become a unique visitor experience, enhancing Broken Hill's appeal as a tourist destination. Sully's Emporium is located within the Argent Street Conservation Area and is on the State Heritage Register. This conversion won the Australian Property Institute Savills Heritage Award and the Corporate/Government category of the Energy Australia, National Trust of Australia (NSW) Heritage Conservation Award in the Built Heritage for projects over $500,000 category in 2005.

FIGURE 4-11 SULLY'S EMPORIUM
Source: Public Website; NSW Department of Planning & RAIA(2008)

4.4.8 THE MINT COINING FACTORY

The surviving structures of the sandstone Coining Factory buildings of the Royal Mint, Sydney (1855-1926) were adapted for use as the new head office of the Historic Houses Trust (HHT). There are two structures on the Mint site: the Mint offices on Macquarie Street (originally the south wing of Governor Macquarie's General or 'Rum' Hospital, constructed between 1811 and 1816) and behind this, the Coining Factory (constructed in 1854 for the Royal Mint). Located in the most important civic precinct of Sydney, these buildings have a remarkable history of use and adaptation over nearly 200 years. The Mint project received both the Royal Australian Institute of Architecture's Sulman Award and the Greenway Award in 2004. At the time the judges commented that the whole ensemble is given cohesion through carefully modulated scale and proportion, juxtapositions of materials, light and shade, old and new, inside and out. A 19th Century walled factory has been transformed into a 21st Century campus.

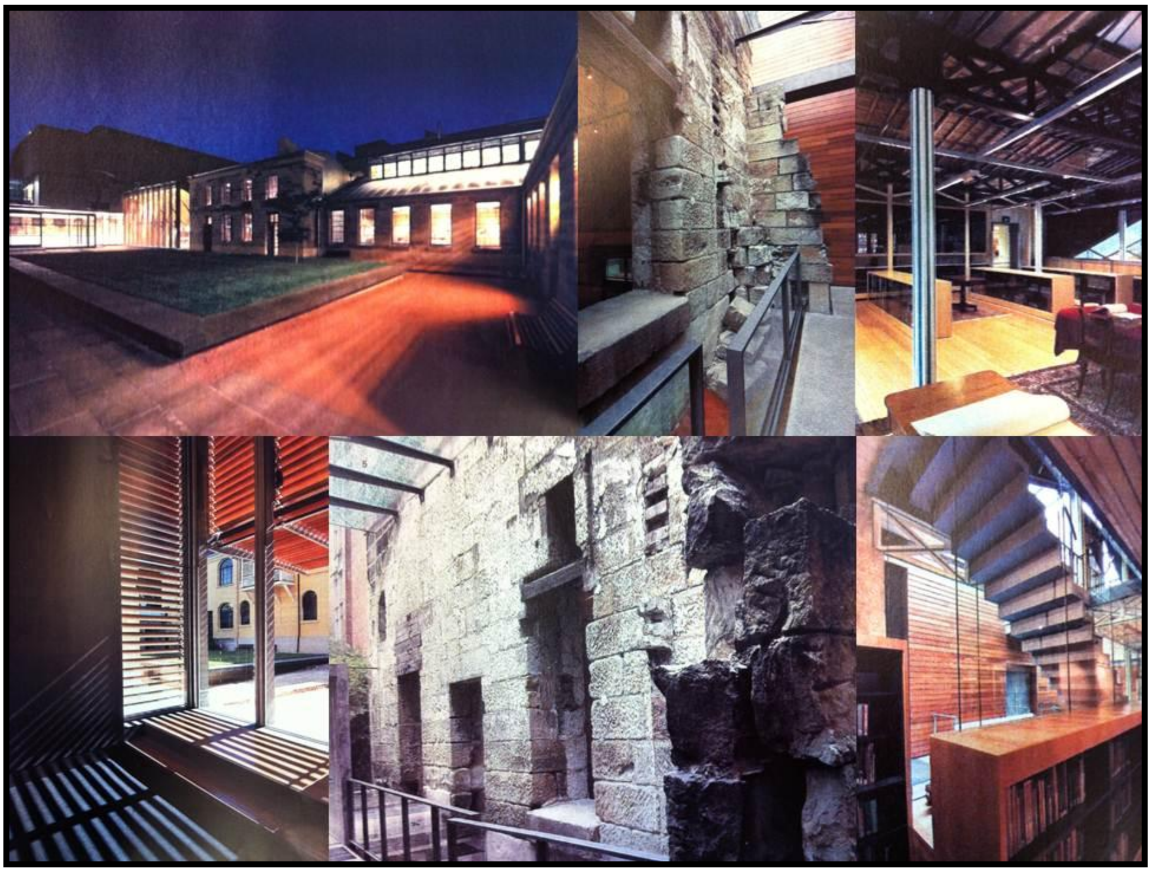


FIGURE 4-12 THE MINT COINING FACTORY
Source: Key expert's photo collections; NSW Department of Planning & RAIA(2008)

4.4.9 FORUM WELLNESS CENTRE

A historic railway workshop building was adapted for the Forum Health and Wellness Centre, owned by University of Newcastle Sport. The building known as Civic Railway Workshop Block A (the former Permanent Way Store or Perway

Building) is on the State Heritage Register. It is located between Workshop Place and Harbour Square at Harbourside in Newcastle. It appears as a combination of heritage railway and contemporary buildings within the Honeysuckle urban regeneration area's contemporary streetscape. The project won the Babic Construction Heritage Award and the Andrews Neil People's Choice Award in the 2007 RAIA Lower Hunter Urban Design Awards.

FIGURE 4-13 FORUM WELLNESS CENTRE
Source: Public Website; NSW Department of Planning & RAIA(2008)

4.4.10 GEORGE PATTERSON WAREHOUSE

Two buildings that were substantially damaged by two simultaneous fires on 2 January 1996 have been retained, conserved and adapted for a hospitality venue, including a boutique hotel, in the CBD. The building was adapted to accommodate a series of bars and function spaces accessible from George Street, a boutique hotel in the former warehouse section off Tank Stream Way, and a nightclub in the lower ground and basement levels. The building was designed in the Queen Anne Revival style and built between 1892-1895 for Holdsworth MacPherson & Co. hardware merchants and ironmongers, as a conjoined showroom and warehouse with a water tower at the junction. To quote the Australian Heritage Database (2011), "this seven-storey building is a good example of a Victorian Free classical style design, containing some notable interiors of the period and is rare for the time in displaying Australian National symbols in three dimensional forms … the façade of brick and render is essentially in the Baroque manner with unusual attention to the side elevations which have arched bays and pilasters." It was the home of The Bulletin newspaper for thirty (30) years since 1931. At the time of its construction it was considered the grandest emporium of its period. The project won an Interior Architecture Award in the 2001 RAIA NSW Chapter Awards.

FIGURE 4-14 GEORGE PATTERSON WAREHOUSE
Source: Key expert's photo collections; NSW Department of Planning & RAIA(2008)

4.4.11 PRINCE HENRY HOSPITAL

The Prince Henry redevelopment project contributes to a sustainable future by providing a model for redevelopment of similar heritage and environmentally sensitive areas in Australia. The Prince Henry site had been used by Aborigines for thousands of years before becoming a hospital site for the quarantine of infectious diseases. The revitalisation of the site balances old and new developments while keeping 80 per cent of the site in public ownership. Over 90 per cent of the demolition materials were reused and these buildings comply with energy-efficiency principles, while the whole redevelopment is based on environmentally sustainable design principles. ThePrince Henry redevelopment won the President's Award from the Urban Development Institute of Australia in 2009, which was the highest accolade possible within the UDIA awards program both state-wide and nationally.

FIGURE 4-15 PRINCE HENRY HOSPITAL
Source: Key expert's photo collections; NSW Department of Planning & RAIA(2008)

4.5 IN-DEPTH INTERVIEWS OF CASE STUDY EXPERTS

The fifteen key stakeholders with expert case study knowledge, including the architectural team, project manager, structural engineer, services engineer, quantity surveyor and project director, are interviewed to solicit their views on key design criteria derived from an analysis of their projects and underpinning literature. A purposeful sampling approach is used since the experts selected are able to provide the most valuable information about the topic under investigation and are deemed to be most likely to help in determining the list of potential design criteria. Details of the experts are outlined in Table 4-8.

TABLE 4-8 THE FIFTEEN (15) EXPERTS INVOLVED IN THE SELECTED CASE STUDIES

Project Name and Location	Key Experts Involved (n=15)
Units at Egan Street, Newtown	1 principal architect
Babworth House, Darling Point	1 principal architect
Tocal Visitor Centre, Tocal	1 principal architect
Toxteth Church and Hall, Glebe	(Expert was not available for interview)
Bushells Building, The Rocks	1 principal architect
Sydney Harbour Federation Trust Offices, Georges Heights	1 principal architect 2 project directors
Sully's Emporium, Broken Hill	(Expert was not available for interview)
The Mint, Macquarie St., Sydney	1 heritage architect consultant
Forum Health and Wellness Centre, Newcastle	1 structural engineer consultant 1 quantity surveyor
George Patterson House, Sydney	1 principal architect
Prince Henry, Little Bay	1 project development manager 1 project manager 1 project architect
GPO Building, Melbourne (pilot study)	1 principal architect

These experts aside from being commissioned to undertake various adaptive reuse projects are very much involved in large scale new development projects. Most of them started not as specialist but they have learnt through the demanding process of adaptively reusing heritage buildings. They were sensitive to the existing building's inherent characters and were able to deal with them without knowing that the interventions that they have made to these heritage buildings became the exemplar for the adaptation guidelines developed by the Heritage Council of NSW

(NSW Department of Planning & RAIA, 2008). Their experiences while undertaking the case study projects were discussed the subsequent sub-sections below.

With help of the pilot study, the questionnaire and list of identified criteria are shown to be feasible. Thus, the identified list of design criteria that guided the in-depth interview is presented in Tables 4-9 to 4-15, showing the number of respondents' agreements to the different design criteria and how they were able to conceive the design criteria based on their experiences in undertaking the case study projects.

The interviews are transcribed and then coded using *NVivo* (see sample coding in Appendix C). Based on the results from the in-depth experts' interviews, a consensus of the experts' opinions is obtained and the list of identified design criteria is confirmed. Although the purpose of the Stage 1 methodology was to gather the list of potential design criteria before they are weighted in Stage 2, it was worthwhile to examine how the experts are able to arrive at this confirmation based on their experience as it allows an understanding of the experts' perception of the importance of each different design criterion. No criteria were eliminated during this process (i.e. all were considered relevant).

4.5.1 LONG LIFE (PHYSICAL)

As shown in Table 4-9, 53 per cent of the experts agree with the structural integrity and material durability design criteria while the workmanship and foundation design criteria received agreement from 46 per cent of the experts. Further, 33 per cent of them agree with the maintainability design criterion while the design complexity received 26 per cent of the experts' agreements. The lowest design criterion in this category is the prevailing climate with 13 per cent of the experts' agreements. This shows that the structural integrity, material durability, workmanship and foundation design criteria were considered most essential in designing buildings. Likewise, the material durability of a building is supported when high standard materials are utilised with quality craftsmanship.

TABLE 4-9 LONG LIFE DESIGN CRITERIA WITH EXPERTS' INTERVIEW RESULTS

Category	Criterion	Experts (n=15)
Long life (Physical)	*Structural integrity* – structural design of the building caters for future uses and loads	**8**
	Material durability - durability of the building asset	**8**
	Workmanship - quality of craftsmanship of structure and finishes	**7**
	Foundation - differential settlement and substrata movement	**7**
	Maintainability - building's capability to conserve operational resources	**5**
	Design complexity - various geometries associated with the building's design and innovation	**4**
	Prevailing climate - changing climatic conditions	**2**

Based on the experts' interviews, their support for the physical category was evident in their adaptive reuse case study projects. In terms of the structural integrity criterion, Expert 8 points out that "old buildings were built solidly so you've got a robust architecture that I think that could be an inspiration for new buildings". Expert 12 agrees, noting that in their project the "original fabric is relatively sound". Expert 4 also states that in their project the "base structure storey was enough to carry load of the additional extra floors", while Expert 14 suggests that "providing extra building capacity for consideration of the future services of the building" is necessary. This is also confirmed by Expert 15, who argues that for a "structurally sound project, an extra capacity for columns and foundation for future proofing of buildings to increase future uses [is required]".

With regards to material durability, Expert 1 says, "it's about the quality of materials used that will last. For example, the thing with this building is that the side walls were triple brick, built a hundred years ago and even if it's lime and mortar they are in good condition". Expert 15 stresses that development teams should "choose materials that last" while Expert 7 comments that in his experience with old buildings, the "materials had been there for a hundred years or more" and were still functioning and lasting.

As for foundation considerations, Expert 1 reports that when designing buildings "it's about minimising waste and maximising the longevity of the building. To me, building for longevity and building with quality is a big one, it is using sensible materials and [ensuring] that the foundations work damn well". Moreover, Expert 12 adds that "ground stability" is another long life design consideration.

While in terms of maintainability, two experts show their views on life cycle costing of buildings. Expert 9 comments that "builders/developers [place] more focus on the construction cost and not on the life cycle cost; more on the construction cost and not how a building has to operate in the future". Expert 1 agrees that in long life design consideration, the use of "sensible materials and getting back on the assessment of full life cycle costing as well as less maintenance" is a must.

Even though, design complexity gained the lowest percentage of experts' agreement, it is worth mentioning the experts' insights on this design criterion in terms of the challenges they've encountered while undertaking their adaptive reuse project. Expert 1 needed to get a head height for a good floor space ratio and solved the problem by "floating the floor above to be able to get the slope we wanted, which is six millimetres higher, to give us our head height for the upper floor". Expert 5 had to find a way to solve the problem of uneven floors and find a way to incorporate the redesigned building with other buildings, so installed glass floor bridges. He also illustrates that "with the new lobby, we wanted to make a statement so we got the lifts and this glass floor bridges going across to meet the old buildings… by putting a false floor we get [uneven floors] to be even".

4.5.2 LOCATION (ECONOMIC)

The location design criteria have the lowest agreements from the fifteen experts (see Table 4-10). 26 per cent of the experts agreed with the planning constraint design criterion while 20 per cent of the experts agree with market proximity and transport infrastructure design criteria.

TABLE 4-10 LOCATION DESIGN CRITERIA WITH EXPERTS' INTERVIEW RESULTS

Category	Criterion	Experts (n=15)
Location (Economic)	*Planning constraints* - site selection, planning, neighbourhood and building design, etc.	**4**
	Market proximity - distance to major city, the CBD, etc.	**3**
	Transport infrastructure - availability and access	**3**
	Population density–geographic location within major city, the CBD, etc.	**2**
	Site access - proximity or link to access roads, parking and communal facilities, etc.	**2**
	Exposure - views, privacy	**2**
	Plot size - built area, spatial proportions, enclosure, etc.	**2**

Some experts encountered challenges with planning constraints. Expert 1 explains that they were "designing for a good floor space ratio so we could go above Council's control" and Expert 2 states that they had to keep "the external integrity of the house as intact as possible".

In terms of market proximity and transport infrastructure, some of the case studies are located in the CBD or near the city centre and the experts agree that accessibility and proximity to traffic generators are factors that need to be considered when designing buildings. The design criteria on population density, site access, plot size and exposure garnered13 per cent of expert agreements.

Although these criteria got low scores, the experts who agreed to its importance illustrates positive quotes, meaning their value is not that less significant to the other criteria but may be just less tangible compared to the other criteria.

4.5.3 LOOSE FIT (FUNCTIONAL)

In Table 4-11, the flexibility design criteria received 80per cent of experts' agreement. Expert 1 mentions that "good design is something, as you say everything, and it designs for the future", while Expert 8 comments that "old buildings have a loose fit" and Expert 9 asserts that it is "most important to design your buildings with maximum flexibility and to take advantage of the ability to convert the building into different uses".

TABLE 4-11 LOOSE FIT DESIGN CRITERIA WITH EXPERTS' INTERVIEW RESULTS

Category	Criterion	Experts (n=15)
Loose fit (Functional)	*Flexibility* - space capability to change according to newly required needs, plug and play elements, etc.	**12**
	Service ducts and corridors - vertical circulation, service elements, raised floors, etc.	**11**
	Spatial flow - mobility, open plan, fluid and continuous	**5**
	Convertibility - divisibility, elasticity, multi-functionality	**5**
	Atria - open areas, interior gardens, etc.	**5**
	Structural grid - ideal and economical limit of span and fully interchangeable	**5**
	Disassembly - options for reuse, recycle, demountable systems, modularity, etc.	**4**

Expert 5 emphasises that there is the "challenge of keeping the building as flexible as possible so not being designed at the moment for a particular tenant but in a way that it can be adapted for another tenant in the future without having to rework the whole building".

As for the service ducts and corridors design criterion which received 73 per cent of the experts' agreement. Expert 2 remarks that in their experience "we do have to create some service ducts to be able to take to new bathroom and kitchen ... the ducts were placed in a discreet way out of the building". Expert 5 relates that in their project they "have to be clever where to put services and sometimes you can get power under the floor". Expert 8 notes that old buildings have ready-made duct spaces such as "fireplaces can be used for modern services and they even put the air-conditioning into the chimneys". Expert 14 explains that the "opportunity to provide access to replace mechanical features, hydraulics, buildings extra capacity must be considered for future servicing and insulation".

33 per cent of the experts agree with the spatial flow, convertibility, atria and structural grid design criteria. With regards to spatial flow and convertibility, Expert 1 notes that "there's always the challenge of such a tight space planning, you've got to minimise or completely exclude circulation space". Expert 6 explains that in their project "walls were taken off to have an open plan", and Expert 13 affirms that in designing buildings it is good to provide an "open design" concept. Expert 15 observes that "column-free spaces are important", while Expert 8 says

that "old buildings can be reused for all sorts of different purposes because they have that ability to accommodate many different uses because the spaces that they provide tend to be more generous in terms of their ceiling height, spaces that the rooms that they created, they tend to be in sensible size and sensible shape".

Regarding the structural grid design criterion, Expert 15 stated that "making adaptable, modular construction/grids for less wastage" matters. Expert 14 remarks that "designing an area against a regular grid, the column and where you can remove the fabric without affecting the other structure" are other design considerations. Expert 1 share his project experience that "we divided the buildings along every second truss line of the building, since there was an existing grid that works very well when dividing the building into four apartments".

Moreover, most experts mention that atria are one of the common features of the buildings in their projects. This demonstrates that the atria design criterion was an important consideration. The experts shared their experiences of how they utilised this feature. Expert 1 explains that they have to create "a balance because the courtyard was the only external facade and they wanted to maximise that space". The atrium in the building project of Expert 10 was damaged in a fire, so he describes how he utilised that feature when the "courtyard was restored with a glass roof over it". Experts 4 and 6 note the importance of the atria to their projects, stating that in both buildings the atria were in central places: the "wings with courtyards link the buildings to form H-type buildings converted to small studio offices" and "the building was provided with a bar kitchen and lounge and courtyard, where people meet" respectively. Expert 8 also comments that "the courtyard was quite a symmetrical design - you have the central court in here, you have two identical wings and two identical wings there".

The design criterion with the lowest agreements was disassembly which received only 26 per cent of the experts' agreements. The experts promote designing buildings for deconstruction because they are easier to disassemble and reuse the materials. Expert 1 notes that "the materials we've reused are the fundamental quality elements of the original building, while a fair bit of exposed steel, recycled timbers and some really good iron bar flooring and structural timbers that we exposed" were used. Expert 2 says that they were "using the same materials and refurbishing the existing materials that were not damaged", while Expert 8 mentions that "they had a lot of timber available of very high quality which we don't have today, so you really want to sort of reuse it".

4.5.4 Low Energy (Technological)

As shown in Table 4-12, the fifteen experts agreed with each of the design criteria in this category, although less so with the Building Management System (BMS), which only received agreement from 20 per cent of the experts. This shows that the environmental aspects in design are evident in heritage buildings but application of BMS is not historically relevant.

Table 4-12 Low Energy Design Criteria with Experts' Interview Results

Category	Criterion	Experts (n=15)
Low energy (Techno-logical)	*Orientation* – micro-climate siting, prevailing winds, sunlight	**15**
	Glazing - sunlight glare control and regulation of internal temperatures, etc.	**15**
	Insulation and shading - thermal mass, sunshades, automated blinds, etc.	**15**
	Natural lighting - inclusion for natural daylight, efficient lighting systems, etc.	**15**
	Natural ventilation - optimise airflow, quality fresh air, increase ambient air intake, etc.	**15**
	Solar access - measures for summer and winter sun	**15**
	Building management systems - monitor and control building operations and performance systems	**3**

Expert 1 agreed that this theme was about the "age-old practice of good siting, good orientation, good shading and good cross-ventilation, well-located thermal mass that admits winter sun and emits summer sun from the massive surface and also you need to consider the light and space of the building". This is supported by Expert 3, who states "it involves designing buildings to maximise their orientation". Expert 2 elaborates by adding that it is "where the sun is captured in the right way and the interior spaces are shielded from the hot west end sun and they had good cross ventilation". He also adds that their project "used all materials that were low embodied energy".

Additionally, Expert 8 illustrates that "the ratio of wall to window is an important factor in the way buildings were designed in the 19th Century and that old buildings had an inherent sustainability because they often have thick walls and thermal mass", which is supported by Expert 5 who states that "these buildings often have a very good thermal performance: slow to heat up, slow to get cold, and so they perform quite well".

The experts also recognised the importance of the glazing, shading and insulation criteria, as well as concurred that there is a need to consider light and space when designing buildings. Expert 1 remarks that in their project "those good overhangs give good protection in summer," while Expert 8 says that with their project, it was important the building should "have good shading since there's not too much glass-to-wall and, if you need additional shading, you can always put a veranda on or an awning over the window", adding that their project "had a clerestory with the top light window with ventilation". Expert 1 agrees that "things worked well with the great north light" orientation while Expert 4 states that "natural light and cross-ventilation is essential when designing buildings. He relates his experience with their project: "[we] have really good cross-ventilation; it was completely opened up and worked very efficiently as trap ventilation because of the void space … they actually have very good wind drawn through the building, through the skylights and through the roof plan". Expert 8 adds that "the old buildings have nice high ceilings so you have plenty of air; usually you don't need too much air conditioning". Additionally, Expert 1 expresses that "the core being in this field of good environmental design is that it's got to be passive solar design, it's the most powerful thing that you can do". However, Expert 5 explains that "it can be a challenge to introduce solar panels to historic buildings".

4.5.5 Sense of Place (Social)

Another category with relatively low agreements from the fifteen experts is the Sense of Place (Social) category, which include the image/identity, aesthetics and history/authenticity received only 26 per cent of the experts' agreements. Only 20 per cent of the experts agree with the design criteria on landscape/townscape. Further, the design criteria on amenity, human scale and neighbourhood received 13 per cent of the experts' agreement. This is shown in Table 4-13.

TABLE 4-13 SENSE OF PLACE DESIGN CRITERIA WITH EXPERTS' INTERVIEW RESULTS

Category	Criterion	Experts (n=15)
Sense of place (Social)	*Image/identity* - social and cultural attributes, values, etc.	**4**
	Aesthetics - architectural beauty, good appearance, proportion, etc.	**4**
	History/authenticity - original fabric, timelessness, socio-cultural traditions, practices, historic character or fabric, etc.	**4**
	Landscape/townscape - visual coherence and organisation of the built environment	**3**
	Amenity - provides comfort and convenience facilities	**2**
	Human scale - anthropometrics and fit to average human scale	**2**
	Neighbourhood - local and social communities	**2**

Regarding the landscape/townscape design criterion, Expert 11 relates that their "development concept was to create a park-like city environment while also retaining the existing bush reserve". Expert 2 remarks that their aim of the project was to "restore the gardens to their original glory as the gardens were when the house was used by the [the original owners of the property]".Expert 6 states that with their project, "the [case study project's] potential and compatible uses were determined to enhance its performance and reflect its former uses in terms of volume, open place and sense of space".

As for the image/identity, aesthetics and history/authenticity design criteria, most experts shared their interesting insights. Expert 2 comments that "there is a heritage integrity that must be respected and that is what must be embedded in the design … for example, the slates on the roof which originally came from Wales in the UK and we reroofed the house in the same way as the original house". Expert 6 relates the importance of taking into account the history of their building, describing that that even "its tank stream was used as an interpretative feature to tell the story of the previous use". Expert 11 likewise remarks that they have retained the "the nurses' chapel and the new houses to reflect the local environment". Expert 12 relates that in dealing with heritage buildings, there should be a "sensitivity and respect for heritage and that they don't want to lose the integrity of the original structure". Expert 1 states that when selecting projects for their case study, they "focus on buildings that had some sort of charms or redeeming features to work with".

This focus on retaining the integrity and charm of the original structure is demonstrated in statements from the experts. Expert 1 states that "we ended up coming up into a tight and a very refined building plan which has a residual aesthetic character worth in any heritage buildings and also the existing brick walls and the existing slabs that we left in place were satisfying elements of the building". Expert 5 notes that "we restored the facade to its original colour". Expert 12 relates that with their project there was the "retention of the winding stairs; retention of the old beam and exposing it as exhibit and other features for exhibits as well as the old signage/poster exhibits". Expert 9 points out that in terms of historicity, one can "retain the perimeter of the building so you don't destroy the existing structure; try to show what the existing building was like and conserve the most important feature of the existing building".

With regards to landscape/ townscape, amenity, human scale and neighbourhood, Expert 7 mentions that "a higher mixed-use density with good public amenities and design" as important factors to consider. Expert 2 says that "the buildings should look comfortable on their site and the whole thing that is important is how the building fits into its context or its landscape". Expert 1 states that "it was like a family environment: we could leave our doors open with a sense of security". Expert 11 states that the "diverse community with a mixture of apartment types, aged care, self-sustained museum and seven community groups integrated in the community encourages passive surveillance". Expert 10 shares his design philosophy: "designing environments for people that embraces public and social point of view and spaces. Expert 3 comments that buildings should be designed with the fundamental principles that are "suitable for potential uses, no barriers, access, stairs to get around, and seamless".

The experts also mentioned that when designing buildings, timelessness, universal design and socio-cultural aspects are considered. Expert 3 states that universal design is an important criterion in designing buildings. Expert 2 explains that "the most important criteria from a design point of view is that the buildings are designed with a certain flair, a quality that will be enduring and classed into the future as a good modern design which can be timeless". Expert 5 believes that all of these aspects are expressions of "emotional quality - that they're much loved by the people because the use of the building or because of the character of the building".

4.5.6 QUALITY STANDARD (LEGAL)

In Table 4-14, the indoor environmental quality design criterion received 73 per cent of the experts' agreement. The standard of finish design criterion received 60 per cent of the experts' agreement. In terms of ensuring indoor environmental quality, the experts were beset by challenges of onsite contamination and remediation cost, which led to delays in time and a high cost of implementation. Two experts encountered contamination problems when their projects were discovered to have asbestos wall cladding, with the worst situation occurring during construction when loose fibre asbestos in the ground was found to have been used to insulate hot water pipes in the ground. All hazardous materials had to be removed before the development of the site could proceed.

TABLE 4-14 QUALITY STANDARD DESIGN CRITERIA WITH EXPERTS' INTERVIEW RESULTS

Category	Criterion	Experts (n=15)
Quality standard (Legal)	*Indoor environmental quality* - provisions for non-hazardous materials, natural fabrics, etc.	**11**
	Standard of finish - provision for high-standard workmanship	**9**
	Acoustics - noise control, sound insulation, etc.	**8**
	Disability Access - provision for disability easement, facilities, etc.	**6**
	Fire protection - provisions for fire safety	**6**
	Energy rating - environmental performance measures	**3**
	Security - provision of direct and passive surveillance designs	**3**
	Comfort - hygiene and clean environment, etc.	**2**
	Occupational health and safety –accounts for special needs of occupants, health and safety risks, building hazard and risk management plan	**2**

As to the standard of finish, Expert 5 states that in their experience, old buildings are of "great quality, often have very fine materials and fine spatial qualities".

In refurbishing or adaptively reusing these buildings, Expert 6 confirms that in their project "the builders were highly skilled tradesmen and all consultants were experienced and specialists". Expert 3 suggests that in terms of finding local tradesmen for sustainability, there is a need "to maintain their skills for use in the adaptive reuse of historic buildings and later for maintenance of the buildings". Expert 9 says that before undertaking the project, they made sure that the "compliance of their project's design was in accordance to the Building Code of Australia". Expert 2 relates that in terms of project compliance, "much of the rest of the building, I have to say, was in such a good condition. The ceilings, the walls and the floors were only the new material introduced to make sure that modern codes and controls were adhered to".

53 per cent of the experts also agree with the acoustic design criterion, noting that sound-proofing problems in old buildings have to be addressed. For example, Expert 12 relates that after completing the case study project, they still cannot prevent the external sound from the surroundings go inside the mall.

40 per cent of the experts agree with the fire protection and disability access design criteria. Expert 5 reports their experiences with their project, stating that "the building wasn't fire-rated, being constructed in the 19th Century, so the council was required to upgrade the building in a way to make it safe for use by the public but also in a way which respects the heritage significance of the buildings". Expert 1 notes that while undertaking their case study project, there was conflict between the design process and the fire regulations, relating that "the thing that I think we could have improved was the common corridor, although this perhaps would be in some conflict with fire regulations," while Expert 14 explains that the "adaptive reuse of new buildings requires access to new service for disability".

Only 20 per cent of the experts agree with the security and energy rating design criteria. In terms of energy ratings, Expert 2 explains that "the principles are to design buildings that have a contemporary feel about them, that have a use of appropriate modern materials that are sustainable, sensitive to their future energy demands and true to ESD principles of design". Several of the experts note that the current methods available for analysing the green potential of existing buildings is insufficient as it fails to take into account the embedded energy and lifetime considerations. This was made clear by Expert 3 who comments that "Green Star is not adequate in respect to dealing with existing buildings: it's towards the demolition of existing buildings", and this is supported by Expert 5, who adds that "at the moment, the Green Star system is very flawed when it comes to old buildings since codes relate to new construction to a large extent".

Finally, the occupational health and safety design criterion received 13 per cent of experts' agreement.

4.5.7 Context (political)

In Table 4-15, the other criterion that all of experts agree with is the ecological footprint design criterion. Expert 6 confirms that "it is better to maintain the original volume of the buildings". Expert 1 relates his insights with their project: a building that was divided into four units where four families now live: "the building is largely built, 27 by 7.5 metres in size, long and thin, built to all boundaries on either side … the spaces were small but they're not tiny and we lived there with two young kids although it was a tight plan".

TABLE 4-15 CONTEXT DESIGN CRITERIA WITH EXPERTS' INTERVIEW RESULTS

Category	Criterion	Experts (n=15)
Context (Political)	*Ecological footprint* - appropriate measure of human carrying capacity	**15**
	Community interest/participation -stakeholder relationship and support	**12**
	Conservation - principles, guidelines, charters governing tangible and intangible heritage protection	**8**
	Urban masterplan - integrated skyline, urban landscape, built environment design and management/practice	**8**
	Zoning - land uses and land patterns	**7**
	Ownership - collaborative commitment, sense of community or ownership, etc.	**4**
	Adjacent buildings - adjacent enclosures, vertical and visual obstacles	**1**

80 per cent of experts are in agreement on the community interest/participation. Expert 6 affirms that "there were public consultations, exhibition and advertisements so that the local community could comment on the project" while Expert 13 adds that "community involvement was sought and encouraged". Expert 12 also says that on their project there were a "lot of consultations and good working relationship with Heritage Victoria" during the design phase. However, the community interest and participation doesn't need to be completed by the design team, as Expert 15 shares that with their project "public consultation is done indirectly through a hired agency".

53 per cent of the experts also agree with the conservation design criterion. The experts state that in many cases the buildings have Conservation Management Plans prior to refurbishment or adaptive reuse which involves heritage management and historic assessment. Expert 11 agrees, stating that with their project "the project's master plan incorporates green design and tackles heritage policies". Since they are dealing with historic buildings the experts adhered to the Burra Charter, however Expert 8 states that "somehow the Charter is fairly loose, it's the general principles that you follow but every project is different and every project is individual and we really go back to those principles".

Expert 13 explains that "the Charter's guiding principle is in terms of observations: how people use the area; reuse principles - when there is a story to be told and urban elements linked to historic significance". Moreover, Expert 1 remarks that in dealing with conservation issues, "we ended up coming up into a tight and a very refined building plan which has a residual aesthetic character worth in any heritage buildings" and Expert 2 clarifies that with their project "we were looking at a minimum change and any change that we had to make to build in a wall or a door or some new opening had to be reversible … in other words, you could undo it easily and we won't be damaging or compromising what we would call a heritage fabric of the house".

The zoning design criterion received agreement from 46 per cent of the experts. Expert 5 agrees that "the building has historical and social significance and is in need of refurbishment or upgrading to make it comply with current code requirements". Expert 7 adds that "planning regulations and development controls" must also be considered in terms of zoning application.

26 per cent of the experts agreed with the ownership design criterion. Expert 2 shares that with their project, they provided a community title and that "there were a number of points of entry into the apartment where people could come and feel that they own it - this was their piece of the apartment, they have the garden, they have the front door and so we arranged different points of entry around the building". From a different ownership perspective, Expert 11 comments that their development had some issues of political ownership in terms of "whether it is under the state or local government jurisdiction/domain".

4.6 INITIAL DEVELOPMENT OF THE ADAPTSTAR MODEL

In conclusion, the Low Energy (Technological) category received the highest percentage of agreement among the seven categories, with all of the design criteria listed under it but one (the building management system design criterion) achieving a 100% consensus. The Sense of Place (Social) category and Location (Economic) category gathered the lowest percentages of agreement with 20% and 6.6% consensus from the respondents respectively. Lastly, the only lowest design criterion which received 6.6 per cent was the adjacent building under the Context (Political) category.

Moreover, the results of the in-depth interviews illustrate that there are some challenges that these experts encountered in the reuse development. They had suggestions as to how the adaptation process could be made better, for example Expert 8 explains that the presence of "a good measured drawing and survey of the old building is very essential" and Expert 9 adds that "good documentation and as-built plans" are needed when undertaking adaptive reuse projects.

Likewise, in terms on how to improve the existing energy rating, Experts made comments on how to improve the existing rating system, noting that the current rating systems fail to take into account aspects that encourage the adaptive reuse and sustainability of existing buildings. Expert 5 states that there is a "need to develop a better system for achieving an excellent environmental rating where you don't have to make the bricks, you don't have to make the steel and you don't have to make the concrete, where there is a sustainable factor in that", while Expert 14 suggests that there should be "more points for retaining the building in terms of extension, rating scale on windows, pressures on development - basement for car parks, extra bicycle spaces/parks - less for cars and more on public transport".

Taking the above into consideration, the initial framework of the proposed adaptSTAR model is shown in Figure 4-16.

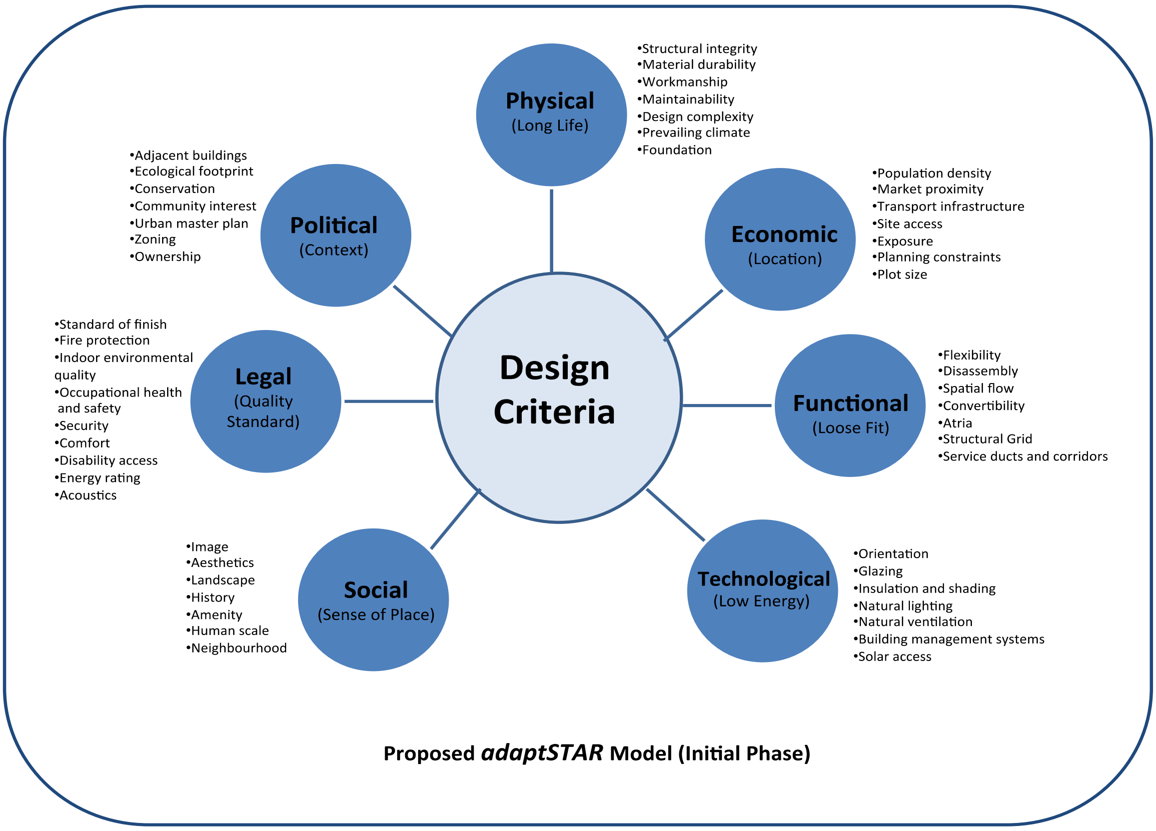


FIGURE 4-16 PROPOSED ADAPTSTAR MODEL (INITIAL DEVELOPMENT)

The design criteria serve as the foundation for the evaluation of new designs using a numerical scale ranging from significant to not significant. An example of how this model may function is demonstrated in Figure 4-17 using the Physical (Long Life) category as an illustration.

Given the base assumption that the Physical category has a value of 14.29 per cent, its corresponding design elements may have different values, but must have a total sum of 14.29 per cent. For instance, the structural integrity and foundation may each have a weight of 20 per cent, while the prevailing climate and design complexity may each be valued at 15 per cent and the rest of the elements may be scored at 10 per cent each of the 14.29 per cent. The performance of any new design, therefore, is scored against these weighted criteria and used to assemble a total score or star rating for the future building. The percentages provided in the sample application of the adaptSTAR model are just examples and the next chapter will determine whether each category indeed has equal value as assumed here.

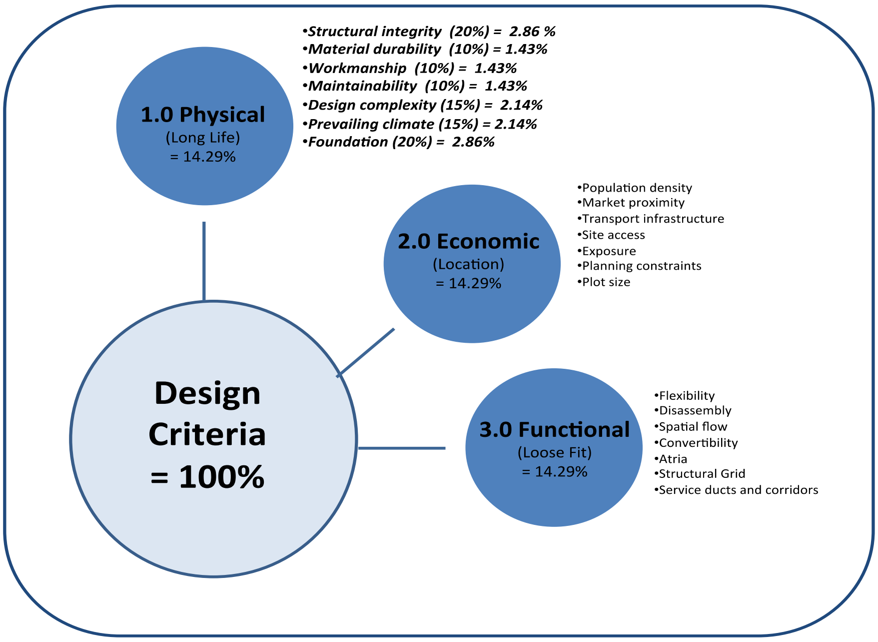


FIGURE 4-17 SAMPLE APPLICATION OF THE ADAPTSTAR MODEL

4.7 LIMITATIONS OF THE METHODOLOGICAL APPROACH

There are two identified weaknesses or limitations in the methodological approach of Stage 1. Firstly, qualitative research is a ‘soft’ science and is exploratory or subjective in nature (Denzin & Lincoln, 1994). Secondly, there is greater potential for bias because of the reliance on the human instrument (i.e. the researcher) who defines the problem, does the sampling, designs the instruments, collects the data, analyses and interprets it and then writes it up. During the collection of data via interviews, respondents may say what they think researchers want to hear and are inclined to paint positive scenarios of not-so positive situations, thus introducing respondents’ bias. The experts also have similar biases and backgrounds given their expertise in heritage conservation and adaptive reuse projects, and this colours their reflections.

However, these limitations are dealt with within the research process using the following strategies. To address the first limitation, multiple and different sources, methods and theories were triangulated to provide corroborating evidence, as suggested by Patton (2002). For the second limitation, Cresswell (1998) recommends that researcher bias be clarified from the outset of the study so that the reader understands the researcher's position and any biases or assumptions that may impact the inquiry.

4.8 CONCLUDING REMARKS

With the completion of the Stage 1 of this research, a list of design criteria have been identified to support the designing of future building adaptive reuse. Based on the interviews with selected expert professionals, the criteria are geared towards the technological/environmental, physical and functional design. Although there is less support for the socio-cultural design criteria, it must be noted that all selected case studies are heritage buildings and successful landmarks in NSW and Victoria.

Chapter 5 will discuss the results of Stage 2 of the research, testing the list of design criteria established by Stage 1 and seeking independent opinion as to their relative weights.

CHAPTER 5

DEVELOPMENT OF THE ADAPTSTAR MODEL

5.1 THE PURPOSE OF THIS CHAPTER

The research methodology for Stage 2 of this study was defined in Chapter 3. The previous chapter resulted in the production of a list of relevant design criteria for future building adaptive reuse. This chapter outlines and discusses the results of Stage 2 of the study, which aims to determine the relative importance of the identified design criteria by seeking independent opinion from practising architects who are engaged in this type of work. As such, the derived weighting applies generally and is not specific to a particular case study.

There are four major elements to this chapter. Firstly, the finalised list of design criteria is provided with short definitions to assist the survey respondents in ranking and weighting each of the categories and sub-categories. Secondly, the final development of the adaptSTAR model is completed, with the weightings of design criteria inserted based on the results from the practitioner survey. Thirdly, an assessment of adaptive reuse potential scores using Langston's ARP model for each case study is made. Fourthly, used adaptSTAR as a measure, comments concerning how each case study could have been improved at the time of its original design and construction are identified. The limitations of the approach are also discussed before a summary of results concludes the chapter. The supporting documents pertaining to the data collection and results of the Stage 2 of this research are presented in Appendix E.

5.2 THE FINAL LIST OF DESIGN CRITERIA

A survey was sent via email to selected architects who specialise in heritage conservation, adaptive reuse and green retrofitting projects in Australia. A purposeful sampling approach was used to select the survey participants and the participants were chosen based on their ability to weight the list of design criteria due to their experience and knowledge, length of professional practice, range of project and project turnover. The selected participants were asked to rate the importance of the identified list of design criteria and weight the relative importance of the seven categories using the online questionnaire software program *Survey Monkey*. This part of the research was conducted over a period of four months.

A list of possible participants for the practitioner survey was obtained from the Australian Institute of Architects (AIA), and a total of 93 emails and web links were sent out. 29 architects from all over Australia responded. The overall response rate was 31.2 per cent and the breakdown of response rates per state is displayed in Table 5-1. The overall response rate of 31.2% for a priori determined sample size is acceptable for statistical confidence.

TABLE 5-1 DISTRIBUTION OF SURVEY RESPONDENTS

State	Survey Samples (n=93)	Survey Respondents (n=29)	Response Rate (%)
ACT	5	3	60.00
NSW	24	7	29.17
NT	1	1	100.00
QLD	30	9	30.00
SA	12	3	25.00
TAS	6	2	33.33
VIC	9	3	33.33
WA	6	1	16.67

Of the completed questionnaires, four had missing data and were excluded from further analysis. The 25 remaining completed surveys were used to analyse the importance of the different building design criteria for adaptive reuse. The questions were responded to using a Likert system with a five-point scale ranging from unimportant (1), not very important (2), no opinion (3), important (4) and critical (5), with these values used to assess the importance of the seven categories concerning the adaptive reuse of a new building. The choice 'no opinion' was considered as a middle or neutral ground in the scale.

The list of design criteria identified was based on experts' in-depth interviews from Stage 1 as discussed in Chapter 4(see Tables4-9 to 4-15). There were 53 sub-categories identified in Stage 1, however some sub-categories were paired together according to their relatedness to shorten the list of design criteria and make it more suitable to a survey questionnaire format that can be answered within eight to ten minutes. There was no need to discard any design criteria during this process, but clearer definition of each criterion was necessary.

There were a total of 26design criteria in the questionnaire for which weightings were required (see Table 5-2 and the detailed survey questionnaire forms in Appendix D). These design criteria were linked to the 7 factors of obsolescence (physical, economic, functional, technological, social, legal and political) upon which the ARP model is based and illustrate that this connection is possible.Part 1 of the survey sought advice on the relativity of the main categories; the second part of the survey sought advice on the importance of the design criteria.

TABLE 5-2 SURVEY QUESTIONNAIRE AND LIST OF DESIGN CRITERIA

Category (7)	Sub-category (26)
Physical	Structural integrity and foundation Material durability and workmanship Maintainability
Economic	Density and proximity Transport and access Plot size and site plan
Functional	Flexibility and convertibility Disassembly Spatial flow and atria Structural grid Service ducts and corridors
Technological	Orientation and solar access Glazing and shading Insulation and acoustics Natural lighting and ventilation Energy rating Feedback on building performance and usage
Social	Image and history Aesthetics and townscape Neighbourhood and amenity
Legal	Standard of finish Fire protection and disability access Occupational health, IEQ, safety and security
Political	Ecological footprint and conservation Community support and ownership Urban masterplan and zoning

With reference to the final list of design criteria as shown in Table 5-2, each was clearly defined as part of the survey form.

5.2.1 PHYSICAL (LONG LIFE)

Structural Integrity and Foundation– this pertains to the structural design of the building and whether it has the strength to cater for different future building uses and loading scenarios; it allows for the potential vertical expansion of the building and ensures the stability of the structure in relation to issues such as differential settlement and substrata movement.

Material Durability and Workmanship– this concerns the materials used for the building that play a crucial role in its durability (i.e. the more durable the materials are, generally the longer is the building's lifespan) and includes the quality of craftsmanship applied to the building's structure and finishes.

Maintainability– this pertains to enhancing building performance over its lifespan, where maintainability attributes are defined as the capability of a building to conserve operational resources.

5.2.2 ECONOMIC (LOCATION)

Density and Proximity – this refers to population density and distance to major cities and/or central business district (CBD).

Transport and Accessibility – this pertains to the location and links to services, pedestrian and vehicular access and other transport facilities.

Plot Size and Site Plan – this concerns the site dimensions, land contours, views to and from the site, percentage of site coverage, planning requirements for adjacent buildings and site development, and includes site exposure such as vistas and privacy, site selection and planning constraints as well as the built area, spatial proportions and enclosures (i.e. adjacent, vertical and visual enclosures).

5.2.3 FUNCTIONAL (LOOSE FIT)

Flexibility and Convertibility – this refers to the diversity of spaces that can be adapted to suit a number of differing configuration and uses, and includes design of a building with future expansion in mind and the capability of a building to change according to new requirements to achieve better function and performance compared to previous conditions; it examines the ease with which a system or component can be modified for use in applications or environments other than those for which it was specifically designed, and allows sufficient planning and space allocation to provide for anticipated future requirements (advocating the principles of divisibility, elasticity and multi-functionality).

Disassembly – this pertains to the ease of dismantling or deconstruction and element and material transformations like the reuse of building components and recycling of building materials, demountable systems, modularity and the like.

Spatial Flow and Atria – this refers to mobility, open plan, fluid and continuous space, as well as provision of open areas, interior gardens, etc.

Structural Grid – this relates to the ideal and economic limits of span to support functional interchangeability.

Service Ducts and Corridors – this concerns the vertical circulation, service elements, raised floors, and other service features of a building.

5.2.4 TECHNOLOGICAL (LOW ENERGY)

Orientation and Solar Access – this relates to the siting and design with regard to microclimate, appropriate climatic strategies, prevailing winds, sunlight, as well as provides measures for summer and winter sun.

Glazing and Shading – this refers to sunlight glare control and regulation of internal temperatures, sunshades and automated blinds.

Insulation and Acoustics – this pertains to the appropriate use of insulation, thermal mass, noise control and sound insulation.

Natural Lighting and Ventilation – this refers to natural daylight, efficient lighting system, optimised airflow, quality fresh air, increased ambient air intake, and other lighting and ventilation attributes.

Energy Rating – this pertains to the environmental performance measures and the use of energy-efficient equipment and appliances.

Learn and Obtain Feedback on Building Performance and Usage – this relates to the coordination of building services, commissioning, churn management, user guide and maintenance and housekeeping, and also includes the monitoring and control of building operations and performance systems.

5.2.5 SOCIAL (SENSE OF PLACE)

Image and History – this conveys the design concept of the building and its social and cultural values and attributes pertaining to the building's authenticity, original fabric, timelessness, socio-cultural traditions, practices, historic character or fabric, and the concept of universal design applied to the built environment.

Aesthetics and Townscape – this refers to the physical appearance and design approach of the building in terms of architectural beauty, good appearance, innovation, proportion, landscape, visual coherence and organisation of built objects, and includes anthropometrics, human scale, and the maintenance and enhancement of natural ecological features and systems as well as vegetation on and around the site.

Neighbourhood and Amenity – this concerns the local and social communities, provides comfort and convenience facilities, amenities and concepts contributing to the public domain.

5.2.6 LEGAL (QUALITY STANDARD)

Standard of Finish – this concerns the provision for high-standard workmanship.

Fire Protection and Disability Access – this pertains to the fire resistance ratings for structural components, provisions for fire safety as well as provision of disability easement, facilities, and other fire and disability requirements for new buildings.

Occupational Health, IEQ, Safety and Security – this account for the special needs of occupants in terms of health and safety risks, comfort, hygiene and clean environment, and pertains to the provisions for non-hazardous materials, natural fabrics, building hazards and risk management plan, including appropriate levels of privacy, transparency, physical and visual access and security of belongings, in place and active measures for screening of building occupants, video monitoring and integration of situation awareness concepts as well as the provision of direct and passive surveillance designs.

5.2.7 POLITICAL (CONTEXT)

Ecological Footprint and Conservation – this pertains to the appropriate measure of human carrying capacity as well as the conservation principles and charters that govern tangible and intangible heritage protection.

Community Support and Ownership – this relates to the community/public sector support and response and/or the recognition of the local social context, and includes the stakeholder relationship and support, collaborative commitment and sense of ownership among the communities.

Urban Masterplan and Zoning – this pertains to land use planning and development control/instruments that include integrated skyline, urban landscape, built environment design, management/practice, land uses and patterns, height control, and other mechanisms/methods used to dictate the land use pattern and development of a city/area.

5.3 STATISTICAL ANALYSIS OF THE SURVEY RESULTS

Gob et al. (2007) state that descriptive analysis is used in many studies requiring statistical interpretation of survey data and Likert scales. Jamieson (2004:p.1217) notes that "Likert scales fall within the ordinal level of measurement." Additionally, attitude-measuring scales are considered ordinal where any two measured values can be compared in terms of the order relation (Gob et al., 2007). Thus, descriptive statistics of the responses for each of the 33 questions were used to illustrate the views of Australian architects on each of the items in the survey. The level of measurement of the responses for each item can be classified as ordinal data, as the opinions represented by each response do not merit any numerical value. Even though there are usually numbers associated with each response, these numbers are only used as a coding system to represent the ordering present as the degree of importance is higher for a response of 'critical' compared to a response of 'important'. With this the median, frequency counts and percentages are computed.

The median represents the middle of a set of data, such that 50% of the responses are below or less than the median value. For example, for a median response of 4 (which corresponds to a response of 'important'), at least half of the architects believe that the corresponding category is either 'important' or 'critical'. The frequency count for each item is the tally of the number of responses pertaining to a certain opinion. Together with the frequency, the percentages show the proportion of the respondents who have the same opinion. The minimum and maximum values can also be determined, as the disparity between these values represents the spread of the data.

Since the data for one item is ordinal, arithmetic operations to summarise the data cannot be performed. Thus, in order to investigate the data further and compute for the mean, standard deviation and correlation, the coding used for the scale 1=unimportant, 2=not very important, 3=no opinion, 4=important, 5=critical will be treated like items in an exam and the responses for all the items under the same main category will be added into an overall score. For example, the corresponding codes for the answers to items 1, 8, 9 and 10, which all pertain to the Physical category, can be added up to yield an importance score for the said category. In this instance, the scores can be used to compute various statistics from the data. The survey questionnaire results table can be found in Appendix E.

The mean of the score for each of the main categories was used to compare the degree of importance of each of the categories as a whole, since all of the items pertaining to that category were considered in computing the mean. The variation in the responses for each category was measured through use of standard deviation. Also, the correlation showed which categories are related to each other. The reliability of the results of the survey and the agreement of the architects in their opinion on the importance of the different categories in the adaptive reuse of a new building were also considered.

Table 5-3 shows the descriptive statistics (the median, highest and lowest values) of each item in Part 1 of the survey questionnaire.

TABLE 5-3 DESCRIPTIVE STATISTICS FOR THE 7 OBSOLESCENCE CATEGORIES

Categories	Median	Highest	Lowest
Physical (Ph)	5 = Critical	5 = Critical	4 = Important
Economic (Ec)	4 = Important	5 = Critical	2 = Not very important
Functional (Fu)	4 = Important	5 = Critical	1 = Unimportant
Technological (Te)	4 = Important	5 = Critical	4 = Important
Social (So)	4 = Important	5 = Critical	2 = Not very important
Legal (Le)	4 = Important	5 = Critical	2 = Not very important
Political (Po)	4 = Important	5 = Critical	2 = Not very important

The Physical category obtained the highest median, which means that at least half of the architects who answered the survey believed that the physical aspect of a new building is 'critical' in its adaptive reuse. Also, with the lowest rating assigned corresponding to 'important', all of the 25 respondents thought that the Physical category is an essential factor to consider in terms of the adaptive reuse of a new building.

The remaining items in the first part of the survey had medians of 4 (important), so at least half of the respondents answered that all the remaining categories are 'important' or 'critical' to adaptive reuse. However, only the Physical and Technological categories had a lowest rating of 4. With lowest ratings of 2 for Economic, Social, Legal and Political, it is clear some architects believe that the categories pertaining to the economic, social, legal and political characteristics of a building are not important aspects of the adaptive reuse of a new building. Furthermore, by giving it a lowest rating of 1, some respondents judged that the Functional category was unimportant to the adaptive reuse potential of a new building. This indicates possible misunderstanding or confusion by some respondents, and underlines the importance of taking a majority view.

Table 5-4 shows the descriptive statistics (the median, highest and lowest values) of each item in Part 2 of the survey questionnaire.

TABLE 5-4 DESCRIPTIVE STATISTICS FOR THE26 DESIGN CRITERIA

Categories	Median	Highest	Lowest
Physical (Ph)			
Structural integrity and foundation	4 = Important	5 = Critical	3 = No opinion
Material durability and workmanship	4 = Important	5 = Critical	3 = No opinion
Maintainability	4 = Important	5 = Critical	3 = No opinion
Economic (Ec)			
Density and proximity	3 = No opinion	5 = Critical	1 = Unimportant
Transport and accessibility	3 = No opinion	5 = Critical	1 = Unimportant
Plot size and site plan	3 = No opinion	4 = Important	1 = Unimportant
Functional (Fu)			
Flexibility and convertibility	4 = Important	5 = Critical	1 = Unimportant
Disassembly	4 = Important	5 = Critical	1 = Unimportant
Spatial flow and atria	4 = Important	4 = Important	1 = Unimportant
Structural grid	4 = Important	5 = Critical	1 = Unimportant
Service ducts and corridors	3 = No opinion	5 = Critical	1 = Unimportant
Technological (Te)			
Orientation and solar access	4 = Important	5 = Critical	2 = Not very important
Glazing and shading	4 = Important	5 = Critical	2 = Not very important
Insulation and acoustics	4 = Important	5 = Critical	2 = Not very important
Natural lighting and ventilation	4 = Important	5 = Critical	2 = Not very important
Energy rating	4 = Important	5 = Critical	1 = Unimportant
Feedback on building performance and usage	3 = No opinion	4 = Important	1 = Unimportant
Social (So)			
Image and history	4 = Important	5 = Critical	2 = Not very important
Aesthetics and townscape	4 = Important	5 = Critical	2 = Not very important
Neighbourhood and amenity	4 = Important	5 = Critical	2 = Not very important
Legal (Le)			
Standard of finish	4 = Important	5 = Critical	2 = Not very important
Fire protection and disability access	4 = Important	5 = Critical	1 = Unimportant
Occupational health, IEQ, safety and security	4 = Important	5 = Critical	1 = Unimportant
Political (Po)			
Ecological footprint and conservation	3 = No opinion	5 = Critical	1 = Unimportant
Community support and ownership	4 = Important	5 = Critical	2 = Not very important
Urban masterplan and zoning	4 = Important	5 = Critical	1 = Unimportant

The median, highest and lowest values for the sub-criteria under the main categories are shown in Table 5-4. The median opinion for each of the sub-criteria under the Physical category shows that at least 50 per cent of the respondents consider structural integrity and foundation, material durability and workmanship, and maintainability to be 'important' in the adaptive reuse potential of a new building. Moreover, all three sub-categories receive a highest rating of 'critical' and lowest rating of 'no opinion', which is the neutral ground in the scale. None of the architects regard the sub-criteria for the Physical category to be 'not very important' in adaptive reuse potential.

For the Economic category, the three sub-criteria obtain a median response of 'no opinion'. This means that at least half of the respondents answered 'no opinion', 'important' or 'critical' to express the value of the economic sub-criteria. Ratings given by the architects for density and proximity, and transport and accessibility range from 'unimportant' to 'critical', while ratings for the plot size and site plan sub-criteria range from 'important' to 'unimportant'.

For the Functional category, there were five sub-criteria. Four of the sub-criteria have a median response value of 'important', except for service ducts and corridors which have a lower median response of 'no opinion'. All the sub-criteria under the functional category have ratings that range from 'unimportant' to 'critical'.

The Technological category has six sub-criteria, five of which receive a response value of 'important' or 'critical' from at least half of the architects who answered the survey. However, the responses of the sub-criteria of feedback on building performance have a middle value of 'no opinion'. The responses for orientation and solar access, glazing and shading, and insulation and acoustics range from 'not very important' to 'critical'. Responses of energy rating range from 'unimportant' to 'critical', while ratings for the sub-criteria of feedback on building performance range from 'unimportant' to 'important'.

There are three sub-criteria identified for the Social category. Each of the three sub-criteria have median responses of 'important' to adaptive reuse and have ratings which range from 'not very important' to 'critical'.

The Legal category has three design sub-criteria, all of which have a median rating of ‘important’, meaning that half of the respondents view each of the legal design criteria to be ‘important’ or ‘critical’ to the adaptive reuse potential of a new building. The views of the architects for the standard of finish criterion range from ‘not very important’ to ‘critical’, while responses for fire protection and disability access, as well as occupational health and safety, range from ‘unimportant’ to ‘critical’.

Finally, in the case of the Political category, community support and ownership together with urban masterplan and zoning have at least 50 per cent of the respondents rating them at least ‘important’ to adaptive reuse potential, while the median response for the ecological footprint and conservation criteria is ‘no opinion’. On the other hand, ratings ranging from ‘unimportant’ to ‘critical’ are given to the sub-criteria pertaining to the ecological footprint and zoning of the building, while community support has responses ranging from ‘not very important’ to ‘critical’.

What is clear is that all of the design criteria are important enough to be included in the adaptSTAR model. This has probably occurred as a result of grouping earlier proposed criteria into a shorter, more concise list. Such a strategy also makes it easier for respondents to make value judgements about the relative merit of each criterion. Too many criteria arguably work against the potential application of the model in practice.

It is worthwhile investigating the graphical distribution of the responses for each of the questions reflecting design criteria in the survey. Histograms are produced to illustrate the responses at a glance. All histograms have the opinions/scale (response) on the x-axis, while on the y-axis is the number of respondents (frequency) who were in agreement. Obsolescence categories relate to questions in the practitioner survey numbered Q1-Q7. Design criteria relate to questions in the practitioner survey numbered Q8-Q10 (Physical), Q11-Q13 (Economic), Q14-Q18 (Functional), Q19-Q24 (Technological), Q25-Q27 (Social), Q28-Q30 (Legal) and Q31-Q33 (Political).

Figure 5-1 indicates that the vast majority of respondents (85% in fact) believe that all seven categories of obsolescence are ‘important’ or ‘critical’. Both the Physical and Technological categories show 100% agreement from respondents that they are perceived as ‘important’ or ‘critical’, but this falls to 92% (Functional), 88% (Social), 72% (Economic and Legal) and 68% (Political). Only 1 respondent (i.e. 4%) think that Functional is ‘unimportant’, 2 or 3 respondents (i.e. 8-12%) think that Economic, Social, Legal and Political are ‘not very important’, and no more than 5 respondents (i.e. a maximum of 20%) have “no opinion” to offer.

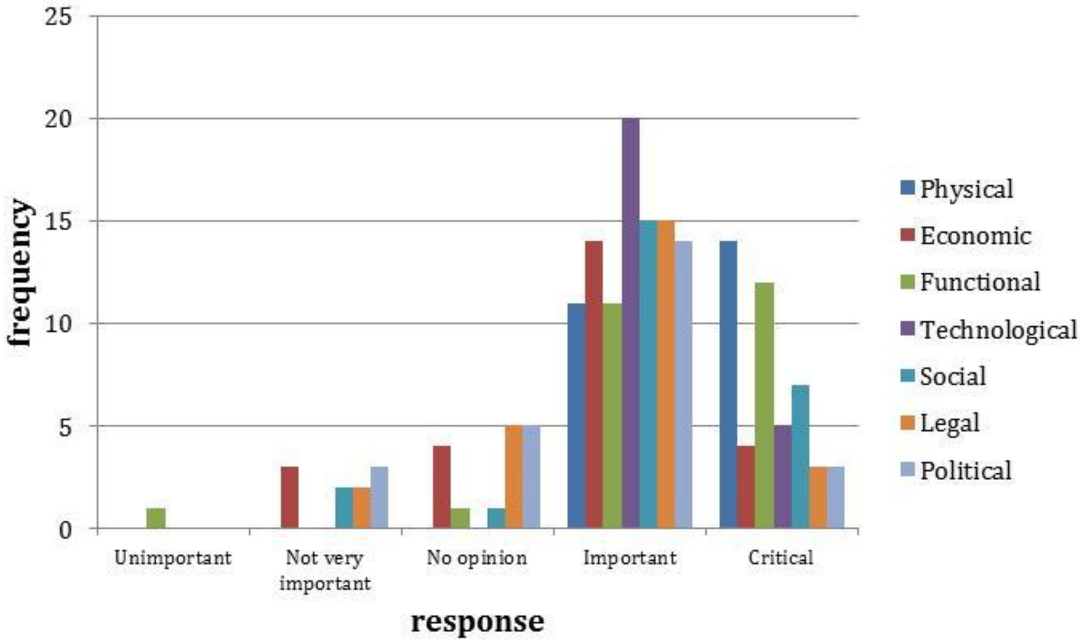


FIGURE 5-1 HISTOGRAM OF OBSOLESCENCE CATEGORY IMPORTANCE

Most respondents confirm the importance they place on physical obsolescence by their opinion profile for each of the three design criteria attached to it. Q8 relates to structural integrity and foundations, Q9 relates to material durability and workmanship, while Q10 relates to maintainability. Figure 5-2 demonstrates that for Q8 and Q10, 96% of respondents consider these criteria are ‘important’ or ‘critical’, and in the case of Q9, 92% share the same opinion. Only a couple of respondents have ‘no opinion’, and no respondents think any of these criteria are ‘unimportant’ or ‘not very important’.

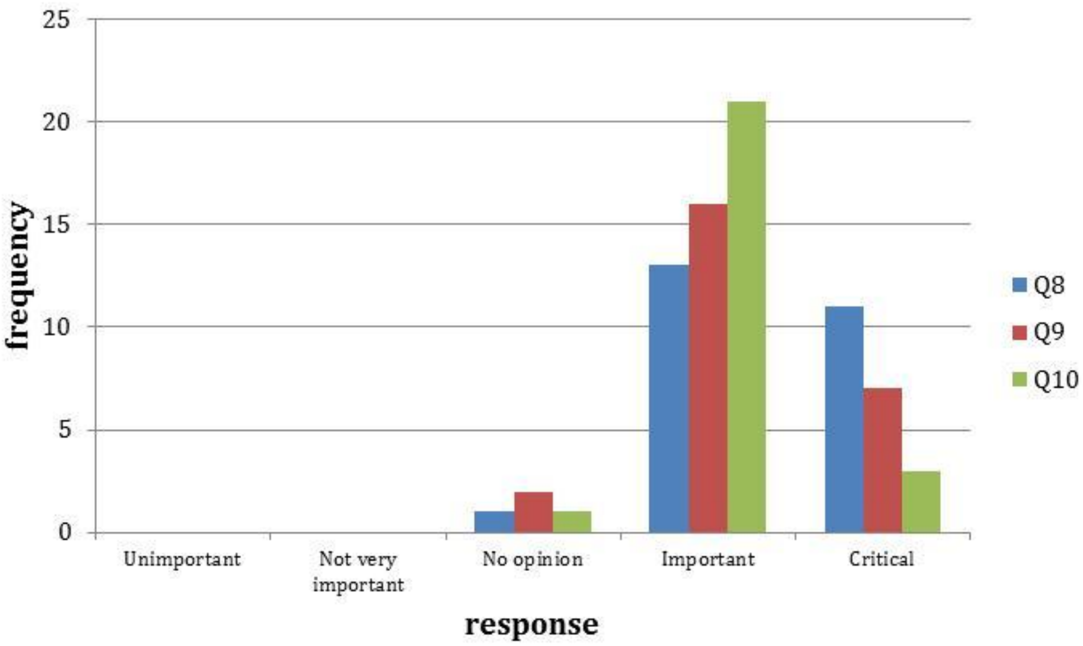


FIGURE 5-2 HISTOGRAM OF PHYSICAL DESIGN CRITERIA IMPORTANCE

There is a wider spread of results for the Economic design criteria, as can be seen in Figure 5-3. Q11 relates to density and proximity, Q12 relates to transport and accessibility, while Q13 relates to plot size and plan shape. Here the majority view is 'no opinion'. Only 32% in fact think that Q11 is 'important' or 'critical', which rises to 36% for Q12 and 44% for Q13. Few respondents believe that any of the economic criteria are either 'unimportant' or 'critical'. Nevertheless, Q13 ranks higher than Q12, which ranks higher than Q11.

The Functional category contains five design criteria; namely flexibility and convertibility (Q14), disassembly (Q15), spatial flow and atria (Q16), structural grid (Q17) and service ducts and corridors (Q18). While 80% agree that Q14 is 'important' or 'critical', this falls to 60% for Q15-Q17 inclusive and 48% for Q18. Overall, the dominant opinion of respondents is that all of the design criteria in this category are 'important'. The results for the Functional category are summarised in Figure 5-4.

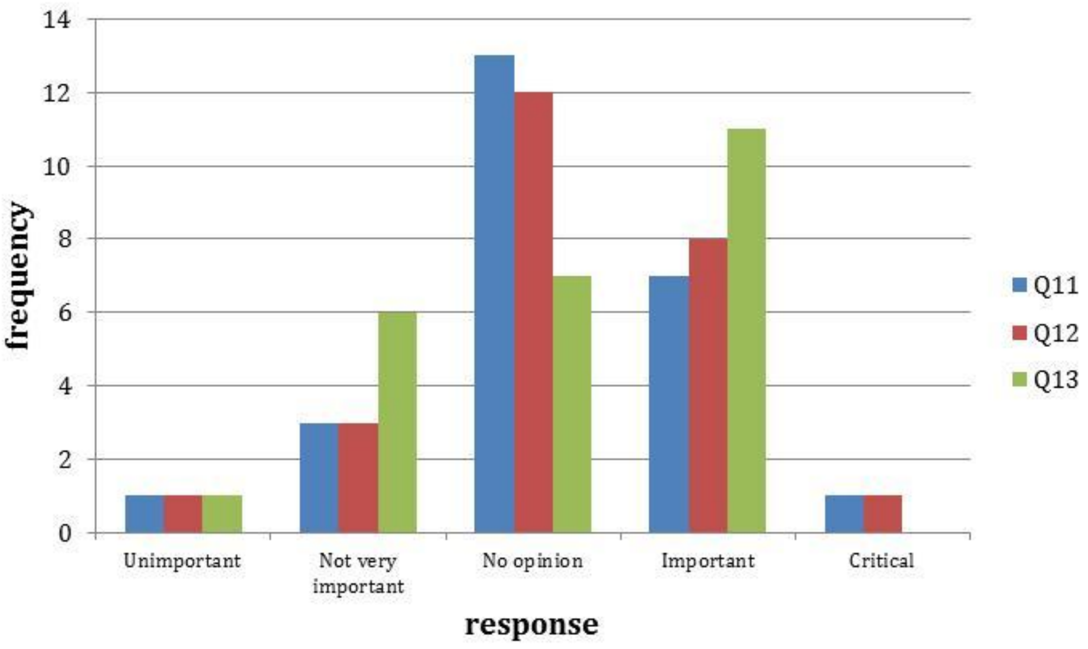


FIGURE 5-3 HISTOGRAM OF ECONOMIC DESIGN CRITERIA IMPORTANCE

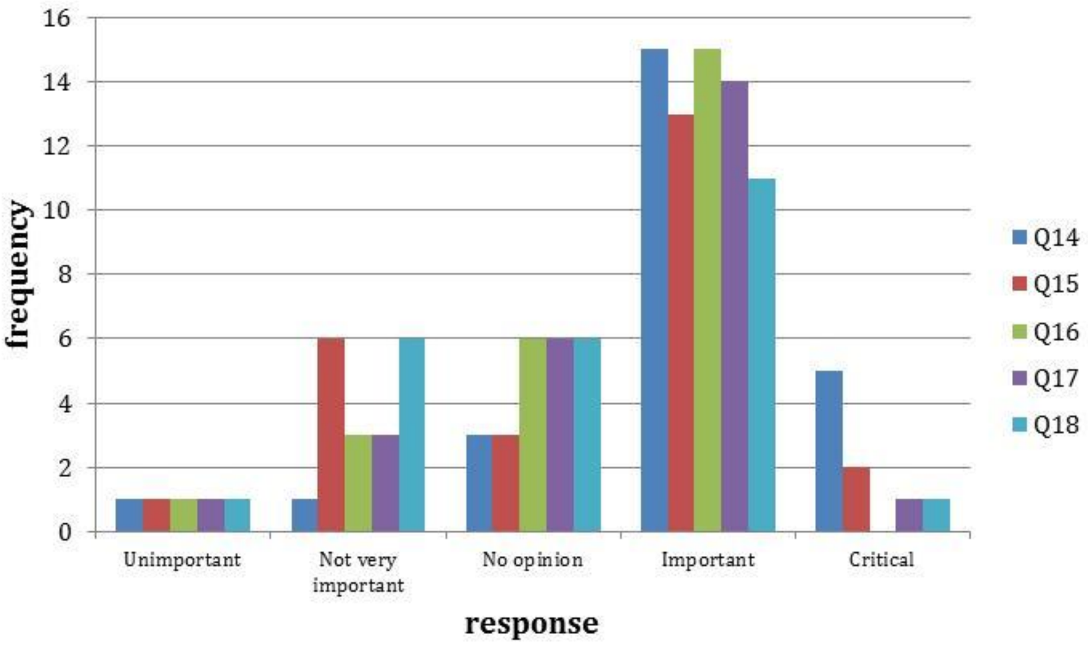


FIGURE 5-4 HISTOGRAM OF FUNCTIONAL DESIGN CRITERIA IMPORTANCE

In regard to the Technology category, six design criteria apply. These comprise orientation and solar access (Q19), glazing and shading (Q20), insulation and acoustics (Q21), natural lighting and ventilation (Q22), energy rating (Q23) and learn and obtain feedback about building (Q24). Reflective of the obsolescence category weighting earlier that shows 100% agreement that this category is 'important' or 'critical', most design criteria in this group receive similar endorsement. Specifically, Q19 has 96% of respondents agreeing that the criterion is 'important' or 'critical', Q22 has 84% in agreement, but this drops to 76% for Q20, 72% for Q21, 60% for Q23 and 44% for Q24. The complete results are shown in Figure 5-5.

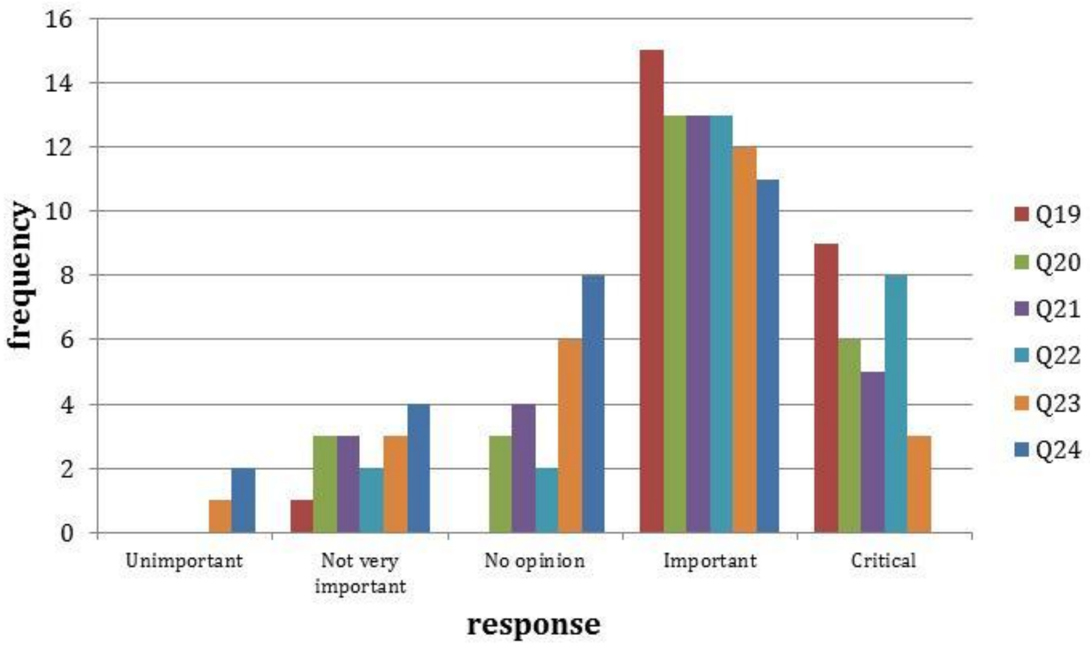


FIGURE 5-5 HISTOGRAM OF TECHNOLOGICAL DESIGN CRITERIA IMPORTANCE

Figure 5-6 summarises the Social design criteria responses. Q25 relates to image and history, Q26 relates to aesthetics and townscape, while Q27 relates to neighbourhood and amenity. While 'important' is the dominant response, a fair amount of dispersion is also evident. 88% of respondents think that Q26 is 'important' or 'critical', while 76% think similarly for Q25 and Q27. Interestingly, no respondent thinks any of the criteria in this group are 'unimportant'.

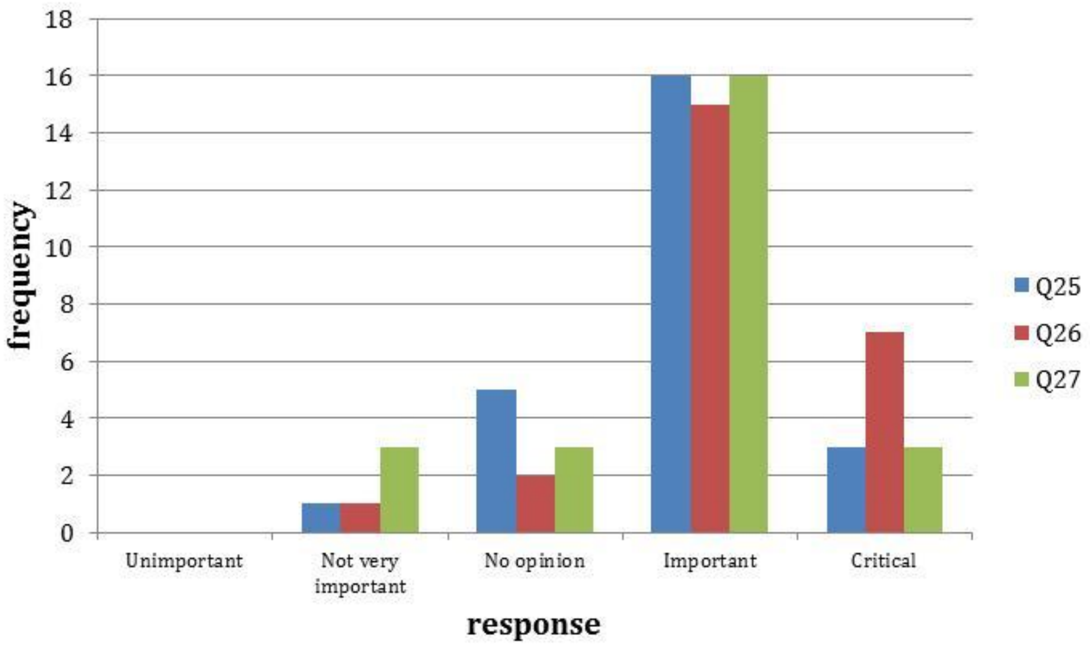


FIGURE 5-6 HISTOGRAM OF SOCIAL DESIGN CRITERIA IMPORTANCE

Q28 (standard of finish), Q29 (fire protection and disability access) and Q30 (occupational health, IEQ, safety and security) combine to form the Legal design criteria. In this case, 80% of respondents think that Q29 is either 'important' or 'critical', but only 68% have the same opinion for the other two criteria. Nevertheless, 'important' is the majority view by more than a factor of 3 (see Figure 5-7).

Finally, the Political category comprises ecological footprint and conservation (Q31), community support and ownership (Q32) and urban masterplan and zoning (Q33). Opinion appears quite varied, with only 48% considering Q31 is 'important' or 'critical', but rising to 60% for Q32 and 68% for Q33. Few in fact consider any of these criteria to be 'critical'. The majority view, however, is 'important'. The results are summarised in Figure 5-8.

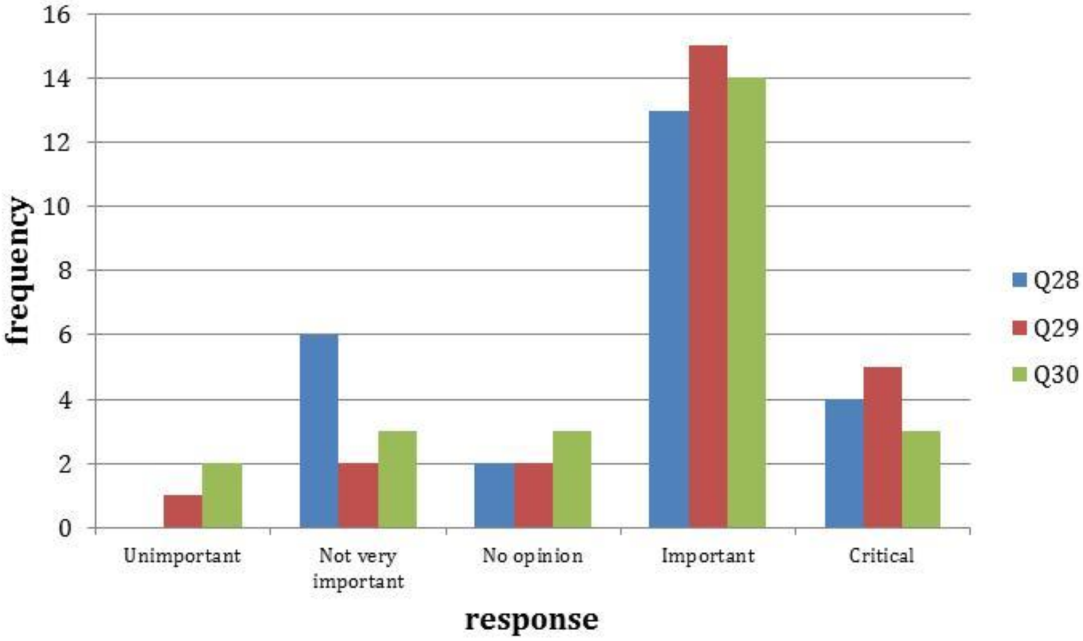


FIGURE 5-7 HISTOGRAM OF LEGAL DESIGN CRITERIA IMPORTANCE

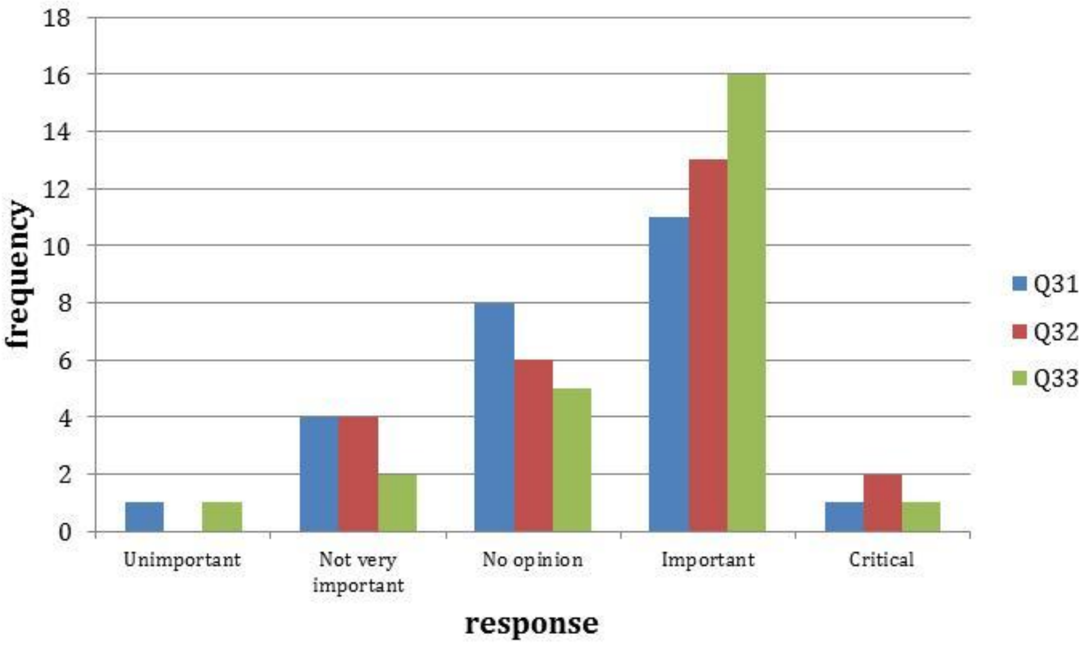


FIGURE 5-8 HISTOGRAM OF POLITICAL DESIGN CRITERIA IMPORTANCE

It is also interesting to look at how the different obsolescence categories are related to each other. This can be seen via the correlation matrix in Table 5-5.

TABLE 5-5 RELATIONSHIP OF THE SEVEN CATEGORIES TO EACH OTHER

	Ph	Ec	Fu	Te	So	Le	Po
Physical (Ph)	1.00						
Economic (Ec)	0.35	1.00					
Functional (Fu)	0.16	0.47	1.00				
Technological (Te)	0.29	0.36	0.54	1.00			
Social (So)	0.61	0.44	0.13	0.65	1.00		
Legal (Le)	0.39	0.66	0.47	0.70	0.53	1.00	
Political (Po)	0.37	0.37	0.49	0.67	0.70	0.49	1.00

The Spearman correlation formula is used for the data, as Spearman's *rho* is more robust for non-normality. The Spearman correlation can range from -1 to +1, where -1 signifies perfect negative correlation, a value of +1 represents perfect positive correlation and 0 signifies no correlation between the categories.

The correlation of the scores for the Legal and Technological as well as the Political and Social categories at 0.7 is the highest for the group. This suggests that the view of the architects on the importance of the Legal category to adaptive reuse is highly related or associated to their view on the Technological category, and this applies equally between Political and Social categories.

The strong correlation between the Technological and Legal categories is because the technological aspects to a new building serve as an improvement to the standard given by regulation and by-laws. The strong correlation is also attributed to the inclusion of green building strategies and rating systems in the refurbishment of existing buildings and in designing new buildings together with other building codes, disability and fire regulations. The strong correlation of the Social and Political categories is because both of these categories tackle the view of community engagement in redevelopment. The socio-cultural values depend on the perception and support of the community. The well-being of society in the built environment is attributed its socio-cultural characteristics such as its image, historicity, architectural merit, aesthetic and townscape benefits as well as good neighbourhood and amenity provisions.

Other categories such as the Technological and Political categories, Legal and Economic categories and Technological and Social categories receive moderately high correlation values of 0.67, 0.66 and 0.65 respectively. Perhaps the Technological and Political categories are related since technological improvement decreases the waste and pollution caused by the building, which will increase community support and conservation efforts. The Legal and Economic categories are related perhaps because the density and proximity in the area where the building is situated, as well as the plot size, are connected to the fire and occupational safety of the structure as stipulated in the fire, disability and building codes. Furthermore, the relationship between the scores of the Technological and Social categories could be because technological improvements in the building can result in better aesthetics and can have an impact on the community in terms of innovation and better quality of life. This implies that the architectural merit and socio-cultural benefits depend on the effective implementation of technological aspects in the design of new buildings.

Gliem and Gliem (2003) suggest that it is imperative to calculate and report Cronbach's alpha coefficient for internal consistency reliability when using Likert scales. Therefore, the reliability of the scale and the measurements are important if the results from the survey would be used in further assessments. Cronbach's alpha, which is a measure of internal consistency, is evidence of the accuracy and reliability of results over time (Gliem & Gliem, 2003). Additionally, measurements from an instrument such as a questionnaire can be said to be stable or reliable if the same results are elicited over a repeated administration of the survey. The alpha coefficient has values ranging from 0 to 1 where 1 represents perfect consistency. It is important to have high consistency or stability in order to generalise the results obtained from a survey. The goal for this research was 0.8, which was achieved (Gliem & Gliem, 2003).The interpretation scale for this test is shown in Table 5-6.

TABLE 5-6 ALPHA COEFFICIENT TABLE

Alpha	High Consistency/Stability
0.9-1	Excellent
0.8-0.9	Good
0.7-0.8	Acceptable
0.6-0.7	Questionable
0.5-0.6	Poor
Less than 0.5	Unacceptable

The alpha coefficient for this study is computed from the responses (not the scores) of the architects' responses. In this case, the value of alpha for the whole survey is 0.93, suggesting that the scale has high reliability and if the respondents were to answer a same survey again in the future, their responses would be similar to what has been collected. Values of the alpha coefficient are also computed for each category, where all of the related items are taken into account. The values are 0.62 for the Physical category, 0.69 for the Economic category, 0.78 for the Functional category, 0.82 for the Technological category, 0.58 for the Social category, 0.90 for the Legal category and 0.78 for the political category.

Another measure of reliability and agreement between respondents is the intraclass correlation coefficient (ICC). This is used in determining if the scores per category which are obtained from the sum of all items pertaining to that category are stable, since the ICC is only applicable to interval scale data. The ICC also measures the stability of the results for continuous data, so the ICC is used to assess the stability of the summated scores for each category. For the scores obtained from the responses, the value of the ICC is 0.72, which again suggests that the results are stable and the architects agree on the scores that they have given.

5.4 CONSENSUS TEST

A unique consensus test is developed in this research to provide clear advice on the level of consensus or consistency between respondent opinions for each question in a Likert survey. A score of 100% is obtained when all respondents share the same opinion (e.g. 100% agreement that criteria is 'important') and a score of 0% is obtained when the opinions of respondents are evenly divided (e.g. 5 respondents select each of the options in the Likert scale). This test works for any number of options, although in this research a 5-point Likert scale is adopted. The standard deviation is a measure of agreement, and in this test the standard deviation of the counts of each of the responses per item is compared to the maximum standard deviation. The maximum standard deviation is the standard deviation if all of the have the same response, regardless of what that response might be. Table 5-7 shows hypothetical consensus test calculations for a 5-point Likert survey of 15 people, 150 people and 100 people respectively.

TABLE 5-7 CONSENSUS TEST ILLUSTRATION

Question	SD	D	N	A	SA	STDEV	CONSENSUS (%)
I	3	3	3	3	3	0	**0.00**
II	0	0	0	15	0	6.7082	**100.00**
III	2	1	8	2	2	2.8284	**42.16**
IV	0	0	1	14	0	6.1644	**91.89**
V	3	2	4	3	3	0.7071	**10.54**
VI	1	6	1	6	1	2.7386	**40.82**
VII	2	4	2	4	3	1	**14.91**
VIII	7	7	1	0	0	3.6742	**54.77**
					Max	6.7082	
Question	**SD**	**D**	**N**	**A**	**SA**	**STDEV**	**CONSENSUS (%)**
I	30	30	30	30	30	0	**0**
II	0	0	0	150	0	67.0820	**100.00**
III	20	10	80	20	20	28.2843	**42.16**
IV	0	0	10	140	0	61.6441	**91.89**
V	30	20	40	30	30	7.0711	**10.54**
VI	10	60	10	60	10	27.3861	**40.82**
VII	20	40	20	40	30	10	**14.91**
VIII	70	70	10	0	0	36.7423	**54.77**
					Max	67.0830	
Question	**SD**	**D**	**N**	**A**	**SA**	**STDEV**	**CONSENSUS (%)**
I	20	20	20	20	20	0	**0.00**
II	0	0	0	100	0	44.7214	**100.00**
III	99	1	0	0	0	44.1645	**98.75**
IV	10	15	20	25	30	7.9057	**17.68**
V	50	50	0	0	0	27.3861	**61.24**
VI	25	25	25	25	0	11.1803	**25.00**
VII	75	25	0	0	0	32.5960	**72.89**
VIII	21	20	20	20	19	0.7071	**1.58**
					Max	44.7214	

*Consensus Test formula = STDEV(X)*100/STDEV(MAX)*
SD = strongly disagree; D = disagree; N = no opinion; A = agree; SA = strongly agree

5.5 FINAL DEVELOPMENT OF THE ADAPTSTAR MODEL

The adaptSTAR-derived weightings reflect the judgments of the respondents on the importance of each of the categories based on the answers to the questionnaire (see Table 5-8) and its derivation of weightings (see Appendix E). Firstly, the weights per category are determined based on the survey responses, which results in the Physical category garnering the highest weight of 16.08%; followed by the Functional category (15.23%); Technological and Social categories (14.85%and 14.37%respectively); the Economic and Legal categories (13.40% and 13.28% respectively); and the Political category (12.79%). The sum of the seven obsolescence categories is 100% with a coefficient of variation of just 8.32%. It is not unreasonable to conclude, therefore, that all of the categories have a similar weight. This was the assumption in Langston's ARP model (Langston, 2008).

The same approach is used to determine the design criteria weights. The results of the calculation, including the application of the Consensus Test to indicate the level of agreement, are shown in Table 5-8.

Additionally, it is worth knowing the consensus percentages per sub- categories as shown in Table 5-8. The percentages of consensus range from the lowest rating of 37.42% up to the highest rating of 80.75%. The maintainability criterion under the physical category received the highest percentage while the service ducts and corridors criterion under the functional category received the lowest percentage in terms of respondents' agreement.

The design criteria which received the most consensus(i.e. >50%) from the respondents are: Maintainability (80.75%); Material durability and workmanship (60.66%); Orientation and solar access (60.33%); Structural integrity and foundation (57.62%); Image and history (57.60%); Urban masterplan and zoning (56.92%); Aesthetics and townscape (55.50%); Spatial flow and atria (54.04%); Flexibility and convertibility (52.15%); Fire protection and disability access (51.77%); and Neighbourhood and amenity (50.60%).

TABLE 5-8 ADAPTSTAR CRITERIA WEIGHTINGS

adaptSTAR Criteria	Raw Weight (%)	Consensus (%)	Total Weight (%)
Physical **16.08**			
Structural integrity and foundation	34.70	57.62	5.58
Material durability and workmanship	33.12	60.66	5.33
Maintainability	32.18	80.75	5.17
Economic **13.40**			
Density and proximity	33.33	45.61	4.47
Transport and accessibility	33.76	43.36	4.52
Plot size and site plan	32.91	40.50	4.41
Functional **15.23**			
Flexibility and convertibility	22.45	52.15	3.42
Disassembly	19.44	43.36	2.96
Spatial flow and atria	19.68	54.04	3.00
Structural grid	19.91	48.58	3.03
Service ducts and corridors	18.52	37.42	2.82
Technological **14.85**			
Orientation and solar access	18.87	60.33	2.80
Glazing and shading	17.11	44.27	2.54
Insulation and acoustics	16.75	43.36	2.49
Natural lighting and ventilation	17.99	48.17	2.67
Energy rating	15.52	38.47	2.31
Feedback on building performance and usage	13.76	40.00	2.04
Social **14.37**			
Image and history	32.65	57.60	4.69
Aesthetics and townscape	35.03	55.50	5.04
Neighbourhood and amenity	32.31	50.60	4.64
Legal **13.28**			
Standard of finish	32.85	44.72	4.36
Fire protection and disability access	35.04	51.77	4.65
Occupational health, IEQ, safety and security	32.12	45.17	4.27
Political		**12.79**	
Ecological footprint and conservation	31.66	39.50	4.05
Community support and ownership	33.98	44.72	4.35
Urban masterplan and zoning	34.36	56.92	4.39

The adaptSTAR model and its corresponding weighted percentages based on the survey results are summarised in Figure 5-9.

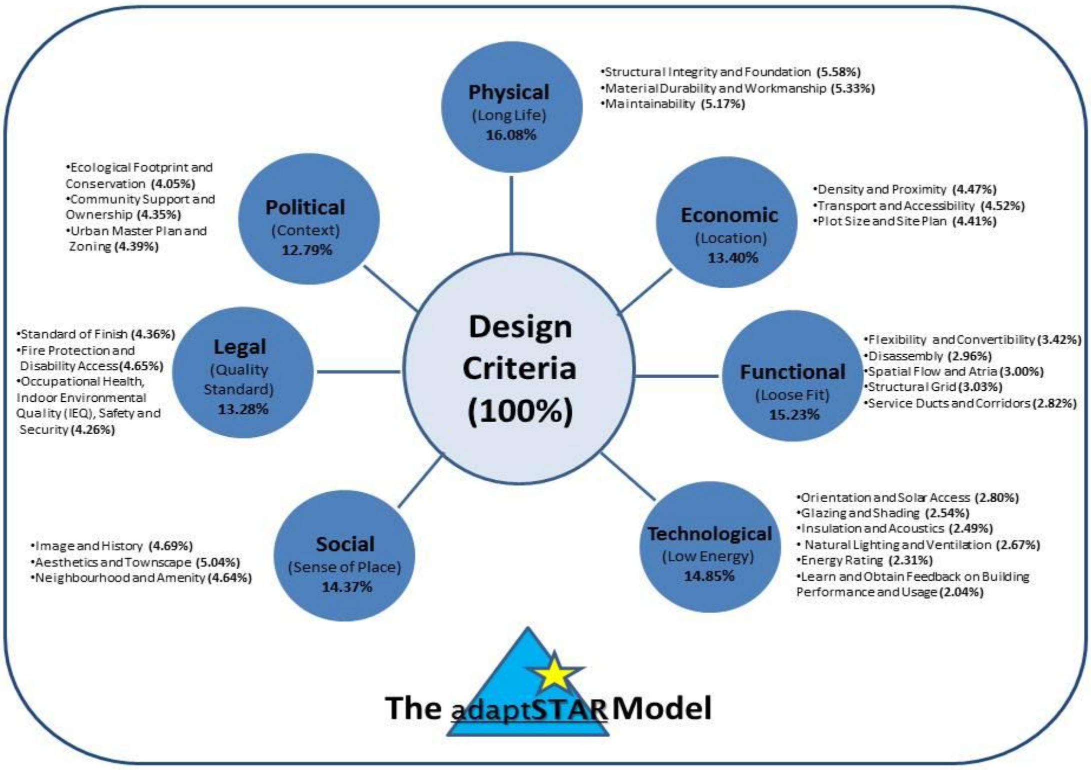


FIGURE 5-9 THE ADAPTSTAR MODEL (FINAL DEVELOPMENT)

The model can be applied using two approaches: either through a general ranking based on the main categories and their corresponding percentages, or by using the detailed ranking based on the design criteria. The latter is recommended.

5.6 TESTING OF THE SELECTED CASE STUDIES USING ARP MODEL

The eleven NSW case studies are assessed by the ARP model to determine an independent ranking of their potential for adaptive reuse. The assessment of the GPO Building in Melbourne, which is the pilot study in this study, can be found in Langston (2008) and is presented in Appendix G. The determination of ARP scores is based on assembled documentation for each case study. To avoid undue bias in this process, two strategies were applied. First, the ARP scores were computed before adaptSTAR criteria and weights were determined, and were not amended at any subsequent stage of the research. Second, Professor Craig Langston performed these assessments independent of the researcher. As designer of the ARP model, it was appropriate to outsource this aspect of the research to ensure that appropriate judgment in scoring the case studies occurred and that the eleven NSW cases were consistent with the pilot. A summary of the ARP results using Professor Langston's template is presented in Table 5-9 (see also Appendix H).

TABLE 5-9 ARP TESTING RESULTS OF THE TWELVE CASE STUDIES

A	B	C	D	E	F	G	H	I	J	K	L	M
Egan Street Apartments	1923	1923	81	150	100	0.40	82	68.6	1	HI	69.8	l
Toxteth Church and Hall	1898	1898	109	200	100	0.28	115	62.9	6	HI	66.7	n
Prince Henry Hospital	1881	1881	122	200	100	0.25	121	62.7	-1	HD	63.2	n
Tocal Visitor Centre	1907	1907	95	150	100	0.33	91	58.9	-4	HD	63.2	n
Defence Buildings	1916	1916	87	150	100	0.30	96	53.9	9	HI	59.3	h
GPO Building, Melbourne	1859	1919	85	200	100	0.28	115	49.1	30	MI	66.7	m
George Patterson House	1892	1892	108	200	100	0.20	134	44.3	26	MI	55.0	x
Grand Babworth House	1912	1912	91	250	97	0.22	144	42.0	53	MI	66.7	m
The Mint Coining Factory	1811	1811	193	250	100	0.12	185	39.7	-8	MD	45.1	n
Bushells Building	1923	1923	78	200	100	0.23	128	36.3	50	MI	59.3	x
Sully's Emporium	1885	1885	119	150	100	0.37	87	32.6	-32	MD	66.6	n
Forum Wellness Centre	1886	1886	120	150	100	0.33	91	32.1	-29	MD	63.2	n
Averages			107	188	100	0.27	100	48.6	9		62.1	
Coefficient of variation (Column G) = 28%												

Legend:

A.	Case study project	HI:	Adaptive reuse potential is high and increasing
B.	Date of construction	HD:	Adaptive reuse potential is high and decreasing
C.	Date of last refurbishment	MI:	Adaptive reuse potential is moderate and increasing
D.	Building age	MD:	Adaptive reuse potential is moderate and decreasing
E.	Forecast of physical life	h:	High
F.	Percentage of calculator completed	l:	Low
G.	Annual rate of obsolescence	m:	Moderate
H.	Predicted useful life	n:	Nil
I.	ARP score	x:	Extreme
J.	Years to useful life reached		
K.	ARP comments		
L.	Maximum ARP score		
M.	ARP risk exposure		

By way of example, the three case studies that received the three highest ARP scores are explained briefly below:

- Egan Street Apartments with an ARP score of 68.60% was constructed in 1923, making it 89 year old. Its expected physical life is calculated to be 150 years, which means that the building should be structurally safe and habitable until 2073. Its obsolescence rate is assessed as 0.40% per annum. The building's useful life is predicted at 81 years and therefore it is expected to become obsolete in 2005. However, its adaptive reuse actually occurred in 2004. The building's ARP score is interpreted as high and increasing with a maximum possible ARP score of 69.80% (i.e. in 2005). In terms of ARP risk exposure, the building's score is 'low'.

- Toxteth Church and Hall with an ARP score of 62.90% was constructed in 1898 and is now 114 years old. Its expected physical life is calculated to be 200 years and therefore stand until 2098. Its obsolescence rate is 0.28% per annum. The building's useful life is calculated at 116 years and it is would have been expected to become obsolete in 2014. Nevertheless, it was adaptively reused in 2007 ahead of forecast. The building's ARP score is interpreted as high and increasing with a maximum possible ARP score of 66.70% possible if the intervention had waiting another 7 years. In terms of ARP risk exposure, the building's score is 'nil'.

- Prince Henry Hospital receives an ARP score of 62.70%. It was constructed in 1881 and is now 131 years old. Its expected physical life is calculated to be 200 years and should be structurally safe until 2081. Its obsolescence rate is 0.25% per annum. The building's useful life is calculated at 121 years and it is therefore expected to become obsolete in 2002. It was adaptively reused in 2003. The building's ARP score is interpreted as high and decreasing with a maximum possible ARP score of 63.20% (in 2002). In terms of ARP risk exposure, the building's score is 'nil'.

The lower the ARP score the less aligned is the date of adaptive reuse intervention compared with the model's forecast. The three case studies garnering the lowest ARP scores are also briefly discussed below:

- Bushells Building scores36.30% for ARP. It was constructed in 1923 (i.e. 89 years old). Its expected physical life is calculated to be 200 years, making it habitable until 2123. Its obsolescence rate is 0.23% per annum. The building's useful life is calculated at 128 years and it is therefore expected to become obsolete in 2051. It underwent adaptive reuse in 2001, some 50 years before forecast. The building's ARP score is interpreted as moderate and increasing with a maximum possible ARP score of 59.60% possible. In terms of ARP risk exposure, the building's score is 'extreme'.

- Sully's Emporium with an ARP score of 32.60 per cent was constructed in 1885. It is now 127 years old. Its expected physical life is calculated to be 150 years and should survive until 2035. Its obsolescence rate is 0.37% per annum. The building's useful life is estimated to be87 years rendering it obsolete in 1972. It wasn't adaptively reused until 2004, 32 years later than expected. The building's ARP score is moderate and decreasing with a maximum possible ARP score of 66.60% arising in 1972. In terms of ARP risk exposure, the building's score is 'nil'.

- Finally, Forum Wellness Centre receives an ARP score of 32.10%. Constructed in 1886, this building is now 126 years old. Its expected physical life is predicted to be 150 years, giving it life until 2036. Its obsolescence rate is 0.33% per annum. The building's useful life is calculated at 91 years and so it is expected to become obsolete in 1977. In 2006 the building underwent adaptive reuse (i.e. 29 years later than expected). The building's ARP score is interpreted as moderate and decreasing with a maximum possible ARP score of 63.20%. In terms of ARP risk exposure, the building's score is 'nil'.

The ARP model can assess physical life between 25 and 300 years (Langston, 2008). Since all case studies are heritage-listed, it is not surprising that the physical life forecasts for the case studies range between 150 and 250 years. The mean estimated physical life is 188 years. The annual obsolescence rate has a highest annual rate of 0.40% and a lowest annual rate of 0.12%, with a mean value of 0.27%. The coefficient of variation for obsolescence across all projects is 28%. The mean predicted useful life is 116 years, and the mean actual building age is 107 years.

In determining the ARP, the ARP score ranges from 32.1% to 68.6% with a mean of 48.6%. This means that the case studies vary between a moderate score (20-49%) and a high score (50-100%). All of the projects have moderate or high ARP scores, which explain why they were all suitable candidates for adaptive reuse. In terms of whether the ARP score is increasing or decreasing, 25% of projects (i.e. 3) are high and increasing, 16.67% of projects (i.e. 2) are high and decreasing, 33.33%of projects (i.e. 4) are moderate and increasing and 25.00% of projects (i.e. 3)are moderate and decreasing potential.

5.7 STRATEGIES FOR IMPROVED CASE STUDY REUSE

With the benefit of hindsight, this section explores the potential for improving the success of adaptive reuse interventions later in the case study's life by adopting different strategies at the time of their original design. This activity is performed in the context of technology and opportunity that the designers had access to when the projects were conceived, as well as the practicality of implementation.

The essential design strategies needed for the improvement of each case study are based on the author's personal judgement as an architect and researcher, while drawing some valuable insights from the data collected through the experts' in-depth interviews with reference to each case study's blueprints and literature reviews (Archer, 2002; NSW Department of Planning and RAIA, 2008; Australian Heritage Database, 2011). Each case study is discussed below.

5.7.1 Egan Street Apartments

As a light industrial building, this building is low maintenance and in good physical condition. This is evident in Figure 5-10 and Appendix B, where the building's exterior façade and sidings are made of brick and concrete. Thus, the building has good quality construction although in the long term the use of timbers as window lintels and doors will have to be repaired or upgraded. Further, in terms of potential vertical expansion, it would have been wise if the intended structural load allowed for possible mezzanine or second level addition. Economically, it is strategically located in the centre of Newtown, which had a medium population density and light industry that has since changed into more residential zoning. It is also a privately-owned building and now considered a local heritage landmark that will attract moderate community interest. Even though the building has tight-space planning, it still offers an open plan layout.

Figure 5-10 Egan St. Floor Plan and Facade

The massive external brick walls of the building provide some thermal mass that help insulate the interior from the outside conditions, however heating is essential. As seen on the existing floor plan, there are only two big windows at the rear side of the building while at the front are doors leading to the small office and the timber roller shutter door for the driveway. This does not allow natural ventilation and provides poor airflow movement in the interiors.

The design strategies identified to improve the original design of this case study include enhancing its structural capacity so that it will be able to accommodate vertical expansion, where in this case a possible mezzanine level extension can be provided. As an industrial building, the designer can anticipate future vertical expansion even though the requirement of the client is only to accommodate their present need for mechanical purposes. Although brickwalls are the popular or available material during those days, cement was also newly introduced around that time. It could have been better to use cement for its walls so that additional beams for possible level extensions in the future can be guaranteed. Besides, the brickwork provided in the original design is only capable of supporting the roof of the building. The provision of cement can encourage a higher floor to ceiling ratio which would be ideal for raised floors or concealed ceiling additions when future expansion needs to cater for vertical and horizontal circulation of services. This is also a good strategy to compensate for its tight plan using all its side boundaries.

Concrete walls have better thermal mass than brickwalls and so can contribute to lower energy demand for the building. Also if a longer awning was provided on the facade and canopies installed over its large windows at the rear, sunshading would be enabled. To improve airflow movement, a good strategy would have been to provide roof exhausts to let out hot air and add insulation linings that can deflect heat and minimise sound transfer. Alternatively, the provision of skylight or clerestory windows would allow natural daylight to the building. In terms of linings, the use of asbestos made products to prevent possible contamination in the future would not have been foreseeable.

As to overall quality, the original design has above standard brickwalls for an industrial building, but the wooden materials were poor. With the use of concrete rather than brick, wooden lintels for the doors and windows would not be used and hence reduce decay and cracking in the future. Also, the use of galvanized iron sheets as roll up shutters could be used instead of the timber shutter doors to increase longevity and lower maintenance. Glazing and fire protection could have been considered in the conceptual design stage, however such technology was not available at that time.

5.7.2 GRAND BABWORTH HOUSE

As a 93-room grand mansion, the building has enjoyed adequate funding for maintenance purposes and its physical condition is good. As shown in Appendix B, the existing plans and its interiors were luxuriously designed and exhibit quality workmanship. It features good joinery, magnificent oak panelled walls, decorative plaster works and grand timber stairway. It is a privately owned high-end estate building and now a State Heritage landmark which will attract high community interest. The mansion is located in a suburban area and has significant garden features. It also has grand balconies and porches that give a good view of the harbour and the garden.

The overall design strategy that was needed to improve the design of the Babworth House would have been to make it more functional in a way that it provides ample spatial flow and allows an open plan layout. Although the mansion has an interior courtyard, balconies and high ceilings, too much room partitions discourage natural ventilation to go deeper into the partitioned rooms. Even though the wooden external walls of the building provided some thermal mass that would help insulate the interior from the outside conditions, moderate heating is still essential. Thus, double skin layer panelled walls with insulation linings could have been provided. Also the use of asbestos made products should not have been used as construction materials for the mansion, but the dangers of asbestos were not known at the time.

The mansion has a skylight allowing daylight passing thru the courtyard; but natural lighting is missing in many of the spaces, especially in the basement area.

5.7.3 TOCAL VISITOR CENTRE

As shown in Figure 5-11 and Appendix B, the centre has received moderate maintenance since it has caretakers to upkeep the whole Tocal Homestead. The centre was constructed to a good standard made of timber, brick and stone, although its sawn round timber posts on solid base rock needs careful maintenance in the long term. The centre's foundation is clay soil overlaying various types of sandstones. It is an 18 metre by 16 metre open structure, 8 metres high at the apex with 4 metre eaves. The original galvanized iron roof was replaced with zincalume roofing sheets during the 1990s. This Australian rural shed and state heritage listed landmark is a historic site of national interest, although located in a rural setting will attract moderate community interest. The centre was privately owned before it was sold to CB Alexander Foundation.

FIGURE 5-11 EXISTING FAÇADE OF TOCAL CENTRE

The centre faces the north and enjoys full use of the sun. Better treatment of the exterior facades could have occurred to improve thermal performance and energy conservation. Further, double-skin external wall and roof cladding construction is needed to incorporate thermal and acoustic insulation. Maximising opportunities for natural ventilation and heating is important such as the provision of exhaust fans in the roof apex, gable vents and louvres for good airflow.

Even though the case study was only intended to store hay and farming equipment, the structural capacity of its original design could have been improved by using a concrete base as the main floor and as a footing for timber columns to protect against decay due to rising damp and water seepage. Also the standard of quality could have been better by installing more durable materials for finishes. Glazing also could have been provided although during those times it would have been unusual to do so for an agricultural shed.

5.7.4 TOXTETH CHURCH AND HALL

As shown in Appendix B, this building is made up of original stone and brick construction displaying good condition and quality standard structure. It is a local heritage landmark located in the centre of Toxteth. A remarkable characteristic of this building is that its conversion is reversible, meaning the building could be turned back into a church in the future. Both church and hall have an open plan layout with high ceiling. It was constructed to a high standard displaying intricate joinery of the roof and ceiling structures. It is privately owned by a religious congregation; however as heritage landmark in the area, it will attract high community interest.

The design strategy that was needed to improve the church and hall comprises providing some technological attributes to encourage natural daylight, ventilation and improve acoustic conditions. It has a good roof and gutter system that allows rainwater collection. Courtyard and landscaping can be provided to join the church and the hall while retaining spatial flow. Skylights or clerestory windows also could have been provided to welcome the sun inside the building and roof vents or cathedral windows cross ventilations for good airflow movement. The structural load could have been allocated for potential vertical expansion like providing a mezzanine level in the future.

5.7.5 BUSHELLS BUILDING

As shown in Appendix B, this seven-storey building is made up of masonry walls, timber columns and exposed timber ceiling beams and joists. The building is in good condition and workmanship is of quality standard. It could have been a high maintenance building due to its multi-level condition and food production purposes. This State heritage building is located at the heart of Sydney's central business district building. It is considered important because of its industrial character; historical associations and a witness to the development of local industry in Sydney. These heritage features will attract high community interest. The building has an open floor space plan and opportunities for reversibility of new additions are possible.

The overall design strategy that was needed to improve the Bushells building involves its functional and legal characteristics. As a multi-storey building and functions for tea production, the building should have better fire egress and stairs allocated as well as the provision for future disability access, ramps and corridors. Lifts could have been provided and atrium and light wells incorporated in the interiors to allow natural lighting. Wood panels or cement boards could have been used for wall partitions instead of the selected products to prevent contamination during future renovation.

Window glazing could have been provided for acoustic and smoke sealing purposes although these features were not yet available at that time. Ample space could have been provided to accommodate service ducts, cabling electrical, air-conditioning and other mechanical systems.

5.7.6 DEFENCE BUILDINGS

As shown in Appendix B, these three buildings are made of wood and brick construction that sit on an asphalt surface. They exhibit low maintenance for a one-storey post-WWI building in good condition. The buildings are well-located and have excellent views to the east across Sydney Harbour. These privately owned buildings were an open-plan military hospital, constructed in good standard.

To improve the original design of these buildings, some legal and technological aspects could have been incorporated into the original design, such as providing landscaping or courtyards along or between the verandahs, installing more roof ventilators, canopy on windows, bigger roof eaves, louvred panels and no asbestos materials for cladding, internal linings and insulations on roofs and ceilings and partitions. Fireplaces to provide heating and double skin layers for exterior walls for thermal mass would have been useful. The clerestory roof and high ceiling allows good airflow movement.

5.7.7 SULLY'S EMPORIUM

As shown in Appendix B, this two-storey stone building with light metal truss for its curved roof was used as a mining hardware store and is structurally sound. This local heritage landmark is located in Broken Hill and considered as an important mining enterprise that will attract moderate community interest. It was a privately owned building with an open-plan type and has good joinery. It has a verandah on its storefront and enjoys rear lane access.

To improve the building's original design, correct safety height of balusters could have been applied, canopies and awnings added for sun-shading and mezzanine considered to open up the area instead of a closed second level, providing better airflow movement and high ceiling clearance. Fire egress and disability access could have been considered in the design since it had a public retail function.

5.7.8 THE MINT COINING FACTORY

As shown in Appendix B, this government-owned two-storey sandstone structure of masonry construction is in good condition. The Mint building is located in the central business district of Sydney was constructed to a good standard. As Sydney's oldest and most precious historical sites it attracts high community interest.

The design strategies that could have been incorporated into the original design include the provision of some passive solar and natural ventilation designs by providing more skylights in the two wings, and landscaping surrounding the building and within the central courtyard. The specification of fire prevention and disability access such fire egress and ramps could also have been provided. Additionally, it would have been wise to the conduct soil testing before construction to try and prevent rising damp, mercury and hydrocarbon contamination, as well as control termite infestation. However, such knowledge may have been lacking during those times.

5.7.9 Forum Wellness Centre

As shown in Appendix B, the centre is a one-storey stone and brick structure and is in good condition. The centre is government-owned and is located in the centre of Newcastle. It has an open-plan layout and of good workmanship standard. As a heritage building it will attract moderate community interest. To improve the future conversion process of this building, some technological and legal aspects of its design could have been incorporated, such as the provision of skylights, roof vents, longer eaves, awnings on windows and roof insulations not made of asbestos. The provision of fire safety equipment within the premises in case of fire and glazing on windows could have been ideal however these features may not have been available during that period.

5.7.10 George Patterson Warehouse

As shown in Appendix B, this six to seven level brick construction with timber joists with cast iron columns and elaborate pressed metal ceilings display a good condition and quality standard building. The building is located in the central business district of Sydney and is now an important heritage landmark that will attract high community interest. The building is privately owned and has an open-plan layout for its showrooms on each level. The massive external walls of the building provided thermal mass that help insulate the interior from the outside conditions, but some form of heating is essential.

To improve the original design of the building, the technological and legal aspects of the building should have been further considered, such as the provision of skylights, light wells and an atrium as well as the provision of clerestory and louvred panels near windows and openings, improving natural light, ventilation and good airflow movement. The glazing of windows, fire stairs and egress, ramps and bigger halls leading to the lifts for disability access would have been worth considering but may have been cost prohibitive. Water tank and hot water heating could have been installed, together with the mechanical plant and lift.

5.7.11 Prince Henry Hospital

As shown in Appendix B, this institutional building showcasing Georgian Revival style architecture in the Federation period is of good condition and quality standard. The building is located in the centre of Little Bay and as an important heritage building it will attract high community interest. It has a substantial open-plan layout, especially within its laboratories; wide verandahs, nice balustrades and joinery, as well as roof slates from England. The external walls of the building provide some thermal mass to help insulate the interior from the outside conditions; nevertheless some form of heating is essential.

The overall design strategy needed to improve the building includes adoption of passive solar and natural ventilation design principles that could help reduce the need for artificial heating and cooling. This may have been achievable by providing skylights and roof vents for daylight and ventilation, roof overhangs, awnings and verandas for sun-shading. Better glazing design and fire protection could have been considered in the conceptual stage.

Further, waterproofing is needed to prevent rising damp problems in the future. A courtyard or atrium could also have been provided. Further, avoidance of potentially toxic materials for the insulation of services, partitions and ceilings to prevent contamination would have made a significant difference later in the building's life.

5.7.12 GPO Building, Melbourne

As shown in Appendix B, the building is made of masonry construction and is in excellent condition. The building is an important heritage landmark located in the centre of Melbourne, and is much beloved by Melbournians. The massive external walls of the building provide good thermal mass and help insulate the interior from the outside conditions, but nevertheless some form of heating is essential although the demand on energy would have been moderate. The building was constructed to a reasonably high standard with cast iron columns, coffered ceilings, intricate grille works and winding wooden stairs.

To improve the original design of the building, water tank and hot water heating could have been installed along with mechanical plant. Further, clerestory windows, louvred panels, atrium and light wells to provide natural lighting and ventilation and good airflow movement can be provided in more areas than just the main postal sorting chamber. Better consideration of fire stairs, fire protection equipment and egress, ramps and bigger circulation areas leading to the lifts for disability access could have provided advantage during future renovation.

5.8 CONCLUDING REMARKS

This chapter has sought to develop the adaptSTAR model by defining and weighting necessary criteria to assess design performance to support future adaptive reuse intervention. The resultant model takes the form of a checklist of considerations that, if implemented, would lead presumably to higher potential for reuse later in life. This aspect, of course, has yet to be tested.

In preparation for validating the model, the ARP scores for each case study were computed. These enable the case studies to be ranked and prioritised for intervention; high ARP scores suggest more likelihood of success than buildings displaying low ARP scores.

In addition, using the identified design criteria retrospectively, suggestions are made as to how each of the case studies could have been improved at the time of their creation. So in each case two design solutions are outlined – one as built and one that incorporates additional improvements to facilitate future adaptation.

The next chapter attempts to validate the model by comparing adaptSTAR scores and ARP scores, and determining if improvement in design leads to higher scores and higher success.

CHAPTER 6
VALIDATION OF THE ADAPTSTAR MODEL

6.1 PURPOSE OF THIS CHAPTER

Chapters 4 and 5 described and discussed Stages 1 and 2 of the research plan and outlined how these stages met the first and second objectives of this research. These objectives were to identify and investigate the critical design factors needed in a design evaluation tool by translating the adaptive reuse model into a set of contemporary design strategies that will maximise the opportunity for future optimal adaptive reuse and to discover and apply individual design criteria and appropriate weightings for each strategy.

The list of potential design criteria and their corresponding weighted importance for future building adaptive reuse is established. The focus of this chapter is to fulfill the third objective of this research: to develop and validate a star rating system. Chapter 5 presented the development of the adaptSTAR model and this chapter will convey its application to the twelve selected case studies by analysing the results of testing the adaptSTAR model on the case studies. The conclusions from the ARP results together with the adaptSTAR scores will be compared against the two hypotheses defined in Chapters 1 and 3.

6.2 TESTING OF THE CASE STUDIES USING ADAPTSTAR

Using the weightings discovered in Section 5.5 in Chapter 5, an adaptSTAR score sheet is developed and used to calculate the future building adaptive reuse star rating of the selected twelve Australian case studies. The case study experts, who are also the principal architects of the case study projects, were asked to assess their projects according to the adaptSTAR score sheet provided to them (see Appendix F). The scoring of course must relate to the latent conditions before any adaptive reuse interventions were made, and therefore is a retrospective analysis. To check the veracity of the experts' responses, as well as ensure the consistency of answers throughout the testing process across case studies, the researcher and her primary supervisor (Professor Langston) independently completed the score sheets and their results were compared to those found by the experts.

Both the researcher and Professor Langston based their collaborative answers on the gathered secondary data and interview transcripts. This process of triangulation was helpful as it allowed the research to establish that some of the experts had answered questions based on their present conditions (i.e. after the adaptive reuse intervention) instead of considering the latent conditions prior to reuse. This moderation process led to an agreed adaptSTAR score for each case study.

A star rating schema is developed to express the adaptSTAR scores in a more practical context. Using a similar approach to that adopted by GBC Green Star and LEED energy rating systems, Table 6-1 lists the adaptSTAR star ratings.

TABLE 6-1 ADAPTSTAR STAR RATINGS

adaptSTAR score	Star Rating
85 - 100	***** (5 stars)
70 - 84	**** (4 stars)
55 - 69	*** (3 stars)
40 - 54	** (2 stars)
25 - 39	* (1 star)
Less than 25	unranked

The following sections discuss and analyse the results of the adaptSTAR testing of the twelve case studies for both the actual (as-built) design and the proposed (improved) design. Appendices I and J contain the supporting evidence.

6.2.1 EGAN STREET APARTMENTS

Egan Street Apartments obtained a moderated adaptSTAR score of 79.10% (4 stars). The distribution of the score across the seven obsolescence categories is illustrated in Figure 6-1.

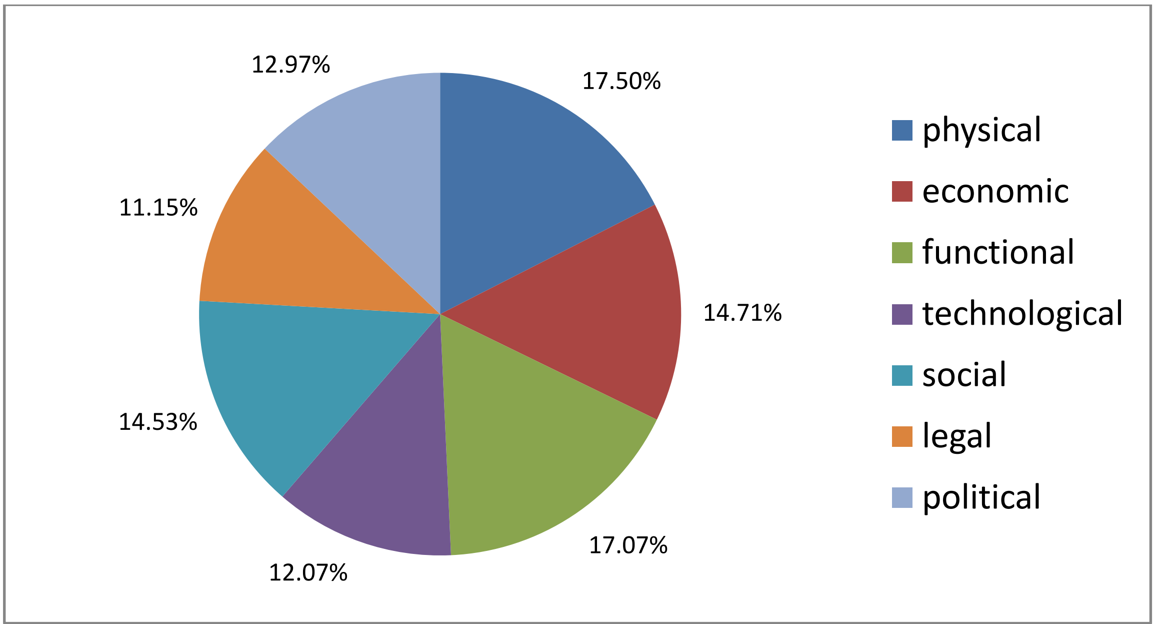


FIGURE 6-1 ADAPTSTAR TEST FOR EGAN STREET APARTMENTS

This score rises to 86.59% (5 stars) if the nominated improvements to the original design had been undertaken when the building was constructed in 1923.

6.2.2 GRAND BABWORTH HOUSE

Grand Babworth House obtained a moderated adaptSTAR score of 75.94% (4 stars). The distribution of the score across the seven obsolescence categories is illustrated in Figure 6-2.

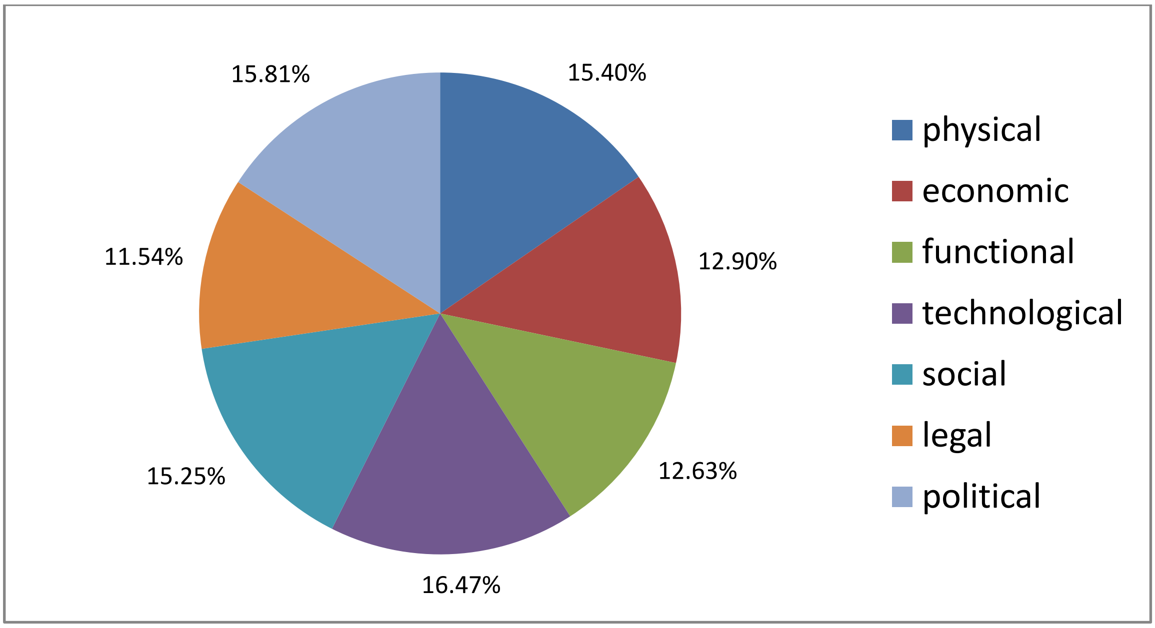


FIGURE 6-2 ADAPTSTAR TEST FOR GRAND BABWORTH HOUSE

This score rises to 80.97% (still 4 stars) if the nominated improvements to the original design had been undertaken when the building was constructed in 1912.

6.2.3 TOCAL VISITOR CENTRE

Tocal Visitor Centre obtained a moderated adaptSTAR score of 62.97% (3 stars). The distribution of the score across the seven obsolescence categories is illustrated in Figure 6-3.

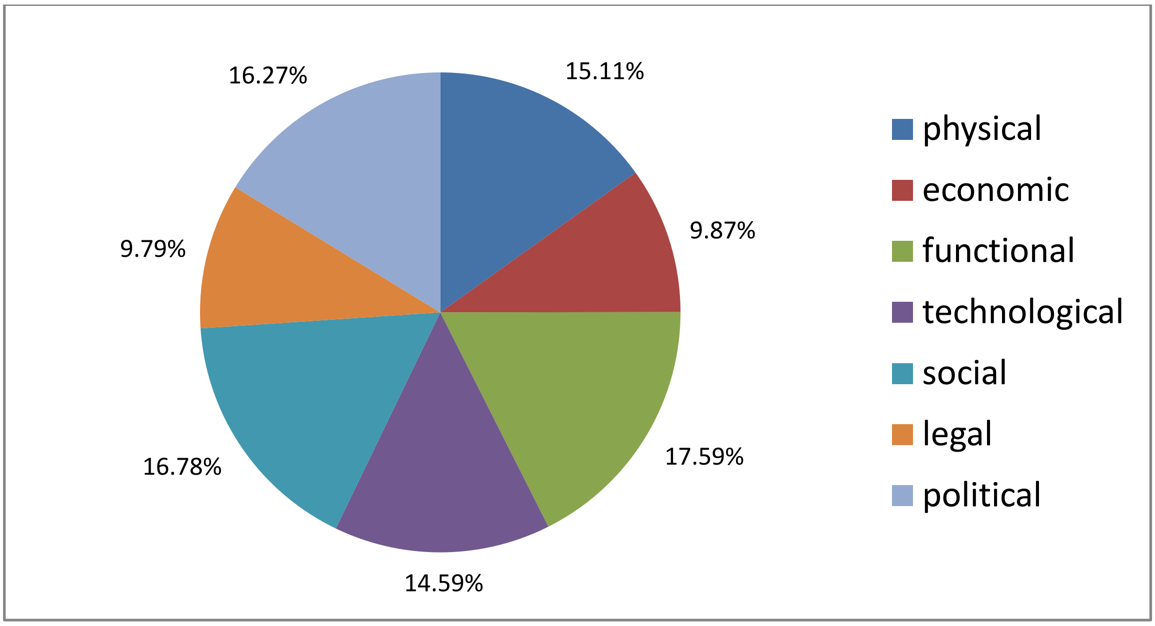


FIGURE 6-3ADAPTSTAR TEST FOR TOCAL VISITOR CENTRE

This score rises to 70.85% (4 stars) if the nominated improvements to the original design had been undertaken when the building was constructed in 1907.

6.2.4 TOXTETH CHURCH AND HALL

Toxteth Church and Hall obtained a moderated adaptSTAR score of 84.27% (4 stars). The distribution of the score across the seven obsolescence categories is illustrated in Figure 6-4.

This score rises to 89.37% (5 stars) if the nominated improvements to the original design had been undertaken when the building was constructed in 1898.

6.2.5 BUSHELLS BUILDING

Bushells Building obtained a moderated adaptSTAR score of 61.94% (3 stars). The distribution of the score across the seven obsolescence categories is illustrated in Figure 6-5.

This score rises to 67.47% (still 3 stars) if the nominated improvements to the original design had been undertaken when the building was constructed in 1923.

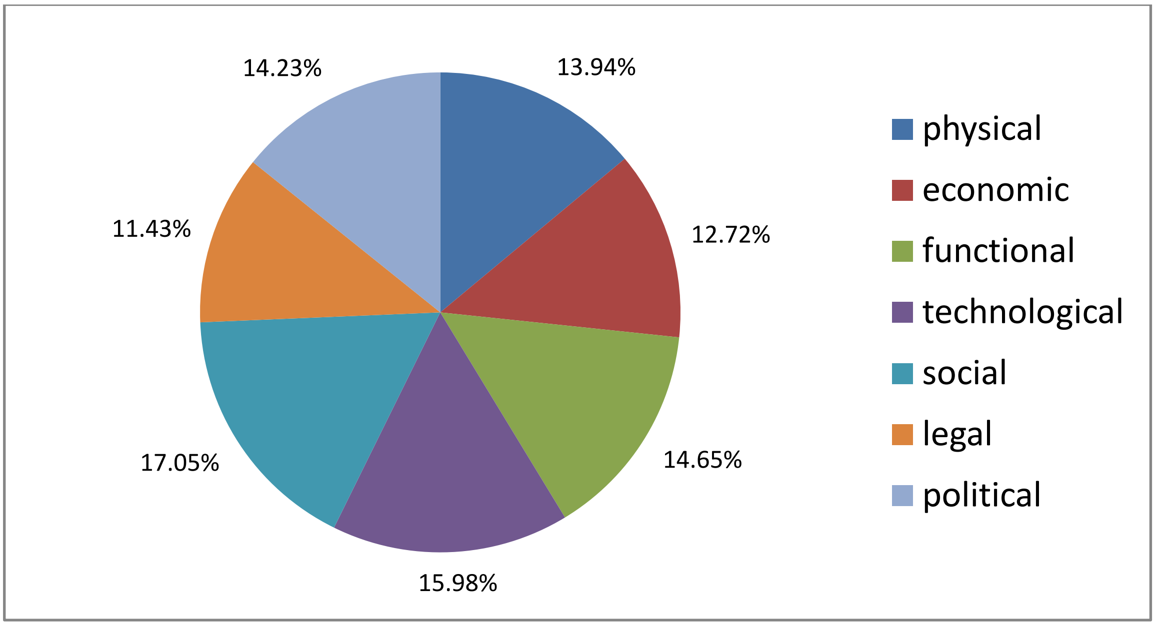


Figure 6-4 adaptSTAR Test for Toxteth Church and Hall

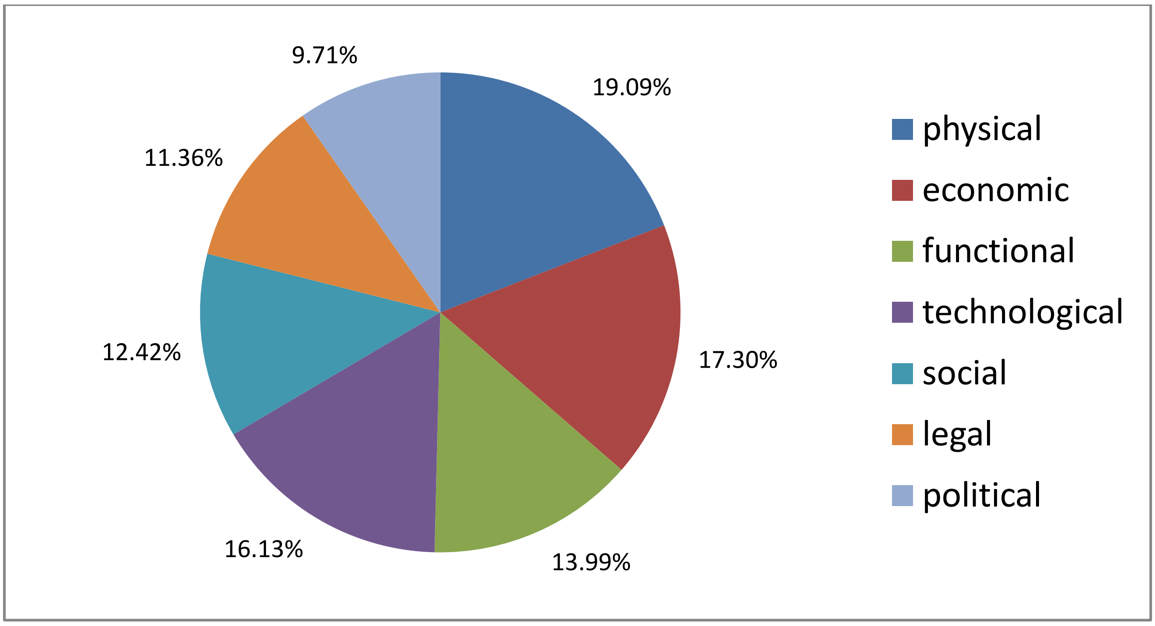


Figure 6-5 adaptSTAR Test for Bushells Building

6.2.6 Defence Buildings

Defence Buildings obtained a moderated adaptSTAR score of 57.83% (3 stars). The distribution of the score across the seven obsolescence categories is illustrated in Figure 6-6.

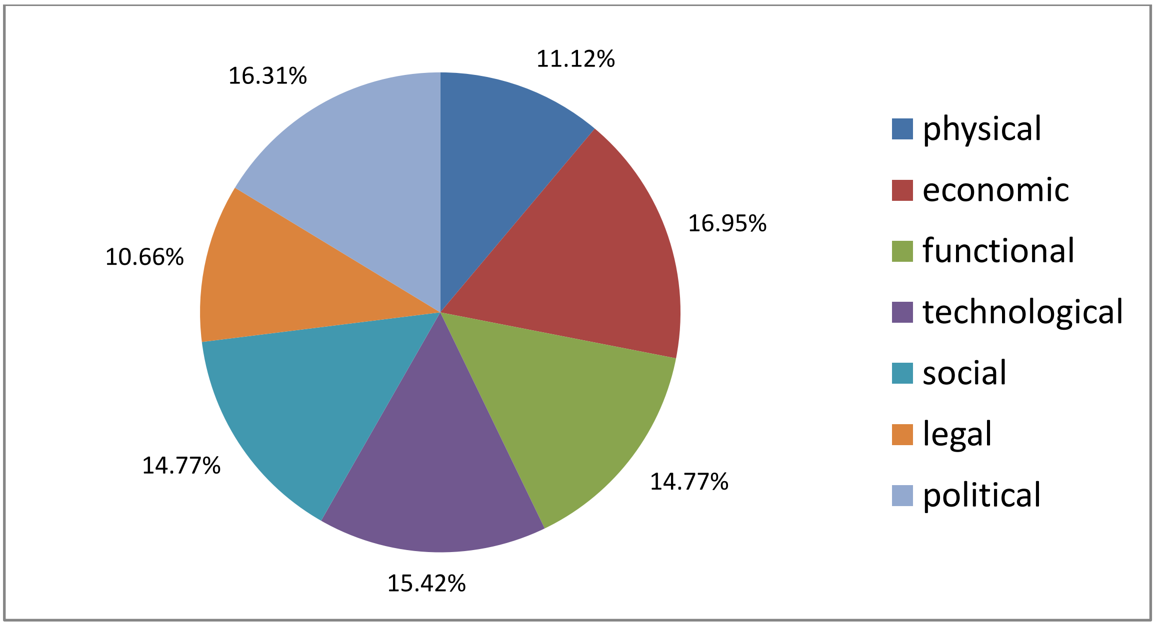


Figure 6-6 adaptSTAR Test for Defence Buildings

This score rises to 62.98% (still 3 stars) if the nominated improvements to the original design had been undertaken when the building was constructed in 1916.

6.2.7 Sully's Emporium

Sully's Emporium obtained a moderated adaptSTAR score of 75.76% (4 stars). The distribution of the score across the seven obsolescence categories is illustrated in Figure 6-7.

This score rises to 79.25% (still 4 stars) if the nominated improvements to the original design had been undertaken when the building was constructed in 1885.

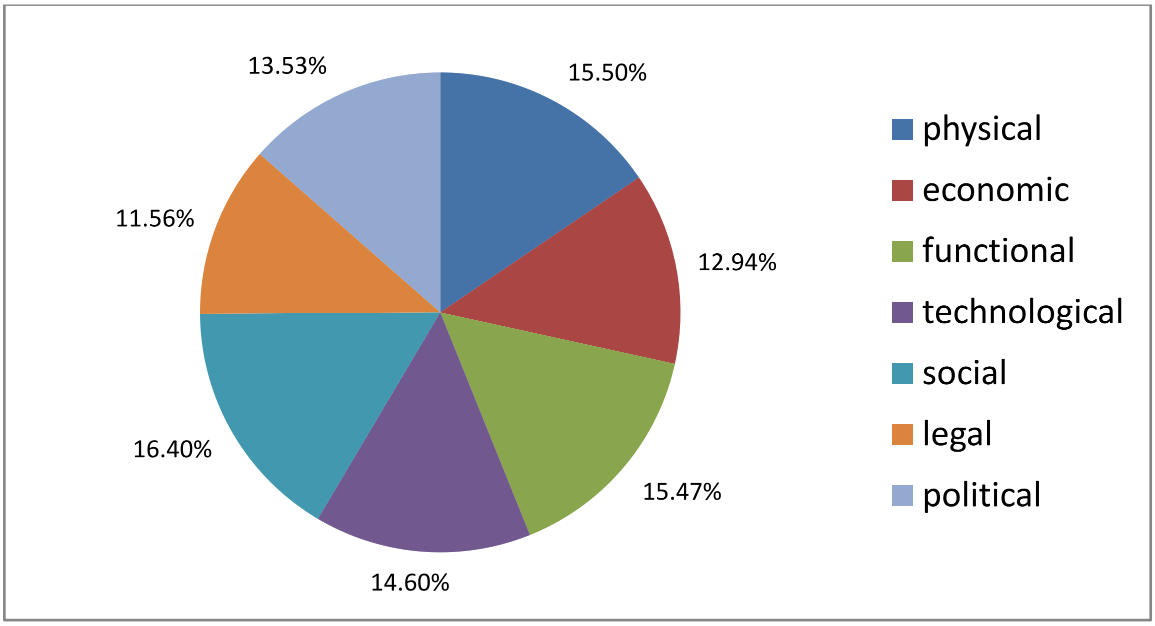


FIGURE 6-7 ADAPTSTAR TEST FOR SULLY'S EMPORIUM

6.2.8 THE MINT COINING FACTORY

The Mint Coining Factory obtained a moderated adaptSTAR score of 56.03% (3 stars). The distribution of the score across the seven obsolescence categories is illustrated in Figure 6-8.

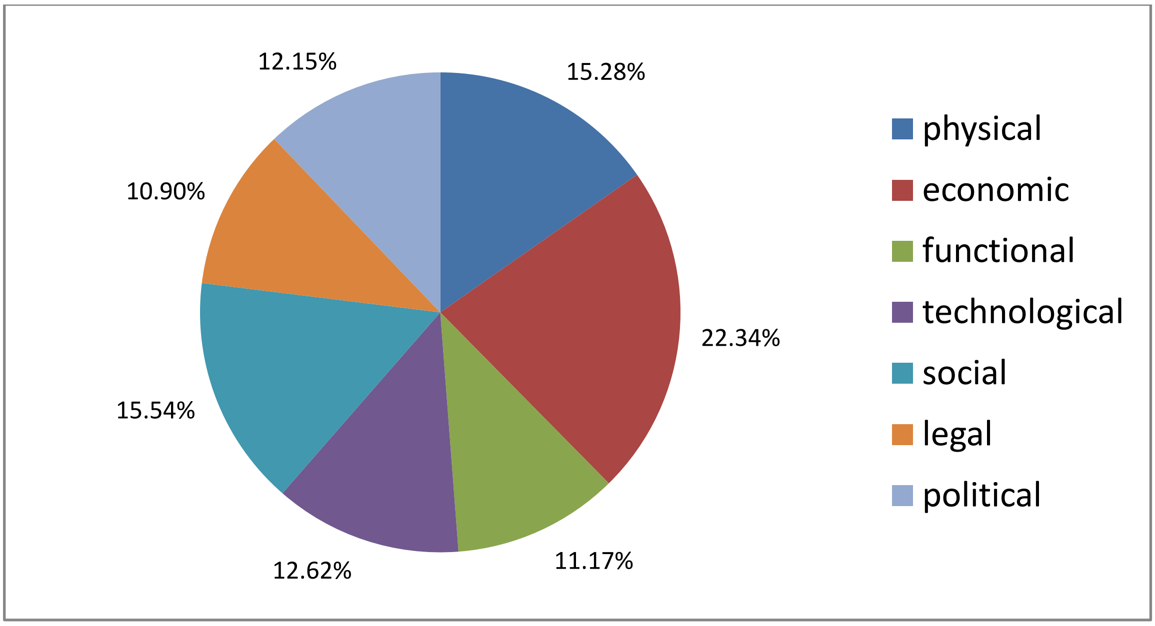


FIGURE 6-8 ADAPTSTAR TEST FOR THE MINT COINING FACTORY

This score rises to 64.78% (still 3 stars) if the nominated improvements to the original design had been undertaken when the building was constructed in 1811.

6.2.9 THE FORUM WELLNESS CENTRE

Forum Wellness Centre obtained a moderated adaptSTAR score of 69.68% (3 stars). The distribution of the score across the seven obsolescence categories is illustrated in Figure 6-9.

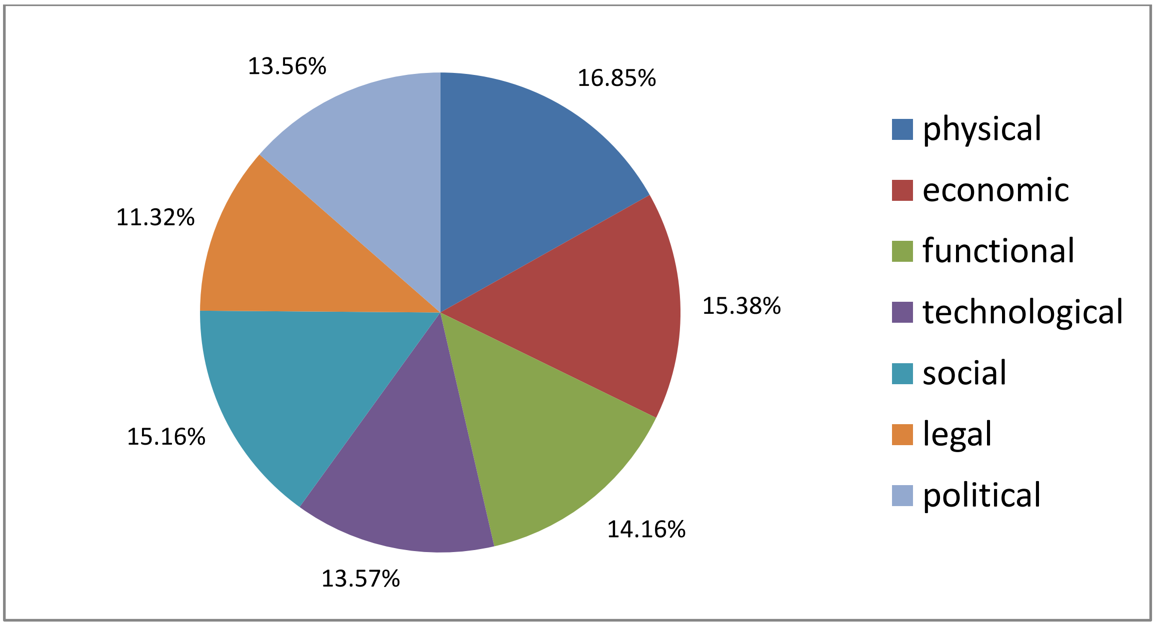


FIGURE 6-9 ADAPTSTAR TEST FOR FORUM WELLNESS CENTRE

This score rises to 74.40% (4 stars) if the nominated improvements to the original design had been undertaken when the building was constructed in 1886.

6.2.10 GEORGE PATTERSON WAREHOUSE

George Patterson Warehouse obtained a moderated adaptSTAR score of 59.63% (3 stars). The distribution of the score across the seven obsolescence categories is illustrated in Figure 6-10.

This score rises to 62.67% (still 3 stars) if the nominated improvements to the original design had been undertaken when the building was constructed in 1892.

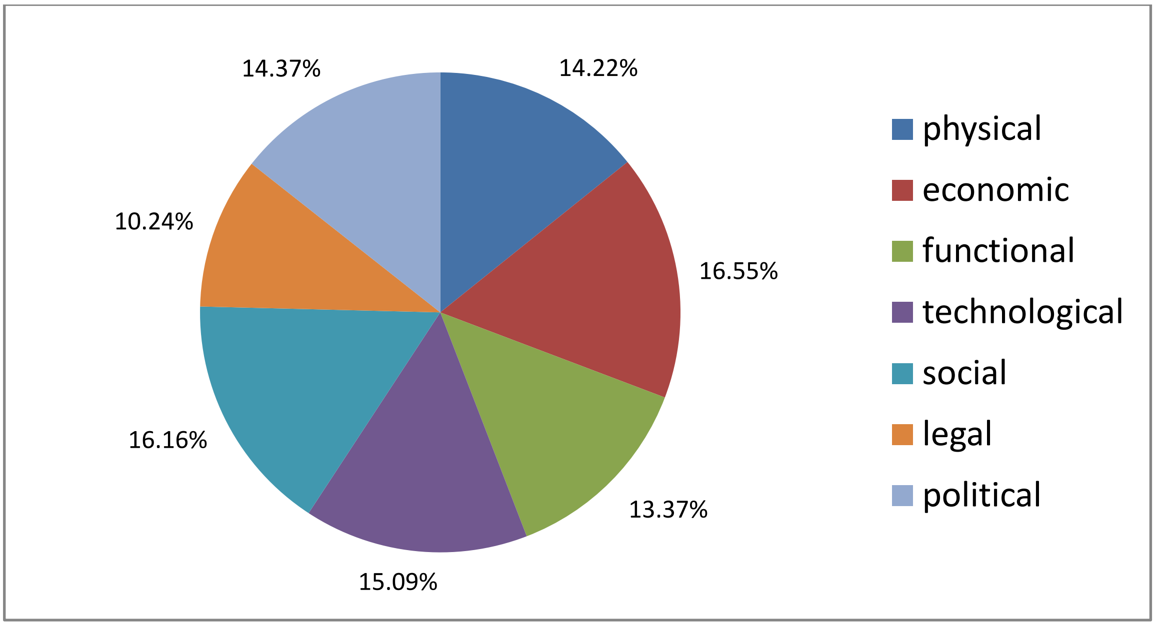


FIGURE 6-10 ADAPTSTAR TEST FOR GEORGE PATTERSON WAREHOUSE

6.2.11 PRINCE HENRY HOSPITAL

George Patterson Warehouse obtained a moderated adaptSTAR score of 69.79% (3 stars). The distribution of the score across the seven obsolescence categories is illustrated in Figure 6-11.

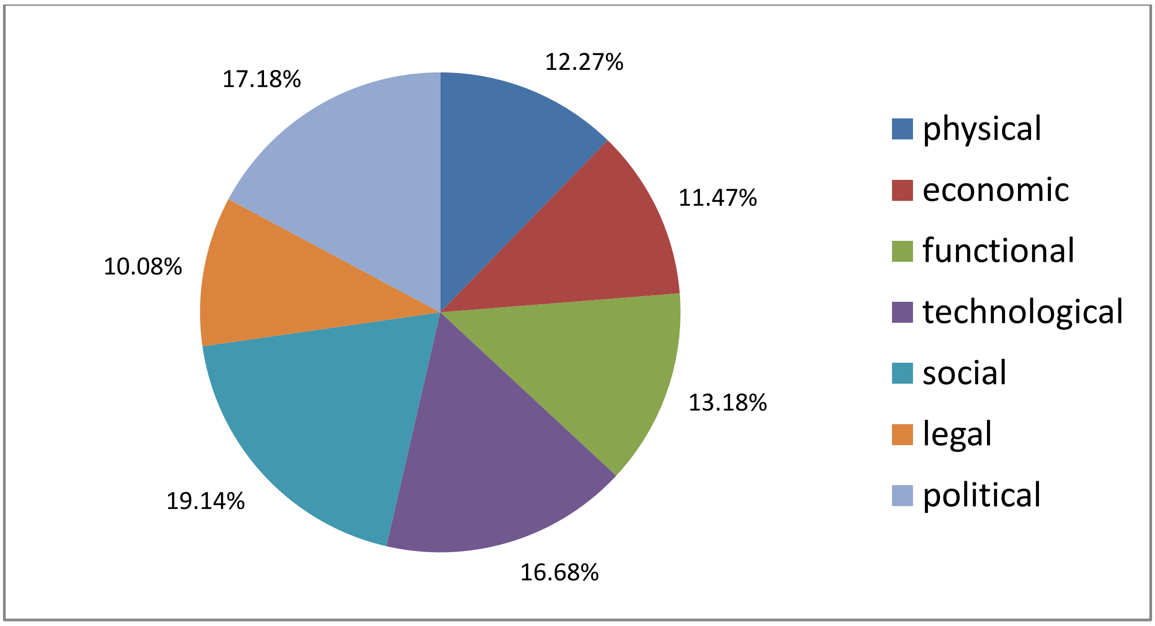


FIGURE 6-11 ADAPTSTAR TEST FOR PRINCE HENRY HOSPITAL

This score rises to 76.96% (4 stars) if the nominated improvements to the original design had been undertaken when the building was constructed in 1881.

6.2.12 GPO Building, Melbourne

GPO Building, Melbourne, obtained a moderated adaptSTAR score of 83.17% (4 stars). The distribution of the score across the seven obsolescence categories is illustrated in Figure 6-12.

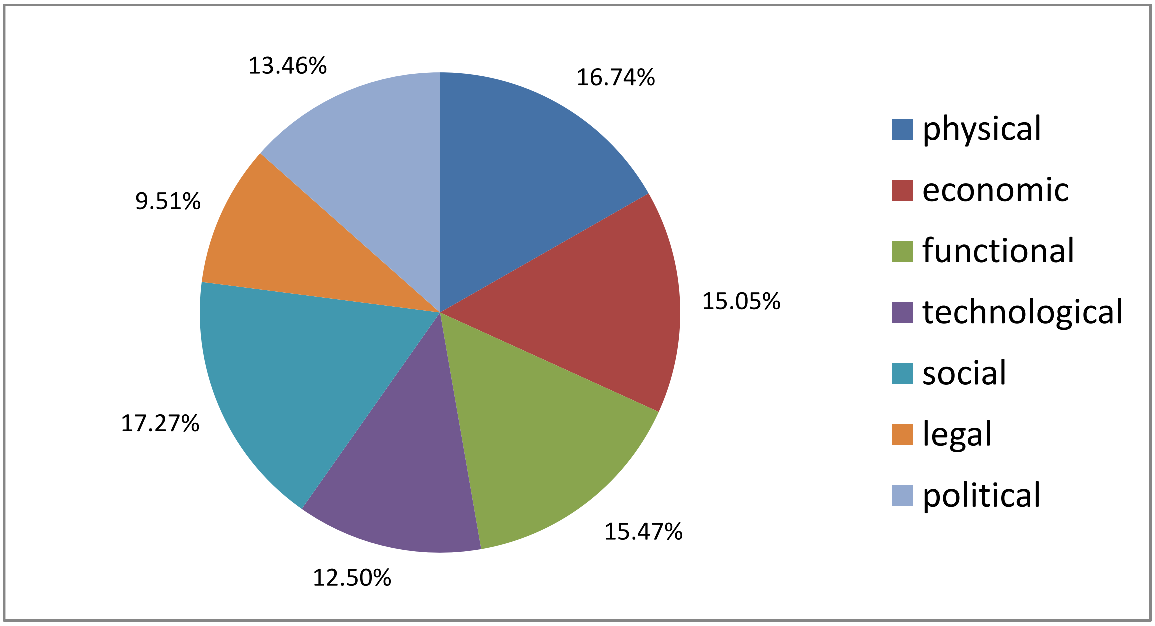


Figure 6-12 adaptSTAR Test for GPO Building, Melbourne

This score rises to 86.30% (5 stars) if the nominated improvements to the original design had been undertaken when the building last underwent major refurbishment in 1919.

6.3 TESTING OF HYPOTHESIS H1

Hypothesis H1 states that there is a relationship between the ARP model and the new adaptSTAR model: the more successful the adaptive reuse project, the higher the adaptSTAR score. Table 6-2 provides the essential data upon which this hypothesis can be initially tested. Scores pertain to the original (as-built) design.

TABLE 6-2 SUMMARY OF ADAPTSTAR AND ARP RESULTS (AS-BUILT)

Case Study Project	adaptSTAR	Actual ARP	Maximum ARP
Egan Street Apartments	79.10	68.6	69.8
Grand Babworth House	75.94	42.0	66.7
Tocal Visitor Centre	62.97	58.9	63.2
Toxteth Church and Hall	84.27	62.9	66.7
Bushells Building	61.94	36.3	59.3
Defence Buildings	57.83	53.9	59.3
Sully's Emporium	75.76	32.6	66.6
The Mint Coining Factory	56.03	39.7	45.1
Forum Wellness Centre	69.68	32.1	63.2
George Patterson House	59.63	44.3	55.0
Prince Henry Hospital	69.79	62.7	63.2
GPO Building, Melbourne	83.17	49.1	66.7
Mean	**69.68**	**48.6**	**62.1**
Coefficient of Variation	**14.30%**	**26.02%**	**10.88%**

In order to validate the adaptSTAR model, the results for the twelve case studies are compared to those produced by the ARP model. The use of regression is applied to exhibit quantitatively the correlation between the adaptSTAR score (taken as the independent variable) and the actual ARP score (taken as the dependent variable). Linear regression (line of best fit) is computed to establish the relationship, if any. Regression analysis is commonly used to determine the relationship between two variables, and the correlation coefficient (r^2) is used to measure the degree of linear association between them on a scale of 0 to 1 (Schroeder et al., 1986). A strong correlation can be interpreted as a coefficient of 0.7 or more (Achen, 1982).

Figure 6-13 shows that there is little relationship between adaptSTAR and actual ARP scores. At first this suggests that H1 cannot be supported. But it is unreasonable to compare adaptSTAR against actual ARP, since the latter is influenced by when the intervention took place, rather than the optimum time.

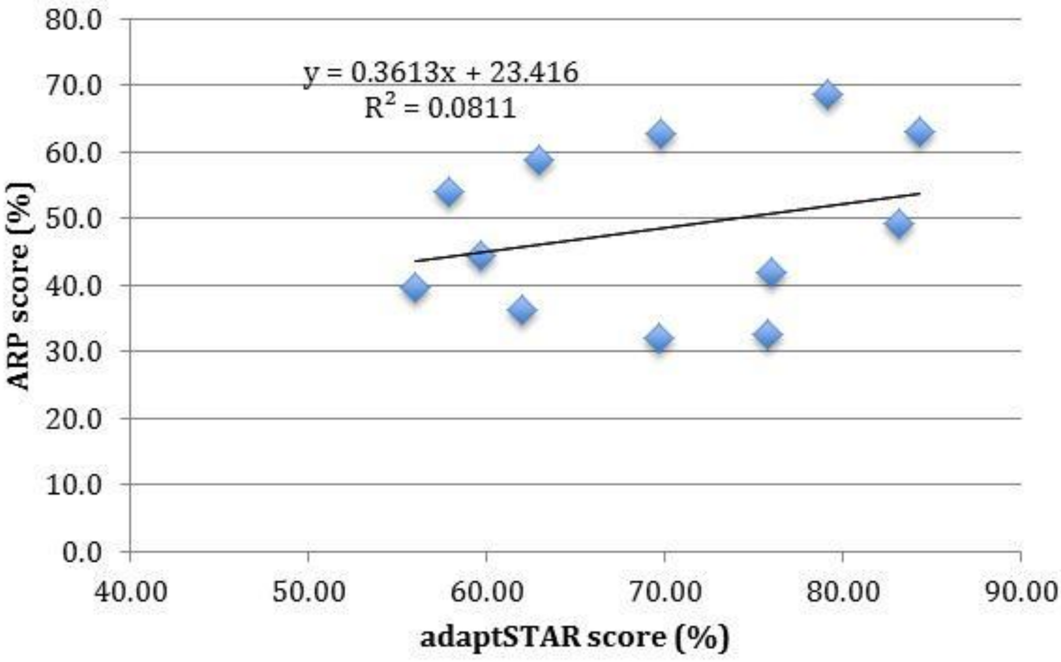


FIGURE 6-13 RELATIONSHIP OF ADAPTSTAR AND ACTUAL ARP SCORES (AS-BUILT)

Figure 6-14, alternatively, compares adaptSTAR with maximum ARP scores. Maximum ARP reflects the optimum intervention point for adaptive reuse (i.e. when the useful life expires and the building is obsolete). While this is a forecast and may not always be correct, so too the adaptSTAR score implies that a future intervention occurs at the appropriate time – not prematurely or belatedly.

The r^2 value of 0.6763 indicates a moderately high correlation between adaptSTAR and maximum ARP. The regression line indicates that higher adaptSTAR scores should occur for higher ARP scores, or in other words, the two variables are positively correlated. The line of best fit provides a possible predictor for the dependent variable (ARP) based on the independent variable (adaptSTAR) in this case.

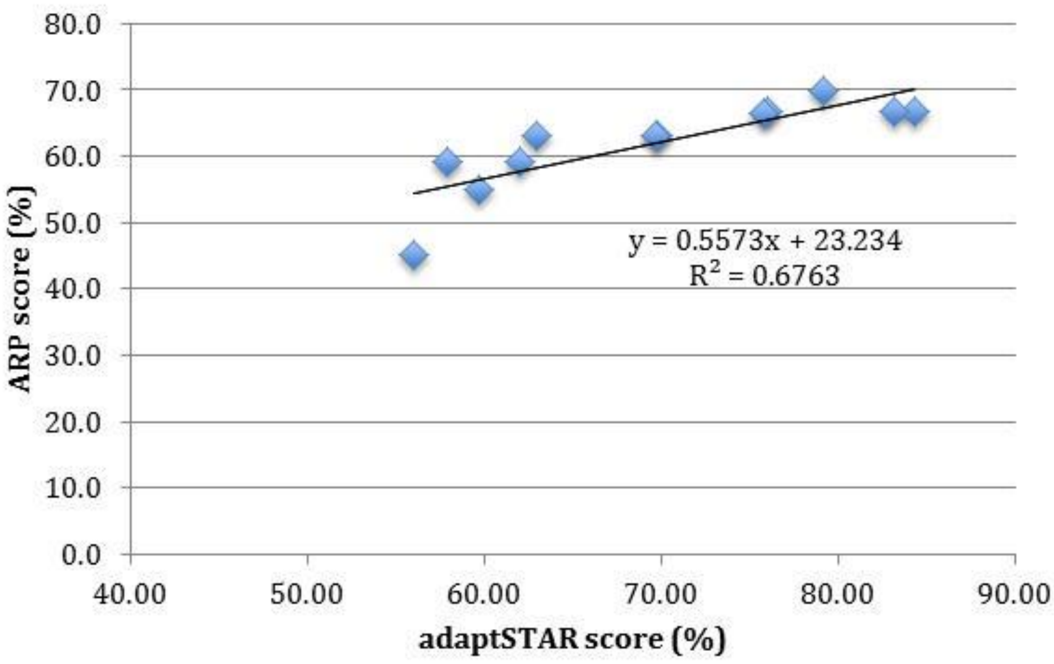


FIGURE 6-14 RELATIONSHIP OF ADAPTSTAR AND MAXIMUM ARP SCORES (AS-BUILT)

Table 6-3 follows a similar procedure, except that the adaptSTAR and ARP scores are adjusted to take account of the proposed improvements to the as-built design. In the case of ARP scores, the 'best case' obsolescence factor is used to recalculate actual and maximum ARP. Improved designs tend to have lower ARP scores as they become obsolete later in life than a design of poorer performance.

TABLE 6-3 SUMMARY OF ADAPTSTAR AND ARP RESULTS (IMPROVED)

Case Study Project	adaptSTAR	Actual ARP	Maximum ARP
Egan Street Apartments	86.59	50.2	59.3
Grand Babworth House	80.97	29.9	55.0
Tocal Visitor Centre	70.85	45.2	50.3
Toxteth Church and Hall	89.39	56.7	63.2
Bushells Building	67.47	15.7	33.0
Defence Buildings	62.98	35.3	45.1
Sully's Emporium	79.25	34.5	55.0
The Mint Coining Factory	64.78	31.1	33.0
Forum Wellness Centre	74.40	34.1	50.3
George Patterson House	62.67	21.7	33.0
Prince Henry Hospital	76.96	62.7	63.2
GPO Building, Melbourne	86.30	39.5	59.3
Mean	**75.22**	**38.1**	**50.0**
Coefficient of Variation	**12.68%**	**36.08%**	**23.07%**

For the improved designs, Figures 6-15and 6-16 compare adaptSTAR with actual ARP scores and adaptSTAR with maximum ARP scores respectively.

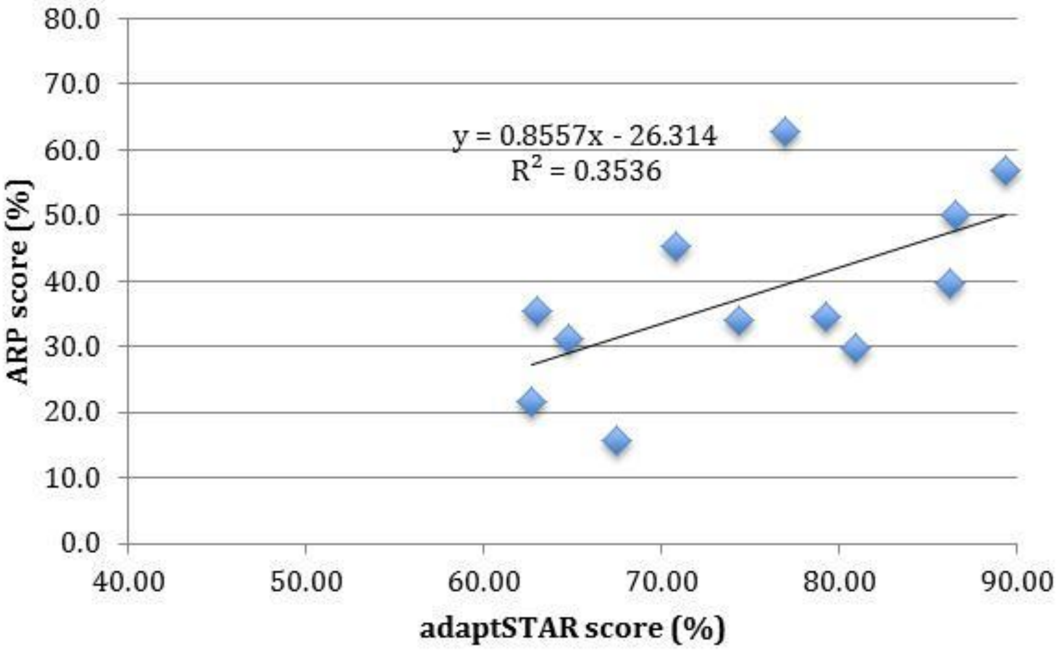


FIGURE 6-15 RELATIONSHIP OF ADAPTSTAR AND ACTUAL ARP SCORES (IMPROVED)

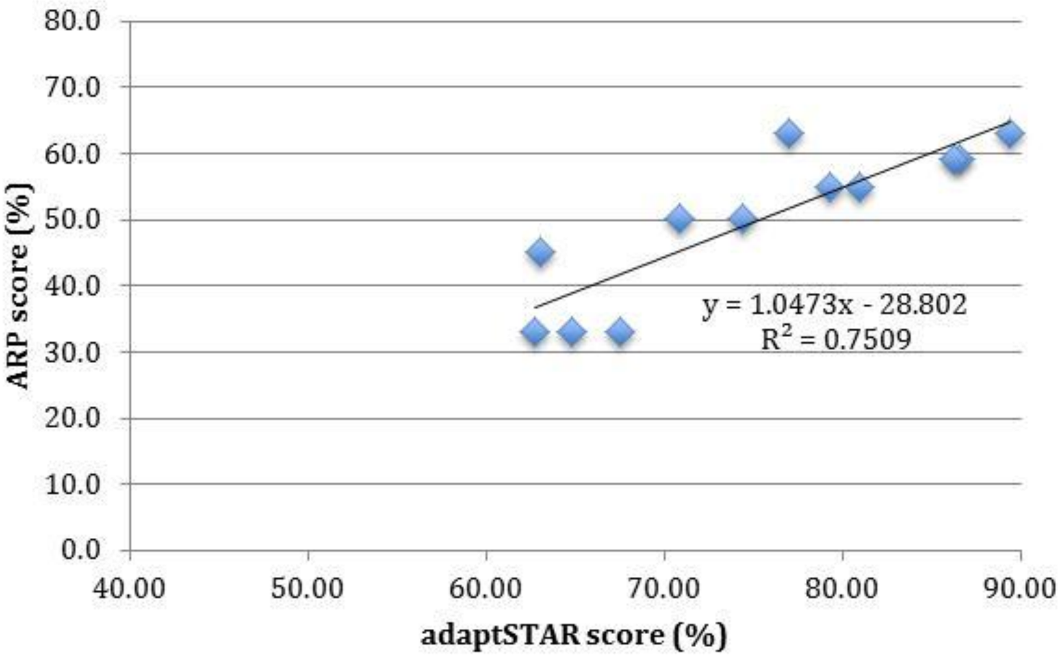


FIGURE 6-16 RELATIONSHIP OF ADAPTSTAR AND MAXIMUM ARP SCORES (IMPROVED)

In both cases the r^2 values increase and are positively correlated. An r^2 of 0.7509 is computed between adaptSTAR and maximum ARP, which is interpreted as a strong relationship. Furthermore, comparing Figure 6-15 with Figure 6-17, it can be observed that the improved designs for each case study out-perform the as-built designs, as indicated by the higher adaptSTAR scores, while the relationship between adaptSTAR and ARP is strengthened.

Hypothesis H1 is therefore proven.

6.4 TESTING OF HYPOTHESIS H2

Hypothesis H2 states that the use of the adaptSTAR tool during the original facility design processes leads to higher ARP scores when the facility is obsolete. Table 6-4 provides the essential data upon which this hypothesis can be tested.

TABLE 6-4 SUMMARY OF ADAPTSTAR AND ARP RESULTS (AS-BUILT V IMPROVED)

Case Study Project	% Change in adaptSTAR	% Change in Actual ARP	% Change in Maximum ARP
Egan Street Apartments	+9.47	-26.82	-15.04
Grand Babworth House	+6.62	-28.81	-17.54
Tocal Visitor Centre	+12.51	-23.26	-20.41
Toxteth Church and Hall	+6.08	-9.86	-5.25
Bushells Building	+8.93	-56.75	-44.35
Defence Buildings	+8.91	-34.51	-23.95
Sully's Emporium	+4.61	+5.83	-17.42
The Mint Coining Factory	+15.62	-21.66	-26.83
Forum Wellness Centre	+6.77	+6.23	-20.41
George Patterson House	+5.10	-51.02	-40.00
Prince Henry Hospital	+10.27	no change	no change
GPO Building, Melbourne	+3.76	-19.55	-11.09
Mean	**+8.22**	**-21.68**	**-20.19**

It most case studies, an improvement in the original design as a result of adaptSTAR insight lead to a reduction in actual or maximum ARP. Only Sully's Emporium and Forum Wellness Centre obeyed the hypothesis in regard to actual ARP, and no case study obeyed the hypothesis in regard to maximum ARP. Furthermore, Prince Henry Hospital's improved adaptSTAR score had no effect on either actual or maximum ARP.

However, the reverse of the hypothesis is generally supported. The use of the adaptSTAR tool during the original facility design processes leads to lower ARP scores when the facility is obsolete. The reason for this is that superior design strategies to enable future adaptive reuse intervention appear to increase the useful life of the building. This result in lower ARP scores as the expected date of intervention is delayed.

Table 6-5 compares useful life predictions between as-built and improved designs as produced by the ARP model. In all but one case, the predicted useful life for the improved design rose above that of the as-built design. A mean increase of about 15% is computed. This suggests that use of the adaptSTAR model during facility design can lead to buildings that have a longer useful life, which implies better deployment of resources and less social cost.

TABLE 6-5 COMPARISON OF USEFUL LIFE FORECASTS (AS-BUILT V IMPROVED)

Case Study Project	Original Useful Life Forecast (yrs)	Improved Useful Life Forecast (yrs)	% Change in Useful Life
Egan Street Apartments	82	96	+17.07
Grand Babworth House	144	168	+16.67
Tocal Visitor Centre	91	106	+16.48
Toxteth Church and Hall	116	121	+4.31
Bushells Building	128	164	+28.13
Defence Buildings	96	111	+15.63
Sully's Emporium	87	101	+16.09
The Mint Coining Factory	185	205	+10.81
Forum Wellness Centre	91	106	+16.48
George Patterson House	134	164	+22.39
Prince Henry Hospital	121	121	no change
GPO Building, Melbourne	116	128	+10.34
Mean	**116**	**133**	**+14.66**

6.5 CONCLUDING REMARKS

Hypothesis H1 is supported by the case study data, while Hypothesis H2 is not. An alternative H2 hypothesis is supported, indicating that the use of the adaptSTAR tool during the original facility design processes leads to lower ARP scores when the facility is obsolete. This is due to increased useful life, which is considered economically, socially and environmentally superior.

Nevertheless, there are only 12 data points in this analysis and further testing of the model is recommended to guarantee its successful application. Moreover, the case studies were all ‘heritage buildings’ which certainly influence the results.

CHAPTER 7
CONCLUSION AND RECOMMENDATIONS

7.1 PURPOSE OF THIS CHAPTER

This chapter presents a brief summary of the previous chapters of the thesis and discusses the results of the three stages of the research methodology in relation to the objectives set out in Chapter 1. This chapter also identifies the limitations of this research and the possibilities for further research. The implications for practice and recommendation for future development and commercialisation of the adaptSTAR model are discussed before the end of the research project is reached.

7.2 THESIS SUMMARY

As the effects of man-made climate change become felt around the world, there has been an increasing global and local focus on strategies that address the causes of climate change. Thus, adaptive reuse is relevant to the current climate change adaptation agenda not only because of its ability to recycle existing buildings, resulting in an overall embodied energy saving and reduced requirement for natural resources, but also because it allows for the up-cycling of these existing buildings into robust urban regeneration projects. Building adaptive reuse is a successful global strategy for re-purposing and extending the lifespan of many types of facilities. One example of this is with historical buildings, where adaptive reuse can help to conserve the socio-cultural and historical values of the buildings for future generations to use and enjoy.

Additionally, upgrading existing buildings is a more climate-friendly strategy than building new energy-efficient buildings. In the past, the protection and maintenance of existing buildings, especially ancient monuments, was encouraged through conservation, preservation and adaptation practices using laws and policies implemented on both a global and local scale. However, in spite of the evidence that shows the importance of adaptive reuse, building designers encounter many challenges in resolving the complex set of issues that need to be considered when undertaking adaptive reuse projects as well as determining the requisite design solutions to sustain buildings as they age, since most buildings are not designed to maximise their future adaptive reuse potential.

One thing that becomes obvious in this research in terms of the review of the existing literature is that there is a lack of consensus about what are the most suitable criteria for design decision-making. In addition, what should be the appropriate design criteria to use for maximising the future adaptive reuse potential of new buildings during their design process, as well as the relative weighting of these design criteria? This issue is considered a major gap in existing knowledge. An additional gap is noted in the lack of a rating tool that effectively considers or predicts the adaptive reuse potential of new or future buildings.

Responding to these two deficiencies, and considering the problem statement in Chapter 1, the aim of this research is to create and validate a design evaluation tool that leads to making purposeful design decisions for future adaptive reuse during the development stage. Initial research suggests that that the embedded adaptive reuse potential of a future building can be represented by measurable critical design factors. Three research objectives are developed from the research aim and are answered by completing the three stages of the research methodology. The three objectives comprise:

1. identify and investigate the critical design factors needed in a design evaluation tool by translating the ARP model (Langston, 2008) into a set of contemporary design strategies that maximise the opportunity for the optimal adaptive reuse of buildings in the future;

2. discover and apply individual design criteria and appropriate weightings for each strategy that are informed by a combination of case study analysis, expert interview and practitioner survey; and

3. develop and validate a star rating system, adaptSTAR, that is aligned to best practice and describes predicted adaptive reuse potential in a quantitative manner at the outset of a new project.

This research is an explorative study and is done using a sequential mixed-mode research methodology (qualitative and quantitative) to collect relevant data and enable the findings to be triangulated and validated. Stage 1 addresses the first research objective and uses a qualitative approach, interviewing key experts involved in the twelve selected award-winning adaptive reuse case studies. A list of key design criteria that is derived from the results of the interviews, field surveys and the underpinning literature is identified and established. Stage 2 addresses the second research objective and uses a quantitative research methodology. Selected registered architects in Australia rank and weight the list of design criteria developed in Stage 1 by assessing the relative importance of each strategy and their contexts via an online survey. Stage 3 addresses the third research objective, which tests the new adaptSTARmodel against Langston's ARP model in order for it to be validated.

Two underlying hypotheses emerge from this validation:

H1: There is a positive relationship between the ARP model and the new adaptSTAR model: the more successful the adaptive reuse project, the higher the adaptSTARscore.

H2: The use of the adaptSTAR tool during the original facility design leads to higher ARP scores when the facility is obsolete.

The results obtained from the three stages are discussed in the next section of this chapter, which addresses how the research objectives are answered and presents the findings of the testing of the hypotheses.

7.3 CONTRIBUTION TO KNOWLEDGE

The findings of this research satisfy the research objectives of the thesis. The literature review confirms there is a need to focus on the importance of the sustainable retrofitting of existing buildings, recognising that building adaptive reuse is an important strategy in the climate change agenda. Two knowledge gaps are addressed by fulfilling the research objectives, as demonstrated by the results of the three stages of the research methodology. Stage 1 of this research develops a list of design criteria that were grouped into seven categories that were closely aligned with the seven obsolescence categories identified in the ARP model (Langston, 2008); thus supporting direct comparison.

These seven categories are physical, economic, functional, technological, social, legal and political. The list of design criteria are ranked and weighted in Stage 2 of the research, leading to the development of the adaptSTAR model. The adaptSTAR model's derived weighted scores in percentages are established and these confirmed that even though the categories have different scores, each of the categories is approximately equal weight. Thus, the assumption of the ARP model that the obsolescence factors are treated equally is vindicated. These weights then determine how each criterion is assessed and produce both a score out of 100 and a star rating that benchmarks a new design in terms of its future adaptive reuse potential (see Figure 7-1).This is both a unique and significant contribution to the built environment disciplines.

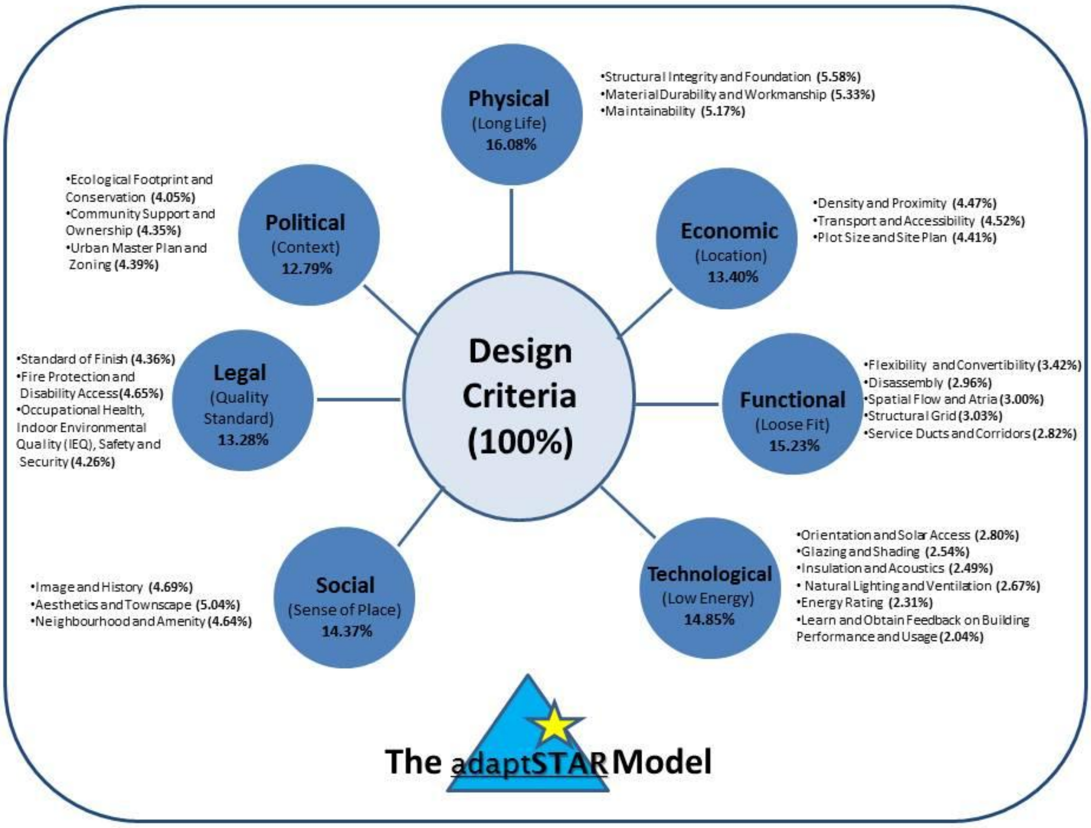


FIGURE 7-1 THE ADAPTSTAR MODEL

To fulfil the third objective, Stage 3 of the research tests of the adaptSTAR model by evaluating the twelve case studies and comparing the results with those produced independently from the ARP model. This process uses both the original as-built design and an improved design; the latter informed by the adaptSTAR model in the context of technologies and knowledge at the time of the original construction.

Hypothesis H1 states that there is a relationship between the ARP model and the new adaptSTAR model: the more successful the adaptive reuse project, the higher the adaptSTAR score. The r^2 value of 0.6763 indicates a moderately high correlation between adaptSTAR and maximum ARP. The regression line indicates that higher adaptSTAR scores should occur for higher ARP scores, or in other words, the two variables are positively correlated. The line of best fit provides a possible predictor for the dependent variable (ARP) based on the independent variable (adaptSTAR) in this case. Repeating this comparison for the improved designs, an even stronger correlation (0.7509) is observed. It is found that the improved designs for each case study outperform the as-built designs, as indicated by the higher adaptSTAR scores, while the relationship between adaptSTAR and ARP is strengthened. Although, there are only 12 data points in this analysis, Hypothesis H1 is therefore proven in this research undertaking. The further testing of the model is recommended to guarantee its successful application as discussed in section 7.4 of this chapter.

Hypothesis H2 states that the use of the adaptSTAR tool during the original facility design processes leads to higher ARP scores when the facility is obsolete. H2 is not supported from the data. The reason for this is that superior design strategies to enable future adaptive reuse intervention appear to increase the useful life of the building. This results in lower ARP scores since the expected date of intervention is delayed. Comparing the as-built and improved designs, it is found that a building's useful life on average increases 14.66%, while the adaptSTAR score increases 8.22% and the maximum ARP score decreases 20.19%. Buildings that are optimised for adaptive reuse potential actually become obsolete later in life than would otherwise be the case, and so contribute more to society before adaptive reuse intervention is necessary.

This research demonstrates that the assessment of future adaptation in newly designed buildings is achievable. The research methodology fills the knowledge gaps identified in the literature. The review of existing research provides insight that there are specific design criteria that lead to achieving future adaptive reuse potential for buildings. Moreover, these design criteria can be measured and developed into a design rating tool, the adaptSTAR model. The adaptSTAR model is an extension to the existing sustainability tools used to measure a building's energy efficiency. It may even be possible to integrate sustainability and adaptability into a single decision tool.

This research extends current knowledge on the significance of adaptive reuse in promoting embodied energy among existing and new buildings as a climate change adaptation strategy. Most importantly, it develops a new concept of 'future building adaptive reuse', which is now defined as a strategy to prolong the useful life of buildings before they reach physical, economic, functional, technological, social, legal or political obsolescence. This concept is a new contribution in the field since existing research focuses on the adaptive reuse of existing buildings only. The introduction of this new concept can help inform architectural design, urban planning and development decisions aimed at reducing overall energy usage of the built environment by minimising embodied energy and promoting vibrant urban regeneration initiatives.

7.4 IMPLICATIONS FOR FURTHER RESEARCH

Focus on the development of new knowledge regarding future building adaptive reuse, sustainability issues and future design directions will continue, probably at an increasing rate for the next generation, propelled by an increasing awareness of environmental responsibility. This focus will make research in this field more important since it not only conveys methods of dealing with the development of new knowledge, but also offers the capacity to manage change. Other research directions that would contribute to the better understanding of adaptive reuse and its link to climate change can be undertaken such as expanding this study beyond the building scale and applied into heritage precincts and historical districts or even at a city wide scale. This study would lead to urban regeneration and sustainability related research initiatives that would strengthen the role of adaptive reuse in the process of shaping cities. This could be a foundation for future research that contributes the development of future urban policy framework in relation to adaptive reuse and sustainability of cities.

Additionally, it would be worthwhile for researchers to widen the focus of this research to include a broader sample of case studies located in different geographical settings and with a more diverse range of design characteristics. To broaden the study from it purposeful sampling approach, it would be worth to expand the sample size by including other actors involved in the decision-making process in adaptive reuse projects such as other building professionals, real estate developers and investors, clients and other private and public/ government institutions.

This research was based on twelve Australian adaptive reuse case studies of heritage-listed buildings. Despite this restricted sample size, it is suggested that the findings can be applied globally. However, the international generalisability has not been tested. Furthermore, this model has also not been tested on existing buildings that are not heritage-listed. Future research could look at exploring global and non-heritage-listed buildings, applying the concept to a large number of case studies with different typologies.

Another interesting research direction may be the application of the adaptSTAR model to unsuccessful adaptive reuse case studies, thus stimulating understanding of the factors that negatively influence adaptive reuse potential during the design process. Studying this area may help with the detailed development and refinement of the model and its concept, as well as test its affectivity as a rating tool similar to Green Star and LEED. Negative evaluation can be a logical step in testing and evaluating the strengths and weaknesses of rating tools like adaptSTAR.

7.5 IMPLICATIONS FOR PRACTICE

The trend towards increasing sustainability through finding new functional purpose for existing buildings, rather than demolishing them and constructing anew, has led to the significance of the concept of future building adaptive reuse. This research provides a checklist that allows for the benchmarking of future buildings with embedded adaptive reuse potential. The application and use of the adaptSTAR model in Australia and on a global scale depends on the willingness of design practitioners and other allied professionals to use the tool during the design process from pre-design and concept decision-making to the implementation of the project. This tool can even be applied to post-construction stages to monitor the adaptability of the newly designed buildings over time.

The adaptSTAR model has important implications for practitioners and clients. However, one issue that may arise that is beyond the scope of this research is the advocacy and awareness process for building clients during the implementation of this model into practice. The design decision-making process involves clients, and if the clients don't recognise the importance of the model's contribution to designing future buildings with maximum adaptive reuse potential, and if the concept is not part of the client's preferences, then the successful inclusion of the model into the design process will be negated.

To ensure that clients are aware of the benefits of using simulation models such as adaptSTAR during the design process and recognise that the model serves as a valuable tool for building sustainability, professional bodies such as the Australian Institute of Architects should take the lead, in conjunction with their counterparts in the global market, in promoting adaptability in the same way organisations such as the Green Building Council have promoted sustainability.

Aside from the publication of a research paper in practice for the implementation of this new rating tool, an open forum is recommended that will serve as an opportunity for public and professional debate so as to publicly discuss and critique the model's future development and commercialisation. Coupled with the publication of this research, this initiative can increase awareness of the potential and benefit of using the adaptSTAR model. Lastly, support for its implementation can be provided through a policy framework or through a commercialisation partnership with a third party developer or professional institute. Other researchers can assist in this process by pursuing future adaptability of buildings in their work.

7.6 CONCLUDING REMARKS

Sir Norman Foster once said that the green agenda is an important issue at present and that every architect or designer will have to design for the present with an awareness of the past for a future which is essentially unknown. This research is timely and has considered Sir Norman's statement since the study investigates previous design principles and strategies in order to inspire future design directions. These design principles highlight the architectural canonical criteria from the Roman architect, Vitruvius such as Utilitas (Commodity), Firmitas (Firmness) and Venustas (Delight); as well as Alex Gordon's criteria for sustainability (i.e. long life, loose fit and low energy) as key design criteria for future buildings.

Many historical buildings, especially those constructed between the 15thand19th centuries, have withstood the passage of time and are still showcasing their beauty and vitality as they embrace new uses. However, in the 20th century, particularly with the emergence of 'international style' buildings, the average building's lifespan has shortened and their function becomes obsolete faster, resulting in the buildings becoming candidates for demolition once they are no longer fulfilling their original purpose. It is important that society does not continue this trend into the 21st Century.

It is not possible to know what lies ahead for future buildings but, using current research on sustainability and the impact on natural resources and climate, it is possible to forecast the connection between built environment activity and sustainability. We know that buildings are responsible for between 40 to 50 per cent of total energy use worldwide. As the single largest contributor to global greenhouse gas emissions, one of the greatest challenges that face the built environment is how to improve and maintain sustainability. To demolish old buildings and replace them with new developments leads to a high demand in energy, land and materials, and the generation of waste, whereas revitalising old buildings and breathing new life and vitality into them extends the building's lifespan and the efficiency of its existence. There are indications that the property and building industry is already changing its mindset, but change needs to happen faster and be supported and encouraged by government policy or legislation.

Considering the social and environmental imperatives, the development undertaken in this research concerning a future adaptation potential rating tool will assist designers in making decisions to achieve optimum efficiency and useful life from their creations. This model's practical application when used with the existing sustainability tools provides a coherent design process, with each of the elements playing different roles that contribute to achieving a more comprehensive result in promoting the sustainability of the built environment during the different stages of the building's lifecycles. Sustainability and adaptability are not mutually exclusive.

An important outcome of this research is its findings can empower designers of buildings to make critical decisions that contribute to improving longevity and future reuse. This research contributes in an innovative way by reverse engineering Langston's ARP model so that the impact of current design decisions on future obsolescence is better understood. The adaptSTAR model provides a new approach in understanding the adaptive reuse value of every building. The list of design criteria is an important development in the research discipline of adaptive reuse potential and establishing the framework of design guidelines for future building adaptive reuse. Both the detailed design criteria and the weighting values of the adaptSTAR model provide significant references to further research in this field.

It is hoped that this work will inspire further investigation into future building adaptive reuse, as well as provide an opportunity for redefining conservation through adaptive reuse and holistically position urban conservation as a determining factor in sustainable development. This research can help promote mutual understanding and empower design professionals, their clients and the communities they serve to take on the role of 'adaptation warriors', safeguarding culture, heritage and the quality of the natural and built environment for future generations to enjoy and admire.

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APPENDICES

Appendix A: Approval Letters

BUHREC Ethics Clearance Approval

BOND UNIVERSITY
BRINGING AMBITION TO LIFE

HUMAN RESEARCH ETHICS COMMITTEE
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Australia
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12 October 2010

Prof Craig Langston, Sheila Conejos, Prof James Smith
Faculty of Business, Technology and Sustainable Development
Bond University

Dear Craig, Sheila and James

Project No: **RO1208**
Project Title: **Designing Future Building Adaptive Reuse**

I am pleased to confirm that your Project, having been reviewed under the Expedited Review Procedure, has been granted approval to proceed.

It is important to remember that BUHREC's role is to monitor research projects until completion. The Committee requires, as a condition of approval, that all investigations be carried out in accordance with the National Health and Medical Research Council's (NHMRC) National Statement on Ethical Conduct in Research Involving Humans and Supplementary Notes. Specifically, approval is dependent upon your compliance, as the researcher, with the requirements set out in the National Statement.

Additionally, approval is given subject to the protocol of the study being under taken as declared in your application, with amendments, where appropriate.

As you may be aware the Ethics Committee is required to annually report on the progress of research it has approved. We would greatly appreciate notification of the completed data collection process and the study completion date.

Should you have any queries or experience any problems, please liaise directly with Caroline Carstens early in your research project: Telephone: (07) 559 54194, Facsimile: (07) 559 51120, Email: buhrec@bond.edu.au.

We wish you well with your research project.

Yours sincerely

Dr Mark Bahr
Chair

www.bond.edu.au/research/ethics

Explanatory Statement for Participants

BOND UNIVERSITY
BRINGING AMBITION TO LIFE

THE MIRVAC SCHOOL OF SUSTAINABLE DEVELOPMENT
Bond University
Gold Coast, Queensland 4229
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(within Australia)
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sustainable.development@bond.edu.au
ABN 88 010 694 121
CRICOS CODE 00017B

Explanatory statement for participants

We wish to extend an invitation to you to be part of the Doctor of Philosophy (PhD) research project on 'Designing Future Building Adaptive Reuse' with BUHREC Protocol Number RO-1208 conducted at Bond University's Institute of Sustainable Development and Architecture.

Designing future buildings with embedded adaptive reuse potential is a useful criterion for sustainability. By extension, planned adaptive reuse is advanced as an emerging and fundamental design consideration for all new projects in the context of national climate change and emission reduction strategies. The reuse of obsolete buildings without extensive demolition or destruction provides a significant benefit to the conservation of resources and the associated energy embedded in new material manufacture and assembly. It is important that the provision for future building adaptive reuse be taken into consideration in new-build schemes.

There is a need for an evaluation tool to help architects maximize future adaptive reuse potential of their buildings at the time they are designed. Therefore this research, for the first time, aims to develop an assessment process for adaptive reuse potential for proposed new buildings, similar in concept to the Green Building Council's Green Star or LEED evaluation methodology.

The research project began with an examination of past and existing literature focused on the building obsolescence, adaptive reuse, sustainability, high performance or smart building principles and adaptable building design parameters. This helped set the tone and direction for this project. As the project progresses with the gathering of more information, the study will be narrowed down to the core ideas that will emerge. The researcher will conduct open-ended, structured and in-depth interviews lasting approximately one (1) hour with expert professionals involved in the 12 identified successful Australian adaptive reuse projects, mainly in NSW, to generate valuable knowledge that will be used to address the objectives of the study.

The interviews will be audio-taped and conducted at your respective offices at an agreed time. All the information generated and the identities of the participants will be strictly kept confidential.

We look forward to your involvement in this research project.

Sincerely,

Sheila Conejos ____________

Prof. Craig Langston ____________

Prof. Jim Smith ____________

NOTE: This study has been approved by Bond University Human Ethics Review Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Co-ordinator (+61 7 559 54 194). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

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Participant Consent Letter (Stage 1)

BOND UNIVERSITY
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PARTICIPANT CONSENT LETTER
(Phase 1: Interview)

I certify that I am at least 18 years old and that I am willing to participate in the above Bond University research project.

I clearly understand the purpose and objectives of the study, its limits and the risks associated with participation.

I am aware that the information that I will provide along with my identity will be kept confidential and will not be revealed in any written report or to any other party. The information generated from me will only be accessible to the researcher and it will be securely kept at the researcher's office located at Bond University.

I understand that I will be asked a series of questions related to the design and technological aspects in the successful implementation of adaptive reuse projects on projects I have been involved with, through an audio-taped in-depth interview that should about one hour.

The researcher has clearly explained what is expected of me in the interview and how my privacy will be protected throughout the study. At any time that I feel uncomfortable, I am aware that I can withdraw from the research without penalty.

Name: ______________________________

Signature: ___________________________

Date:_______________________________

Email address: ______________________

NOTE: This study has been approved by Bond University Human Ethics Review Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Co-ordinator (+61 7 559 54 194). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

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Online Survey Letter for Participants (Stage 2)

BOND UNIVERSITY
BRINGING AMBITION TO LIFE

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Email: isda@bond.edu.au

ABN 89 010 694 121
CRICOS CODE 00017B

Subject: Designing for Future Building Adaptive Reuse

Dear Colleague,

This is an invitation to you to be part of my PhD research project on "Designing for Future Building Adaptive Reuse" (BUHREC Protocol Number RO-1208) conducted at Bond University's Institute of Sustainable Development and Architecture. The research concerns designing for future building adaptive reuse from the outset, and will lead to the creation of an evaluation tool to assist architects to produce new designs that are sympathetic to future change.

The research is being carried out in two stages:
• Stage One: Interviews were conducted with professional experts involved in a range of award-winning Australian adaptive reuse projects in NSW, Canberra and Melbourne to determine the key design criteria.
• Stage Two: An online survey is now being conducted via selected members of the Australian Institute of Architects to weight the relative importance of these criteria.

This survey will only take approximately 10 minutes to complete. Your judgement in weighting the list of design criteria and categories will help refine a new design tool called adaptSTAR capable of assessing new building decisions in the context of their potential for subsequent adaptive reuse. You can complete the survey right now or at your convenience via this personal link which will allow direct online access. Completion of the survey implies consent to participate in this research. Here is the link to the survey:

http://www.surveymonkey.com/s.aspx

This link is uniquely tied to this survey and your email address. Please do not forward this message.

This survey is entirely voluntary and there are no known or anticipated risks to participation in this study. Once the data have been analyzed, you will receive a copy of the report. If you would be interested in greater detail, an electronic copy (e.g., PDF) of the entire thesis can be made available to you upon request.

If you have any questions regarding this study, please contact me at 0434192685 or by email at sconejos@bond.edu.au. If you have any concerns, please contact my principal supervisor: Professor Craig Langston at 07- 5595-2233 or by email at clangsto@bond.edu.au.

Many thanks in advance for your interest and valuable assistance with this research.

Yours sincerely,

Sheila Conejos
PhD Candidate and
Practising Architect (United Architects of the Philippines and Union Internationale des Architectes)

NOTE: This study has been approved by Bond University Human Ethics Review Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Co-ordinator (+61 7 559 54 194). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

www.bond.edu.au/isda
www.bond.edu.au

Appendix B: The Twelve Case Studies

The eleven case studies were based from the book published by the NSW Department of Planning & RAIA in 2008, entitled "*New Uses for Heritage Places: Guidelines for the Adaptation of Historic Buildings and Sites*", which is a joint publication of the Heritage Council of New South Wales and the Royal Australian Institute of Architects, Sydney. Further, a section on in-depth interview summary and supporting literatures were included to add to the case studies profile as presented in the published book (NSW Department of Planning & RAIA, 2008). Moreover, together with the NSW award-winning adaptive reuse case studies, the GPO Building which was used as the pilot study in the first year of the research study is also presented herein. Below are the selected twelve case studies of the research study:

A

SMALL SCALE INDUSTRIAL TO RESIDENTIAL: EGAN STREET, NEWTOWN

55 :
Egan Street, Newtown has been adapted for apartments and a studio space for a collective of architects.

56 :
The interior of the industrial warehouse, prior to its adaptation.

57, 58 :
New elements were added which are functional and contemporary, yet sympathetic.

57 :

THE PROJECT

A small industrial warehouse was adapted to create three affordable contemporary apartments and a studio office space for a collective of architects, while retaining the heritage significance of the place. The original office entry was retained as the entry to the studio from Egan Street and new steel framed windows were inserted in place of the original timber roller shutter. The painted signs, rough sawn timber trusses, and items of industrial archaeology — including the original line shafting — have been retained, reminding future generations of the building's former working life.

The original external brick walls and concrete slab were retained. The position of the original trusses formed the natural division between the new apartments. Behind the street façade the roof and timber trusses were raised to achieve viable first floor clearances. A north-facing courtyard was created for each apartment by removing part of the roof between the trusses.

The tight site required a clever use of space to make the 70 square metre apartments feel generous, light and airy. The new apartments inserted in the robust brick structure are obviously modern, but the original fabric remains clearly legible.

THE SITE

The building that occupies 23-25 Egan Street, Newtown is of local historic significance. It is a representative example of a 1920s light industrial development and makes a positive aesthetic contribution to the streetscape. It is located in the O'Connell Town Estate Conservation Area.

The utilitarian workshop building was constructed in the 1920s for Gough Bros Sheet Steel Metal Workers. It was used continuously by the company as a metal workshop, panel beater's and mechanic's workshop until 1964. Since then it has changed ownership twice and was used for car repairs until it was purchased by the current owners in 2000.

THE CHALLENGES

The original warehouse building covered the entire site, which measures 27 metres x 8 metres, and contained a small office and mezzanine at the Egan Street entrance, and modest toilet and wash-up facilities at the rear. A high degree of architectural integrity existed, although repairs to the fabric were required.

The Egan Street façade contained an entrance door and a large timber roller shutter, and was structurally sound, but in need of minor repairs. The parapet was constructed of detailed brickwork and had large painted signs. The rear façade, facing the lane, was of much plainer face brickwork than the Egan Street façade and contained two large windows on the boundary. The concrete lintels to these windows were in need of repair, and the glazing did not meet Building Code of Australia (BCA) requirements with regard to fire separation.

The permissible floor space ratio for the site was 0.7:1; however, the existing building covered 1.1:1. Height was restricted to 6 metres. Each apartment required private open space.

THE SOLUTIONS

The architectural philosophy guiding the project was to retain a tangible memory of the building's past, respect the existing significant fabric, and insert strong new elements that were functional and contemporary, yet sympathetic. Despite the small dimensions of the site, the architects cleverly used space to create three 70 square metre apartments, with a separate studio shopfront. This was achieved by taking advantage of the existing floor space ratio and parapet height. The original trusses and roof were raised 600mm without any adverse effects to neighbouring properties. SEPP1 objections for floor space ratio and height were lodged as part of the development application process.

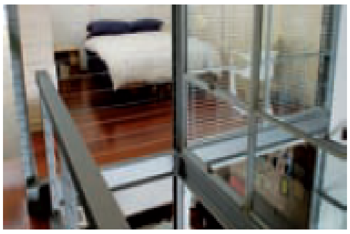
The layout retains a generosity of space and maximises the usable area, while appearing an appropriate evolution of the existing building. Energy efficiency is achieved through a layout that optimises solar access to habitable spaces for the winter months. Ample natural daylight to habitable rooms, and the inclusion of solar hot water, further reduces energy demand. The roof overhang provides shading to glazing during the summer months and the cathedral ceilings are fully insulated.

THE LESSONS

The completed project complies with all relevant building standards and sets a benchmark for small scale, sustainable inner-city mixed use developments. It demonstrates how to adapt existing buildings in environmentally and socially beneficial ways. The architects consulted with local residents and former South Sydney Council planners and heritage advisors. The latter endorsed the contemporary design approach to the new insertions.

The project provides a viable model for adaptive reuse of an industrial heritage building to create affordable housing. It advocates sustainable design and retention of heritage significance in preference to demolition, to create a richer urban environment.

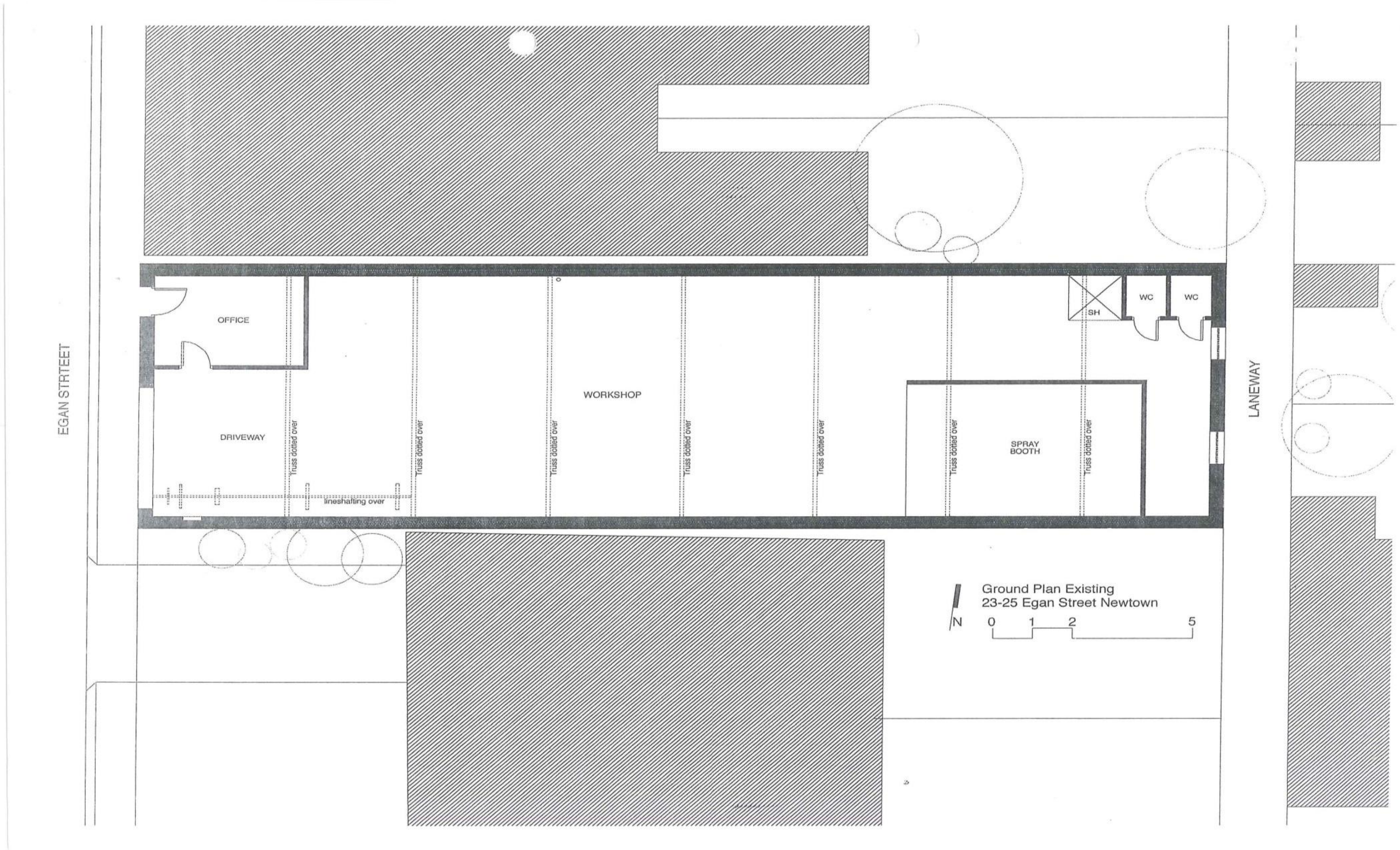
The project won the 2006 NSW Royal Australian Institute of Architects ESD/Energy Efficiency Award, the Multiple Housing Award and the Presidents Award. The project was also the recipient of the 2006 National Trust Adaptive Re-Use Award.



59 :

Above: The industrial warehouse prior to adaptation.
Below: The building after adaptation for apartments.

ADAPTATION PRINCIPLES		ASSESSMENTS
Understand significance		• The architects demonstrated a good understanding of the local significance of the building
New use to be appropriate to heritage significance	Retain use when significant	
	New uses to be compatible	• Use changed from industrial to residential but the industrial character was retained
Level of change to be appropriate to significance	Minimise impact on significant fabric	• External features are respected and conserved in the new design • Tangible evidence of the past use was retained
	Conserve significant interiors	• Interior features are conserved in the new scheme
Provide for reversibility and future conservation		• The new works do not preclude an alternative future use
Conserve relationship between significant setting and views		• The streetscape quality of the building was important and conserved
Provide for long-term management and viability		• The project puts the building to new sustainable uses. The success of the residential apartments will secure the property's ongoing care
Reveal and interpret heritage significance		• The significance of the building and its past use is celebrated in the architectural design solution



Ground Plan Existing
23-25 Egan Street Newtown

23-25 Egan Street, Newtown, NSW, 2042

Council: City of Sydney

Area Density: 43 d/ha

Development Density: 143 d/ha

Architect: Mackenzie Pronk Architects with architects in association Julie Mackenzie, Shack Design and Kieran McInerney

Builder: W.F. Pullan and Sons – John Pullan

Site Area: 210m² (7.8m x 27m)

Building Height: 2 storey

FSR: Existing use rights enabled the mixed use zoning to be achieved and an increased floor space ratio based on the existing FSR of 1.2:1 rather than 0.7:1 permissible in the City of Sydney LEP.

Site Coverage: 88%. Each apartment site area is 6.6m x 7.0m and achieves an internal courtyard of approximately 9m²

Setbacks: 0m

Car parking: 0 cars / 5 bike racks located in corridor

Number of dwellings and dwelling mix: 3 dwellings x 70m² each and one commercial studio

Cost: $1,570/m² (total construction cost $550,000)

Photography: Oliver Berlin


Locality Plan

PROJECT DESCRIPTION

The development is located in the inner-city Sydney suburb of Newtown in a heritage conservation area. A single-storey brick building was adapted into three strata dwellings and a studio. Built in 1923, the structure had been used as a metal workshop, panel beaters and auto mechanics for 77 years.

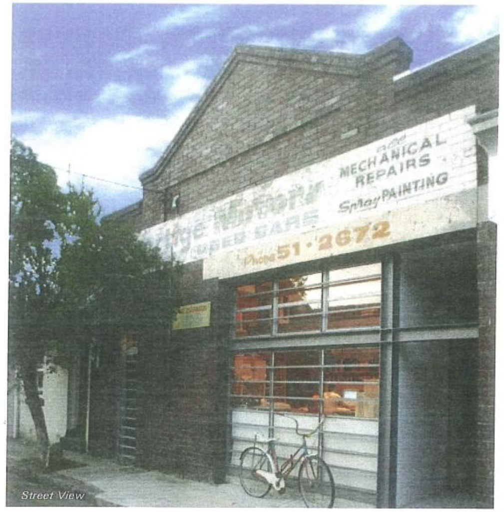
The original perimeter brick walls were kept and the existing roof trusses raised by 600 mm to sit on top of the parapet without causing major additional overshadowing to the adjoining properties. This enabled a two-storey development within the existing building fabric.

The tight urban nature of the site meant that the apartments were arranged around three private north-facing courtyards. This provides natural ventilation, light and outlook for all the rooms. The tree tops from neighbouring gardens give them additional privacy and green screening. The courtyards significantly extend the ground-floor living spaces with an attractive entertaining area. The bedroom, study and bathroom are located on the first floor between the original trusses, with large skylights allowing excellent light and ventilation.

The original roller door to Egan Street was replaced with new steel-framed glazing to the commercial studio. There is a separate inset entry that gives access to the three apartments via a common corridor to the south. The studio and the entrance both activate the street frontage.

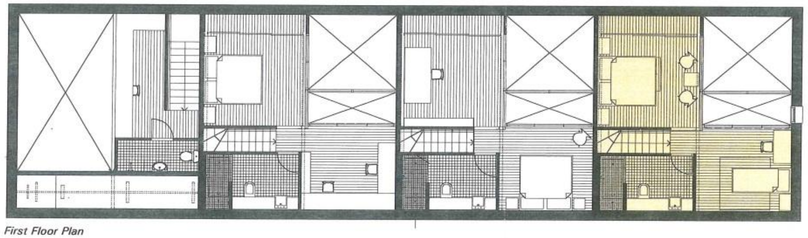
Passive solar design principles and natural ventilation have reduced the need to depend on artificial heating and cooling in the apartments.

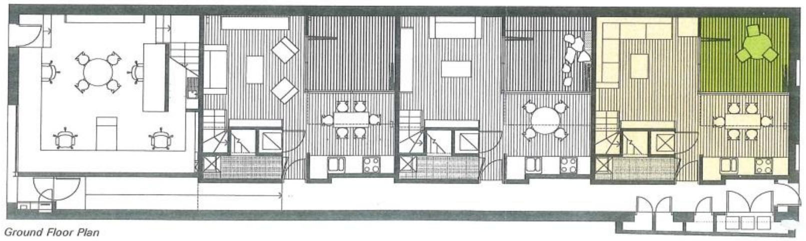
The project shows design innovation and creativity in combining three homes and an office on a small urban site. The council dropped its usual car parking requirement to allow the higher-density project to occur. This is an excellent example of a successful inner-city, residential, adaptive re-use of an older building.

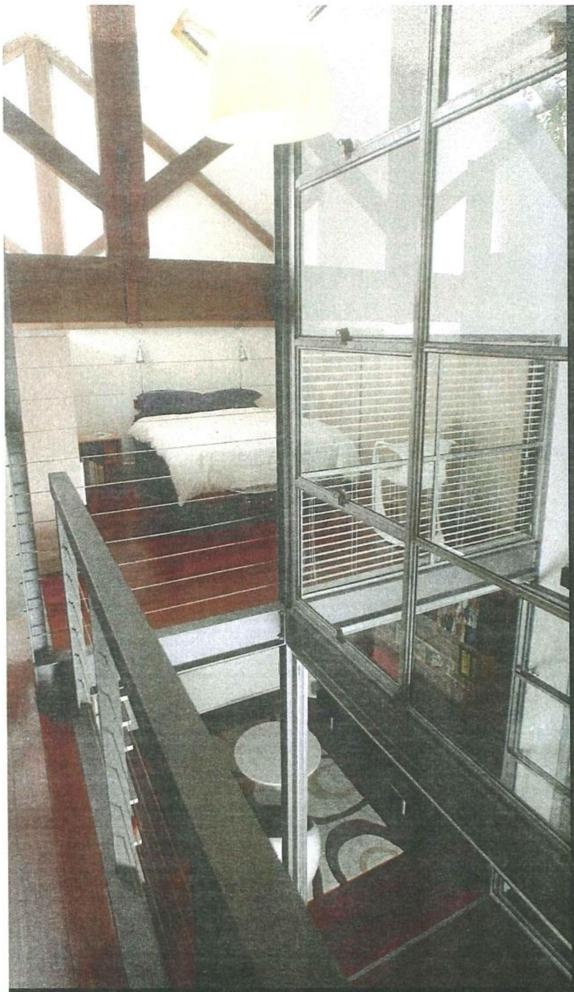


Street View


Interior Courtyard


First Floor Plan


Ground Floor Plan



PROJECT DESCRIPTION

As a group of young architects we sought a warehouse building for adaptive reuse into which we could build affordable apartments. 23-25 Egan Street, Newtown, constructed in 1922, offered a simple architectural form, utilitarian finishes, original timber trusses, colourful painted signs and artefacts of industrial archaeology worthy of conservation.

The key architectural philosophies guiding the project were to retain a tangible memory of the building's past, venerate the existing significant fabric and insert strong new elements that were functional and contemporary, yet sympathetic. Despite the small dimensions of the site, measuring only 27m x 8m, we arrived at a design to create 3 apartments, with a separate studio shopfront. The layout retains a generosity of space and maximises the usable area whilst appearing a natural evolution of the existing building.

The apartments are accessed via a common corridor to the south. Each apartment has an open plan kitchen, dining and living room on the ground floor arranged around a north-facing courtyard. The courtyard facades are glazed and feature large folding doors and a two storey north facing glazed wall. Upstairs a bathroom, bedroom and study are housed between the original trusses, with large skylights providing ample light and ventilation. A steel framed void connects the storeys.

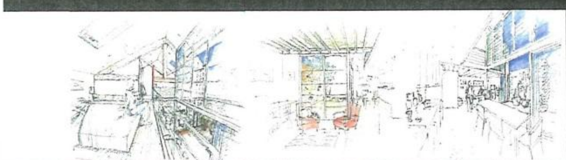
We designed the apartments for ourselves as a collective, pooling skills and resources to gain access to the housing market. The layout and details were common and costs were strictly controlled. The overall construction cost was $550,000. Materials were recycled on site including bricks, original trusses and timbers. New work was built in recycled timber and steel with hoop pine ply joinery.

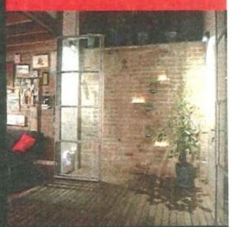
Energy efficiency is achieved through a layout that optimises solar access to habitable spaces, ample natural daylight to all rooms and the use of solar hot water. The roof overhang provides shading to glazing during the summer months and the cathedral ceilings are fully insulated. The void over the dining area encourages stack ventilation that is further enhanced by vented skylights.

The project provides a viable model for adaptive reuse of an industrial heritage building to create affordable housing. It advocates sustainable design and retention of heritage significance in preference to demolition, to create a richer urban environment.

PROJECT TEAM

Architects/Owners Julie Mackenzie Julie
Mackenzie Architect
Neil
Mackenzie MackenziePronk Architects
Heidi Pronk MackenziePronk Architects
Jason Veale Shack Design
Kieran McInerney Kieran McInerney Architects
Heritage Architect Julie Mackenzie Julie
Mackenzie Architect
Structural Engineer Richard Green Tay-





23-25 Egan St Newtown

B

GRAND CITY HOUSE TO APARTMENTS: BABWORTH HOUSE, DARLING POINT

59 :
Babworth House after its adaptation for apartments.

60 :
Babworth House prior to adaptation.

61 :
A glazed conservatory within the internal rear courtyard.

THE PROJECT

A grand 93-room Sydney mansion called Babworth House was adapted to five apartments, and ten new houses were constructed within its grounds. The house and its garden setting are listed on the State Heritage Register.

THE SITE

Babworth House was designed by Morrow and de Putron in 1912 on the site of Mount Adelaide House, a Mortimer Lewis design. The house was commissioned by Sir Samuel Horden. Following his death in 1956 it was used by St Vincent's Hospital (1961-1998). Major rooms were retained without significant alteration. Services, such as bathrooms, kitchens, laundries and a hospital lift, were clustered about the inner courtyard and within the eastern wing.

Designed in the Federation Arts and Crafts style, the house displays an eclectic mix of Classical Revival, Arts and Crafts and Art Nouveau styles. Magnificent oak-panelled walls, decorative plaster work and an imposing timber stairway characterise the interior. The site, which continued to the harbour's edge, included significant garden features and plantings, integral to the site's heritage significance.

THE CHALLENGES

The land value in this area is at a premium and the house and garden were unlikely to be retained in a single ownership, other than for institutional uses. At an early stage, defining a use for this very large house and preserving the relationship between the house and its garden setting was considered critical. The ongoing management of the site as a single entity also needed to be secured.

The division of the house into apartments needed to recognise the relationship between the principal rooms and retain their original configuration, with any subdivision of interior spaces unlikely to be permissible. The new apartments were required to incorporate lifts and up-to-date services without affecting significant fabric. Dormer windows in the attic bedrooms within the roof space could only face into the internal courtyard and there could be no visual impact upon the external roof form. The division of the house into five apartments created compliance challenges with the Building Code of Australia.

THE SOLUTIONS

A conservation management plan was prepared, followed by a development control plan for the entire estate. Detailed discussions throughout the process with the Heritage Office and Woollahra Municipal Council resulted in approval of the layout of the apartments within Babworth House, and the location of ten new houses with roof gardens set into the lower grounds. These were designed to ensure that Babworth House retained unimpeded views to the harbour.

The original grand porches were used to create individual entries for each of the five apartments, with no impact on significant elevations or external fabric. The planning was dependent upon the introduction of a sympathetic glazed conservatory within the internal rear courtyard. This permitted Apartment 3 to span across both wings at the rear of the house. Apartment 5 was designed within the original basement store of Babworth House, and was extended to incorporate and interpret the remnant stone footings of Mount Adelaide House.

Significant rooms were conserved and retained in their original configuration, resulting in innovative fire and acoustic separation details. New lifts, stairs and services were carefully installed without impact upon significant fabric, while fire and acoustic separation were sandwiched between existing and new panelled doors within existing openings.

The new houses in the lower grounds were positioned so that they did not interrupt harbour views from Babworth House, and all parking was located underground, to maximise the garden setting of the estate.

The former gabled brick and slate roofed garage was adapted to a gatehouse residence by the addition of a new glazed and copper roofed pavilion reflecting the proportions of the original garage. A connecting glazed and copper-louvered atrium link interpreted a former glasshouse.

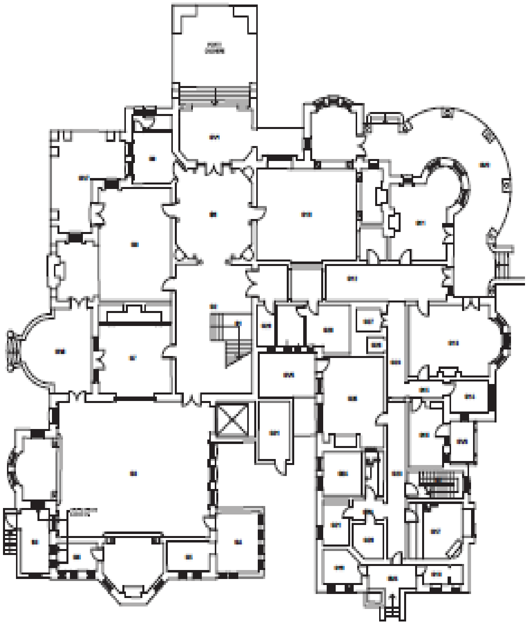
Community title, rather than strata subdivision, was used as a means of ensuring the garden setting was conserved as a single entity. Community title legally shares responsibility between the apartment owners for the ongoing maintenance and conservation of Babworth House and its formal gardens in perpetuity.

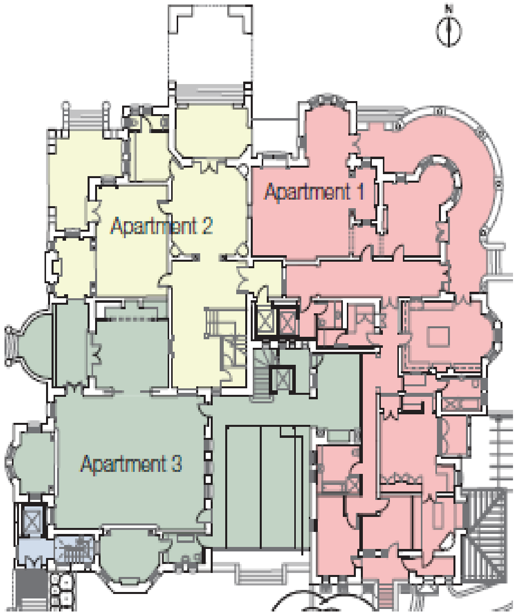
THE LESSONS

Detailed discussions at the outset of the project with the Heritage Office and Woollahra Municipal Council were an intense and collaborative exercise. They resulted in new, sympathetic design approaches being considered and approved for an innovative yet sensitive adaptation of Babworth House that secured its ongoing care and use. The owner/developer's co-operative and committed involvement throughout the entire process, ensured an exceptional heritage outcome for both Babworth House and its garden setting.

Investment in a well developed conservation plan and the preparation of a masterplan for the site, in advance of the development application, was successful in managing local community expectations.

The Babworth House adaptation was the recipient of the Woollahra Conservation Award in 2004 and was short-listed for the RAIA and National Trust 2004 awards.

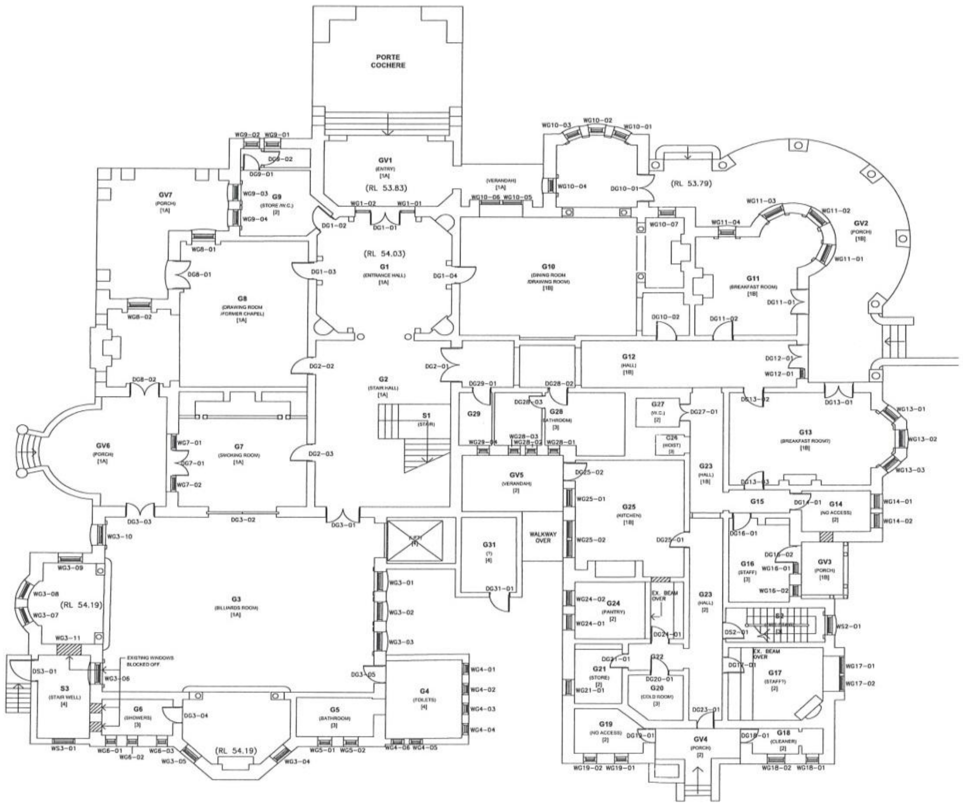




Above: The ground floor plan prior to adaptation.
Right: The ground floor of Babworth House showing the layout of apartments 1-3.

ADAPTATION PRINCIPLES		ASSESSMENTS
Understand significance		• The conservation plan clearly identified significance, and this was translated into policy in the DCP
New use to be appropriate to heritage significance	Retain use when significant	• Residential use was retained, although at a higher level of density, and the garden setting was conserved
	New uses to be compatible	• The new houses in the grounds retained the original residential use, as did the apartments
Level of change to be appropriate to significance	Minimise impact on significant fabric	• New buildings were placed sensitively in relation to garden features and views from the house to the harbour were retained
	Conserve significant interiors	• The apartment layouts maintained the original relationships between significant rooms and new services were located in areas of lower importance
Provide for reversibility and future conservation		• The new occupancy configuration does not prevent the future reconversion to a house with a single occupancy
Conserve relationship between significant setting and views		• The views from the house and garden areas to the harbour have been retained • The views from the house to garden features have been conserved
Provide for long-term management and viability		• Community title rather than strata title was used, which provided joint and shared ownership and responsibility for the house and garden, including the new buildings
Reveal and interpret heritage significance		• Significant fabric was conserved and restored. The garden was re-established following the construction and adaptation


MITCHELL ROAD
DARLING POINT ROAD
MT ADELAIDE STREET
EASTBOURNE ROAD
EASTBOURNE ROAD
SUGGESTED PLANTING SCHEDULE - BABWORTH ESTATE
LEGEND
BABWORTH ESTATE, DARLING POINT
LANDSCAPE PLAN
Prepared for Byrne Lewis Group Pty Ltd
by CONTEXT LANDSCAPE DESIGN
context



GROUND FLOOR PLAN

LEGEND

[1A]	- VERY HIGH SIGNIFICANCE	-NO SUBDIVISION -NO NEW OPENINGS -NO NEW PLUMBING SERVICES
[1B]	- HIGH SIGNIFICANCE	-LIMITED ADAPTION -NEW OPENINGS POSS. IN INTERNAL WALLS -NO NEW PLUMBING EXCEPT KITCHEN
[2]	- MED. SIGNIFICANCE	-RETAIN AND CONSERVE, MAY ADAPT OR RECONFIGURE -OPENINGS MAY BE MADE INTO WALLS BUT NOT WHERE ABUTTING 1a OR 1b -NO NEW OPENINGS IN EX. WALLS
[3]	- LOW SIGNIFICANCE	-MAY BE SUBSTANTIALLY ADAPTED INTERNAL OPENINGS BUT NOT NEAR 1a OR 1b
[4]	- INTRUSIVE	-MAY BE ALTERED OR REMOVED

LEGEND

ROOM NUMBER i.e. **G1**
(FORMER USE) ENTRANCE HALL
[SIGNIFICANCE LEVEL] [1A]

Door Number i.e. DG1-01
(Door/room number/door number)

Window Number i.e. WG1-01
(Window/room number/window number)

ISSUE	AMENDMENT	APPROVED	DATE
D	ISSUE FOR DEMOLITION CC		04/05/01
C	ISSUE FOR DA	JAR	21/07/00
B	ISSUE TO WOOLLAHRA COUNCIL	JAR	15/03/00
A	PRELIMINARY ISSUE	JAR	03/03/00

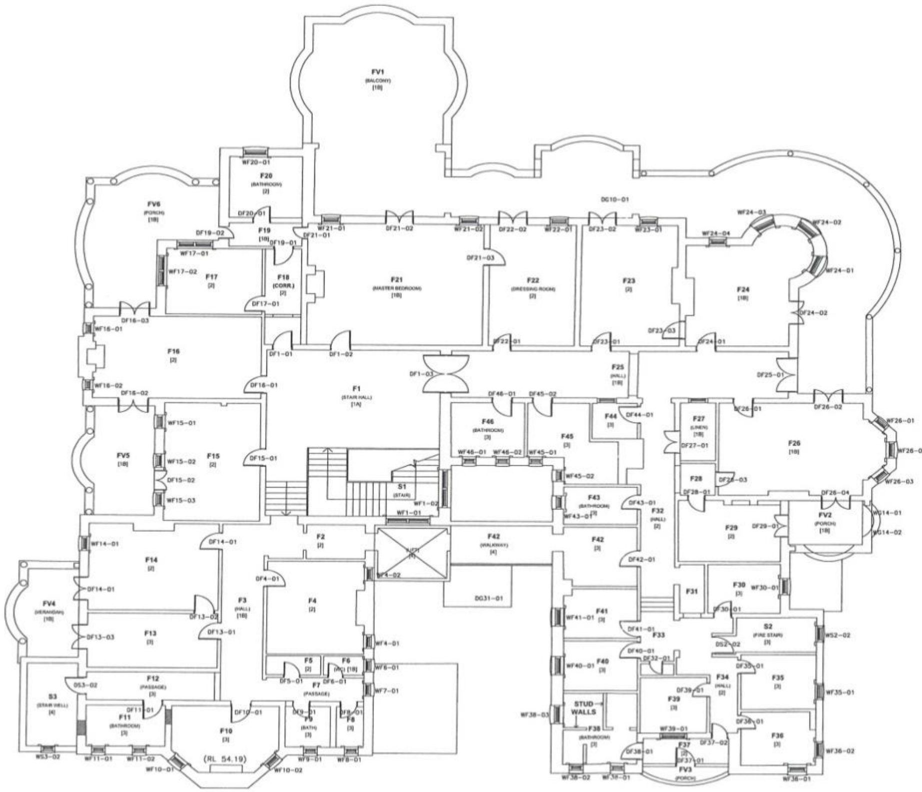
CLIENT
BYRNE LEWIS GROUP

JOB
BABWORTH HOUSE

DRAWING
EXISTING GROUND FLOOR PLAN

CONYBEARE MORRISON & PARTNERS
ARCHITECTS, URBAN & LANDSCAPE DESIGN CONSULTANTS
L1, 52 – 58 William St EAST SYDNEY NSW 2011 Ph (02)9380 8811

DRAWN CMP
SCALE (A1) 1:100
DATE JULY 2000
DWG No. 00011–0101
ISSUE D
CAD REF. X:/2000/00011/–0101–2–3



UPPER FLOOR PLAN

LEGEND

[1A]	- VERY HIGH SIGNIFICANCE	-NO SUBDIVISION -NO NEW OPENINGS -NO NEW PLUMBING SERVICES
[1B]	- HIGH SIGNIFICANCE	-LIMITED ADAPTION -NEW OPENINGS POSS. IN INTERNAL WALLS -NO NEW PLUMBING EXCEPT KITCHEN
[2]	- MED. SIGNIFICANCE	-RETAIN AND CONSERVE, MAY ADAPT OR RECONFIGURE -OPENINGS MAY BE MADE INTO WALLS BUT NOT WHERE ABUTTING 1a OR 1b -NO NEW OPENINGS IN EX. WALLS
[3]	- LOW SIGNIFICANCE	-MAY BE SUBSTANTIALLY ADAPTED INTERNAL OPENINGS BUT NOT NEAR 1a OR 1b
[4]	- INTRUSIVE	-MAY BE ALTERED OR REMOVED

LEGEND

ROOM NUMBER (FORMER USE) [SIGNIFICANCE LEVEL]	i.e.	G1 ENTRANCE HALL [1A]
Door Number	i.e.	DG1-01 (Door/room number/door number)
Window Number	i.e.	WG1-01 (Window/room number/window number)

ISSUE	AMENDMENT	APPROVED	DATE
D	ISSUE FOR DEMOLITION CC		04/05/01
C	ISSUE FOR DA	JAR	21/07/00
B	ISSUE TO WOOLLAHRA COUNCIL	JAR	15/03/00
A	PRELIMINARY ISSUE	JAR	03/03/00

CLIENT: BYRNE LEWIS GROUP

JOB: BABWORTH HOUSE

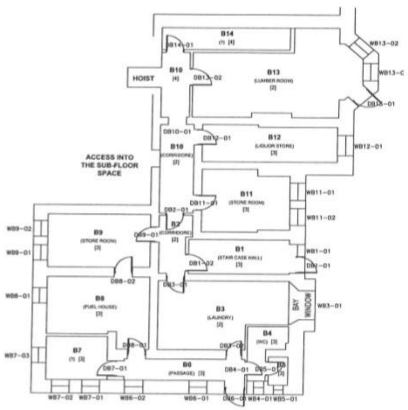
DRAWING: EXISTING UPPER FLOOR PLAN

CONYBEARE MORRISON & PARTNERS
ARCHITECTS, URBAN & LANDSCAPE DESIGN CONSULTANTS
L1, 52 - 58 William St EAST SYDNEY NSW 2011 Ph (02)9380 8811

DRAWN: CMP SCALE: (A1) 1:100

DATE: JULY 2000 DWG No. 00011-0102 ISSUE: D

CAD REF. K:/2000/00011/-0101-2-3



BASEMENT FLOOR PLAN

EXISTING REFLECTED CEILING PLAN

LEGEND

[1A]	- VERY HIGH SIGNIFICANCE	-NO SUBDIVISION -NO NEW OPENINGS -NO NEW PLUMBING SERVICES
[1B]	- HIGH SIGNIFICANCE	-LIMITED ADAPTION -NEW OPENINGS POSS. IN INTERNAL WALLS -NO NEW PLUMBING EXCEPT KITCHEN
[2]	- MED. SIGNIFICANCE	-RETAIN AND CONSERVE, MAY ADAPT OR RECONFIGURE -OPENINGS MAY BE MADE INTO WALLS BUT NOT WHERE ABUTTING 1a OR 1b -NO NEW OPENINGS IN EX. WALLS
[3]	- LOW SIGNIFICANCE	-MAY BE SUBSTANTIALLY ADAPTED INTERNAL OPENINGS BUT NOT NEAR 1a OR 1b
[4]	- INTRUSIVE	-MAY BE ALTERED OR REMOVED

LEGEND

ROOM NUMBER i.e. **G1**
(FORMER USE) ENTRANCE HALL
[SIGNIFICANCE LEVEL] [1A]

Door Number i.e. DG1-01
(Door/room number/door number)

Window Number i.e. WG1-01
(Window/room number/window number)

ISSUE	AMENDMENT	APPROVED	DATE
D	ISSUE FOR DEMOLITION CC		04/05/01
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A	PRELIMINARY ISSUE	JAR	03/03/00

CLIENT
BYRNE LEWIS GROUP

JOB
BABWORTH HOUSE

DRAWING
EXISTING BASEMENT FLOOR
& REFLECTED CEILING PLANS

CONYBEARE
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DRAWN: CMP
SCALE: (A1) 1:100

DATE: JULY 2000
DWG No.: 00011-0103
ISSUE: D
CAD REF. K:/2000/00011/-0101-2-3

C

RURAL AGRICULTURAL BUILDING TO FUNCTION CENTRE: TOCAL VISITOR CENTRE, TOCAL

62 :
The Tocal Visitor Centre was adapted from an early 20th century hay shed.

63 :
The Tocal hay shed prior to adaptation.

64 :
The centre is now recognised as one of the best wedding function centres in the Hunter Valley.

65 :
Recycled and local materials were used in the building wherever possible.

THE PROJECT

The Tocal Visitor Centre was adapted from an early 20th century hay shed within the State Heritage-listed Tocal Homestead precinct. It still maintains the appearance and feel of an Australian rural shed. It provides a multi-purpose visitor centre for both Tocal Homestead and Tocal Agricultural College. It is capable of seating 100 guests, has a 60 seat theatrette and exhibition areas, and provides modern and comfortable amenities for visitors. There has been no adverse impact on the nationally significant farm complex. The external shed dimensions remained intact after it was adapted. The visitor centre enables more people to understand Tocal and rural life from the 1820s to contemporary times.

Key features of the project include:

- introduction of a mezzanine floor to increase capacity;
- installation of north facing glass windows to improve comfort and increase energy conservation;
- development of a double-skin external wall and roof construction to incorporate thermal and acoustic insulation, while maintaining the original framework and cladding;
- excavation and use of a basement for amenities and an additional display area;
- use of recycled materials and traditional techniques in construction;
- introduction of a ramp access and a toilet for people with disabilities; and
- potential to install a lift to provide access to other levels.

THE SITE

The hay shed was probably built just after 1907 to store the loose hay grown on the flats. It was carted up to its site using a horse and wagon and is an integral part of the farm complex. Over its life it has been used to store hay along with machinery and pumpkins. As the hay shed was located away from the main farm complex, it remained under-used for much of the 20th century. The roof had been replaced in the 1980s with zincalume (since replaced with the original corrugated galvanized iron), but the existing cladding on the sides remained.

THE CHALLENGES

One of the features of Tocal is its unique buildings and long construction period, dating from 1825 to 1965. A design was needed which continued this layering of significance, and which retained the external appearance and parameters of the original building, but allowed for some internal reorganisation. At the same time, the original interior wall and ceiling had to remain intact.

The brief aimed for maximum energy efficiency. Air conditioning was required, but opportunities for natural ventilation had to be maximised, and the use of air conditioning minimised.

Costs had to be carefully controlled and accountability to a number of funding bodies was required.

THE SOLUTIONS

The hay shed had to be adapted to provide a comfortable, energy efficient multi-function centre. It had to look like and feel like a hay shed. Features that had been removed since the building was constructed were reintroduced in another form, such as the original opening for the tall hay laden carts, which was reinterpreted in the new skylight in the north façade.

Recycled fabric from the property, together with some local materials, were used wherever possible; they included timber from wind-blown spotted-gum trees, rabbit netting and roller-wire strainers, found in farm sheds. Traditional techniques of repair and construction also added to the authenticity and cost effectiveness of the project. Tiles imported in the late 1940s (new and still in their box) were found in the shed, and hinges and other fencing materials were incorporated into the facilities associated with the building.

The side fence and safety rail for the mezzanine were designed around the use of rabbit-proof netting. The top rail was an iron bark sapling, commonly used on stockyards. This reflected the widespread use of rabbit-proof netting in Tocal in the 1920s.

Glazing, including high performance glass in some areas, was used across the whole northern face of the building. The glass wall is set back to express the original structure, especially when viewed from the north and the adjacent road. The building is designed to use natural systems as much as possible so that air conditioning is only used when necessary. Louvres were incorporated at the base of the northern glass wall together with gable vents and exhaust fans in the roof apex, to provide maximum natural air flow. An innovative heat pump system was installed in a prominent location in the basement.

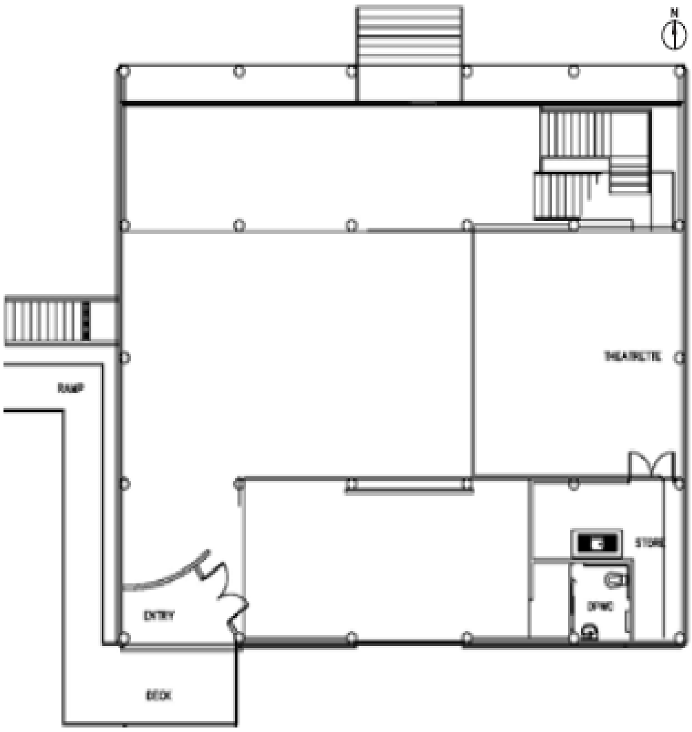
A double-skinned wall and roof cladding were developed to introduce thermal and acoustic insulation into the building, while retaining the appearance internally and externally of corrugated iron.

THE LESSONS

The shed had to embody some of the essential elements of Australian rural history, but also be a quality building, consistent with the other buildings on the homestead site and at the College. The client, project director and architect had a unified vision of a high quality and durable facility, using the best possible materials and tradespeople.

The converted shed won the 2007 Ten Carat Award for Best Wedding Reception – Hunter Valley.

Cost effectiveness was paramount during the design and development of the project. Cost estimates were prepared at the beginning of the project and used to guide project expenditure. The long-term investment in a durable and sustainable facility was also recognised as a priority.



The ground floor of the hay shed following the adaptation.

ADAPTATION PRINCIPLES		ASSESSMENTS
Understand significance		• An overarching conservation management plan informed the site masterplan • Individual buildings and elements had conservation management strategies to inform development applications
New use to be appropriate to heritage significance	Retain use when significant	• While the barn use was redundant, other farm buildings in the precinct were retained in agrarian use
	New uses to be compatible	• The new use provides facilities to support the visitor and tourism function of the homestead complex
Level of change to be appropriate to significance	Minimise impact on significant fabric	• The barn form, character and envelope are unchanged, and significant fabric has been conserved • The recent roof was replaced with original material
	Conserve significant interiors	• Significant interior fabric has been conserved • Double-skinned wall and roof lining have provided an energy efficient interior • Materials have been recycled and new materials sourced locally
Provide for reversibility and future conservation		• The new use does not prevent future reconversion to barn
Conserve relationship between significant setting and views		• Minimal external changes and new work did not affect the setting or views
Provide for long-term management and viability		• The new use provides a viable use for the building within a larger complex of buildings and helps to support the overall complex
Reveal and interpret heritage significance		• Significant elements and fabric have been conserved, new works sustained traditional practices associated with farm buildings – using local material and trades

CASE STUDY

D

LOCAL CHURCH AND CHURCH HALL TO RESIDENTIAL: TOXTETH CHURCH, GLEBE

66 :
The former Toxteth Church and hall now accommodates two residences.

67 :
The Toxteth Church prior to adaptation.

THE PROJECT

A former church and church hall were adapted as two residences. The principal elevations, roofs and overall forms of the buildings were retained and conserved. Mezzanines were inserted and pavilions added at the rear, creating light-filled contemporary spaces with cross ventilation. The new lightweight structures are steel and glass, and make a distinctive modern statement, compared with the original stone and brick structures.

The new design incorporates disabled access, with the potential for future lifts. The specially designed roof and gutter system collects rainwater for large underground water storage tanks, which act as heat banks. The water is reticulated throughout to the bathrooms and laundries, which have dual plumbing for tank and mains water supply.

THE SITE

The church and hall are located in the Toxteth Estate conservation area. The site is orientated north-south and has rear lane access. The streetscape of predominantly Victorian houses has a mixed residential character, with single and two-storey terraces and some single dwellings.

THE CHALLENGES

The buildings were empty and vandalised for many years and required extensive conservation work. Innovative architectural planning was required to retain the character of the buildings, especially internally. The church and hall are listed as heritage items on the local environment plan, which has heritage incentives permitting use beyond the zoning restrictions. Council queried the proposed residential use of buildings zoned for ecclesiastical use, which led to an extended approvals process.

THE SOLUTIONS

Open-plan living areas are located on the free-standing mezzanines, with bedrooms below. This preserves the overall volumes and intricate joinery of the roof and ceiling structures. New glazed pavilions provide additional spaces, which are separated from the original church and hall by courtyards. The rear elevations allow maximum winter sun penetration and natural air movement, which reaches all parts of the existing church and hall.

The new work is supported by a steel structure independent of the historic church and hall, ensuring the work is totally reversible in the future. The design of the cruciform-shaped steel columns reduces the apparent bulk, and achieves a sense of lightness. Careful planning and site works preserve mature trees on the site.

THE LESSONS

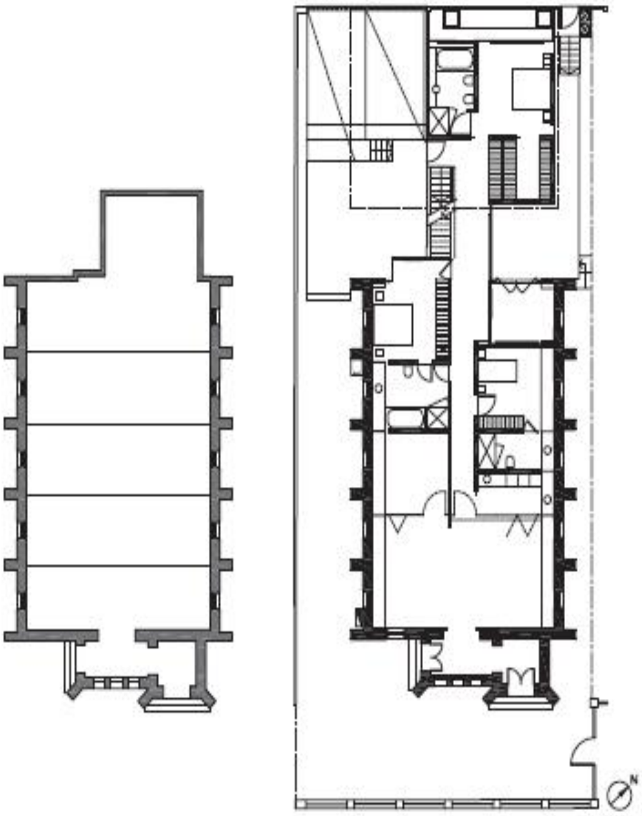
The combination of architectural skills in heritage conservation and contemporary design has conserved the heritage buildings. At the same time, it has achieved an integrated and innovative adaptive reuse which, over time, has been accepted by the local authorities and local residents.

The conversion was a finalist for the Greenway Award in the 2007 RAIA NSW Chapter Awards.

68 :
Open plan living areas are located on the free-standing mezzanines.

69 :
New glazed pavilions provide additional spaces.

70 :
The rear elevations allow maximum natural air movement.



Left: Toxteth Church prior to adaptation.
Right: Toxteth Church showing the adaptation to a residence, ground floor plan.

ADAPTATION PRINCIPLES		ASSESSMENTS
Understand significance		• A thorough significance analysis of the fabric was undertaken by the architect
New use to be appropriate to heritage significance	Retain use when significant	
	New uses to be compatible	• New use as residential does not preclude future public functions for the building
Level of change to be appropriate to significance	Minimise impact on significant fabric	• Significant fabric led the design solution and was revealed and conserved
	Conserve significant interiors	• Interior features were conserved and used as features in new design
Provide for reversibility and future conservation		• New work was inserted in a way that reveals the building's form and fabric, and can be removed easily without requiring reconstruction
Conserve relationship between significant setting and views		• The relationship between the building and the street was conserved in the new design, including the design of new entry
Provide for long-term management and viability		• The new use secures the building use in an ongoing way
Reveal and interpret heritage significance		• Significant features and architectural elements provided inspiration for the new design

Glebe Society Bulletin 4/2007 May/June

Adaptive reuse

Two success stories

Bellevue

Our presenters (l to r) David Stevenson, Lise Morgan and Gary Waller.

Photo: Phil Young

On Tuesday 1 May, David Stevenson, architect of Lacoste and Stevenson, and Gary Waller, of G & C Waller Builders, provided a fascinating presentation of the conservation and adaptive reuse of *Bellevue*, on Blackwattle Bay. The audience of fifty Glebe Society members and friends were particularly pleased and impressed by the slides used to illustrate the talk of both presenters. It reminded us of the extreme state of dilapidation the building had been reduced to, and showed wonderful details of the techniques used and outcomes achieved.

Thanks are especially due to Diane Gray, Katharine Vernon and Dorothy Davis for the planning that went into the event, and assistance on the day from Neil, Anne and many others.

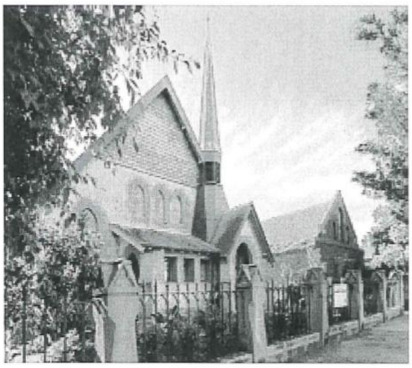
I especially want to thank the City Council for their enthusiastic assistance in making this presentation possible. Lise Morgan, the project manager, was very supportive, and the Council assisted by making *Bellevue* available, allowing us to borrow chairs and tables free of charge, and by providing payment for the speakers.

- Jan Macindoe

Toxteth Uniting Church

On Friday evening, 18 May, many members and other Glebe residents accepted the invitation to visit the former Uniting Church at 19a Toxteth Road which has been converted to residential use by the well-known heritage architect Otto Cserhalmi.

From the outside the building appears to be unchanged, but inside it has become a modern "upside down" four bedroom home. The architect has designed a glass and steel structure with a mezzanine floor that "clips" inside the church. The kitchen and living rooms are on this level, under the beams of the original vaulted ceiling.



The church and, on the right, the church hall.
Photo courtesy Ray White Real Estate

The conversion is reversible, so the building could be turned back into a church in the future.

Five years ago, in *Bulletin* 7/2002, Neil Macindoe made this comment in his Planning Report:

Toxteth Uniting Church, 19 Toxteth Road

This temple, with the accompanying Hutchinson Memorial Hall (1898), is proposed to become residential. Some years ago the Uniters moved to the old City Mission Hall in St Johns Road, and more recently the kindergarten in Hutchinson Hall moved to St Brendan's Hall, Johnston Street, Annandale. Since then various unsuitable schemes have been mooted, but the present solution, whereby each building becomes a separate dwelling, with small extensions at the rear and fairly minimal alteration, is more acceptable, in the absence of any religious revival.

Now let's see what happens to the *Abbey* site.

- Edwina Doe

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E

INNER CITY INDUSTRIAL SITE TO OFFICES: THE BUSHELLS BUILDING, THE ROCKS

71 :
The Bushells Building with its repainted façade and reinstated signage.

72 :
The Bushells Building was previously used for tea manufacture.

73, 74 :
The surviving industrial artefacts provide an intriguing insight into the past process of tea manufacture.

THE PROJECT

This former factory building was adapted to modern offices in a way that preserves the structural clarity of the warehouse spaces, conserves and incorporates a number of significant artefacts, and provides a rewarding and unique work environment. The building had been vacant from 1975 until 1999.

Detailed study was undertaken to insert the new elements sensitively, and to protect, conserve, and interpret the existing features of the building and its associated artefacts. Modern services and amenities were introduced; windows were reglazed for acoustic and smoke sealing purposes; the southern light-well was enclosed and new passenger lifts and access bridges in a multi-storey foyer/ atrium were provided, as well as a new, fully-complying fire stair.

THE SITE

The Bushells Building is a landmark within the historic Rocks area of Sydney and is listed on the State Heritage Register. It was designed by renowned architects HE Ross & Rowe in 1923 and is one of a number of significant city buildings by this firm. The building is important because of its industrial character and its historical association with the Bushells Company, once synonymous with Australia's cultural identity through prolific and successful marketing campaigns over the last century. Bushells maintained the same use for the building from 1923 to 1975 and it retains many of its industrial manufacturing features.

The building is important because it helps us understand the development of local industry in Sydney. It contains rare evidence of this form of manufacture and food production, which historically occurred within the industrial fringe of Sydney's Central Business District. It also provided jobs for both men and women, predominantly from The Rocks area, for over 50 years.

THE CHALLENGES

There were several challenges associated with the adaptation and compliance with the Building Code of Australia. They included the introduction of new services to meet modern office standards — lifts, air conditioning, fire services and protection, fire stairs and acoustic separation — in an expressed timber structure with timber floors.

A large number of industrial artefacts, which contributed to the building's significance, had to be meaningfully incorporated into the design. There were also contamination issues, such as lead paint, asbestos, asbestos cement and kalsomine paint. Conservation work was also necessary to the building's exterior. The design also had to be flexible to meet the possible needs of future tenants.

THE SOLUTIONS

Works including the repainting of the façades, repair of brickwork and windows, and reinstatement of Bushells signage, which contributes to the building's landmark status. Within the building the painted masonry walls, timber columns and exposed timber beams and joists have been retained, as have the tea handling equipment, spiral chutes, hoppers and various types of lift. These surviving industrial artefacts provide an intriguing insight into the past process of tea manufacture. Some tea hoppers, and the former lift enclosures, now house storage areas and small meeting rooms.

A new partition system preserves the special qualities of the open plan floor space, while still allowing appreciation of the artefacts, timber structure and natural light. New electrical and computer services have been introduced within a raised floor structure, while the mechanical plant is located around the periphery of the building and above a central access spine, retaining the expression of the significant timber ceilings.

Three new lifts have been integrated into the southern light well, avoiding alteration to the interior while providing a handsome atrium space. The new entry foyer at the south-east corner of Harrington Street provides direct access to the atrium. Bridges constructed of glass and steel cross the atrium, connecting each floor to the lifts. The lightweight construction of the bridges allows light to penetrate through the light well, maintaining the quality of space throughout. There are six floors of open plan office space — each level is approximately 1000 square metres in area.

The overall roofscape has been retained with minor modification. The mechanical plant equipment has been concealed by a new louvred roof to the 'temple tower', which once housed a water tank.

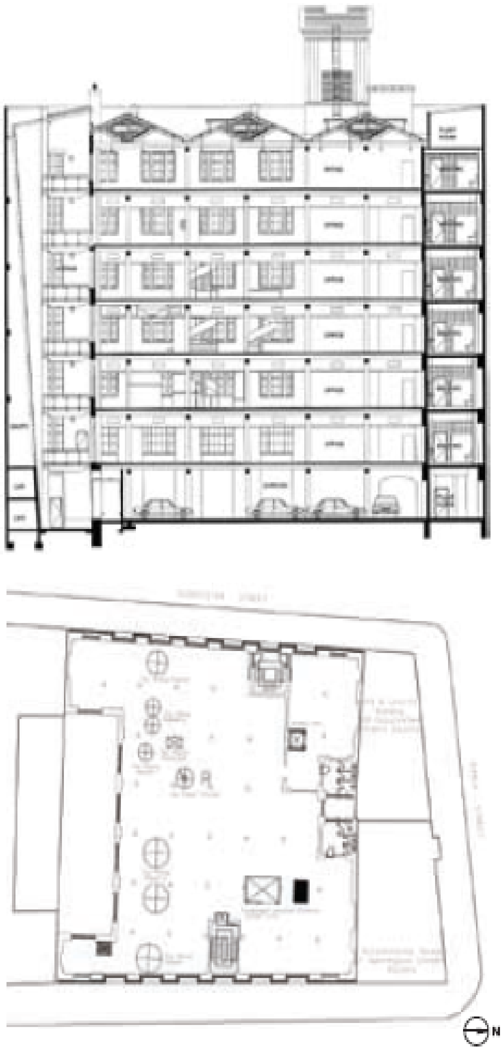
73 :

THE LESSONS

The project benefited from an owner/developer that recognised the value of adapting the building. Skilled design professionals were involved throughout who understood the significance of the building, and were able to balance the need for conservation and their client's aspirations by finding creative solutions to very difficult problems. Working with an enthusiastic contractor, who rose to the challenge of working sympathetically with an existing building, rather than seeing the building as an impediment, was also an important factor in the project's success.

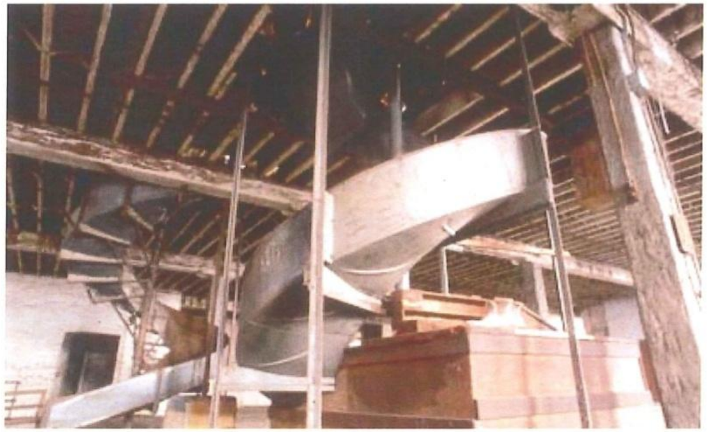
The project was awarded the Master Builders Association Excellence in Construction Merit Award for the Restoration or Renovation of an Historic Building and the UNESCO Award for conservation and adaptation in 2001 and was highly commended for both the Australian Property Institute Award for Best Development (heritage refurbishment) and the Property Council of Australia Rider Hunt Award for conservation and adaptation in 2002.

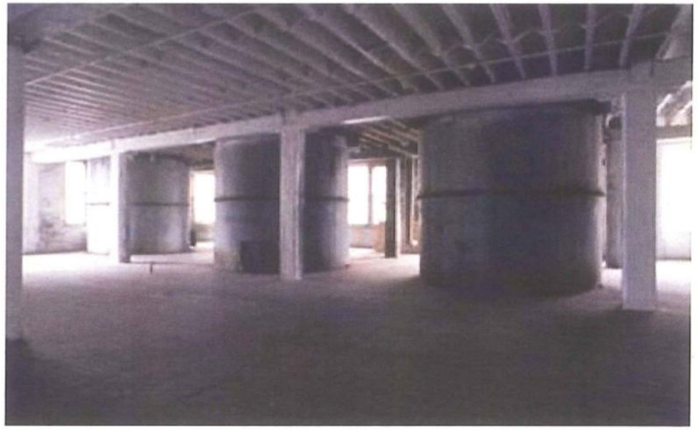
74 :



Top: Section showing the building's adaptation for offices.
Below: The ground floor plan showing its former use.

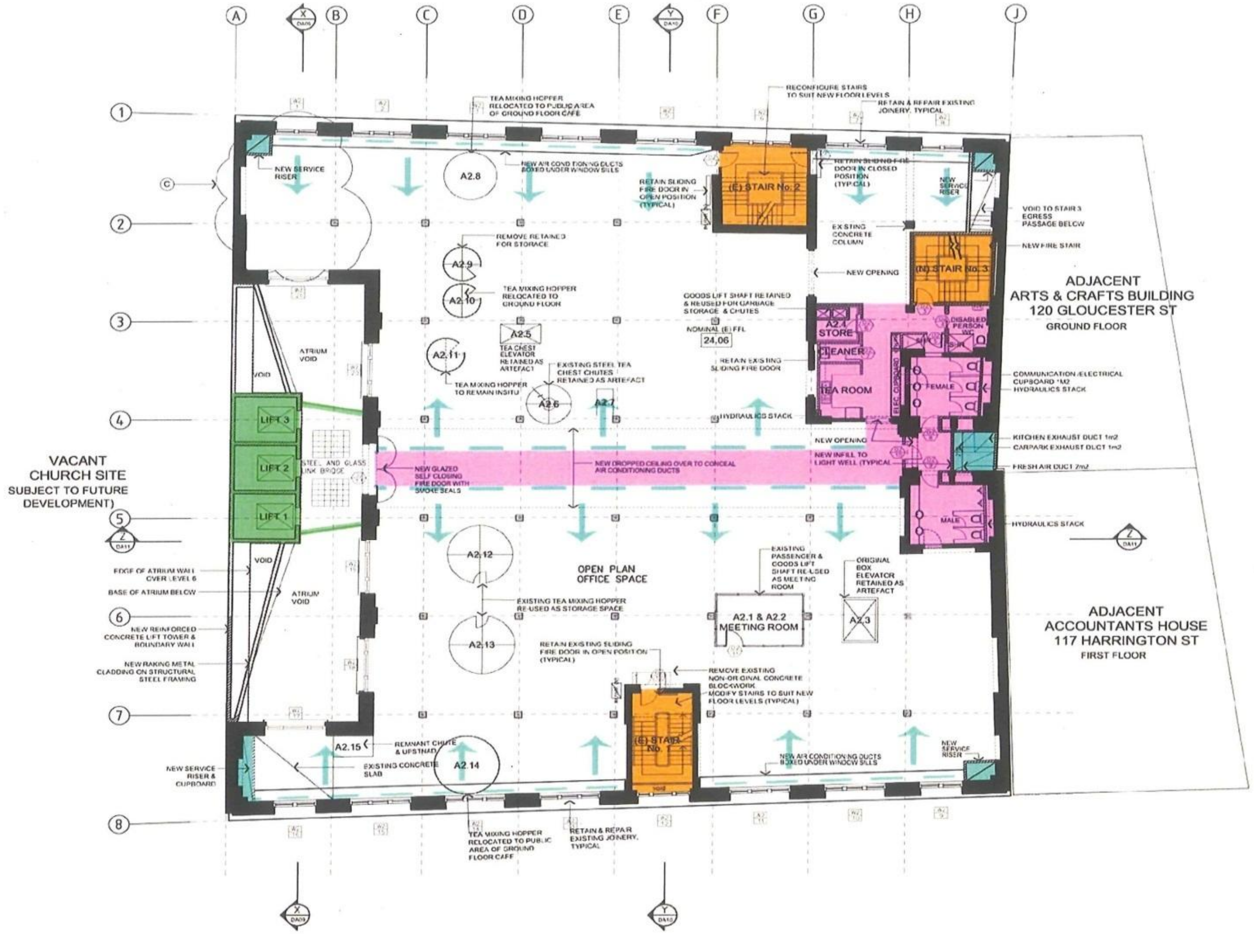
ADAPTATION PRINCIPLES		ASSESSMENTS
Understand significance		• A conservation management plan identified significance and guided the works
New use to be appropriate to heritage significance	Retain use when significant	
	New uses to be compatible	• The new use as offices has retained the building's spatial qualities and its remnant artefacts
Level of change to be appropriate to significance	Minimise impact on significant fabric	• Significant features and artefacts were conserved, including a landmark sign
	Conserve significant interiors	• Interior features have been conserved; modern partition and raised floor systems provide necessary services without compromising the interior spaces
Provide for reversibility and future conservation		• The partition system and services can be removed
Conserve relationship between significant setting and views		• Landmark signage has been retained
Provide for long-term management and viability		• The new use and its overall management system provide for holistic building management
Reveal and interpret heritage significance		• Significant building fabric has been conserved and remnant artefacts and signage retain the historic character of the building and reveal and interpret its former use





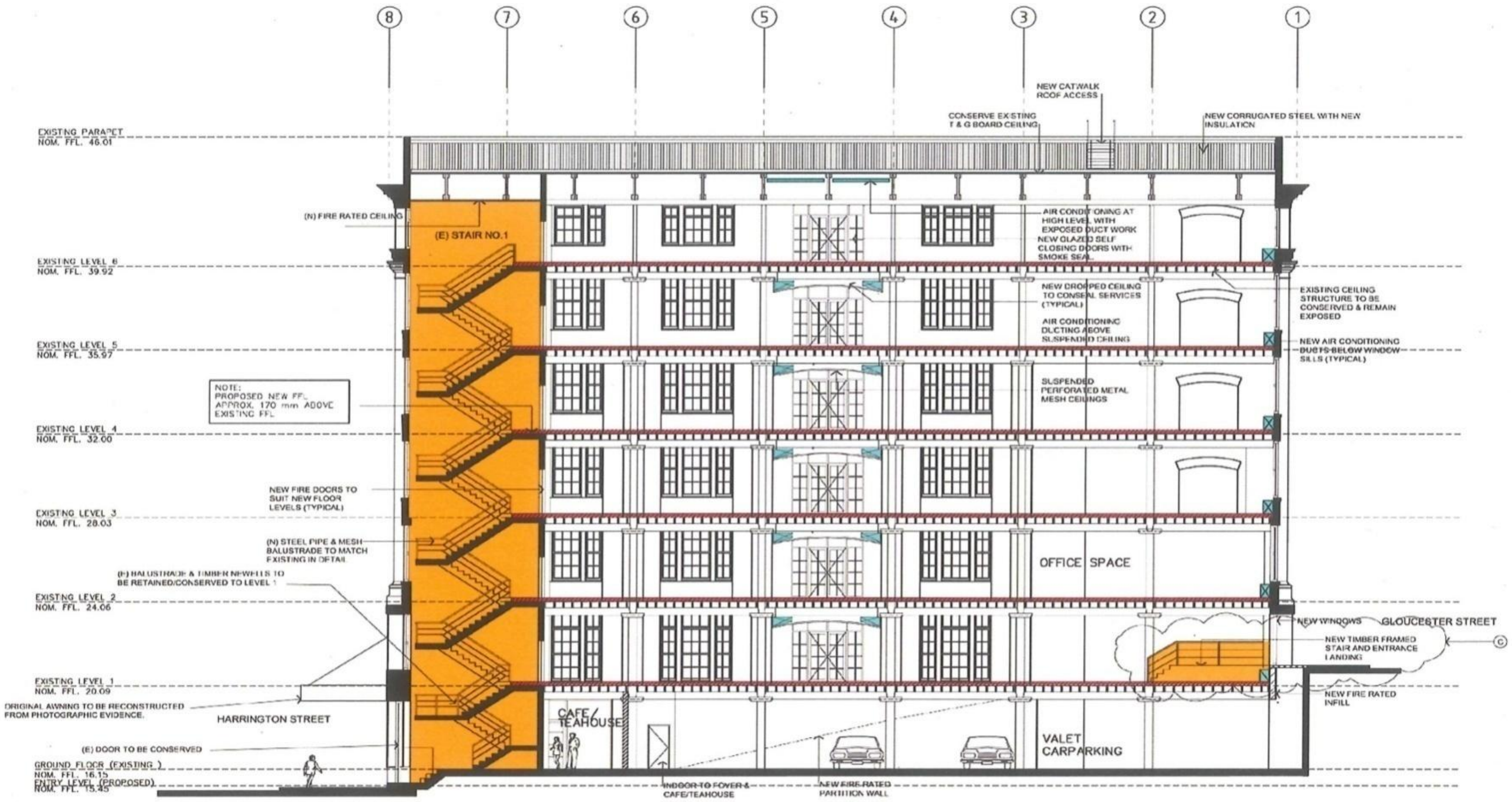
Bushells Building, The Rocks

tanner Architects



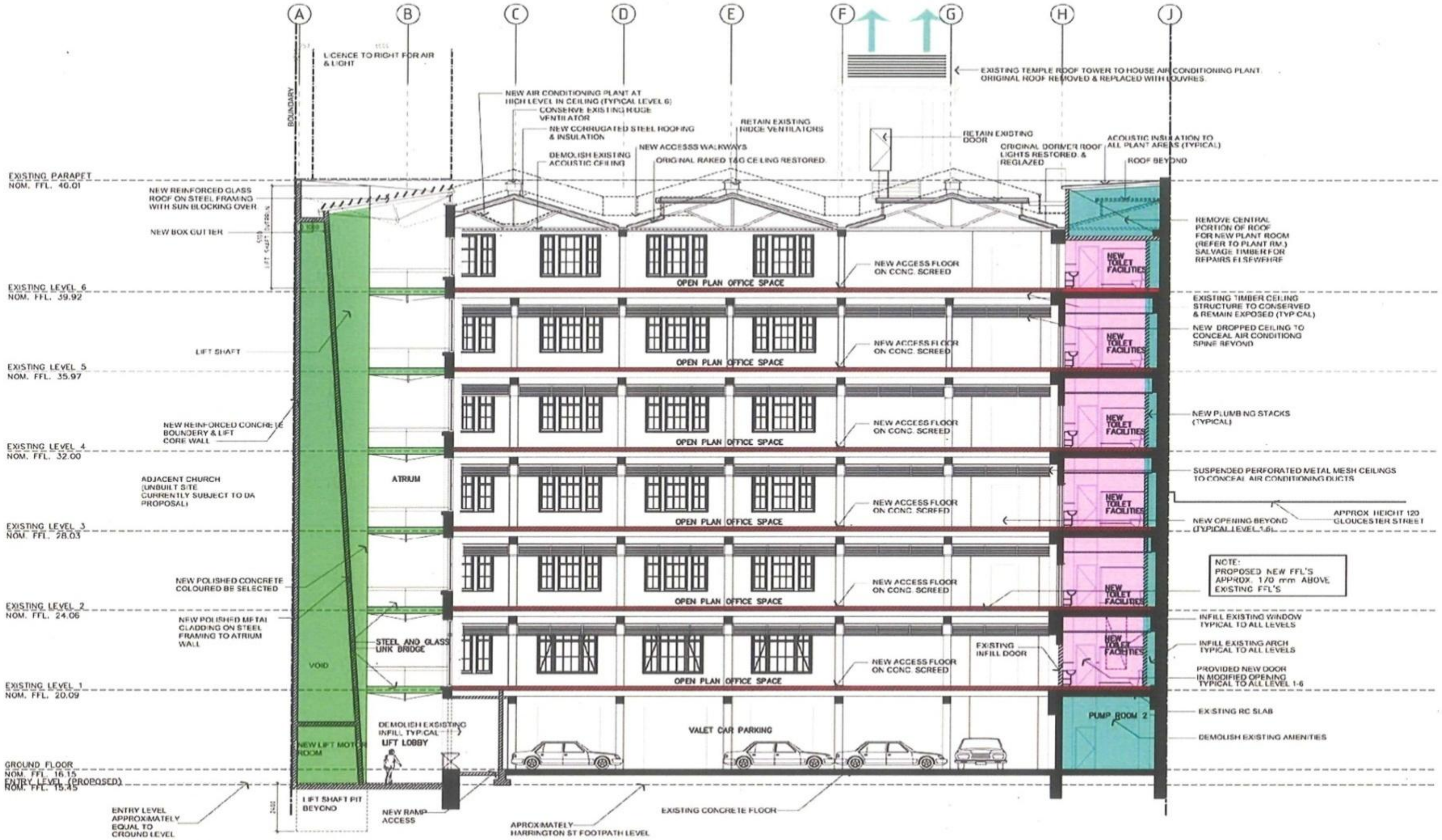
Bushells Building, The Rocks

tanner Architects



Bushells Building, The Rocks

tanner Architects



Bushells Building, The Rocks

tanner Architects

F

DEFENCE BUILDINGS TO SYDNEY HARBOUR FEDERATION TRUST OFFICES: GEORGES HEIGHTS

75 :
The Sydney Harbour Federation Trust office at Georges Heights.

76 :
The former hospital building in use.

THE PROJECT

A group of former WWI hospital buildings was adapted by the Sydney Harbour Federation Trust as part of an overall plan for a headland park extending from Rawson Oval to Middle Head.

Three former hospital buildings were converted into a linked office space and headquarters for the Sydney Harbour Federation Trust. A majority of later infill structures was demolished, leaving one small section with a clerestory roof. The area was converted into a central kitchen/eating/social space connected to a sheltered outdoor courtyard.

THE SITE

The former hospital buildings are located on the sloping ridge line of the Middle Head peninsula and are on the Commonwealth Heritage List. They sit on a prominent knoll on the ridge-line, with excellent views to the east across Sydney Harbour. Two of the buildings were part of a 1915 Army Auxiliary hospital and are considered rare.

All three buildings had been converted to other uses by the Army over time.

THE CHALLENGES

The challenge was to retain the character of the original hospital buildings, and the separate quality and simple hut-like character of all three buildings, while linking them to create office space and meeting rooms. Accretions had to be removed to interpret the original army hospital and kitchen, and engineering works had to comply with current standards. Asbestos sheeting on roofs and internal linings had to be removed, but rare, early exterior asbestos sheeting was retained and repaired.

THE SOLUTIONS

The site was the subject of a conservation management plan. Because the Sydney Harbour Federation Trust is the landowner, consent authority and developer a fully integrated outcome was achieved.

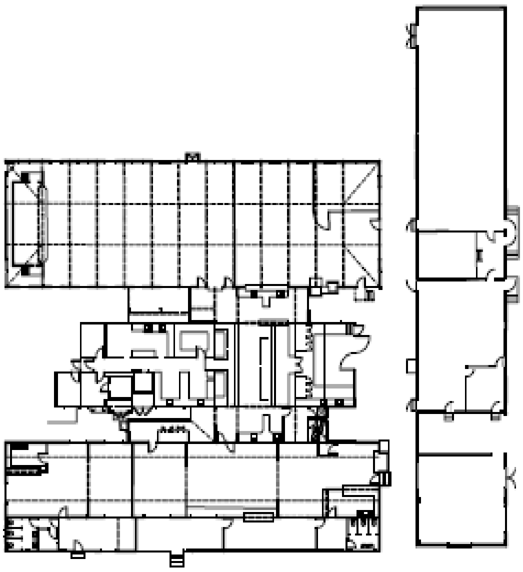
During the conversion of the three buildings Lobb Lane was reinterpreted as an internal access/gallery space, glazed at both ends. Ramps were designed internally to link the different floor levels subtly. New elements were introduced, such as the entrance canopy and ramp. Although complementary, they are clearly distinguishable as new work. Under-floor strengthening and additional wall bracing were introduced to meet structural requirements. The new steel support for the clerestory is clearly and simply expressed. The restrained landscaping to Irving Place interprets the footprint of the previously demolished kitchen block and incorporates water tanks linked to toilets and garden watering. The original colour scheme for the interior of the hospital buildings was reused. It was determined by paint ladders left on display. A central circular air conditioning duct was located in the upper part of the cathedral ceiling space. Skirting ducting supplies wiring to individual desks. Loudspeakers on the roof of Building 29 have been retained, and roof ventilators replaced to match the missing originals.

THE LESSONS

The contracts for re-roofing and asbestos removal would have been more effectively handled as an integral part of the office conversion project, rather than undertaken as separate contracts.

77 :
The original colour scheme for the interior of the hospital buildings was used.

78 :
During the adaptation, a central kitchen/eating/social space was created, connected to a sheltered outdoor courtyard.



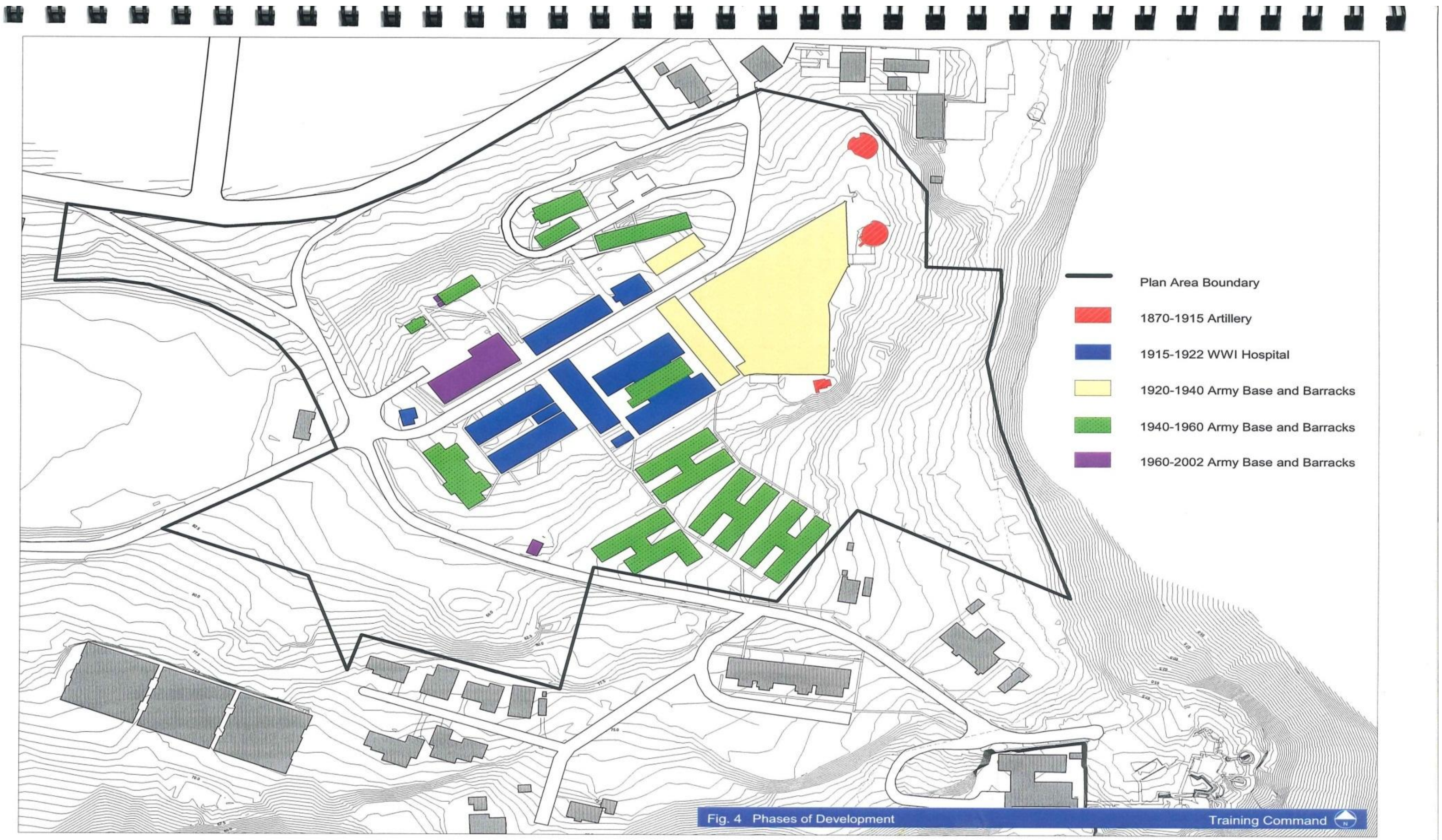
Above: The buildings prior to adaptation.
Right: The plan shows the linking of the three buildings for office space.

ADAPTATION PRINCIPLES		ASSESSMENTS
Understand significance		• A conservation management plan (CMP) for the precinct identified significance and policies to guide adaptation
New use to be appropriate to heritage significance	Retain use when significant	
	New uses to be compatible	• New uses for administration purposes entail minimal impact on the spaces
Level of change to be appropriate to significance	Minimise impact on significant fabric	• The original fabric has been retained wherever possible. Areas of greater impact have been concentrated in areas of lesser significance. Asbestos in internal walls & ceilings has been removed, but the external wall cladding retained
	Conserve significant interiors	• The removal of false ceilings and later internal partitioning and the replacement of some windows and joinery to match the originals has revealed the interior character of the army hospital
Provide for reversibility and future conservation		• Reversibility has been incorporated in different degrees according to heritage significance • Connecting links to the office complex could be removed to revert to three separate buildings. A maintenance program for the continued conservation of buildings has been implemented.
Conserve relationship between significant setting and views		• The relationship between the original building groupings and access roads and the surrounding open space has been carefully maintained, with restrained new landscaping that includes interpretation of the sites of the former important buildings
Provide for long-term management and viability		• The Trust structure allows for overall site and tenant management. Tenant fit-outs are approved by the Trust to achieve compliance with the CMP guidelines
Reveal and interpret heritage significance		• Conservation work has revealed the original volumes and character of the Army hospital buildings • Further interpretation will be provided at the site

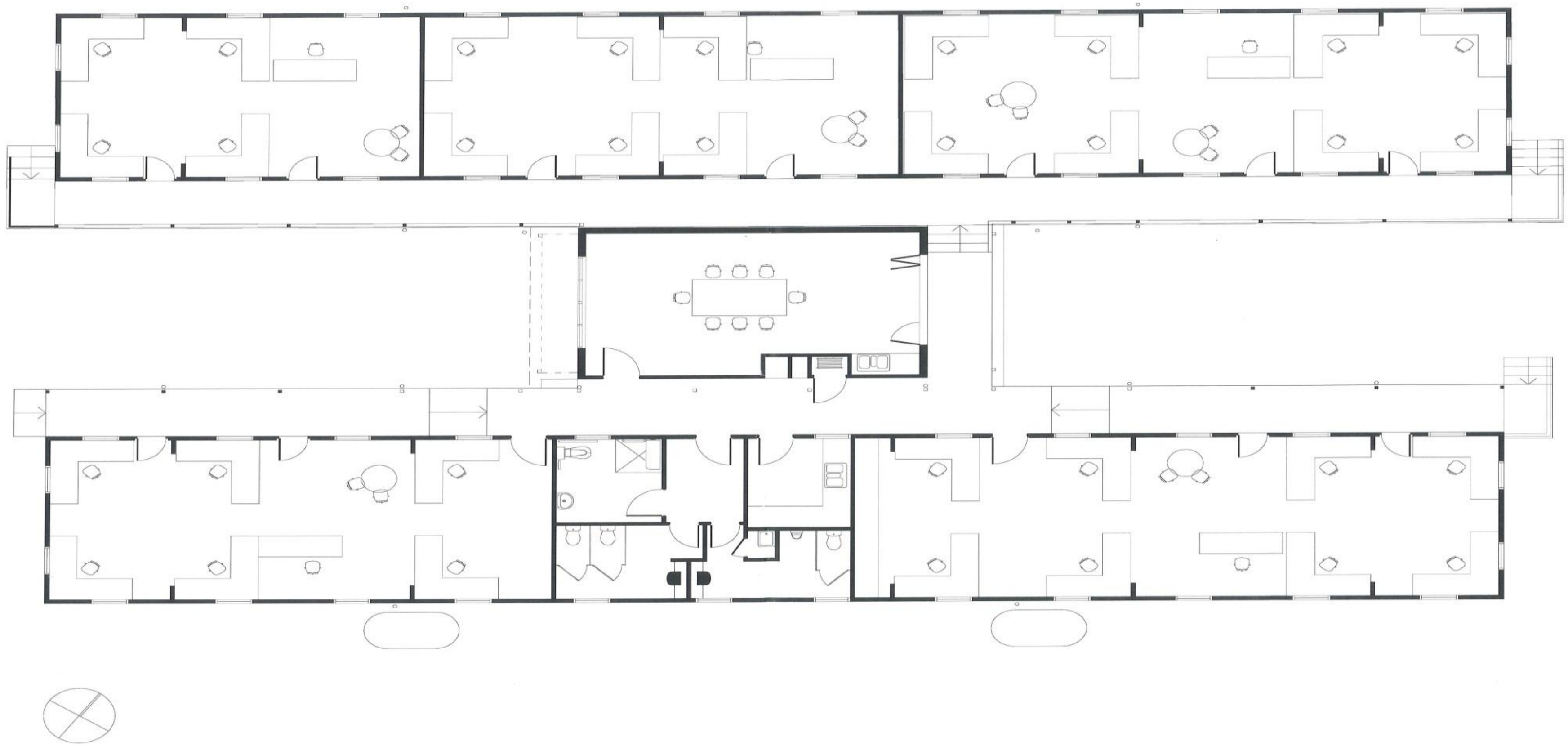
Wards G,H,I and J of the 21 Army Auxiliary Hospital, Georges Heights

The view today with B23 and 21(Wards H and I) conserved. Ward G was demolished now leased as a Dance Academy

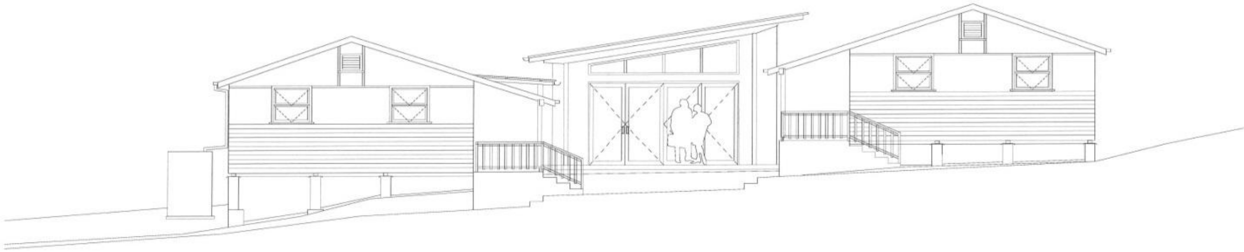
Remains of the verandah wall of the former Ward G discovered during site works and incorporated into the relandscaped area.


Plan Area Boundary
1870-1915 Artillery
1915-1922 WWI Hospital
1920-1940 Army Base and Barracks
1940-1960 Army Base and Barracks
1960-2002 Army Base and Barracks
Fig. 4 Phases of Development
Training Command

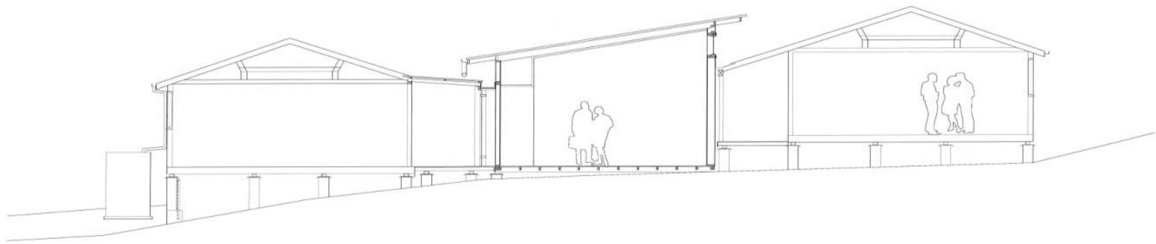
As- built Plan of the Adaptively Reused Defence Buildings



As- built Elevation of the Adaptively Reused Defence Buildings



As- built Section of the Adaptively Reused Defence Buildings



G

COMMERCIAL BUILDING TO REGIONAL ART GALLERY: SULLY'S EMPORIUM, BROKEN HILL

79 :
Broken Hill Regional Art Gallery.

80 :
The building was previously a mining hardware store.

THE PROJECT

The Broken Hill Regional Art Gallery was adapted from a near ruinous former mining hardware building in the main street of Broken Hill. The project was carried out in three stages as funding became available. The building now exhibits the extraordinary art of the Broken Hill region, including contemporary art and the local council collection, which dates from the council's establishment in 1886. Interpretation was added to tell the history of the building and the story of the development of Sully's Emporium as an important mining enterprise. Local artists, the council and tourists share the use of the building. It has become a unique visitor experience, enhancing Broken Hill's appeal as a tourist destination.

THE SITE

Sully's Emporium is located within the Argent Street Conservation Area and is included on the State Heritage Register. It has a characteristic streetscape of shopfronts with verandahs and buildings with rear lane access. The building was constructed in two sections. A two-storey stone building with a shopfront with a cellar, and upper gallery, was erected in 1889, to the design of Adelaide architect George Abbott; the contractors were Walter & Morris, also of Adelaide. In 1894, two adjacent shops were added, with a cellar and offices above, to create an elaborate unified façade with a single storey verandah. The firm had a livery and blacksmith's shop in the rear yard.

THE CHALLENGES

The building had deteriorated significantly and was being vandalised. It was structurally sound, but the open section of the 1889 part of the building retained original, damaged balustrading, which was neither safe nor of regulation safety height. Careful joinery work reused original components to meet the correct safety height. The two sections of the building were not internally linked at the first floor level, but this was resolved and a lift was added at the rear of the complex. The installation of air conditioning was a major design challenge and expense, because of visibility issues and the location of ducts.

THE SOLUTIONS

The building was adapted to display the art works. The ground floor incorporates an entry and exit and shop within the former office area of the building. Sections of original shop joinery were retained and conserved. The original curved roof on the first floor was lined, while still exposing the significant 1889 light metal truss. This provided insulation for the climate control required for the art works. Former offices on the first floor of the 1894 section were amalgamated to provide additional gallery space. The lath and plaster walls, which were in poor condition, were removed. The original staircase frieze was retained, and a new complying timber stair installed. Corrugated iron — a widely used material in Broken Hill — was used for the new rear toilet and lift extension, clearly distinguishing it from the early masonry section of the building.

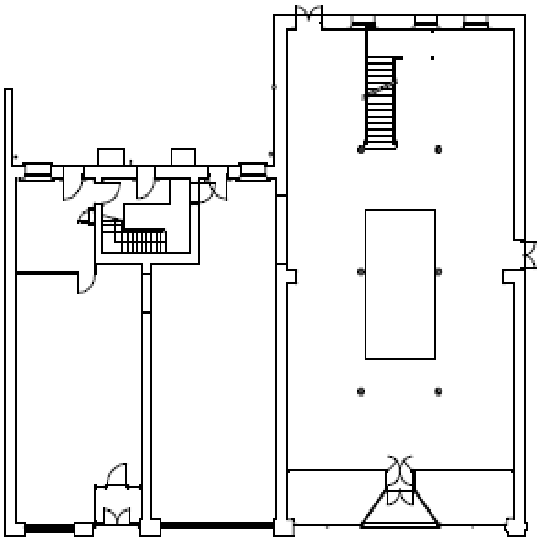
THE LESSONS

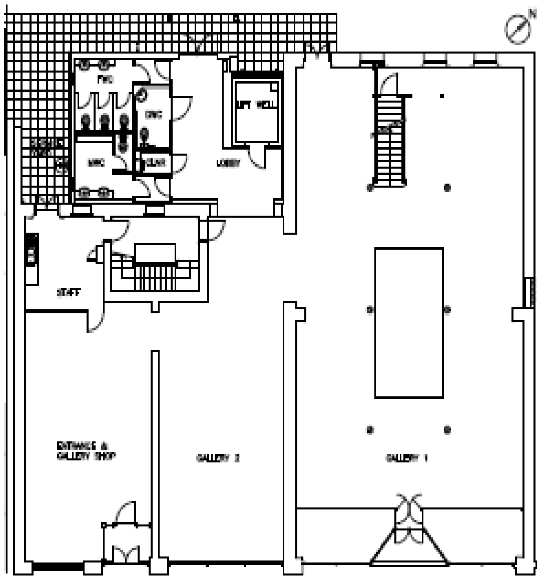
Despite a lack of finance or an agreed use, Broken Hill City Council was committed to retaining this significant main street building. By undertaking the work in stages, funding became available from a variety of sources. However, the project was always constrained by a limited budget. Flexibility in the architectural services provided was essential, so that solutions could be accommodated within changing funding conditions. The design approach allowed for contemporary design elements to sit comfortably with the important heritage qualities of the building.

81 :
The ground floor incorporates the new entry/exit and shop.

82 :
The original curved roof has been lined, while still exposing the significant 1889 light metal truss.

The conversion won the Australian Property Institute Savills Heritage Award and the Corporate/Government category of the EnergyAustralia National Trust of Australia (NSW) Heritage Conservation Award in the Built Heritage for projects over $500,000 category in 2005.





Above: Ground floor plan prior to adaptation.
Right: Ground floor plan showing the shop and gallery spaces and rear extension.

ADAPTATION PRINCIPLES		ASSESSMENTS
Understand significance		• A thorough significance assessment and fabric analysis was undertaken by the architect and used to guide the works
New use to be appropriate to heritage significance	Retain use when significant	• Some commercial use has been retained in the gallery use
	New uses to be compatible	• The gallery use retains some commercial functions and provides public access to the building
Level of change to be appropriate to significance	Minimise impact on significant fabric	• Significant fabric was carefully conserved; the new use demanded only a light touch • A new complying stair complemented and supplemented the original stair, which was retained
	Conserve significant interiors	• Interior features that survived were retained, such as internal office joinery and gallery balustrading
Provide for reversibility and future conservation		• New works have been simply undertaken, minimising their impact on the building fabric. Future works will expand the gallery facilities in a separate but linked building.
Conserve relationship between significant setting and views		• The streetscape character and verandah were conserved early on in the project to attract interest in the building and draw attention to its significance
Provide for long-term management and viability		• The gallery use provides ongoing viability for the building, which has become an important local cultural facility
Reveal and interpret heritage significance		• The light touch of the conservation works and architectural intervention has let the building 'speak for itself' by conserving significant features and not introducing new elements that obscure original features

H

THE MINT: COINING FACTORY TO HISTORIC HOUSES TRUST HEAD OFFICE AND LIBRARY, MACQUARIE STREET, SYDNEY

83 :
The new headquarters of the Historic Houses Trust.

84 :
The former sandstone Coining Factory buildings of the Royal Mint.

THE PROJECT

The surviving structures of the sandstone Coining Factory buildings of the Royal Mint, Sydney (1855-1926) were adapted for use as the new head office of the Historic Houses Trust (HHT). The buildings had served as government offices and law courts from 1927-1997 and had been left vacant and partially demolished. The conservation and interpretation of these significant but neglected buildings has provided a viable new use, public access and new areas of public open space. The project aimed to combine the best of conservation theory and practice with the best of contemporary architecture.

While most of the office facilities were to be provided within the adapted Coining Factory, new buildings were also necessary. These were carefully located on vacant areas of the site. They do not re-create the form of earlier demolished historic structures, but are contemporary in design. The intention of the HHT was twofold: there should be no confusion between the heritage fabric and the new fabric, and the adaptation should create a lively and busy precinct that expressed the organisation's commitment to conservation excellence and to contemporary architecture and programming.

THE SITE

There are two structures on the Mint site — the Mint offices on Macquarie Street (originally the south wing of Governor Macquarie's General or 'Rum' Hospital, constructed from 1811-1816) and behind this, the Coining Factory (constructed in 1854 for the Royal Mint). Located in the most important civic precinct of Sydney, these buildings have a remarkable history of use and adaptation over nearly 200 years. They served as the assistant surgeon's residence, military hospital, dispensary and infirmary for the poor, the Royal Mint, government offices, law courts and museum.

The site is included on the State Heritage Register and the buildings are listed on Schedule 1 of the Central Sydney Heritage Local Environmental Plan.

85 :
Within the existing building, the large industrial spaces were re-established to reveal the original pre-fabricated cast iron structures, masonry and painted walls.

THE CHALLENGES

The site was the only area on the eastern side of Macquarie Street not developed — the 'missing piece' in one of the most important historic civic precincts of Sydney. Used as temporary accommodation for government departments and law courts for almost 50 years, the Coining Factory had been partially demolished during the 1960s. Remaining structures suffered from rising and falling damp and termite damage. The extent of surviving original interior finishes and fabric was unknown, as 20th century additions obscured the majority of the interiors. This 20th century fabric also contained hazardous material such as asbestos products and lead paint. Documentary research, confirmed by site surveys, indicated the presence of mercury contamination and hydrocarbons.

To ensure the long-term conservation of the site, the surviving industrial interiors were to be adapted to modern office uses, with minimal interference to the fabric. To meet the requirements of head office accommodation, new buildings were also to be constructed within this historic precinct.

THE SOLUTIONS

Before the project commenced a considerable amount of time was spent establishing the approach and identifying issues, risks and opportunities. A team of highly qualified practitioners was appointed following a rigorous selection process. A clear project structure was also established from the beginning.

The brief clearly articulated the HHT's requirements — the best of conservation practice combined with the best of contemporary architecture. This philosophy was reinforced during the course of the project.

Following commencement of the preliminary design work documentary analysis and physical investigation of the site was undertaken. Twentieth-century additions to the buildings were documented and carefully removed, to reveal as much as possible of the surviving original structures. At the same time, an archaeological program was undertaken. This site investigation was linked to remediation and reduced the risk of discovering significant archaeological remains or hazardous materials.

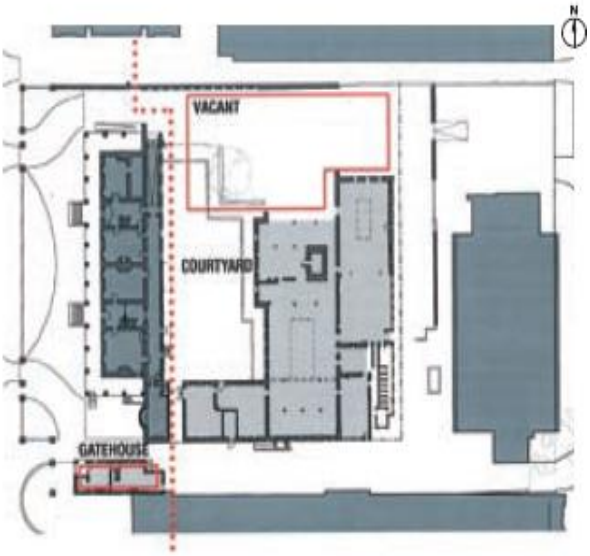
The design for the new buildings evolved out of the symmetry of the original buildings, and the relationship of the site to Macquarie Street and the Domain. The new structures were carefully located to complement the proportions and geometric alignments of the existing buildings. They are clearly articulated and distinguishable from the older fabric, and their character and form relates to their location and associated immediate heritage context. The new structures also protect the surviving historic fabric.

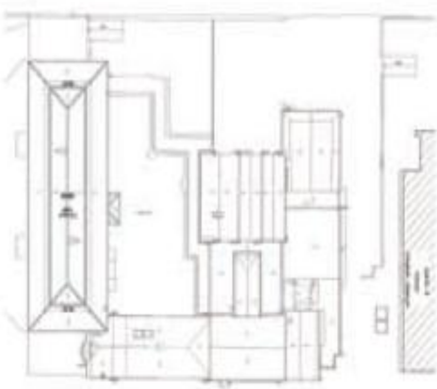
Within the existing buildings, the large industrial spaces were re-established to reveal the original pre-fabricated cast iron structures, masonry and painted walls. Original doorways, windows and skylights were re-opened to return light to the buildings and new floors, and openings and services were carefully located to preserve existing fabric with its evidence of use and adaptation. Archaeological elements were also incorporated into the new interiors.

THE LESSONS

A rigorous selection process established a team of highly qualified consultants to undertake the brief and accept the conceptual framework with enthusiasm. The thorough investigation of the surviving structures and archaeological evidence of the site at the start of the project reduced the risk of unexpected discoveries. Indeed, it resulted in the integration of historic building fabric and archaeological elements into the design of the new office spaces.

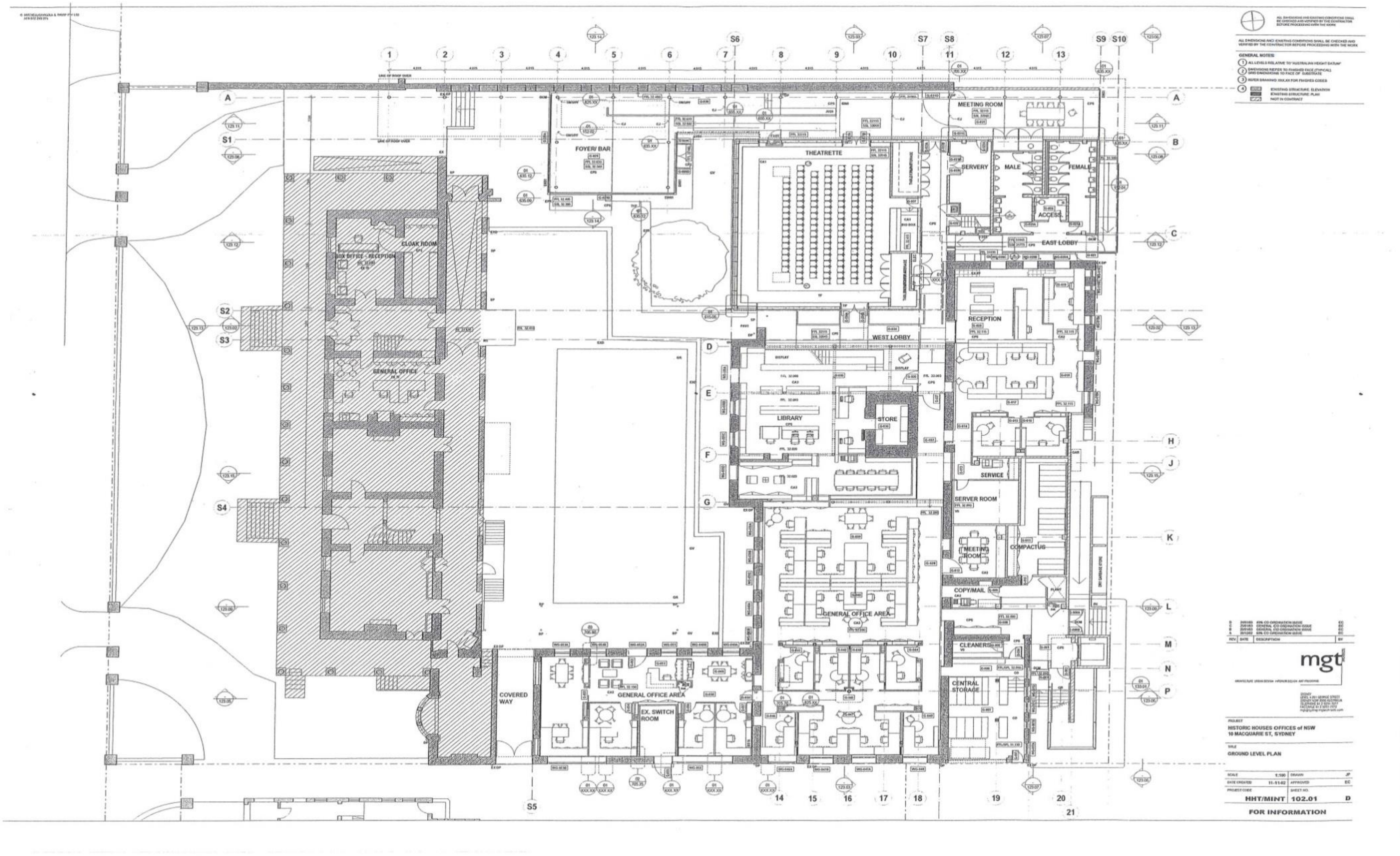
The Mint project received both the Royal Australian Institute of Architecture's Sulman Award and the Greenway Award in 2004. At the time the judges commented that 'The whole ensemble is given cohesion through carefully modulated scale and proportion, juxtapositions of materials, light and shade, old and new, inside and out. A 19th century walled factory has been transformed into a 21st century campus.'

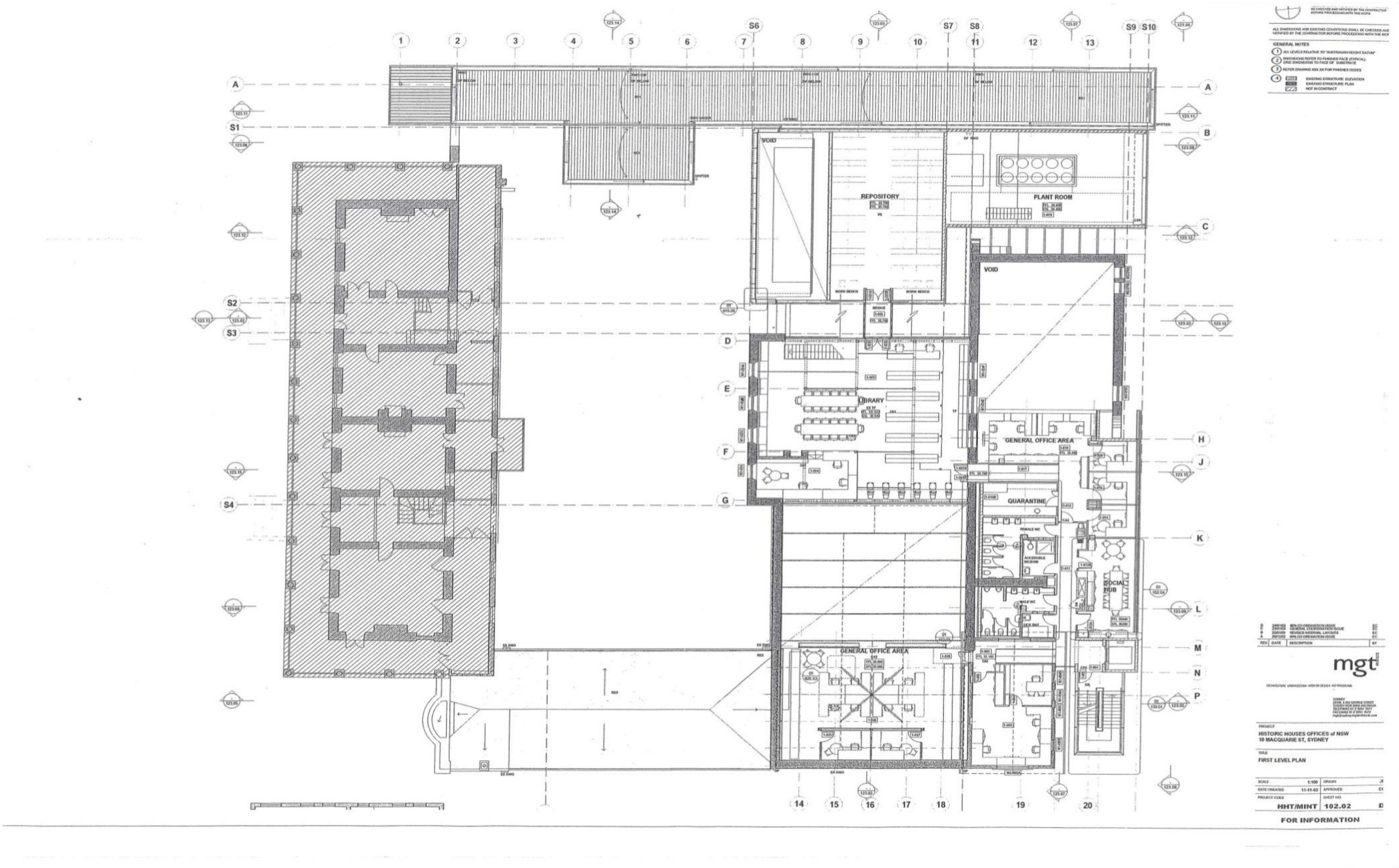




Top: The ground floor plan showing the layout of buildings prior to adaptation.
Below: The plan showing the adaptation of the former Coining Factory building for office space and the new building.

ADAPTATION PRINCIPLES		ASSESSMENTS
Understand significance		• The conservation management plan was allowed to evolve as the site investigation and analysis proceeded, informing the design process
New use to be appropriate to heritage significance	Retain use when significant	• The new use continues a 200 year history of the site's use as public offices
	New uses to be compatible	• Continues history of changing use and adaptation of site buildings and enhances public access/interpretation
Level of change to be appropriate to significance	Minimise impact on significant fabric	• The thorough site analysis undertaken before detailed design and documentation enabled the conservation and integration of significant fabric
	Conserve significant interiors	• Original fabric was revealed and preserved within the new spaces and structures • Significant fabric was protected but not obscured by new structures and work • The energy efficient 'tempered air' ventilation system minimised changes to the interior environment
Provide for reversibility and future conservation		• The majority of new work sits separately from the heritage fabric, providing for future change or reversibility with minimal impact
Conserve relationship between significant setting and views		• The scale and form of the new buildings has enhanced the nature and use of the central courtyard of the site, and strengthened the relationship of the site as a whole to both Macquarie Street and the Domain
Provide for long-term management and viability		• The overall design concept separated public and cultural activity areas from head office and business areas, allowing these operations to run independently and concurrently, thus increasing options for use and long-term viability
Reveal and interpret heritage significance		• The new use has provided for the conservation of historic buildings and fabric, and public access and site interpretation through displays, signage and public activities, without the cost of full museum infrastructure


MEETING ROOM
FOYER/ BAR
THEATRETTE
SERVERY
MALE
FEMALE
ACCESS
EAST LOBBY
CLOAK ROOM
BOX OFFICE - RECEPTION
RECEPTION
WEST LOBBY
GENERAL OFFICE
LIBRARY
STORE
SERVICE
SERVER ROOM
MEETING ROOM
COMPACTUS
COPY/MAIL
GENERAL OFFICE AREA
CLEANERS
CENTRAL STORAGE
COVERED WAY
GENERAL OFFICE AREA
EX. SWITCH ROOM
mgt
PROJECT
HISTORIC HOUSES OFFICES of NSW
10 MACQUARIE ST, SYDNEY
TITLE
GROUND LEVEL PLAN
SCALE 1:100
DRAWN JP
DATE CREATED 11-11-02
APPROVED EC
PROJECT CODE HHT/MINT
SHEET NO. 102.01 D
FOR INFORMATION


GENERAL NOTES
VOID
REPOSITORY
PLANT ROOM
LIBRARY
GENERAL OFFICE AREA
QUARANTINE
SOCIAL HUB
GENERAL OFFICE AREA
mgt
PROJECT
HISTORIC HOUSES OFFICES of NSW
10 MACQUARIE ST, SYDNEY
TITLE
FIRST LEVEL PLAN
SCALE 1:100
DATE CREATED 11-11-02
APPROVED
PROJECT CODE
SHEET NO.
HHT/MINT 102.02
FOR INFORMATION

RAILWAY WORKSHOP BUILDING TO HEALTH AND WELLNESS CENTRE: THE FORUM HEALTH AND WELLNESS CENTRE, NEWCASTLE

86 :
The Forum Health and Wellness Centre.

87 :
The Interior of the building when it was known as Civic Railway Workshop Block A.

THE PROJECT

An historic railway workshop building was adapted for The Forum Health and Wellness Centre, owned by University of Newcastle Sport. The concept of 'a building within a building' was adopted, maintaining a strong axis through the building and retaining existing openings and part of a former platform to interpret the previous use.

THE SITE

The building known as Civic Railway Workshop Block A (the former Permanent Way Store or Perway Building) is on the State Heritage Register. It is located between Workshop Place and Harbour Square at Harbourside in Newcastle. It appears as a combination of heritage railway and contemporary buildings within the Honeysuckle urban regeneration area's contemporary streetscape. The workshop building is of simple form and is constructed of brick.

THE CHALLENGES

The challenge was to maintain the sense of scale and size of the internal volume, and to interpret the building's previous use. The brief, for large open spaces and acoustic and visual separation between uses within the building, created a potential conflict with the heritage values of the building. Any new additions were to be clearly discrete from the heritage building, with little impact on the public domain.

THE SOLUTIONS

The concept of 'a building within a building' kept new internal structures independent of the existing fabric, allowing the new development to maintain a minimum and reversible impact on the significant fabric of the building. Spatial and acoustic requirements were met by separating the aerobics area on a mezzanine over the equipment areas in the main body of the building. The mezzanine structure does not touch the external walls, and infilling with clear glass maintains the sense of scale, while achieving acoustic separation. New additions to the rear of the building, housing the new changing room areas, are clearly discrete from the heritage building.

THE LESSONS

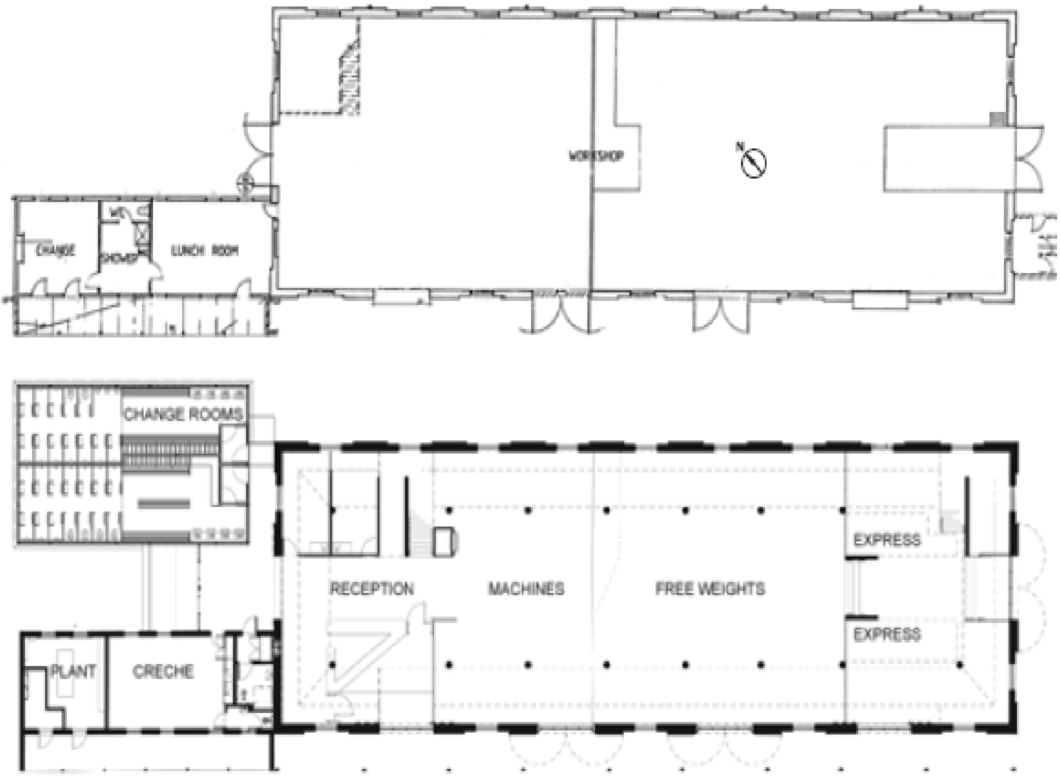
The design and execution of the facility required the co-operation of the Heritage Office, Newcastle City Council and the Honeysuckle Development Corporation within a tight time frame. The tight brief and budget guided the design resolution of the building and its spaces. Since opening in late 2006, the centre has been a great success with over 3000 memberships sold to date, out-performing its business plan.

The project won the Babic Construction Heritage Award and the Andrews Neil Peoples Choice Award in the 2007 RAIA Lower Hunter Urban Design Awards.

88, 89 :
The mezzanine structure does not touch the external walls, and infilling with clear glass maintains the sense of scale and achieves acoustic separation.

88 :

89 :



Top: Plan showing the building's former use as a railway workshop.
Below: Plan showing the layout of the new centre.

ADAPTATION PRINCIPLES		ASSESSMENTS
Understand significance		• An overarching conservation management plan informed the site masterplan • Individual buildings and elements had conservation management strategies to inform development applications
New use to be appropriate to heritage significance	Retain use when significant New uses to be compatible	• Health centre use demands were compatible with the former workshops use
Level of change to be appropriate to significance	Minimise impact on significant fabric Conserve significant interiors	• Main building features were conserved in the adaptation
Provide for reversibility and future conservation		• The industrial building is now part of a major regeneration area that has been converted to mixed and residential uses. The new use is an insertion into the building and can be removed later if required
Conserve relationship between significant setting and views		• The building's character and role within the revived precinct retains it as an important urban feature
Provide for long-term management and viability		• The new use provides for the future viability of the building in a single ownership
Reveal and interpret heritage significance		• The design of the health club reveals the building features and uses them to drive design character

J

WAREHOUSE TO HOTEL COMPLEX: GEORGE PATTERSON HOUSE, SYDNEY

90 :
George Patterson House now accommodates hospitality venues and a boutique hotel.

91 :
The building damaged by fire in 1996.

THE PROJECT

Two buildings — substantially damaged by two simultaneous fires on 2 January 1996 — have been retained, conserved and adapted for a hospitality venue, including a boutique hotel in the CBD. The 1996 fire focussed public attention on the loss of heritage buildings in the city, prompting Sydney City Council to require the adaptation rather than demolition of the buildings.

In 1998 a prominent entrepreneur purchased the site with the aim of retaining and celebrating the significance of the building, including its disastrous fire. This required an innovative approach to the treatment of the original fabric.

The building was adapted to accommodate a series of bars and function spaces accessible from George Street, a boutique hotel in the former warehouse section off Tank Stream Way, and a nightclub in the lower ground and basement levels.

The missing sections of the building were reconstructed in an interpretive way, retaining evidence of the fire on the façades, and in the central glass roofed garden bar area.

All service and access facilities for the bars and function rooms were housed in a new ten-storey building immediately to the north, to allow the original showroom spaces and the large hole created by the fire to be retained as single open spaces. The new building houses lifts, fire stairs, kitchens, loading dock, offices and a penthouse.

THE SITE

The building was designed in the Queen Anne Revival style and built between 1892-1895 for Holdsworth MacPherson & Co. hardware merchants and ironmongers, as a conjoined showroom and warehouse with a water tower at the junction. At the time of its construction it was considered the grandest emporium of its period.

There were six levels of showrooms and offices fronting George Street, plus a lower ground and basement off Bridge Lane. The adjacent warehouse was of seven levels, with a lower ground floor, and fronted Bridge Lane and Tank Stream Way. The site is surrounded by streets and narrow lanes.

Subsequently, four floors were removed from the George Street end and two from the east end. The fire in the centre of the building created a large void down to ground level.

The site was not listed by Sydney City Council at the time of the fire in 1996, but had been proposed for listing, generating much debate.

THE CHALLENGES

The severe fire damage required a prospective owner/developer with more than the usual imagination and commitment. The building had been without weather protection and exposed to extensive water damage. Even elements in sound condition could not meet current loading codes.

THE SOLUTIONS

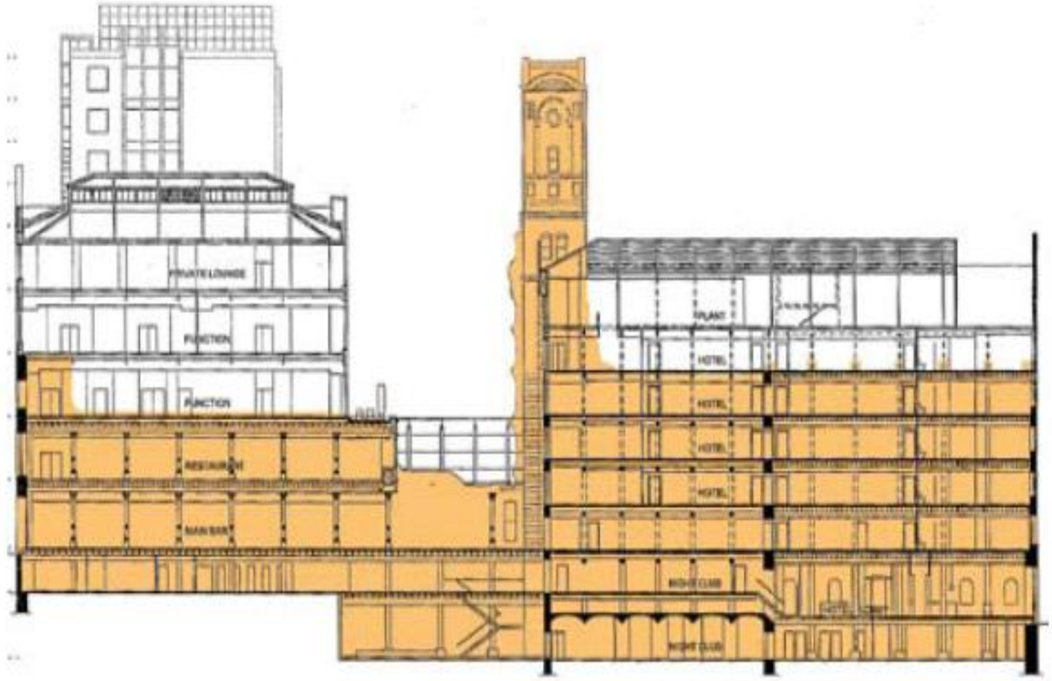
The structural inadequacies of the timber joists were resolved by adding a concrete slab above the existing floors. This allowed the joists and flooring to remain exposed from the underside.

92 :

92 :
The modern fabric has been successfully incorporated into the heritage space.

93 :
Missing sections of the pressed metal ceilings were reconstructed to reinstate the sense of quality and grandeur in the public spaces.

Extent of original fabric shown coloured.



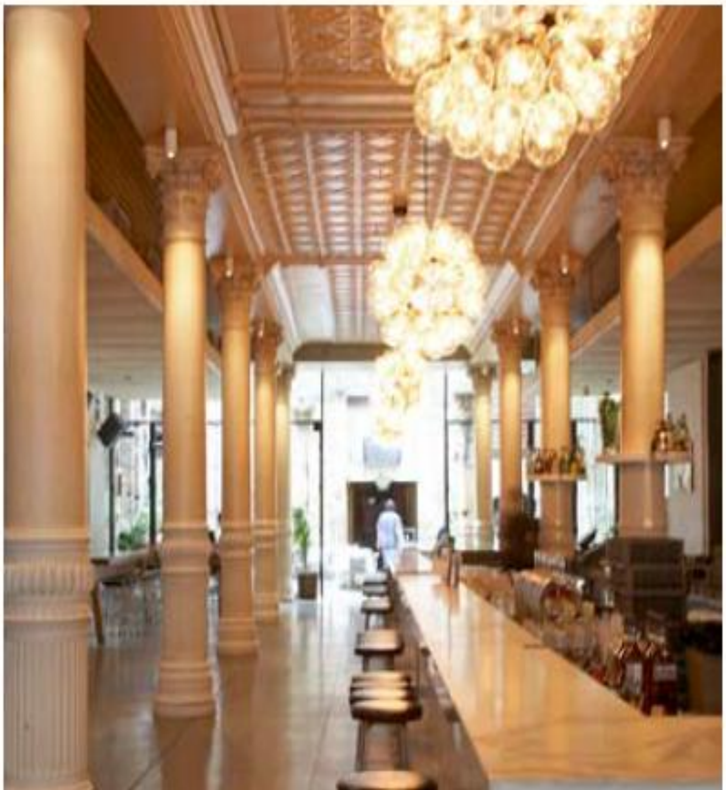
The brick walls were extended to approximate their original height to house the reconstructed spaces, incorporating modern steel windows, in the same manner as the earlier work below. A bright red brick line was used to separate the old and new work, which marked the extent of the surviving sections of the building. Original sandstone elements were reproduced in render, while projecting cornices were executed in prefabricated GRC.

The original surviving spaces were used as the basis and inspiration for the new work, particularly the interior design, finishes and furnishings. In all but the service areas, the existing spaces and in many cases also their finishes have been retained as the signature or identity of the space.

The original showroom spaces, with their cast-iron columns and elaborate pressed metal ceilings, were retained as single large spaces, by housing all service areas and vertical access at the George Street end, in a new building immediately to the north of the existing building.

Missing sections of the pressed metal ceilings were reconstructed to reinstate the sense of quality and grandeur in the public spaces.

The central section, which was gutted by fire, was roofed over in glass, creating a unique and exciting sunlit atrium space in the midst of the building. The evidence of the fire is preserved and protected here and is clearly the inspiration for the space.



93 :

GEORGE PATTERSON HOUSE (CONTINUED)

The boutique hotel has been fitted out in the manner of luxurious New York style warehouse apartments. Services were run within false ceilings in corridor and service spaces, while the original structure remains exposed in bedrooms and public spaces.

The hotel entry off Bridge Lane uses a modified loading dock, retaining the original timber doors either side of a highly finished modern entry door, signalling the modern style and luxury of the interior.

The Tank nightclub located in the basement retains the decayed and ruined finishes of this space and contrasts with new elements — bathrooms, bars, lounges, DJ booth and stairs. These are clearly modern and clean, but retain and respect the 'rawness' presented by the earlier elements and surfaces.

The demolished upper levels of the George Street façade were re-interpreted with new masonry, but rebuilt one floor lower.

Internally, the pressed metal ceilings were repaired or reconstructed and elsewhere the timber framing and joists were left exposed in hotel rooms and public spaces.

THE LESSONS

The client's enthusiasm and commitment to the adaptive re-use of the fire damaged ruin was crucial. Without their support throughout the execution of the project much of the original fabric, and hence the identity of the place, would have been lost.

The honesty and design quality of the new work retains the integrity of the surviving elements, and provides them with an appropriate and elegant context and, most importantly, a viable use which celebrates their survival.

The finished project interprets the significance of the place and its unique identity so that there is little need for the more conventional forms of interpretation, such as signage.

Public access to the buildings from the surrounding lanes has re-activated these underused spaces and integrated the project back into the historic patterns and finer grain of the city's public spaces. This is a process which will evolve further, but the project has clearly re-established the viability of the public use of these narrow lanes.

The project won an Interior Architecture Award in the 2001 RAIA NSW Chapter Awards.

ADAPTATION PRINCIPLES		ASSESSMENTS
Understand significance		• A study was done prior to the fire to establish the heritage significance of the building • Another analysis of heritage significance followed after the fire
New use to be appropriate to heritage significance	Retain use when significant New uses to be compatible	• Key fire-damaged spaces were left to reveal the story of the site • The existing spaces and, in many cases, their finishes have been retained as the signature or identity of the space • The eastern end of the original showroom wing, which suffered the most fire damage has been retained as an open space, complete with its fire damaged finishes. This space and the basement below are now signature spaces for the identity of the place. • The new use encourages public visitation and celebration of the spaces. • In all spaces the qualities and character of the original or damaged space determined or inspired the character and finishes of the new use and fit-out • All service areas required for the public function areas were located in the adjacent new building
Level of change to be appropriate to significance	Minimise impact on significant fabric Conserve significant interiors	• All repair and stabilisation work to the remaining fabric was done using traditional materials and techniques • Some reconstructed elements were carried out using modern materials • Significant sections of the fire damaged interiors were conserved, including finishes
Provide for reversibility and future conservation		• Wherever possible, existing structure and elements were left in place, with new elements and services fitted around them
Conserve relationship between significant setting and views		• The adaptive reuse and redevelopment has created one of the most popular gathering places in Sydney • The project has re-enlivened the narrow lanes that were once an important and active part of the city
Provide for long-term management and viability		• The site has a mix of viable new uses
Reveal and interpret heritage significance		• The finished project interprets the significance of the place and its unique history and identity

K

HERITAGE-LED URBAN REGENERATION: REVITALISATION OF A GOVERNMENT HEALTH FACILITY TO RESIDENTIAL, COMMERCIAL AND HEALTH FACILITIES, PRINCE HENRY AT LITTLE BAY

94 :
One of the 1914 Flowers Wards was conserved and adapted for a museum.

95 :
Prince Henry Hospital was historically important because of its treatment of infectious diseases.

96 :
Aerial view showing the Prince Henry Hospital site.

THE PROJECT

The former Prince Henry Hospital site has been redeveloped for a variety of uses including residential, commercial, health and community facilities. This highly sensitive coastal site has natural, geological, landscape, archaeological, Aboriginal, built and social heritage values that are recognised by its listing on the State Heritage Register. A conservation management plan for the site recognised the need to approach the site as a cultural landscape, and also identified significant elements of the site. A masterplan identified qualitative and quantitative principles of approach, identified elements to be demolished, and established uses across the site. The developer, Landcom, tendered specific precincts to a number of developers, who submitted development applications for their projects.

THE SITE

The site encompasses approximately 84 hectares of coastal land and includes two golf clubs. There are two cemeteries outside the boundary, linked historically to the site. It is bounded by a main arterial road to the west and the coast to the east. To the north and south are areas containing eastern suburbs banksia scrub, an endangered ecological community.

The hospital dates from the 1880s and is historically the most important hospital for infectious diseases in NSW. The spectacular coastal location, the layout and setting of the landscape, the buildings and their past functions and the significance of individual elements make it an extremely important site.

It has significant natural landscape features consisting of rocky headlands, a beach, pockets of eastern suburbs banksia scrub and a nationally significant geological outcrop, some 20 million years old. There are also precincts of archaeological significance.

The cultural plantings and layout of the site are of heritage significance in their own right. The site is also of Aboriginal heritage significance because of the number of artefacts and relics on the site and the ongoing association with Aboriginal people through to the present. The hospital has great social significance to medical practitioners and health workers, and has played a significant role in the historical development of health care in Australia. There was already a small museum run by the Prince Henry Trained Nurses Association on the site.

THE CHALLENGES

These multiple layers of heritage significance presented a number of challenges for the developer. Landcom, however, was very committed to ensuring the heritage of this place was well managed and that the development provided long-term sustainable solutions to the conservation and future management of the site as a whole. Best practice in all aspects of the project, including design quality and sustainability, were also aims of the development.

It was important to recognise from the early planning stages that the site already had a strong urban design character of its own, derived from its historical development. The alternative of razing the site and creating a new urban realm would have destroyed the multiple layers of heritage significance, as well as resulting in community opposition and an inferior development.

Contamination from the previous hospital function was a major problem, which could not be economically or practically resolved, leading to the demolition of some of the heritage items. The costs of decontamination escalated considerably during the project, putting pressure on the conservation aspects of the project.

Council engineers were not prepared to relax their standards for some aspects of the public domain such as the roadways, resulting in some road widening, and the loss of characteristic sandstone kerbing in the historic precinct.

K

LITTLE BAY (CONTINUED)

THE SOLUTIONS

The approach to the development of the site was agreed with the statutory authorities at the beginning. A conservation management plan was prepared at the outset of the project to identify important elements of the site and ensure informed planning decisions. It identified the various types of heritage significance on the site.

The Heritage Office required information that was balanced against the level of approval required at each stage of the project. This informed a masterplan for the site, providing common understanding and certainty about how the development would proceed for the developer, the community and statutory authorities.

Various sections of the site were then tendered. The masterplan identified which buildings could be demolished, those to be adaptively reused, building envelopes for infill buildings, and specified appropriate uses across the site. It retained some health-care facilities on the site, continuing the significant relationship between the site and its previous health-care functions.

More detailed conservation policies were then prepared by the developers for each precinct. The pattern of early consultation with the authorities helped in managing difficult areas. Development applications for each section were then prepared. Some exemptions from further Heritage Council of NSW approval were provided where sufficient detail had been given at masterplan stage. This allowed development to be accelerated at later stages.

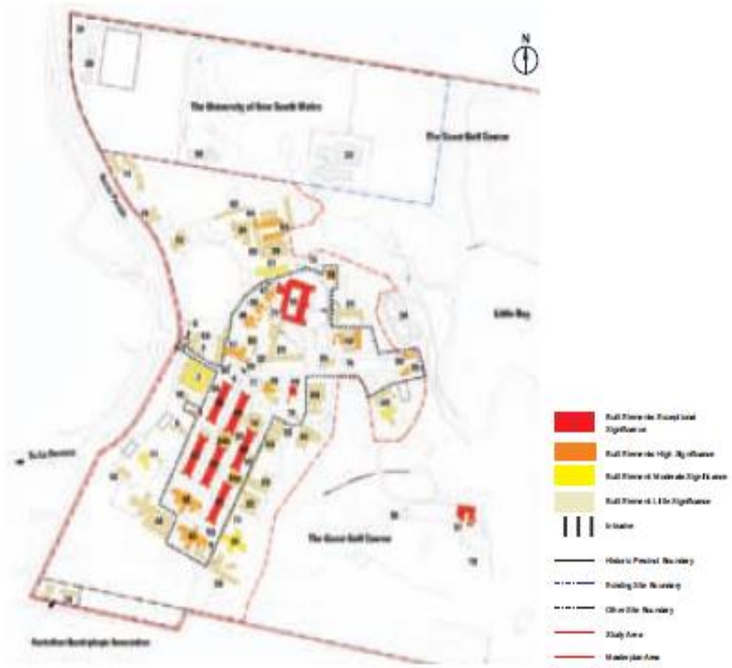
Landcom conserved one of the 1914 Flowers Wards early in the project. This became a museum run by the Prince Henry Trained Nurses Association, which has had a long involvement with the site. The roofs of all the Flowers Wards buildings were also repaired. This gave the community and the marketplace confidence that the heritage buildings would be conserved, helping to attract developers to the project.

The developer formed a design review panel to guide decision-making on urban design and the architectural design of individual buildings. The Heritage Office also provided dedicated officers to meet the demands of the lengthy approvals process.

Landcom is establishing a reserve trust to control and manage the land and buildings that remain in public ownership, including the on-site community groups. The ongoing costs of the trust will be met by the NSW Government.

There is a community management scheme for the entire Prince Henry Hospital site which recognises the need for site management where there are several owners, and special environmental qualities. It protects the interests of landowners and the local environment.

The community association has the responsibility for maintaining Prince Henry's community assets, such as the water sharing scheme, some landscape areas, private roads, and the entire communications network.



Top: Prince Henry Hospital Masterplan showing the relative significance of built elements.
Above: Prince Henry Hospital Redevelopment Masterplan.

THE LESSONS

The project demonstrates the benefit of a holistic approach to heritage management. It is vital in such projects that discussions take place early to provide certainty as early as possible to minimise development risk. Good groundwork also ensures there is consistent decision-making by the various statutory authorities, and provides for community and developer confidence in the planning process.

Clear client vision, good consultants, established working relationships between heritage authorities, and a pragmatic approach by heritage authorities, were important ingredients for the project's success.

The Prince Henry development has won a number of housing, planning and design awards:

Urban Development Industry Association (UDIA) – Winner for Concept Design (2003)

Planning Institute of Australia (PIA) NSW Division – Commendation for Excellence in Planning for Urban Design Plans and Ideas (2003)

Sustainable Water Challenge Water Sensitive Urban Design Award – Winner (2003)

Housing Industry of Australia (HIA) Greensmart Water Efficiency Housing – Winner (2005)

UDIA Marketing – Winner (2005)

HIA NSW Special Purpose Housing – Winner (2005)

HIA Special Purpose Housing – Winner (2006)

97 : One of the conserved Flowers Wards.

ADAPTATION PRINCIPLES		ASSESSMENTS
Understand significance		• An overarching conservation management plan informed the site masterplan • Individual buildings and elements had conservation management strategies to inform development applications
New use to be appropriate to heritage significance	Retain use when significant New uses to be compatible	• Health care facilities and community uses were retained in some areas of the site • Museum and chapel uses continued following the development • Public access to the site and its beaches was retained and additional public uses were provided • Wards and nurses' accommodation were converted to residential suites incorporating the structural and service capacities of the existing buildings • New functions were provided in new buildings
Level of change to be appropriate to significance	Minimise impact on significant fabric Conserve significant interiors	• Appropriate changes were identified in the masterplan, conservation management plan (CMP) and conservation management strategies (CMSs) • Identified in CMSs • Flowers Ward 1 was conserved as a representative building from the site's period of greatest heritage significance
Provide for reversibility and future conservation		• Heritage significance was set in the CMP and CMSs and linked to masterplan controls • Prime areas of eastern suburbs banksia scrub were conserved for regeneration • The highly significant geological site has been conserved with limited physical access for specialist groups with interpretation provided
Conserve relationship between significant setting and views		• The setting has been recognised as integral to the site's heritage significance • Road layouts and landscape features and plantings influenced new design • Views were conserved, limiting new building locations and heights
Provide for long-term management and viability		• The Reserve Trust and community management schemes provide overarching management frameworks for the public domain areas and holistic heritage management in the long term
Reveal and interpret heritage significance		• Heritage significance drove urban design and design solutions for the site and the location of buildings and new uses • Interpretive facilities have been provided in museum • An interpretation plan was developed for the site and integrated into the masterplan • Each element/project includes interpretive measures

Appendix C: Example Coding of Experts' Interview Results from NVivo

Tree Nodes

Name	Sources	References	Created On
Physical Category	0	0	29/06/2012 5:02 PM
St	8	12	29/06/2012 5:05 PM
M	8	10	29/06/2012 5:06 PM
W	7	7	29/06/2012 5:06 PM
M	5	5	29/06/2012 5:07 PM
D	4	5	29/06/2012 5:07 PM
Pr	2	2	29/06/2012 5:08 PM
Fo	7	8	29/06/2012 5:09 PM
Economic Category	0	0	29/06/2012 5:09 PM
P	2	2	29/06/2012 5:11 PM
M	3	3	29/06/2012 5:12 PM
Tr	3	3	29/06/2012 5:13 PM
Ex	2	2	29/06/2012 5:15 PM
Pl	4	4	29/06/2012 5:15 PM
Pl	2	3	29/06/2012 5:16 PM
Sit	2	2	29/06/2012 5:17 PM
Technological Cate	0	0	29/06/2012 5:10 PM
Or	15	18	29/06/2012 5:21 PM
Gl	15	18	29/06/2012 5:21 PM
In	15	22	29/06/2012 5:21 PM
N	15	20	29/06/2012 5:21 PM
N	15	22	29/06/2012 5:22 PM
B	3	3	29/06/2012 5:22 PM
S	15	20	29/06/2012 5:22 PM
Social Category	0	0	29/06/2012 5:11 PM
Im	4	9	29/06/2012 5:23 PM

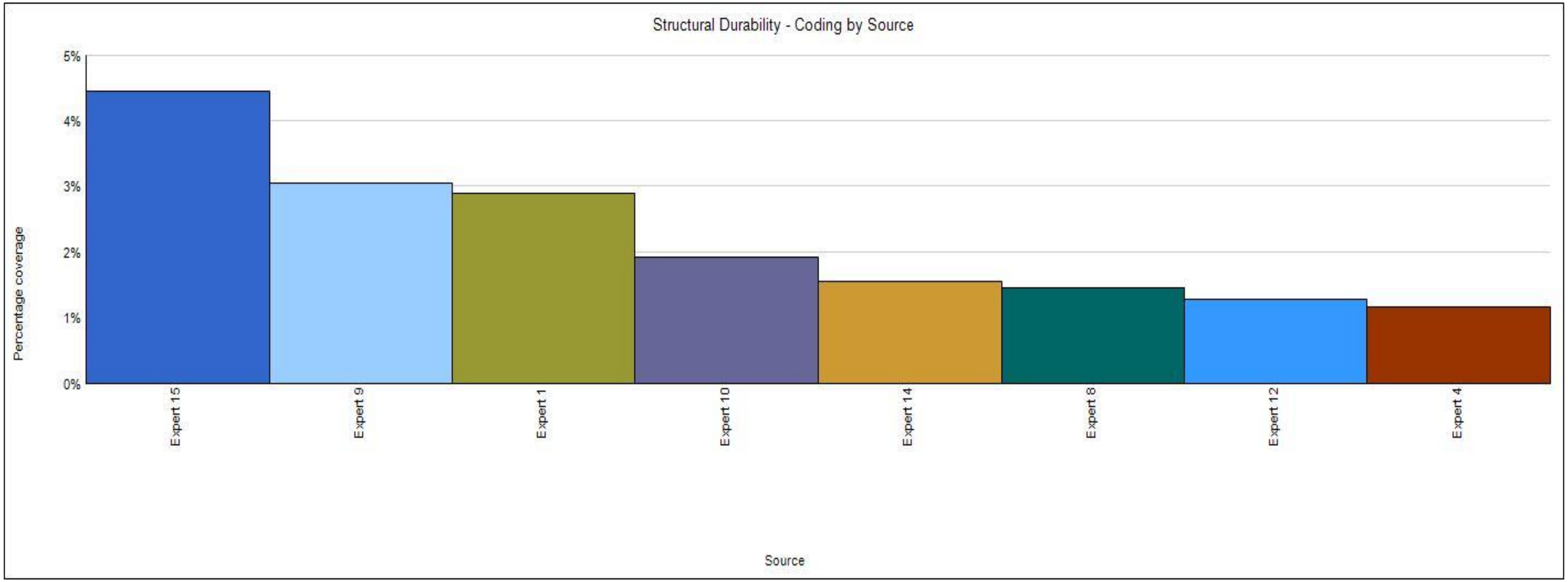
Tree Nodes

Name	Sources	References	Created On
A	4	5	29/06/2012 5:23 PM
La	3	6	29/06/2012 5:23 PM
Hi	4	12	29/06/2012 5:24 PM
A	2	2	29/06/2012 5:24 PM
H	2	2	29/06/2012 5:24 PM
N	2	2	29/06/2012 5:24 PM
Political Category	0	0	29/06/2012 5:11 PM
A	1	1	29/06/2012 5:25 PM
Ec	15	20	29/06/2012 5:25 PM
C	8	17	29/06/2012 5:26 PM
C	12	12	29/06/2012 5:26 PM
Ur	8	9	29/06/2012 5:26 PM
Zo	7	7	29/06/2012 5:26 PM
O	4	5	29/06/2012 5:27 PM
Functional Categor	0	0	29/06/2012 5:18 PM
Fl	12	13	29/06/2012 5:18 PM
Di	4	5	29/06/2012 5:18 PM
S	5	8	29/06/2012 5:19 PM
C	5	7	29/06/2012 5:19 PM
At	5	5	29/06/2012 5:19 PM
St	5	5	29/06/2012 5:19 PM
S	11	15	29/06/2012 5:20 PM
Legal Category	0	0	29/06/2012 5:20 PM
St	9	11	29/06/2012 5:27 PM
Fir	6	10	29/06/2012 5:27 PM
In	11	12	29/06/2012 5:27 PM
O	2	2	29/06/2012 5:28 PM

Tree Nodes

Name	Sources	References	Created On
S	3	3	29/06/2012 5:28 PM
C	2	2	29/06/2012 5:28 PM
Di	6	8	29/06/2012 5:29 PM
E	3	8	29/06/2012 5:29 PM
Ac	8	9	29/06/2012 5:29 PM

NVivo Coding of Expert Interview Results in Chart for Structural Durability Design Criterion



NVivo Coding of Expert Interview Results in Text and Percentage of References for Structural Durability Design Criterion

<Internals\interviews and litrevs\Expert 1> - § 3 references coded [2.89% Coverage]

Reference 1 - 1.37% Coverage

a. It's about the quality of materials used that will last. For example, the thing with this building's that the side walls were triple brick built a hundred years ago and even if it's lime and mortar they are in good condition

Reference 2 - 0.84% Coverage

b. It's about minimizing waste and maximising longevity of the building. To me building for longevity and building with quality is a big one.

Reference 3 - 0.68% Coverage

a. The Egan Street façade contained an entrance door and a large timber roller shutter, and was structurally sound,

<Internals\interviews and litrevs\Expert 10> - § 1 reference coded [1.92% Coverage]

Reference 1 - 1.92% Coverage

a. Height of the building, core of the building, offset, utilising existing structures and add 10 to 12 floors- analyse the structures, put floors at a normal height.

<Internals\interviews and litrevs\Expert 12> - § 2 references coded [1.29% Coverage]

Reference 1 - 1.03% Coverage

a. Original fabric is relatively sound

Reference 2 - 0.26% Coverage

b. Stability

<Internals\interviews and litrevs\Expert 14> - § 1 reference coded [1.56% Coverage]

Reference 1 - 1.56% Coverage

a. Providing extra building capacity for consideration of the future services of the building.

<Internals\interviews and litrevs\Expert 15> - § 1 reference coded [4.46% Coverage]

Reference 1 - 4.46% Coverage

a. Structurally sound project: extra capacity for columns and foundation (future proofing of buildings to increase future uses),

<Internals\interviews and litrevs\Expert 4> - § 1 reference coded [1.17% Coverage]

Reference 1 - 1.17% Coverage

a. Base structure story enough to carry load of the additional extra floor/ layer

<Internals\interviews and litrevs\Expert 8> - § 2 references coded [1.46% Coverage]

Reference 1 - 0.97% Coverage

a. You've got built in sustainability in old buildings because they often have thick walls and thermal mass and that's the case with these buildings as you can see very thick wall these are all stonewalls here and slate roof

Reference 2 - 0.50% Coverage

b. Built solidly so you've got a robust architecture that I think that is could be an inspiration for new buildings.

<Internals\interviews and litrevs\Expert 9> - § 1 reference coded [3.05% Coverage]

Reference 1 - 3.05% Coverage

a. Builders/ developers more focus on the construction cost and not on the life cycle cost. More on the construction cost and not how much a building have to operate in the future.

Example Coding from NVivo as Exported in Excel

Type	Name	Memo Link	Sources/Experts	Nvivo References
Tree Node	Physical Category			
	Tree Node	Structural Durability	8	12
	Tree Node	Material Durability	8	10
	Tree Node	Workmanship	7	7
	Tree Node	Maintainability	5	5
	Tree Node	Design Complexity	4	5
	Tree Node	Prevailing Climate	2	2
	Tree Node	Foundation	7	8
Tree Node	Economic Category			
	Tree Node	Population Density	2	2
	Tree Node	Market Proximity	3	3
	Tree Node	Transport Infrastructure	3	3
	Tree Node	Exposure	2	2
	Tree Node	Planning Constraints	4	4
	Tree Node	Plot Size	2	3
	Tree Node	Site Access	2	2
Tree Node	Technological Category			
	Tree Node	Orientation	15	18
	Tree Node	Glazing	15	18
	Tree Node	Insulation and Shading	15	22
	Tree Node	Natural Lighting	15	20
	Tree Node	Natural Ventilation	15	22
	Tree Node	Building Management Systems	3	3
	Tree Node	Solar Access	15	20
Tree Node	Social Category			
	Tree Node	Image and Identity	4	9
	Tree Node	Aesthetics	4	5
	Tree Node	Landscape and Townscape	3	6
	Tree Node	History and Authenticity	4	12
	Tree Node	Amenity	2	2
	Tree Node	Human Scale	2	2
	Tree Node	Neighbourhood	2	2

Tree Node	Political Category			
	Tree Node	Adjacent Buildings	1	1
	Tree Node	Ecological Footprint	15	20
	Tree Node	Conservation	8	17
	Tree Node	Community Interest and Participation	12	12
	Tree Node	Urban Masterplan	8	9
	Tree Node	Zoning	7	7
	Tree Node	Ownership	4	5
Tree Node	Functional Category			
	Tree Node	Flexibilty	12	13
	Tree Node	Disassembly	4	5
	Tree Node	Spatial Flow	5	8
	Tree Node	Convertibility	5	7
	Tree Node	Atria	5	5
	Tree Node	Structural Grid	5	5
	Tree Node	Service Ducts and Corridors	11	15
Tree Node	Legal Category			
	Tree Node	Standard of Finish	9	11
	Tree Node	Fire Protection	6	10
	Tree Node	Indoor Environmental Quality	11	12
	Tree Node	Occupational Health and Safety	2	2
	Tree Node	Security	3	3
	Tree Node	Comfort	2	2
	Tree Node	Disability Access	6	7
	Tree Node	Energy Rating	3	8
	Tree Node	Acoustics	8	9

(Refer to Tables 4-1 to 4-7, The List of Design Criteria with the Experts' Interview Results in Chapter 4 of this Thesis)

Note: The data collection, interview transcriptions and coding analysis in NVivo 8 format can be found in the CD provided.

Appendix D: Online Survey Questionnaire

Designing for Future Building Adaptive Reuse

Part 1: Weighting of Important Design Criteria

Below is a list of identified design criteria for the successful implementation of future building adaptive reuse. The list is based on relevant literature on existing and recent design strategies, as well as, in-depth interviews with selected professionals involved in the past implementation of award winning Australian adaptive reuse projects located mainly in New South Wales and a pilot study in Victoria.

***Please provide your view of the importance of each of the following seven categories applicable to new buildings with high adaptive reuse potential:**

	Unimportant	Not very important	No Opinion	Important	Critical
1. Physical (Long Life) Category - pertains to the building's strength, material durability, quality workmanship, etc.	○	○	○	○	○
2. Economic (Location) Category- pertains to the building's location, marketability, access to transport, etc.	○	○	○	○	○
3. Functional (Loose Fit) Category- pertains to the building's plan arrangement, flexibility, ease of service access, disassembly, etc.	○	○	○	○	○
Technological (Low Energy) Category- pertains to ESD criteria such as solar access, orientation, natural ventilation and lighting, etc.	○	○	○	○	○

Page 1

Designing for Future Building Adaptive Reuse

	Unimportant	Not very important	No Opinion	Important	Critical
Social (Sense of Place) Category - pertains to image and history, aesthetics, townscape, neighbourhood, amenity, etc.	◯	◯	◯	◯	◯

	Unimportant	Not very important	No Opinion	Important	Critical
Legal (Quality Standard) Category- building standards, regulations, codes, accessibility, energy rating, etc.	◯	◯	◯	◯	◯

	Unimportant	Not very important	No Opinion	Important	Critical
Political (Context) Category-pertains to community support and ownership, culture, heritage potential, etc.	◯	◯	◯	◯	◯

Part 2: Weighting of the Identified Design Criteria per Design Category

The key design categories are further divided into criteria potentially supporting the successful implementation of future building adaptive reuse. *Please provide your view of the importance of each criterion applicable to designing new buildings with high adaptive reuse potential:

1. Long Life (Physical) Category

	Unimportant	Not very important	No Opinion	Important	Critical
a.Structural Integrity and Foundation - building's structural design which caters to future uses and loads; and the foundation's stability.	◯	◯	◯	◯	◯

	Unimportant	Not very important	No Opinion	Important	Critical
b. Material Durability and Workmanship- durability of the building asset and the quality of craftmanship and finishes.	◯	◯	◯	◯	◯

	Unimportant	Not very important	No Opinion	Important	Critical
c. Maintainability- enhancing building performance over its lifespan and building's capability to conserve operational resources.	◯	◯	◯	◯	◯

2. Economic (Location) Category

	Unimportant	Not very important	No Opinion	Important	Critical
a. Density and Proximity- population density and distance to major cities/ CBD.	◯	◯	◯	◯	◯

	Unimportant	Not very important	No Opinion	Important	Critical
b. Transport and Accessibility- location and links to services, pedestrian and vehicular access and other transport facilities.	◯	◯	◯	◯	◯

	Unimportant	Not very important	No Opinion	Important	Critical
c. Plot Size and Site Plan- site selection, site coverage, site exposure, built area and spatial proportions, site enclosure and planning requirements for adjacent buildings and develoments.	◯	◯	◯	◯	◯

Designing for Future Building Adaptive Reuse

3. Functional (Loose Fit) Category:

	Unimportant	Not very important	No Opinion	Important	Critical
a. Flexibility and Convertibility- space capability to change according to new uses, advocating the principles of divisibility, elasticity and multi-functionality.	○	○	○	○	○
b. Disassembly- the ease of dismantling or deconstruction, pertaining to element and material transformations like reuse of building components, recycling of building materials, demountable systems, modularity, etc.	○	○	○	○	○
c. Spatial Flow and Atria- mobility, open plan, fluidity and continuity, as well as providing open areas, interior gardens, etc.	○	○	○	○	○
d. Structural Grid- ideal and economic floor spans and openness.	○	○	○	○	○
e. Service Ducts and Corridors-vertical circulation, service elements, raised floors, etc.	○	○	○	○	○

4. Technological (Low Energy) Category:

	Unimportant	Not very important	No Opinion	Important	Critical
a. Orientation and Solar Access- siting and design with regard to microclimate, appropriate climatic strategies, prevailing winds, sunlight, as well as access to summer and winter sun.	◯	◯	◯	◯	◯
b. Glazing and Shading- sunlight glare control and regulation of internal temperatures, sunshades, automated blinds, etc.	◯	◯	◯	◯	◯
c. Insulation and Acoustics- appropriate use of insulation, thermal mass, noise control and sound insulation.	◯	◯	◯	◯	◯
d. Natural Lighting and Ventilation- natural daylight, efficient lighting systems, optimal airflow, quality fresh air, ambient air intake, etc.	◯	◯	◯	◯	◯
f. Energy Rating- environmental performance measures and the use of energy efficient equipment and appliances.	◯	◯	◯	◯	◯

Designing for Future Building Adaptive Reuse

	Unimportant	Not very important	No Opinion	Important	Critical
e. Learn and obtain feedback on building performance and usage (BIM, BMS, etc.)- monitor and control building operations and performance systems, coordination of building services, commissioning, churn management, user guide and maintenance, etc.	◯	◯	◯	◯	◯

5. Social (Sense of Place) Category:

	Unimportant	Not very important	No Opinion	Important	Critical
a. Image and History- conveys the design concept of the building, the social and cultural values and attributes, building's authenticity, original fabric, timelessness, socio-cultural traditions, practices, historic character or fabric, etc.	◯	◯	◯	◯	◯

	Unimportant	Not very important	No Opinion	Important	Critical
b. Aesthetics and Townscape- architectural beauty, good appearance, innovation, proportion, landscape, visual coherence and organization of the built environment, including scale, enhancement of natural ecological features, vegetation on and around site, etc.	◯	◯	◯	◯	◯

	Unimportant	Not very important	No Opinion	Important	Critical
c. Neighbourhood and Amenity-local and social communities, providing comfort and convenience facilities, amenity and concepts contributing to the public domain.	◯	◯	◯	◯	◯

6. Legal (Quality Standard) Category:

	Unimportant	Not very important	No Opinion	Important	Critical
a. Standard of Finish- high standard workmanship, compliance, thresholds exceeded.	◯	◯	◯	◯	◯

	Unimportant	Not very important	No Opinion	Important	Critical
b. Fire Protection and Disability Access- fire resistance ratings for structural components, provisions for fire safety as well as provision of disability easement, facilities, etc.	◯	◯	◯	◯	◯

	Unimportant	Not very important	No Opinion	Important	Critical
c. Occupational Health, IEQ, Safety and Security- special needs of occupants, health and safety risks, comfort, hygiene and clean environment; non-hazardous materials, ; appropriate levels of privacy, transparency, physical and visual access and security.	◯	◯	◯	◯	◯

Designing for Future Building Adaptive Reuse

7. Political (Context) Category

	Unimportant	Not very important	No Opinion	Important	Critical
a. Ecological Footprint and Conservation- appropriate measure of human carrying capacity, including conservation principles, charters, policies, etc.	◯	◯	◯	◯	◯
b. Community support and Ownership- Community / public sector support response, support and / or recognition of local social context, Stakeholder engagement, etc.	◯	◯	◯	◯	◯
c. Urban Master plan and Zoning- integrated skyline, urban landscape, built environment design, management/ practice, land uses and patterns, height control, etc.	◯	◯	◯	◯	◯

Any other comments you would like to make?

Would you like to have a copy of this research survey report?

☐ Yes ☐ No

Appendix E: Stage 2 Supporting Documents

Results of Online Survey Questionnaire (Raw Data)

	R1	R2	R3	R4	R5	R6	R7	R9	R10	R11	R12	R13	R14	R15	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R29
Q1	5	4	5	4	4	4	4	4	5	4	5	4	5	4	5	4	5	5	5	5	5	5	5	5	4
Q2	4	4	3	2	2	4	4	4	3	4	5	4	4	4	3	4	4	5	4	4	2	4	5	5	3
Q3	5	5	5	5	4	4	5	5	1	4	5	5	4	5	4	4	5	4	4	5	4	3	5	4	4
Q4	4	4	4	4	5	4	5	4	4	4	4	4	4	4	4	4	4	4	5	4	4	5	5	4	4
Q5	4	5	5	2	5	4	5	5	4	4	4	3	4	4	4	4	4	4	4	4	4	5	5	4	2
Q6	5	4	4	3	2	2	4	4	3	4	4	4	4	5	4	3	4	4	5	3	3	4	4	4	4
Q7	2	4	4	4	4	2	4	5	3	4	4	3	4	4	4	3	4	3	4	4	5	4	5	3	2
Q8	5	5	5	4	4	4	4	4	5	4	5	5	5	4	4	3	5	5	4	4	5	5	4	4	4
Q9	5	4	4	4	4	4	5	4	3	4	5	4	4	4	4	4	4	5	4	5	4	5	5	4	3
Q10	4	4	4	4	4	4	4	4	3	4	5	4	4	4	4	4	4	5	4	4	4	4	5	4	4
Q11	3	4	3	3	1	4	4	4	3	3	3	3	4	3	2	3	3	5	3	4	2	4	2	3	3
Q12	4	4	3	3	1	3	5	4	3	3	3	3	4	3	2	3	4	4	4	3	2	2	4	3	3
Q13	4	4	4	4	1	2	2	4	3	3	4	4	2	3	2	3	3	4	3	4	4	2	2	3	4
Q14	4	5	4	5	1	4	3	5	4	4	4	4	4	4	4	3	4	4	4	5	5	3	2	4	4
Q15	2	4	4	5	1	2	4	4	4	4	4	3	4	2	4	2	3	2	4	4	5	3	2	4	4
Q16	4	4	4	2	1	2	4	3	3	4	4	4	4	4	4	4	4	3	4	4	4	3	2	3	3
Q17	4	4	4	3	1	2	5	3	4	4	4	4	4	3	4	3	4	4	4	4	2	4	2	3	3
Q18	4	4	2	5	1	2	4	4	3	4	4	2	4	2	3	3	4	3	4	3	4	2	2	3	4

Q19	4	5	4	4	4	4	5	5	4	4	5	5	4	5	4	4	4	4	5	4	5	5	4	4	2
Q20	4	5	5	4	3	4	5	4	2	4	4	5	4	4	5	4	4	3	5	4	4	2	4	3	2
Q21	4	5	5	4	3	2	5	4	2	4	4	3	4	4	5	4	4	3	5	4	4	4	4	3	2
Q22	5	4	5	4	2	4	5	4	2	5	4	5	4	4	5	4	4	3	5	4	4	5	4	3	4
Q23	4	4	4	4	1	2	5	4	3	4	5	3	4	4	4	4	4	3	5	3	2	2	4	3	3
Q24	4	4	4	3	1	1	4	3	3	2	4	2	4	4	4	3	3	3	4	4	2	2	4	3	3
Q25	4	5	4	3	4	4	3	4	4	3	4	4	4	4	4	3	3	4	4	5	2	4	5	4	4
Q26	5	4	5	4	2	4	5	4	4	3	4	5	4	4	4	4	4	4	4	4	5	5	5	4	3
Q27	5	4	4	3	4	2	5	4	2	3	4	4	4	4	4	4	4	4	4	4	4	4	5	3	2
Q28	5	4	4	3	2	2	5	4	2	4	5	4	4	4	2	4	4	3	4	5	2	4	4	4	2
Q29	4	4	4	4	1	2	5	4	4	5	5	4	4	4	4	3	4	5	5	4	2	4	4	4	3
Q30	4	4	4	4	1	1	5	4	2	5	5	4	4	4	4	3	3	4	4	4	2	3	4	4	2
Q31	2	5	4	2	1	2	4	4	3	3	4	3	4	3	4	3	3	3	3	4	4	4	4	4	2
Q32	2	4	4	4	4	2	4	5	3	3	4	3	4	4	4	3	3	4	4	5	2	4	4	3	2
Q33	4	4	4	4	1	2	5	4	3	3	4	4	4	4	4	3	4	3	4	4	2	4	4	4	3

Legend:
Q1-33= survey questions
R1-29= survey respondents

Note: The analysis in excel format can be found in the CD provided.

ADAPTSTAR-DERIVED WEIGHTINGS FOR THE OBSOLESCENCE CATEGORIES

Categories	UI=1	NVI=2	NO=3	I=4	C=5	Total	Weight (%)	Mean	COV
Physical	0	0	0	52	80	132	**16.08**	4.55	176.03
Economic	0	6	12	72	20	110	**13.40**	3.79	184.92
Functional	1	0	3	56	65	125	**15.23**	4.31	163.56
Technological	0	0	0	92	30	122	**14.85**	4.21	236.75
Social	0	4	3	76	35	118	**14.37**	4.07	193.05
Legal	0	4	21	64	20	109	**13.28**	3.76	166.58
Political	0	8	18	64	15	105	**12.79**	3.62	168.45
						832	100.00		

ADAPTSTAR-DERIVED WEIGHTINGS FOR THE DESIGN CRITERIA

Physical Category	UI=1	NVI=2	NO=3	I=4	C= 5	Total	%	Mean	COV	Weight (%)
Physical										
Structural integrity and foundation	0	0	3	52	55	110	34.70	4.40	146.41	5.58
Material durability and workmanship	0	0	6	64	35	105	33.12	4.20	161.48	5.33
Maintainability	0	0	3	84	15	112	32.18	4.08	221.27	5.17
						317	100.00			16.08
Economic										
Density and proximity	1	6	39	28	5	79	33.33	3.16	161.36	4.47
Transport and accessibility	1	6	36	32	5	80	33.76	3.20	151.49	4.52
Plot size and site plan	1	12	21	44	0	78	32.91	3.12	145.12	4.41
						237	100.00			13.40
Functional										
Flexibility and convertibility	1	2	9	60	25	97	22.45	3.88	150.28	3.42
Disassembly	1	12	9	52	10	84	19.44	3.36	144.28	2.96
Spatial flow and atria	1	6	18	60	0	85	19.68	3.40	177.69	3.00
Structural grid	1	6	18	56	5	86	19.91	3.44	157.89	3.03
Service ducts and corridors	1	12	18	44	5	80	18.52	3.20	130.73	2.82
						432	100.00			15.23
Technological										
Orientation and solar access	0	2	0	60	45	107	18.87	4.28	156.60	2.80
Glazing and	0	6	9	52	30	97	17.11	3.88	127.57	2.54

shading										
Insulation and acoustics	0	6	12	52	25	95	16.75	3.80	127.57	2.49
Natural lighting and ventilation	0	4	6	52	40	102	17.99	4.08	131.99	2.67
Energy rating	1	6	18	48	15	88	15.52	3.52	122.19	2.31
Feedback on building performance and usage	2	8	24	44	0	78	13.76	3.12	143.34	2.04
						567	100.00			14.85
Social										
Image and history	0	2	15	64	15	96	32.65	3.84	167.76	4.69
Aesthetics and townscape	0	2	6	60	35	103	35.03	4.12	150.60	5.04
Neighbourhood and amenity	1	6	9	64	15	95	32.31	3.80	160.50	4.64
						294	100.00			14.37
Legal										
Standard of finish	0	12	6	52	20	90	32.85	3.60	138.89	4.36
Fire protection and disability access	1	4	6	60	25	96	35.04	3.84	150.73	4.65
Occupational health, IEQ, safety and security	2	6	9	56	15	88	32.12	3.52	143.46	4.26
						274	100.00			13.28
Political										
Ecological footprint and conservation	1	8	24	44	5	82	31.66	3.28	134.63	4.05
Community support and ownership	0	8	18	52	10	88	33.98	3.52	142.05	4.35
Urban masterplan and zoning	1	4	15	64	5	89	34.36	3.56	178.76	4.39
						259	100.00			12.79

Appendix F: adaptSTARQuestionnaire Template

INSERT NAME OF CASE STUDY HERE …							
When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.							
How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.							✖
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.							✖
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.							✖
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.							✖
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.							✖
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.							✖
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.							✖
The building has significant components or systems that support disassembly and subsequent relocation or reuse.							✖
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.							✖
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.							✖
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.							✖

The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.							✖
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.							✖
The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.							✖
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.							✖
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.							✖
The building supports efficient operational and maintenance practices including effective building management and control systems.							✖
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.							✖
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.							✖
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.							✖
The building displays a high standard of construction and finish consistent with current market expectations.							✖
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.							✖
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.							✖
The building’s design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.							✖
The building displays a high level of community interest and political support for its future care and preservation.							✖
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.							✖

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Appendix G: Adaptive Reuse Potential Model (Langston, 2008)

The Sustainability Implications of Building Adaptive Reuse

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Abstract— **Building adaptive reuse is an important global topic. In the context of sustainable development and the effects of climate change caused by previous disregard for our environment, adaptive reuse has significant implications. This paper aims to examine how the construction industry can reposition itself to increase focus on the revitalization of existing buildings as an alternative to demolition and replacement. The paper reports on current research undertaken in Australia as part of a nationally-funded program in collaboration with industry, proposes a new model for early identification of adaptive reuse potential, tests this model with case study data, and looks at the social advantage from making better use of what we already have. The paper proposes that adaptive reuse needs to be planned at the outset, and if this is done wisely and routinely, it will provide a means of realizing sustainability objectives without reducing investment levels or economic viability for the industry. In fact, adaptive reuse is the future of the construction industry.**

Keywords- Building adaptive reuse; Sustainability; Obsolescence; Refurbishment potential; Construction industry

I. INTRODUCTION

Climate change is a contemporary and global area of scientific enquiry and research. The challenges that changing environments have on society are significant (e.g. Stern, 2006; Bouwer and Aerts, 2006). Many have concluded that climate change is the most important challenge facing humankind, and indeed other life on Earth. Sir David King, Britain's Chief Scientist, described the Stern Report (Stern, 2006) as the most detailed economic analysis yet conducted.

Climate change will influence our world in a number of ways, including detrimental economic, environment and social impact. Some of the expected challenges of climate change identified by Stern (2006) include:

1. shrinking the global economy (reducing GDP) by 20%,
2. international effort required to reach the required scale of reductions,
3. no action could result in floods, melting glaciers, threatened wildlife, droughts and up to 200 million people becoming refugees,
4. similar scale impacts to the world wars and great depression of the 20th century,
5. irreversible climate changes,
6. global warming and sea level rise for at least another one hundred years,
7. need to decarbonize the power sector by 60-70%, end deforestation and make deep cuts in transport emissions,
8. 40% of wildlife species could become extinct,
9. 1 in 6 of the world population could face water shortages,
10. US$9 trillion in mitigation costs with just 10-15 years to act, and
11. more significant impacts in Africa and the developing world.

The built environment has a prominent role to play in this debate, particularly as it demands 40% of global resources and generates a proportionate amount of waste. Climate change adaptation is about human responses to this challenge, and how the impacts of a changing climate can be minimized as much as practicable (Burton et al., 2005). A major contribution that the built environment can make to climate change adaptation is in the area of making better use of the infrastructure that we already have. While new design and construction should be optimized for environmental performance, it would take around one hundred years to substantially renew the stock of existing buildings even if high environmental compliance was mandatory on every new project, both immediately and globally.

Existing buildings that are obsolete or rapidly approaching disuse and potential demolition are a 'mine' of raw materials for new projects; a concept described by Chusid (1993) as 'urban ore'. Even more effective, rather than extracting these raw materials during demolition or deconstruction and assigning them to new applications, is to leave the basic structure and fabric of the building intact, and change its use. This approach is called 'adaptive reuse'. Breathing 'new life' into existing buildings carries with it environmental and social benefits and helps to retain our national heritage. To date, a focus on economic factors alone has contributed to

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destruction of buildings well short of their physical lives.

This study investigates the role that the construction industry can play in climate change adaptation. There needs to be shift from new-build to reuse or refurbishment and this needs to happen rapidly. But the literature on building reuse is limited and appropriate methods of identification and analysis of opportunities are poorly understood. This study advocates a rethink of our approach to sustainable development. Rather than simply build less, we should be more strategic on where to build and how to make the most of existing resources.

Specifically this paper aims to:

1. outline an integrated model for the assessment of adaptive reuse potential in buildings,
2. validate this model through retrospective evaluation of a large number of completed projects, and
3. speculate on the implications for climate change adaptation of an increased focus on the preservation of existing buildings with adaptive reuse potential as an alternative to premature destruction or dilapidation.

To achieve these aims this paper will discuss the conceptual model that has developed from progress on an Australian Research Council *Linkage Project* entitled "Strategic Assessment of Building Adaptive Reuse Opportunities". Then, using a retrospective approach, a large number of completed adaptive reuse projects will be evaluated by the model to determine if forecasted and actual performances are a close match. A detailed case study of one of these projects is discussed to illustrate the process. Finally the paper will consider the contribution that an adaptive reuse agenda can make to enhance sustainable development in the light of increasing pressure to minimize the effects of climate change while continuing to deliver prosperity and enhanced living standards.

II. OBSOLESCENCE

Buildings are major assets and form a significant part of facility management operations. Although buildings are long lasting they require continual maintenance and restoration. Eventually, buildings can become inappropriate for their original purpose due to obsolescence, or can become redundant due to change in demand for their service. It is at these times that change is likely: demolition to make way for new construction or some form of refurbishment or reuse (Langston and Lauge-Kristensen, 2002).

Refurbishment can of itself take many forms, ranging from simple redecoration to major retrofit or reconstruction. Sometimes the buildings are in good condition but the services and technology within them are outdated, in which case a retrofit process may be undertaken. If a particular function is no longer relevant or desired, buildings may be converted to a new purpose altogether. This is adaptive reuse.

Older buildings may have a character that can significantly contribute to the culture of a society and conserve aspects of its history. The preservation of these buildings is important and maintains their intrinsic heritage and cultural values. Facility managers are frequently faced with decisions about whether to rent or buy, whether to extend or sell, and whether to refurbish or construct. Usually these are financial decisions, but there are other issues that should bear on the final choice, including environmental and social impacts.

Johnson (1996: p.209) indicates that, as society has advanced, its use of buildings has become more temporal. He states that "advances in technology and commerce, including the growth of industrial and office automation, and user demands for more comfortable environments for work and leisure have led to large numbers of buildings becoming obsolete or redundant and these changes have provided an abundance of buildings suitable for rehabilitation and reuse".

Buildings, like other assets, can become obsolete over time. Buildings both deteriorate and become obsolete as they age. A building's service life, which may be interpreted as its structural adequacy (i.e. structural safety), is effectively reduced by obsolescence, resulting in a useful life somewhat less than its expected physical life. The useful (effective) life of a building or other asset in the past has been particularly difficult to forecast because of premature obsolescence (Seeley, 1983). Obsolescence may be described as constituting one or more of the following attributes:

1. physical
2. economic
3. functional
4. technological
5. social
6. legal
7. political

Surrogate estimation techniques were developed to quantify each of the obsolescence categories listed above. The rationale behind these methods is described in Langston et al. (2008). The conclusions are summarized below.

Physical obsolescence can be measured by an examination of maintenance policy and performance. Useful life is effectively reduced if building elements are not properly maintained. A scale is developed such that buildings with a high maintenance budget receive a 0% reduction, while buildings with a low maintenance budget receive a 20% reduction. Interim scores are also possible, with normal maintenance intensity receiving a 10% reduction.

Economic obsolescence can be measured by the location of a building to a major city, central business district or other primary market or business hub. Useful life is effectively reduced if a building is located in a low density demographic. A scale is developed such that buildings sited in an area of high population density receive a 0% reduction, while buildings sited in an area of low population density receive a 20% reduction. Interim scores are also possible, with average population density receiving a 10% reduction.

Functional obsolescence can be measured by determining the extent of flexibility embedded in a building's design. Useful life is effectively reduced if building layouts are inflexible to change. A scale is developed such that buildings with a low churn cost receive a 0% reduction, while buildings with a high churn cost receive a 20% reduction. Interim scores are also possible, with typical churn costs receiving a 10% reduction.

Technological obsolescence can be measured by the building's use of operational energy. Useful life is effectively reduced if a building is reliant on high levels of energy in order to provide occupant comfort. A scale is developed such that buildings with low energy demand receive a 0% reduction, while buildings with intense energy demand receive a 20% reduction. Interim scores are also possible, with conventional operating energy performance receiving a 10% reduction.

Social obsolescence can be measured by the relationship between building function and the marketplace. Useful life is effectively reduced if building feasibility is based on external income or if the service for which the building is intended is in decline. A scale is developed such that buildings with fully owned and occupied space or with an increasing market presence receive a 0% reduction, while buildings with fully rented space or with a decreasing market presence receive a 20% reduction. Interim scores are also possible, with balanced rent [illegible]

scores into the positive range (i.e. -20% to +20%). In this case, should the potential interference be seen as an advantage, it may extend a building's useful life and help offset other obsolescence considerations, which are all negative or neutral. Examples of a positive influence include government funding opportunities or enhanced tax concessions that can be accessed when pursuing an adaptive reuse strategy (Gardner, 1993).

In addition to the above, environmental obsolescence is obviously relevant to today's society and arguably deserving of individual assessment. But in this study environmental issues are subsumed within technological obsolescence given the choice of an energy intensity surrogate. As the marketplace continues to become more sustainability-conscious, social, legal and political obsolescence will increasingly reflect the environmental agenda.

III. INTEGRATED MODEL

The conceptual framework of an approach to identify and rank adaptive reuse potential (ARP) for existing buildings is described fully in Langston et al. (2008). It has generic application to all countries and all building typologies. It requires an estimate of the expected physical life and the current age of the building, both reported in years. It also requires an assessment of physical, economic, functional, technological, social, legal and political obsolescence. Obsolescence is advanced as a suitable method to reduce expected physical life in order to calculate objectively the useful life of a building. An algorithm is developed that takes this information and produces an index of reuse potential expressed as a percentage. Existing buildings in an organization's portfolio, or existing buildings across a city or territory, can therefore be ranked according to the potential they offer for adaptive reuse. Where the current building age is close to and less than the [illegible]

[illegible]

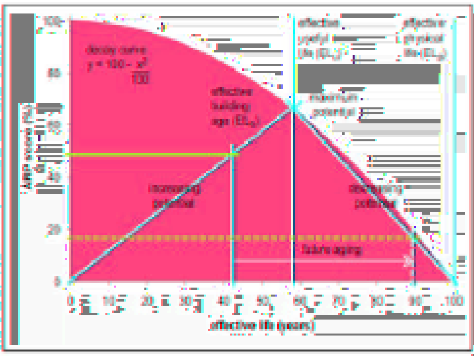

Figure 1. Adaptive Reuse Potential Model (Langston et al., 2008)

The estimation of expected physical life is the starting point for the calculation of useful life. Useful life is then determined through application of Equation 1. The form of the equation confirms the notion that useful life is indeed discounted physical life, and uses the long-established method of discounted cash flow as its basis, where the "discount rate" is taken as the sum of the obsolescence factors per annum (i.e. factors are divided by L_p).

$$\text{Useful life } (L_u) = \frac{L_p}{\left(1 + \sum_{i=1}^{7} O_i\right)^{L_p}} \qquad (1)$$

where:

L_p =*physical life (years)*
O_1 =*physical obsolescence (% as decimal pa)*
O_2 =*economic obsolescence (% as decimal pa)*
O_3 =*functional obsolescence (% as decimal pa)*
O_4 =*technological obsolescence (% as decimal pa)*
O_5 =*social obsolescence (% as decimal pa)*
O_6 =*legal obsolescence (% as decimal pa)*
O_7 =*political obsolescence (% as decimal pa)*

Values for EL_u (effective useful life), EL_b (effective building age) and EL_p (effective physical life) are determined by multiplying L_u, L_b and L_p by 100 and dividing by L_p respectively, which enables a maximum scale for *x* and *y* axes of 100. L_b is defined as the current age of the building (in years).

The above approach makes four important assumptions. First, that a maximum scale of 20% is used to judge the impact of each obsolescence category over the building's physical life. Second, that this rate of reduction is uniform each year. Third, that each obsolescence category is equally weighted. Finally, that the rates of obsolescence can be summed across categories, as opposed to selecting the most significant category and ignoring the rest. Future refinement of the model may need to revisit some of these assumptions.

To assist in the forecast of physical life, a calculation template has been developed. A series of questions gives insight into the longevity of a building according to three primary criteria: namely environmental context, occupational profile and structural integrity. Each category is equally weighted, and comprises ten questions requiring simple yes/no answers. Where information is unknown, a blank answer (no response) is then ignored in the calculation. Three questions under each primary criterion are double weighted due to their relative importance.

Some questions are worded so to deliver a positive score, while some are negative and others neutral (positive or negative). The type of question is distributed evenly throughout the template. The calculation algorithm assumes a base of 100 years and then adds or deducts points (years) according to the responses to questions. It is similar in concept to the *Living to 100 Calculator* that predicts human life expectancy (see http://www.livingto100.com). Some conservatism is applied to the estimate and the forecast is rounded down to one of the following outcomes: 25, 50, 75, 100, 150, 200, 250 or 300 years. The template is unsuitable for temporary structures or for iconic monuments that both require specialist judgment.

Figure 2 presents the physical life calculator. The rationale behind the questions and the choice of weighting is the subject of a separate paper currently under development. Field-testing of its suitability across a range of building types is an integral part of this study.

IV. RESEARCH METHODOLOGY

The integrated model, articulated here for the first time, involves the estimation of physical life (using the physical life calculator), the assessment of each of the seven obsolescence rates (using surrogate estimation techniques), the discounting of physical life to derive useful life (using Equation 1) and the determination of adaptive reuse potential (using the ARP model).

To validate this approach on new projects is impossible. It has therefore been decided to identify as many completed adaptive reuse projects as practicable and to undertake a retrospective evaluation to discover the proximity of the forecasts to reality. No restrictions were introduced other than temporary structures and ancient monuments were avoided (as the physical life calculator is not applicable for these projects).

An Internet search was conducted to identify suitable projects and to uncover the necessary information to enable the model to be populated with data. Where a project did not have sufficient information available it was discarded. Some projects were known to the author and investigated by site visit. Critical information comprised the date of construction and the date of adaptive reuse.

After an extensive online search, a total of 64 projects were identified and compiled into a database for further analysis. Many more were found but key information was not readily available. The total number of adaptive reuse projects globally is unknown. The selected projects covered a range of building typologies and locations and spanned from an actual useful life between 8 years (built in 2000) and 265 years (built in 1740). The average year of original construction was 1898 and the average year when the project was adaptively reused was 2001, giving a mean difference of 103 years.

A summary of the database showing the results is provided in Table I. The projects have been sorted into increasing order based on the percent difference between predicted and actual useful life (Column J). Figure 3 shows graphically the spread of results for useful life (both expected and actual) from the sample.

Physical life worksheet

suggested forecast (years) = **200**

Project Name:
Melbourne GPO comprising concrete structure and massive stone-faced masonry walls, steel roof framing with glass vaulted ceiling, large open plan atrium and perimeter offices

			y/n ?
environmental context	Is the building located within 1 kilometre of the coast?		n
	Is the building site characterised by stable soil conditions?	#	y
	Does the building site have low rainfall (<500mm annual average)?		y
	Is the building constructed on a 'greenfield' site?		n
	Is the building exposed to potential flood or wash-away conditions?		n
	Is the building exposed to severe storm activity?		n
	Is the building exposed to earthquake damage?		n
	Is the building located in a bushfire zone?		n
	Is the building located in an area of civil unrest?	#	n
	Are animals or insects present that can damage the building fabric?	#	y
occupational profile	Is the building used mainly during normal working hours?		n
	Are industrial type activities undertaken within the building?	#	n
	Is the building open to the general public?		y
	Does the building comprise tenant occupancy?		n
	Is a building manager or caretaker usually present?	#	y
	Is the building intended as a long-term asset?	#	y
	Does the building support hazardous material storage or handling?		n
	Is the building occupation density greater than 1 person per 10 m^2?		n
	Is the building protected by security surveillance?		n
	Is the building fully insured?		y
structural integrity	Is the building design typified by elements of massive construction?		y
	Is the main structure of the building significantly over designed?		y
	Is the building structure complex or unconventional?		y
	Are building components intended to be highly durable?	#	y
	Are there other structures immediately adjacent to the building?		y
	Is the building founded on solid rock?	#	y
	Was the workmanship standard for the project high?		y
	Is the roof design susceptible to leaking in bad weather conditions?	#	y
	Is the building protected against accidental fire events?		n
	Is the building designed as a public monument or landmark?		y

Note:
Questions indicated (#) are double weighted

Figure 2. PHYSICAL LIFE CALCULATOR

V. RESULTS

A. Physical Life Forecast

The physical life calculator produced a range of outcomes from 50 years to 250 years. Given all projects were adaptively reused it is not surprising that shorter lives were not found. No project scored 300 years either but several were close. The diversity of outcomes seemed reasonable and in all but a few cases an appropriate forecast was achieved. The mean physical life estimated in this study was 154.30 years.

Table I. Retrospective Study Summary

A	B	C	D	E	F	G	H	I	J	K	L
1	Richmond	1852	n/a	2003	150	0.30	96	151	-36.42	0.00	no potential
2	Cambridge	1920	n/a	2004	100	0.60	55	84	-34.52	24.80	moderate and decreasing
3	New York	1850	n/a	2004	150	0.27	101	154	-34.42	0.00	no potential
4	Seattle	1890	n/a	2001	150	0.47	75	111	-32.43	38.30	moderate and decreasing
5	San Antonio	1940	n/a	2007	100	0.75	48	67	-28.36	48.60	moderate and decreasing
6	Seattle	1926	n/a	2001	100	0.60	55	75	-26.67	38.70	moderate and decreasing
7	Cleveland	1890	n/a	2002	150	0.37	87	112	-22.32	40.00	moderate and decreasing
8	Dorchester	1810	n/a	1986	200	0.18	141	176	-19.89	20.50	moderate and decreasing
9	Beacon	1927	n/a	2003	100	0.50	61	76	-19.74	38.60	moderate and decreasing
10	Adelaide	1869	1876	1989	150	0.33	91	113	-19.47	39.60	moderate and decreasing
11	Hong Kong	1932	n/a	2007	100	0.50	61	75	-18.67	41.60	moderate and decreasing
12	Madrid	1914	n/a	2004	100	0.25	74	90	-17.78	17.40	low and decreasing
13	Los Angeles	1926	n/a	2007	100	0.40	67	81	-17.28	31.70	moderate and decreasing
14	Beechworth	1867	n/a	1997	200	0.30	110	130	-15.38	54.20	high and decreasing
15	Richmond	1909	n/a	2004	150	0.40	82	95	-13.68	56.80	high and decreasing
16	Minneapolis	1878	1928	2004	100	0.40	67	76	-11.84	40.10	moderate and decreasing
17	Georgetown	1765	n/a	1960	200	0.08	172	195	-11.79	4.70	low and decreasing
18	Bexhill-on-Sea	1935	n/a	2008	150	0.57	65	73	-10.96	73.30	high and decreasing
19	Melbourne	1882	n/a	2001	150	0.23	106	119	-10.92	35.20	moderate and decreasing
20	Richmond	1918	n/a	2001	100	0.30	74	83	-10.84	29.60	moderate and decreasing
21	Beijing	1740	n/a	2005	250	0.02	238	265	-10.19	0.00	no potential
22	New York	1920	n/a	2006	100	0.25	78	86	-9.30	24.90	moderate and decreasing
23	Richmond	1913	n/a	2003	150	0.40	82	90	-8.89	62.00	high and decreasing
24	Washington	1892	n/a	2002	150	0.27	101	110	-8.18	44.60	moderate and decreasing
25	Salt Lake City	1904	n/a	2003	150	0.33	91	99	-8.08	54.60	high and decreasing
26	Hong Kong	1906	n/a	2003	150	0.33	91	97	-6.19	56.80	high and decreasing
27	Georgetown	1796	n/a	1962	200	0.13	156	166	-6.02	30.20	moderate and decreasing
28	Richmond	1905	n/a	2007	150	0.30	96	102	-5.88	52.40	high and decreasing
29	Melbourne	1939	n/a	2000	100	0.55	58	61	-4.92	61.50	high and decreasing
30	Bath	1790	n/a	2004	250	0.08	205	214	-4.21	26.20	moderate and decreasing
31	Launceston	1868	n/a	2001	200	0.23	128	133	-3.76	54.90	high and decreasing
32	Richmond	1902	n/a	2006	150	0.27	101	104	-2.88	51.20	high and decreasing
33	Geelong	1911	n/a	1996	150	0.40	85	85	0.00	24.60	moderate and increasing
34	San Diego	1924	n/a	2008	200	0.23	84	84	0.00	39.00	moderate and increasing
35	Norwich	1855	n/a	2006	250	0.20	152	151	0.66	62.90	high and increasing
36	Halifax	1907	n/a	2007	150	0.27	101	100	1.00	54.70	high and increasing
37	Philadelphia	1877	n/a	2001	200	0.23	128	124	3.23	57.60	high and increasing
38	Los Angeles	1906	n/a	2003	150	0.27	101	97	4.12	53.00	high and increasing
39	Cambridge	1887	n/a	2008	200	0.23	128	121	5.79	56.20	high and increasing
40	Auckland	1914	n/a	1998	150	0.33	91	84	8.33	58.30	high and increasing
41	Sydney	1892	n/a	2002	200	0.25	121	110	10.00	57.20	high and increasing
42	Carisle	1891	n/a	2001	200	0.25	121	110	10.00	57.20	high and increasing
43	Brunswick	1928	n/a	2007	150	0.37	87	79	10.13	60.80	high and increasing
44	Perth	1880	n/a	2001	200	0.20	134	121	10.74	49.60	moderate and increasing
45	Los Angeles	1925	n/a	2007	150	0.33	91	82	10.98	56.90	high and increasing
46	North Adams	1890	n/a	1999	200	0.25	121	109	11.01	56.70	high and increasing
47	New York	1918	n/a	2008	150	0.27	101	90	12.22	49.20	moderate and increasing
48	Seattle	1927	n/a	2008	150	0.33	91	81	12.35	56.20	high and increasing
49	Pittsburgh	1879	n/a	1976	150	0.20	111	97	14.43	39.30	moderate and increasing
50	New Haven	1932	n/a	2003	150	0.40	82	71	15.49	60.10	high and increasing
51	Richmond	1897	1920	2003	150	0.30	96	83	15.66	51.40	high and increasing
52	Sydney	1894	n/a	1985	150	0.23	106	91	16.48	43.30	moderate and increasing
53	Richmond	1920	n/a	2006	150	0.27	101	86	17.44	47.00	moderate and increasing
54	Chicago	1913	n/a	2002	200	0.30	110	89	23.60	56.60	high and increasing
55	London	1947	n/a	2000	100	0.40	67	53	26.42	43.40	moderate and increasing
56	New York	1890	1957	2007	100	0.40	67	50	34.00	41.00	moderate and increasing
57	**Melbourne**	**1859**	**1919**	**2004**	**200**	**0.28**	**116**	**85**	**36.47**	**49.10**	**moderate and increasing**
58	Barcelona	1962	n/a	2003	75	0.40	56	41	36.59	33.20	moderate and increasing
59	San Francisco	1917	n/a	2002	150	0.17	117	85	37.65	28.60	moderate and increasing
60	Canberra	1976	n/a	2003	100	0.95	39	27	44.44	59.00	high and increasing
61	Chicago	1922	1932	2007	200	0.30	110	75	46.67	47.70	moderate and increasing
62	Canberra	1927	n/a	1998	200	0.33	105	71	47.89	49.40	moderate and increasing
63	Canberra	1927	n/a	2003	200	0.28	116	76	52.63	43.90	moderate and increasing
64	Gold Coast	2000	n/a	2008	50	1.10	29	8	262.50	18.40	low and increasing
	Mean:	**1898**		**2001**	**154.30**	**0.34**	**98.09**	**99.67**	**5.42**	**43.04**	

KEY:

KEY:	*A*	*Project ID*
	B	*Location*
	C	*Date or Original Construction*
	D	*Date of Previous Major Renewal*
	E	*Date of Adaptive Reuse (Completion)*
	F	*Predicted Physical Life (years)*
	G	*Annual Obsolescence Rate (%)*
	H	*Predicted Useful Life (years)*
	I	*Actual Useful Life (years)*
	J	*Percent Difference (columns F and G)*
	K	*ARP Score (%)*
	L	*ARP Comments*

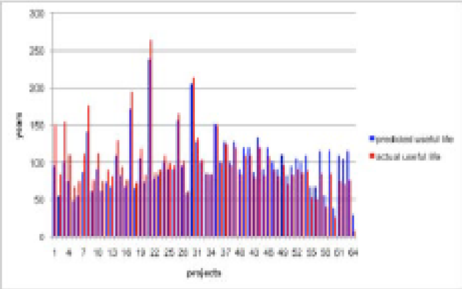

Figure 3. COMPARISON OF EXPECTED AND ACTUAL USEFUL LIFE

B. *Annual obsolescence rate*

Obsolescence rates were assessed according to the previously described criteria and summed. The total was then divided by the physical life estimate to give an annual rate of obsolescence. The mean value was 0.34%. The highest annual rate found was 1.10% and the lowest was 0.02%. The coefficient of variation across all projects was 53.09% and therefore demonstrated significant dispersion. These figures are used in much the same way as a conventional discount rate, albeit smaller in magnitude, to translate physical life into predicted useful life.

C. *Useful life estimation*

Using Equation 1, predicted useful life was computed. These results were then compared to actual useful life as determined by the difference between the date of adaptive reuse completion and the date of construction. Where a major renovation occurred between these two dates, the renovation date was taken as the original construction date. This approach has overestimated the actual useful life as no cognizance was taken of the duration of the adaptive reuse site processes, which in all likelihood would span several years on large projects. Similarly, a few projects lay dormant for many years before a decision was taken to revitalize them, and this time has not been subtracted. It is considered that the overestimation of actual useful life is in the order of 5%.

The mean predicted useful life was 98.09 years. The mean actual useful life was 99.67 years. The proximity of these two figures was encouraging. However, the percent difference between estimated and actual was calculated for each case study, and this varied between -36.42% and +262.50%. While the mean difference was just +5.42%, the absolute value of the differences led to a true mean of 22.51%. Overall the ratio of predicted useful life to physical life was 63.57% indicating that approximately one-third of physical life remained when these projects had become obsolete.

To validate the reliability of the model, predicted and actual useful life were compared using linear regression. The line of best fit was computed as $y=0.9527x$. In fact, if actual useful life was reduced by about 5% to account for inherent overestimation, the line of best fit would have been $y=x$ thus indicating a 45^0 line or perfect comparison. The degree of scatter was illustrated by an r^2 of 0.72013, which is a high value and suggests a tight relationship. If the line of best fit is assumed to be $y=x$, r^2 falls to just 0.69971, which is a truer indication of reliability. While a correlation between predicted and useful life is on face value illogical, the use of regression was employed here to demonstrate quantitatively the accuracy of the model, as shown graphically in Figure 4.

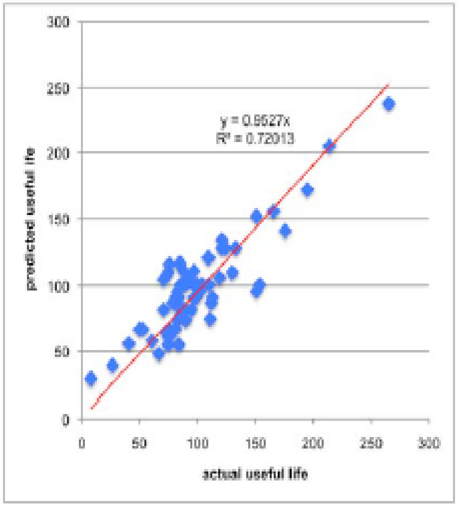

Figure 4. VALIDATION OF USEFUL LIFE FORECAST

D. *Adaptive reuse potential*

Entering the key data into the ARP model led to the determination of the ARP score. This varied from 0 to 73.30% with a mean of 43.04%. ARP relates to a scale of 50-100 being a high score, 20-49 being a moderate score and 0-19 being a low score (zero actually indicates no potential), each reflecting approximately one-third of the area under the decay curve. Overall, 91% of projects demonstrated a moderate or high ARP score, but this is not surprising given all of them were examples of completed adaptive reuse. Obviously a few of them may have been bad decisions, or the model inadequate to value them, so maybe 9% of projects were not simulated correctly.

The model can also describe adaptive reuse potential as increasing or decreasing. In this study 27% of projects exhibited a score that was high and increasing, 23% high and decreasing, 16% moderate and increasing, 25% moderate and decreasing, 5% low and increasing, 3% low and decreasing, and 1% exhibited no potential.

The previous results confirm that the integrated model is reasonably robust for predicting the useful life of buildings. Further research is underway to test if the derived ARP score is also robust. This involves the detailed examination of a number of existing projects that have yet to undergo revitalization. The methodology to be applied needs to consider economic, environmental and social benefits and compare the ARP ranking across the range of projects with this evaluation. If the ARP ranking matches the evaluation ranking then it can be concluded that the ARP model is quite robust. The results will be reported in a future paper.

VI. DETAILED CASE STUDY – GPO MELBOURNE

A detailed case study is provided to illustrate the methodology used in the previous analysis. The chosen project was the General Post Office (GPO) in Melbourne (Project 57 in Table 1). The building was constructed on the corner of Elizabeth and Bourke Streets in 1859, following some earlier and modest structures dating back to 1837. Between 1859 and 1867 a much grander two-storey building was developed. The building underwent further major renovation, completed in 1919, including the new sorting hall.

However, in 1992 Australia Post announced plans to end the GPO's major postal role in favor of decentralized mail centers. The building was to be sold. In 1993 a shopping centre was proposed but the permit later lapsed. In 1997 a hotel was proposed, but this idea also did not proceed. Then again in early 2001 plans for a retail centre were announced. The project had to overcome a major setback when almost gutted by fire in September 2001. Nevertheless, the work was finally completed and the building was opened to the public in October 2004 (further information can be found at http://www.melbournesgpo.com/#history).

The building included a tasteful restoration of the main sorting hall (see Figure 5) and a modern extension to the northern end of the complex (see Figure 6). Williams Boag Architects, along with design consultants like Arups and the successful contractor St Hilliers, were involved in this important project. It is now one of the more prominent and well-known adaptive reuse case studies in Australia. It subsequently won the RAIA National Award for Commercial Buildings and the Sir Osborn McCutcheon Commercial Architecture Award.

Figure 5. GPO MELBOURNE INTERIOR (FORMER SORTING HALL)

Figure 6. GPO MELBOURNE EXTERIOR (SHOWING NEW EXTENSION

Actual physical life of the project is unknown, despite its near demise in 2001, and an inspection would suggest there are many good years left. The expected physical life was determined using the data shown previously in Figure 2. Using 1919 as the new base, the calculated life of 200 years means the building should be structurally safe until 2119. Future major renovation could extend this date, and would undoubtedly occur given its heritage value to the City of Melbourne.

Obsolescence was assessed as though the evaluation was undertaken in 1919. At that time, physical obsolescence would have been rated high as maintenance would not have been a priority, and this was evidenced by accelerated deterioration that subsequently occurred. Economic obsolescence was zero as the building was in the center of Melbourne. Functional obsolescence was also low as the remodeled building had substantial open space. The massive external walls of the building provided some thermal mass that would help insulate the interior from the outside conditions, but nevertheless some form of heating was essential and the demand on energy would have been moderate. But from a social perspective this building was owned and occupied by a government authority and did not rely on external income to survive. The building was constructed to a reasonably high standard and so legal obsolescence was low. But as a major community building, it would be logical to assume that future changes would attract considerable community interest, so political obsolescence would be high as this may limit future opportunities for change.

Therefore obsolescence was assessed at 15%, 0%, 5%, 10%, 0%, 5% and 20% respectively across the seven categories (total 55%), leading to an obsolescence rate (over 200 years) of 0.28% per annum. Using Equation 1, useful life was calculated at 116 years. Again applying the base of 1919, the building would be expected to become obsolete in 2035. The reality was considerably less (a difference of 36.47%).

Using these outcomes for physical and useful life, an ARP score of 49.1% is achieved, as shown in Figure 1 previously. This is interpreted as moderate potential and increasing. A few years later and the building would pass 50% and be seen as having high potential. The maximum ARP score possible is 66.6% given a useful life of 116 years (note this is 58% of the expected physical life, or 58 years on the 100-year scale used in Figure 1). But substituting expected useful life with the actual useful life of 85 years, the ARP score would have risen to 81.9%. This is a very strong case for adaptive reuse on the basis of the substantial 'embedded physical life' remaining in the building.

VII. IMPLICATIONS FOR SUSTAINABLE DEVELOPMENT

The ARP score serves as a means of benchmarking (identifying low, moderate or high potential for reuse in individual buildings), timing (understanding increasing or decreasing reuse potential and prioritizing work) and ranking mutually exclusive projects (the higher the score the more potential for reuse). Application of this integrated model makes it possible to quickly scan the stock of existing buildings within an organization's property portfolio or a specific location and to determine which buildings are worthy of further more detailed investigation. If the model is accurate then better use of existing resources in analysis and design effort can be achieved. Validation of the robustness of the ARP score itself is the next stage of the *Linkage Project*. It involves the comparison of the ARP score with a comprehensive feasibility study for a sample of projects yet to undergo reuse. If the ranked order of the realized benefits of each project is identical to the ARP ranking, then the model provides a shortcut for future project selection.

Adaptive reuse is a special form of refurbishment that poses 'interesting' challenges for designers. Changing the class (functional classification) of a building may introduce new regulatory conditions and perhaps require zoning consent. There are clear economic, environmental and social benefits that can make this option attractive to developers. In some cases an increase in floor space ratios can be obtained and concessions received for pursuing government policy directions by regenerating derelict public assets. In recent years redundant city office buildings have been converted into high quality residential apartments, bringing people back to cities and in the process revitalizing them. Society also wins through preservation of cultural and heritage values and better use of existing infrastructure.

A. Economic benefits

Rehabilitated space can be created more quickly than new space, unless extensive structural reconstruction is required. Johnson (1996) suggests that rehabilitation typically takes half to three-quarters of the time necessary to demolish and reconstruct the same floor area. The shorter development period reduces the cost of financing and the effect of inflation on construction costs, so organizations that wish not to relocate have less disruption to operations and cash flow, and reducing temporary accommodation expenses.

Despite the time advantages, the cost of converting a building is generally less than new construction because many of the building elements already exist. Given there are no expensive problems to overcome, like asbestos removal or foundation subsidence, the reuse of structural elements is a significant saving. Older buildings, however, may not comply with present regulations, particularly in the area of fire safety, which may generate some structural changes or additional protective measures. It is essential that any building being considered for major refurbishment have a thorough survey undertaken to confirm its structural and constructional quality, and its compliance with building ordinances.

B. Environmental benefits

Environmental benefits from rehabilitation arise through the recycling of materials, reuse of structural elements and the reduction in generated landfill waste. These translate into cost advantages to the owner, but have much wider environmental implications. Older buildings sometimes were constructed using a range of quality materials that typically display a useful life well in excess of their more modern counterparts (e.g. use of solid stone walls, slated roofs, marble floors, etc.). The embodied energy saving through reuse of these materials or other forms of recycling can be substantial.

Furthermore, many older buildings employ massive construction in their external envelope, which can reduce energy consumption in heating and cooling through passive design and deliver long-term operational efficiencies. Opening windows, natural ventilation and natural lighting are all desirable qualities where external noise and pollution are not issues. Low-rise structures also eliminate the need for expensive vertical transportation systems.

The reuse of existing public infrastructure, like telecommunications, water, gas, sewerage and drainage, can relieve demands on local authorities to extend infrastructure and to reclaim natural landscapes from sprawling urban development.

C. Social benefits

Older buildings sometimes provide social benefits such as intrinsic heritage values. They can retain attractive streetscapes, add character and provide status and image to an organization through the use of massive and highly crafted materials. Older buildings are often in advantageous locations in city centers and close to transport making reuse (where appropriate) more viable. They add to a sense of community and are often appreciated as comfortable working environments by occupants.

Reduction in vacant or derelict buildings potentially adds vibrancy to communities, reduces crime and other unsocial behavior, and raises living standards through added investment and revitalization.

Tully (1993) argues that refurbishment generates 25% more employment than new building construction per square meter of floor space as a result of the higher ratio of labor-intensive activities. However issues of legislative compliance, fire safety, disabled access and heritage constraints (such as a requirement for facade retention) are possible disadvantages that should be properly explored. The redesign of existing buildings is often more challenging than new-build although the scope of work may be lower.

D. *Impact on the global construction industry*

A change in focus away from new construction might be received with some disquiet from developers and contractors. It may be assumed that the effect on the economy would be undesirable and work against wealth creation and rising living standards. But a move towards refurbishment (including but not limited to adaptive reuse) will add efficiency to our industry. What should result is higher profit levels and more work opportunities, leading to better investment levels and economic viability for the industry as a whole. In most countries new-build is adding just a few percent to our stock of buildings each year, while the vast majority are progressing slowing yet irrevocably down the decay curve towards eventual destruction. Devoting effort to ensuring that natural decay is not accelerated and that maximum value is extracted from our investments is just commonsense.

But the biggest opportunity for the global construction industry is converting existing buildings into more sustainable assets that can reduce our reliance on fossil fuels and minimize waste generation and pollution (Fournier and Zimnicki, 2004). In this way significant inroads can be made quickly in curbing our carbon use and contributing towards reductions in climate change pressure. Redirecting the industry towards retrofit activities will accelerate climate change adaptation targets compared to new construction initiatives and help avoid or at least delay some of the undesirable climatic consequences of modern human civilization. It will also help ensure that building longevity is enhanced.

Furthermore, where new-build does occur, it should be designed with future adaptive reuse in mind. If planned at the outset, subsequent works can be made more efficient and investment returns further strengthened. The seven categories of obsolescence described in this paper can be seen as important principles for designers (e.g. use of high quality materials, flexibility in spatial layouts, reduced reliance on non-renewable energy). In fact, the ideals of 'long life, loose fit and low energy' advocated in architecture schools for centuries is now more important than ever, and coupled with recycling and deconstruction initiatives in buildings that have reached the end of their physical lives, our industry can demonstrate higher sustainability performance. A rating scheme for adaptive reuse potential in new design is our next research topic.

VIII. CONCLUSION

Building adaptive reuse is an important global topic. In the context of sustainable development and the effects of climate change caused by previous disregard for our environment, adaptive reuse has significant implications. This paper has examined how the construction industry can reposition itself to increase focus on the revitalization of existing buildings as an alternative to demolition and replacement. The paper has reported on current research undertaken in Australia as part of a nationally-funded program in collaboration with industry, proposed a new model for early identification of adaptive reuse potential, tested this model with case study data, and looked at the social advantage from making better use of what we already have. The paper proposed that adaptive reuse needs to be planned at the outset, and if this is done wisely and routinely, it will provide a means of realizing sustainability objectives without reducing investment levels or economic viability for the industry. In fact, adaptive reuse is the future of the construction industry.

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Appendix H: Adaptive Reuse Potential (ARP)TestingDocuments

ARP Testing of Egan Street Apartments

Adaptive reuse potential

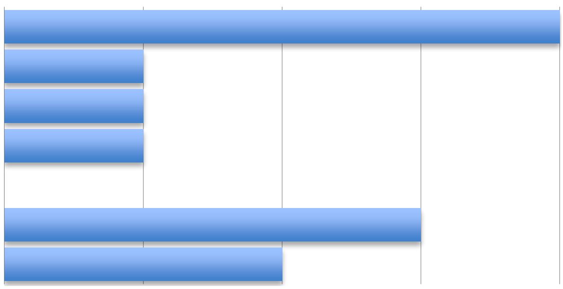
adaptive reuse potential (ARP%) = **68.6**

Low maintenance annual budget and in good condition, medium population density and light industry, largely open plan but tight, open and airy, brick wall as insulation, owner-occupied building, good quality construction, heritage protected

physical life (L_p) =	150 years	index =	180
building age (L_b) =	81 years	override =	

original construction date =	1923	today's date =	2004
last refurbishment date =	1923	(enter only if refurbishment was major)	

physical (O_1)	0.20
economic (O_2)	0.05
functional (O_3)	0.05
technological (O_4)	0.05
social (O_5)	
legal (O_6)	0.15
political (O_7)	0.10
total =	0.60



obsolescence rate pa 0.40

useful life (L_u) =	82.4 years	adaptive reuse potential is high and increasing
years to useful life =	1.4 years	
maximum arp score (%) =	69.8	(assuming $L_u = L_b$)
ARP difference (%) =	1.8 %	

Risk Management: **low**

best case obsolescence =	0.45 (low)		
useful life (L_u) =	95.7		
ARP% =	50.2	adaptive reuse potential is high and increasing	(no change)
worst case obsolescence =	0.65 (high)		
useful life (L_u) =	78.4		
ARP% =	70.0	adaptive reuse potential is high and decreasing	
ARP difference (%) =	39.6		

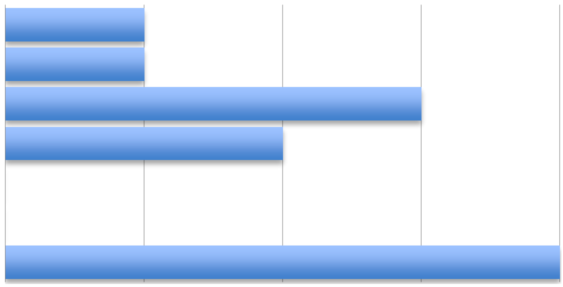
Adaptive reuse potential

adaptive reuse potential (ARP%) = **42.0**

Low maintenance annual budget and in good condition, low population density and exclusive area, largely open plan and flexible, tropically designed, owner-occupied building, high quality construction, heritage protected

physical life (L_p) =	250 years	index =	270
building age (L_b) =	91 years	override =	
original construction date =	1912	today's date =	2003
last refurbishment date =	1912	(enter only if refurbishment was major)	

physical (O_1)	0.05
economic (O_2)	0.05
functional (O_3)	0.15
technological (O_4)	0.10
social (O_5)	
legal (O_6)	
political (O_7)	0.20
total =	0.55



obsolescence rate pa 0.22

useful life (L_u) =	144.3 years	adaptive reuse potential is moderate and increasing
years to useful life =	53.3 years	
maximum arp score (%) =	66.7	(assuming $L_u = L_b$)
ARP difference (%) =	58.6 %	

Risk Management: **moderate**

best case obsolescence =	0.40 (low)	
useful life (L_u) =	167.6	
ARP% =	29.9	adaptive reuse potential is moderat (no change) and increasing
worst case obsolescence =	0.60 (high)	
useful life (L_u) =	137.3	
ARP% =	46.3	adaptive reuse potential is moderat (no change) and increasing
ARP difference (%) =	54.9	

Adaptive reuse potential

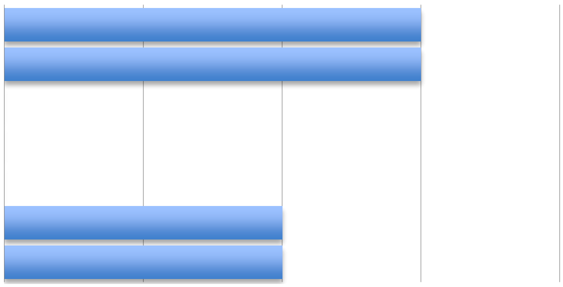
adaptive reuse potential (ARP%) = **58.9**

Low maintenance annual budget and have caretakers, low population density and agricultural area, very flexible spaces and quite open, lightly designed and airy, owner-occupied building, good quality construction, heritage protected

physical life (L_p) =	150 years	index =	150
building age (L_b) =	95 years	override =	

original construction date =	1907	today's date =	2002
last refurbishment date =	1907	(enter only if refurbishment was major)	

physical (O_1)	0.15
economic (O_2)	0.15
functional (O_3)	
technological (O_4)	
social (O_5)	
legal (O_6)	0.10
political (O_7)	0.10
total =	0.50



obsolescence rate pa 0.33

useful life (L_u) =	91.1 years	adaptive reuse potential is high and decreasing
years to useful life =	-3.9 years	
maximum arp score (%) =	63.2	(assuming $L_u = L_b$)
ARP difference (%) =	7.2 %	

Risk Management: **nil**

best case obsolescence =	0.35 (low)		
useful life (L_u) =	105.7		
ARP% =	45.2	adaptive reuse potential is moderat and increasing	
worst case obsolescence =	0.65 (high)		
useful life (L_u) =	78.4		
ARP% =	55.8	adaptive reuse potential is high and decreasing	(no change)
ARP difference (%) =	23.6		

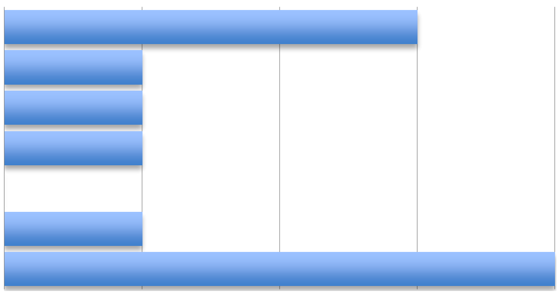
Adaptive reuse potential

adaptive reuse potential (ARP%) = **62.9**

Low maintenance annual budget and in good condition, central area near park, largely, open plan and flexible, good thermal performance, owner-occupied building, high quality construction, heritage protected

physical life (L_p) =	200 years	index =	240
building age (L_b) =	109 years	override =	
original construction date =	1898	today's date =	2007
last refurbishment date =	1898	(enter only if refurbishment was major)	

physical (O_1)	0.15
economic (O_2)	0.05
functional (O_3)	0.05
technological (O_4)	0.05
social (O_5)	
legal (O_6)	0.05
political (O_7)	0.20
total =	0.55



obsolescence rate pa 0.28

useful life (L_u) =	115.5 years	adaptive reuse potential is high and increasing
years to useful life =	6.5 years	
maximum arp score (%) =	66.7	(assuming $L_u = L_b$)
ARP difference (%) =	5.9 %	

Risk Management: **nil**

best case obsolescence =	0.50 (low)		
useful life (L_u) =	121.4		
ARP% =	56.7	adaptive reuse potential is high and increasing	(no change)
worst case obsolescence =	0.80 (high)		
useful life (L_u) =	90.0		
ARP% =	66.0	adaptive reuse potential is high and decreasing	
ARP difference (%) =	16.3		

Notes:

ARP Testing of Bushells Building

Adaptive reuse potential

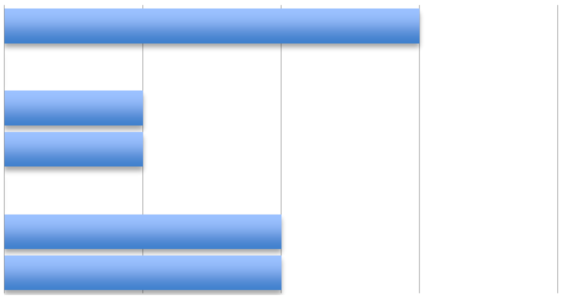
adaptive reuse potential (ARP%) = **36.3**

Low maintenance annual budget and in good condition,high population density and business district, largely open plan and flexible,good thermal performance, owner-occupied building, high quality construction, heritage protected

physical life (L_p) =	200 years	index =	220
building age (L_b) =	78 years	override =	

original construction date =	1923	today's date =	2001
last refurbishment date =	1923	(enter only if refurbishment was major)	

physical (O_1)	0.15
economic (O_2)	
functional (O_3)	0.05
technological (O_4)	0.05
social (O_5)	
legal (O_6)	0.10
political (O_7)	0.10
total =	0.45



obsolescence rate pa 0.23

useful life (L_u) =	127.6 years	adaptive reuse potential is moderate and increasing
years to useful life =	49.6 years	
maximum arp score (%) =	59.3	(assuming L_u = L_b)
ARP difference (%) =	63.6 %	

Risk Management: **extreme**

best case obsolescence =	0.20	(low)
useful life (L_u) =	163.8	
ARP% =	15.7	adaptive reuse potential is low and increasing
worst case obsolescence =	0.50	(high)
useful life (L_u) =	121.4	
ARP% =	40.6	adaptive reuse potential is moderat (no change) and increasing
ARP difference (%) =	158.6	

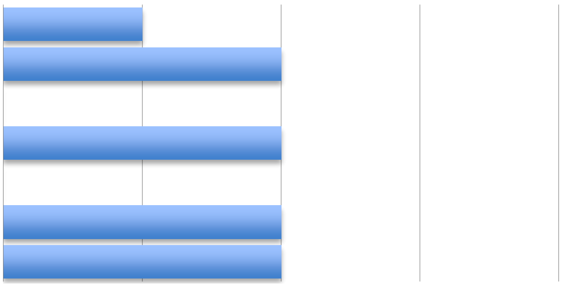
Adaptive reuse potential

adaptive reuse potential (ARP%) = **53.9**

Low maintenance annual budget, medium population density, largely open plan and flexible,tropically designed, owner-occupied building, high quality construction, heritage protected

physical life (L_p) =	150 years	index =	190
building age (L_b) =	87 years	override =	
original construction date =	1916	today's date =	2003
last refurbishment date =	1916	(enter only if refurbishment was major)	

physical (O_1)	0.05
economic (O_2)	0.10
functional (O_3)	
technological (O_4)	0.10
social (O_5)	
legal (O_6)	0.10
political (O_7)	0.10
total =	0.45



obsolescence rate pa 0.30

useful life (L_u) =	95.7 years	adaptive reuse potential is high and increasing
years to useful life =	8.7 years	
maximum arp score (%) =	59.3	(assuming $L_u = L_b$)
ARP difference (%) =	10.0 %	

Risk Management: **high**

best case obsolescence =	0.30 (low)	
useful life (L_u) =	111.2	
ARP% =	35.3	adaptive reuse potential is moderat and increasing
worst case obsolescence =	0.60 (high)	
useful life (L_u) =	82.4	
ARP% =	65.1	adaptive reuse potential is high and decreasing
ARP difference (%) =	84.4	

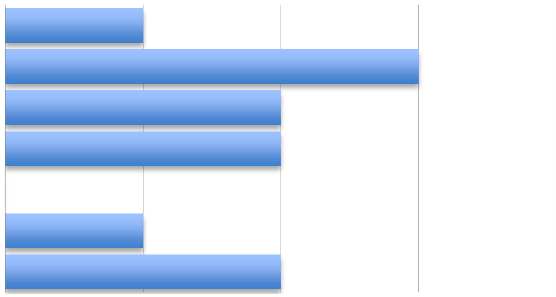
Adaptive reuse potential

adaptive reuse potential (ARP%) = **32.6**

Low maintenance annual budget, business area in Broken Hill, open plan and flexible spaces,good thermal performance, owner-occupied building, good quality construction, heritage protected

physical life (L_p) =	150 years		index =	170
building age (L_b) =	119 years		override =	
original construction date =	1885		today's date =	2004
last refurbishment date =	1885	(enter only if refurbishment was major)		

physical (O_1)	0.05
economic (O_2)	0.15
functional (O_3)	0.10
technological (O_4)	0.10
social (O_5)	
legal (O_6)	0.05
political (O_7)	0.10
total =	0.55



obsolescence rate pa 0.37

useful life (L_u) =	86.6 years	adaptive reuse potential is moderate and decreasing
years to useful life =	-32.4 years	
maximum arp score (%) =	66.6	(assuming $L_u = L_b$)
ARP difference (%) =	104.4 %	

Risk Management: **nil**

best case obsolescence =	0.40 (low)	
useful life (L_u) =	100.6	
ARP% =	34.5	adaptive reuse potential is moderat (no change) and decreasing
worst case obsolescence =	0.65 (high)	
useful life (L_u) =	78.4	
ARP% =	31.5	adaptive reuse potential is moderat (no change) and decreasing
ARP difference (%) =	8.9	

Adaptive reuse potential

adaptive reuse potential (ARP%) = **39.7**

Low maintenance annual budget, CBD and near park, largely open plan and flexible,good thermal performance, owner-occupied building, high quality construction, heritage protected

physical life (L_p) =	250 years	index =	270
building age (L_b) =	193 years	override =	
original construction date =	1811	today's date =	2004
last refurbishment date =	1811	(enter only if refurbishment was major)	

physical (O_1)	
economic (O_2)	
functional (O_3)	0.05
technological (O_4)	0.05
social (O_5)	
legal (O_6)	
political (O_7)	0.20
total =	0.30

obsolescence rate pa 0.12

useful life (L_u) =	185.2 years	adaptive reuse potential is moderate and decreasing
years to useful life =	-7.8 years	
maximum arp score (%) =	45.1	(assuming L_u = L_b)
ARP difference (%) =	13.6 %	

Risk Management: **nil**

best case obsolescence =	0.20	(low)
useful life (L_u) =	204.7	
ARP% =	31.1	adaptive reuse potential is moderat and increasing
worst case obsolescence =	0.50	(high)
useful life (L_u) =	151.7	
ARP% =	36.6	adaptive reuse potential is moderat (no change) and decreasing
ARP difference (%) =	17.9	

Adaptive reuse potential

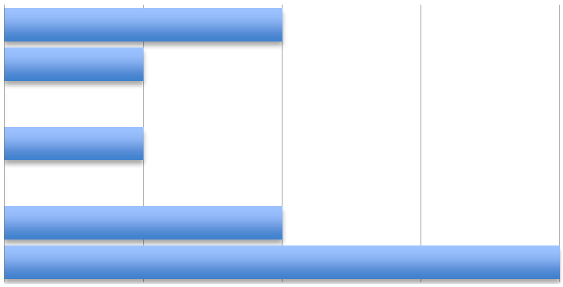
adaptive reuse potential (ARP%) = **32.1**

Low maintenance annual budget, medium to high population density, largely open plan and flexible,good thermal performance, owner-occupied building, good quality construction, heritage protected

physical life (L_p) =	150 years	index =	150
building age (L_b) =	120 years	override =	

original construction date =	1886	today's date =	2006
last refurbishment date =	1886	(enter only if refurbishment was major)	

physical (O_1)	0.10
economic (O_2)	0.05
functional (O_3)	
technological (O_4)	0.05
social (O_5)	
legal (O_6)	0.10
political (O_7)	0.20
total =	0.50



obsolescence rate pa 0.33

useful life (L_u) =	91.1 years	adaptive reuse potential is moderate and decreasing
years to useful life =	-28.9 years	
maximum arp score (%) =	63.2	(assuming $L_u = L_b$)
ARP difference (%) =	96.5 %	

Risk Management: **nil**

best case obsolescence =	0.35 (low)		
useful life (L_u) =	105.7		
ARP% =	34.1	adaptive reuse potential is moderat and decreasing	(no change)
worst case obsolescence =	0.65 (high)		
useful life (L_u) =	78.4		
ARP% =	30.5	adaptive reuse potential is moderat and decreasing	(no change)
ARP difference (%) =	10.7		

ARP Testing of George Patterson Warehouse

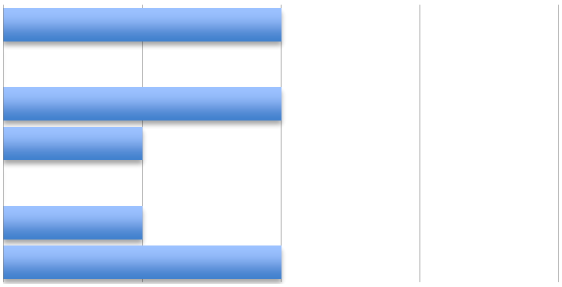
Adaptive reuse potential

adaptive reuse potential (ARP%) = **44.3**

Low maintenance annual budget, high population density and CBD, largely open plan and flexible,good thermal performance, owner-occupied building, high quality construction, heritage protected

physical life (L_p) =	200 years	index =	220
building age (L_b) =	108 years	override =	
original construction date =	1892	today's date =	2000
last refurbishment date =	1892	(enter only if refurbishment was major)	

physical (O_1)	0.10
economic (O_2)	
functional (O_3)	0.10
technological (O_4)	0.05
social (O_5)	
legal (O_6)	0.05
political (O_7)	0.10
total =	0.40



obsolescence rate pa 0.20

useful life (L_u) =	134.1 years	adaptive reuse potential is moderate and increasing
years to useful life =	26.1 years	
maximum arp score (%) =	55.0	(assuming $L_u = L_b$)
ARP difference (%) =	24.2 %	

Risk Management: **extreme**

best case obsolescence =	0.20 (low)	
useful life (L_u) =	163.8	
ARP% =	21.7	adaptive reuse potential is moderat (no change) and increasing
worst case obsolescence =	0.45 (high)	
useful life (L_u) =	127.6	
ARP% =	50.2	adaptive reuse potential is high and increasing
ARP difference (%) =	131.0	

Adaptive reuse potential

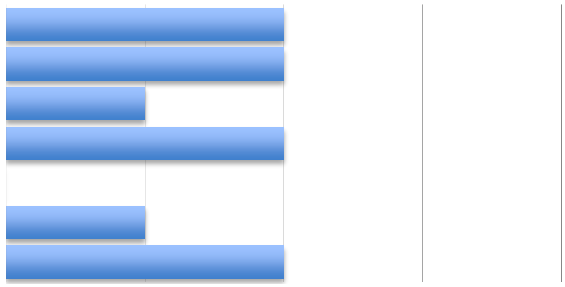
adaptive reuse potential (ARP%) = **62.7**

Low maintenance annual budget, low population density along Sydney's coastline, open plan and flexible spaces,good thermal performance, owner-occupied building, high quality construction, heritage protected

physical life (L_p) =	200 years	index =	200
building age (L_b) =	122 years	override =	

original construction date =	1881	today's date =	2003
last refurbishment date =	1881	(enter only if refurbishment was major)	

physical (O_1)	0.10
economic (O_2)	0.10
functional (O_3)	0.05
technological (O_4)	0.10
social (O_5)	
legal (O_6)	0.05
political (O_7)	0.10
total =	0.50



obsolescence rate pa 0.25

useful life (L_u) =	121.4 years	adaptive reuse potential is high and decreasing
years to useful life =	-0.6 years	
maximum arp score (%) =	63.2	(assuming $L_u = L_b$)
ARP difference (%) =	0.8 %	

Risk Management: **nil**

best case obsolescence =	0.50 (low)		
useful life (L_u) =	121.4		
ARP% =	62.7	adaptive reuse potential is high and decreasing	(no change)
worst case obsolescence =	0.70 (high)		
useful life (L_u) =	99.4		
ARP% =	58.4	adaptive reuse potential is high and decreasing	(no change)
ARP difference (%) =	6.8		

Appendix I: adaptSTARTemplates (As-built)

4-UNIT RESIDENTIAL APARTMENTS, EGAN STREET, NEWTOWN, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.			■			the walls could support the roof but not new work	✔
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.					■	yes the external walls were double and triple brickwork	✔
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.					■	face brick excellent lifespan	✔
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.					■	yes located in the middle of Newtwon 100mtrs away from the r	✔
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.					■	yes several bus routes and a train station all within close walkin	✔
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.			■			it is a double terrace house block close to the top of the local to	✔
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.					■	it had potential within the built and council control envelope	✔
The building has significant components or systems that support disassembly and subsequent relocation or reuse.				■		yes the large span oregon roof trusses were easily reused at a h	✔
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.					■	yes	✔
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.					■	yes	✔
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.			■			not relevant in our case	✔
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.				■		long side faced north	✔
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.		■				no the brick walls were built on the boundary	✔

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.					■	there is good mass in the external walls	✔
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.			■			not really it was just a good open span brick box with pitched m	✔
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.			■			the warehouse / factory type building neither good nor bad	✔
The building supports efficient operational and maintenance practices including effective building management and control systems.		■				the warehouse / factory type building neither good nor bad	✔
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.				■		the building has quaint 1920's brick detailing to its street façade	✔
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■		the building has quaint 1920's brick detailing to its street façade	✔
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.				■		was a working local mechanics when we bought it we retained	✔
The building displays a high standard of construction and finish consistent with current market expectations.			■			quality original face brickwork	✔
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.			■			it did comply for its warehouse/factory use	✔
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.				■			✖
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.				■			✖
The building displays a high level of community interest and political support for its future care and preservation.			■			yes	✔
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.					■	yes	✔

BUHREC Protocol Number RO-1208 **Score: 79.10**

GRAND BABWORTH HOUSE, DARLING POINT, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.		■				Foreseeable future would not envision further expansion. Roof space utilised in conversion.	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.					■	Building fabric in good condition largely reframed with all new works in matching quality.	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.				■		Building/Grounds regularly maintained through established sinking fund.	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.			■			Situated in the prestige suburb of Darling Point Sydney it is converted from Institutional use to residential apartments.	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.			■			Regular bus services along Darling Point Road, 10 minute walk to Edgecliff station.	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.					■	Atop the highest contour of Darling point, the building was provided with adequate curtilages.	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.		■				Adaptive reuse into apartments with high market value lessens likelihood. Some costs would be incurred.	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.		■				Adaptive use agreement with Heritage Authorities required reversibility of all structural changes.	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.			■			Adaptive reuse incorporated glazed roofing of a courtyard to facilitate realisation of this criteria.	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.				■		As a high quality luxury mansion, all rooms, circulation spaces and balconies are generous in their scale.	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.					■	Yes.	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.				■		Orientation is good, most major rooms of each apartment capitalise on sunlight and harbour/district views and outlook.	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.					■	Designed originally with appropriate fenestration shade performance, very little modification required.	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				■		Masonry and brick cavity wall with glass roofed court enclosure and new plate roof installed.	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■	Building is air-conditioned, however was originally designed not to require it.	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.				■		Would require confirmation as the age of the building, approximately 100 years old, predates green star rating.	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.			■			Subdivision of 5 corporate strata titled apartments, controlled by a Body Corporate, with grounds program.	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.					■	Alterations to the building required stringent adherence to best practice conservation and adaptive reuse.	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.					■	Designed by architects Morrow and de Putron in the Art Nouveau style, the building is an exemplar of its type.	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.		■				Provision of communal open space with well-appointed gardens and provision of waterfront access.	✓
The building displays a high standard of construction and finish consistent with current market expectations.				■		Successful restoration of this historic Horden Family Mansion allowing its adaptive reuse as apartments.	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■				All such high standards are fully met.	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.				■		Building provides luxury accommodation for 5 generously appointed apartments.	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.				■		Preservation and restoration of over 90% of the existing structure	✓
The building displays a high level of community interest and political support for its future care and preservation.					■	Provision is made for opening the property on an annual basis for interest groups.	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.					■	A high degree of conformity to all local and state regulatory requirements.	✓

BUHREC Protocol Number RO-1208 **Score: 75.94**

TOCAL VISITOR CENTRE, TOCAL, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.	■					capacity and heritage	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■		existing materials	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.				■		existing perfromance	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.		■				it is in a country location	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.	■					it is not	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.				■		it does	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.					■	it has proven such	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.		■				only bits are likely to be reusable	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.				■		limited capacity to change due to heritage controls	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.			■			the floor plate is limited but floor to floor in parts is high	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.				■		service access is relatively easy	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.				■		orientation was a given as it existed	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			■			this was part of the design parameter	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.			■			it does	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.				■		this was a design parameter an it works this way	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.			■			it has not been assessed but should meet it	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.	■					there is no BMS but has simple and effective control system	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.				■		it is part of a very historic property & is on heritage registers	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■		it has a strong rural aesthetic	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.			■			it already has achieved this as a function venue	✓
The building displays a high standard of construction and finish consistent with current market expectations.		■				this is proven by its high use	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■				it met all requirement when it was built but may not meet all	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.			■			this is evident by the favourable comments received	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.				■		this is evident in its wide acceptance and recognition	✓
The building displays a high level of community interest and political support for its future care and preservation.				■		the function centre and heritage interest will ensure this	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.				■		this will be controlled by the heritage listing	✓

BUHREC Protocol Number RO-1208 **Score: 62.97**

TOXTETH CHURCH AND HALL, GLEBE, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.			■				✖
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■			✖
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.				■			✖
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.				■			✖
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.				■			✖
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.				■			✖
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.					■		✖
The building has significant components or systems that support disassembly and subsequent relocation or reuse.				■			✖
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.				■			✖
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.					■		✖
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.		■					✖
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.					■		✖
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.				■			✖
The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.					■		✖
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■		✖
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.				■			✖
The building supports efficient operational and maintenance practices including effective building management and control systems.				■			✖
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.					■		✖
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.					■		✖
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.					■		✖
The building displays a high standard of construction and finish consistent with current market expectations.					■		✖
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■					✖
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.				■			✖
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.				■			✖
The building displays a high level of community interest and political support for its future care and preservation.					■		✖
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.					■		✖

BUHREC Protocol Number RO-1208

Score: 84.27

BUSHELLS BUILDING, THE ROCKS, SYDNEY, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.				■		The building had a large floor plate, and an option for extendin	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■		Correct	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.			■			Correct, though modern plant, lighting will have a shorter life th	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.				■		Correct	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.				■		Correct. Near major road junctions, rail and bus	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.				■		Agree. Views/outlook by Sydney standards are limited	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.				■		Agree. Plan is big and can adapt	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.		■				Agree. Modern introductions - a/c, toilets - can be readily chang	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.			■			Disagree - spacial and structural transformations will lose the h	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.			■			Plate and height remarks are correct, but regular hardwood pos	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.		■				Agree	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.			■			Heavy construction and trad. Windows give reasonable therma	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			■			As per above	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				■		Heavy masonry walls and new insulation in the roof plane	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.				■		Correct. While a/c has been introduced the building operated w	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.				■		This has never been confirmed, but performance would be to a	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.		■				Agree	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.			■			Agree	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.			■			Agree	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.		■				Coffee/tea shop in base	✓
The building displays a high standard of construction and finish consistent with current market expectations.			■			Has always been easy to let, esp. to groups who want somethin	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■				Yes	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.			■			A superior workplace environment	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.		■				Existing structure used, a much better environment than the st	✓
The building displays a high level of community interest and political support for its future care and preservation.		■				Best appreciated by those who have seen the interiors.	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.			■			An office building in an office precinct, close to transport in Syd	✓

BUHREC Protocol Number RO-1208 **Score: 61.94**

(DEFENCE BUILDINGS) SYDNEY HARBOUR FEDERATION TRUST OFFICES, GEORGES HEIGHTS, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.		■					✖
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.		■					✖
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.		■					✖
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.			■				✖
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.			■				✖
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.					■		✖
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.			■				✖
The building has significant components or systems that support disassembly and subsequent relocation or reuse.		■					✖
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.			■				✖
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.			■				✖
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.			■				✖
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.				■			✖
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			■				✖

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The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.		■					✖
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.			■				✖
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.		■					✖
The building supports efficient operational and maintenance practices including effective building management and control systems.				■			✖
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.			■				✖
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.		■					✖
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.				■			✖
The building displays a high standard of construction and finish consistent with current market expectations.		■					✖
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■					✖
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.			■				✖
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.			■				✖
The building displays a high level of community interest and political support for its future care and preservation.				■			✖
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.				■			✖

BUHREC Protocol Number RO-1208

Score: 57.83

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(SULLY'S EMPORIUM) ART GALLERY, BROKEN HILL, REGIONAL NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.			■			original fabric is relatively sound and stable ground	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■		most of the existing elements were retained	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.				■		low level of maintenance	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.			■			located in a town centre	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.			■			near to transport facilities and accessible	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.					■	good precinct, large site, good view	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.					■	almost open plan	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.		■				concept of reversibility is not yet introduced	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.					■	opportunities foratrium and open area	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.				■		allows mezzanine level extension	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.			■			these needed to be carefully considered prior to insertion	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.				■		good building orientation	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.				■		has a front verandah for sun shelter	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				■		made of bricks and wood	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.				■		traditional building envelope with capacity for thru ventilation	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.				■		no energy rating that time	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.		■				no BMS that time	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.				■		state heritage value - potential for conversion	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■		architectural value within the streetscape	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.					■	it was used as an emporium	✓
The building displays a high standard of construction and finish consistent with current market expectations.				■		good construction standard - despite deterioration and neglect	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■				fire and disability codes not yet well implemented that time	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.				■		potential for adaptation recognised	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.				■		supports ecological sustainability & doesn't disturb habitat	✓
The building displays a high level of community interest and political support for its future care and preservation.				■		public and private consultations throughout the process	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.				■		strict conservation control, adheres to master plan and zoning	✓

BUHREC Protocol Number RO-1208 **Score: 75.76**

MINT COINING FACTORY, SYDNEY, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.		■				not applicable	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■		good quality sandstone & joinery	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.		■				ditto	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.					■	located at south end of Macquarie Street near Hyde Park	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.					■	ditto	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.				■		ditto	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.				■		versatility is evident	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.	■					masonry and high heritage value not suitable for disassembly	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.		■				some workshop areas	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.	■					not applicable	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.		■				not applicable	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.		■				not applicable	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			■			conventional window wall ratio	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.			■			not applicable	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.			■			not applicable	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.		■				not applicable	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.	■					not sure what this means	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.				■		important historic building	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■		ditto	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.	■					not applicable	✓
The building displays a high standard of construction and finish consistent with current market expectations.			■			sandstone and joinery	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.	■					not applicable	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.			■			not applicable	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.			■			not applicable	✓
The building displays a high level of community interest and political support for its future care and preservation.			■			not applicable	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.		■				conservation plan was prepared in advance of changes	✓

BUHREC Protocol Number RO-1208 **Score: 56.03**

FORUM HEALTH AND WELLNESS CENTRE, NEWCASTLE, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.			■				✖
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■			✖
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.				■			✖
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.				■			✖
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.				■			✖
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.				■			✖
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.				■			✖
The building has significant components or systems that support disassembly and subsequent relocation or reuse.		■					✖
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.				■			✖
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.				■			✖
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.		■					✖
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.			■				✖
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			■				✖

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				■			✖
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.			■				✖
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.				■			✖
The building supports efficient operational and maintenance practices including effective building management and control systems.		■					✖
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.				■			✖
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■			✖
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.			■				✖
The building displays a high standard of construction and finish consistent with current market expectations.			■				✖
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■					✖
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.				■			✖
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.			■				✖
The building displays a high level of community interest and political support for its future care and preservation.				■			✖
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.				■			✖

BUHREC Protocol Number RO-1208 **Score: 69.68**

GEORGE PATTERSON WAREHOUSE, SYDNEY, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.	■					the heritage building structure is timber and/or cast iron with v	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■		the building fabric not affected by fire was in good condtion	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.			■			the building is in good condtion	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.					■	the building is located on george street , sydney	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.					■	the building is located near wynyard station	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.	■					the building is constrained by its size and context	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.			■			the existing structure allows it to be adapted to other uses	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.		■				mainly the cast iron structure	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.				■		as a result of the fire there is a natural atria	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.		■				the building has an old structure	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.		■				the structure is exposed so is the services	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.			■			the building is orientated east west with long north facing walls	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			■			the building has good deep windows which provide sun shading	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				■		the building has a traditional masonry façade which provides ex	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.			■			the glazed atria provdes excellent natural light and ventilation	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.			■			due to its use and its façade it would be able capable of achievi	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.		■				it has excellent operational procedures	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.				■		it has excellent heritage values and thru its use provides a posit	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■		the building relates well to the existing streetscape	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.		■				the building is well used by the local community	✓
The building displays a high standard of construction and finish consistent with current market expectations.			■			the building is well built	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.	■					due to its use the building has to comply with all standards	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.			■			for the type of use the building provides an excellent workplace	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.			■			there is no significant habitat disturbance issues	✓
The building displays a high level of community interest and political support for its future care and preservation.			■			the building is enjoyed by many	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.				■		the building conforms to current urban planning strategies	✓

BUHREC Protocol Number RO-1208

Score: 59.63

PRINCE HENRY HOSPITAL, LITTLE BAY, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.		■				it was solidly built, the additional load was not much	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■		built in 1935, it was still in excellent condition prior to reuse	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.		■				heritage buildings always require some more intensive mainten	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.		■				it is a suburban location, but nearby mixed use	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.		■				bus to city only a few doors away	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.					■	yes it had high amenity when constructed in 1935 and still does	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.				■		origially labs with big spans- ideal for most use	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.	■					there is nothing that can easily be disassembled/ relocated	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.			■			the original labs were designed for natural light	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.			■			the original labs had high ceilings and large rooms	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.				■		only two stories, the roof space and under floor provide adequa	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.					■	the original labs had northern orientation	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.				■		it does, now that sunshading and verandahs have been added	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				■		the original building was (double) cavity brick	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■	the long sides face north/south; passive ventilation	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.		■				it has low energy demand, but 5-star is hard to achieve for a he	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.			■			no different to any apartment building	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.					■	it is heritage listed and its past is celebrated	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■		it has won architectural/ heritage awards	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.					■	the development has great amenity	✓
The building displays a high standard of construction and finish consistent with current market expectations.			■			it has won awards, and has high resale values	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■				of course it does	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.			■			it is now a residential building	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.				■		the newly planted native garden is compatible with ecological s	✓
The building displays a high level of community interest and political support for its future care and preservation.					■	the building is in private strata ownership	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.					■	prince henry masterplan specifies apartments	✓

BUHREC Protocol Number RO-1208 **Score: 69.79**

GPO BUILDING, MELBOURNE, VIC.

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.				X		commencing in 1860 the building was designed as a major civic building without a view to expansion vertically or	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.					X	as above, it was designed to last the distance	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.				X		at 140+ years old, even quality materials require attention. Some of the stone has poor lasting qualities and ageing	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.					X	located in prime commercial retail centre of Melbourne	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.					X	served by Melbourne tram network on both of its street fronta	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.				X		minor additional free area only, a tightly controlled high profile heritage site	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.					X	rigid layout for an original purpose not easily adapted to new c	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.				X		as above first point, never intended to change and built accordi	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.				X		highly controlled heritage environment	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.				X		high ceilings yes, floor plates small in comparison to contempor	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.				X		building originally had minimum services, inclusion of contemporary services a complex matter	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.			X			orientation not considered when this building designed, its formal civic presence was the prevailing driver of its design	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			X			see above item	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				X		no wall insulation, 19th century solid brick and stone construction provides good thermal mass.	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.				X		the original internal work space space was a top lit atrium,that changed a few years after its establishment.Large windows	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.				X		very high energy demand to control internal environment for c	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.			X			high volumes, interconnected spaces hard to get at areas work against efficiency of control and make maintenance difficult	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.					X	One of Melbourne's most famous architectural heritage buildings with an important social history attached to it	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.					X	see above item	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.					X	it provided a postal service to the city and a civic reference poi	✓
The building displays a high standard of construction and finish consistent with current market expectations.				X		It displays high quality construction and finish consistent with fine heritage structures, not general current expectations	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		X				building requires high level of services to achieve compliance	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.			X			most workers and occupiers regard it as tired old fashioned and in need of modernisation and upgrade.	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.			X			building was designed in boom times, post gold rush when the advancement of the great golden city, Marvellous Melbourne	✓
The building displays a high level of community interest and political support for its future care and preservation.					X	emotional support for retention of building, heritage controls state and local government reinforce its importance and	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.					X	meets all metropolitan and city of Melbourne requirements	✓

BUHREC Protocol Number RO-1208 **Score: 83.17**

Appendix J: adaptSTAR Templates (Improved)

4-UNIT RESIDENTIAL APARTMENTS, EGAN STREET, NEWTOWN, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.					■	the walls could support the roof but not new work	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.					■	yes the external walls were double and triple brickwork	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.					■	face brick excellent lifespan	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.					■	yes located in the middle of Newtwon 100mtrs away from the r	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.					■	yes several bus routes and a train station all within close walkin	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.			■			it is a double terrace house block close to the top of the local to	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.					■	it had potential within the built and council control envelope	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.				■		yes the large span oregon roof trusses were easily reused at a h	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.					■	yes	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.					■	yes	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.			■			not relevant in our case	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.				■		long side faced north	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.					■	no the brick walls were built on the boundary	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.					■	there is good mass in the external walls	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■	not really it was just a good open span brick box with pitched m	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.					■	the warehouse / factory type building neither good nor bad	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.		■				the warehouse / factory type building neither good nor bad	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.				■		the building has quaint 1920's brick detailing to its street façade	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■		the building has quaint 1920's brick detailing to its street façade	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.				■		was a working local mechanics when we bought it we retained	✓
The building displays a high standard of construction and finish consistent with current market expectations.					■	quality original face brickwork	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.			■			it did comply for its warehouse/factory use	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.				■			✗
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.				■			✗
The building displays a high level of community interest and political support for its future care and preservation.			■			yes	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.					■	yes	✓

BUHREC Protocol Number RO-1208 **Score: 86.59**

GRAND BABWORTH HOUSE, DARLING POINT, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.		■				Foreseeable future would not envision further expansion. Roof space utilised in conversion.	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.					■	Building fabric in good condition largely reframed with all new works in matching quality.	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.				■		Building/Grounds regularly maintained through established sinking fund.	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.			■			Situated in the prestige suburb of Darling Point Sydney it is converted from Institutional use to residential apartments.	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.			■			Regular bus services along Darling Point Road, 10 minute walk to Edgecliff station.	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.					■	Atop the highest contour of Darling point, the building was provided with adequate curtilages.	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.					■	Adaptive reuse into apartments with high market value lessens likelihood. Some costs would be incurred.	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.					■	Adaptive use agreement with Heritage Authorities required reversibility of all structural changes.	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.					■	Adaptive reuse incorporated glazed roofing of a courtyard to facilitate realisation of this criteria.	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.				■		As a high quality luxury mansion, all rooms, circulation spaces and balconies are generous in their scale.	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.					■	Yes.	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.				■		Orientation is good, most major rooms of each apartment capitalise on sunlight and harbour/district views and outlook.	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.					■	Designed originally with appropriate fenestration shade performance, very little modification required.	✓

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The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				■		Masonry and brick cavity wall with glass roofed court enclosure and new plate roof installed.	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■	Building is air-conditioned, however was originally designed not to require it.	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.				■		Would require confirmation as the age of the building, approximately 100 years old, predates green star rating.	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.			■			Subdivision of 5 corporate strata titled apartments, controlled by a Body Corporate, with grounds program.	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.					■	Alterations to the building required stringent adherence to best practice conservation and adaptive reuse.	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.					■	Designed by architects Morrow and de Putron in the Art Nouveau style, the building is an exemplar of its type.	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.		■				Provision of communal open space with well-appointed gardens and provision of waterfront access.	✓
The building displays a high standard of construction and finish consistent with current market expectations.				■		Successful restoration of this historic Horden Family Mansion allowing its adaptive reuse as apartments.	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■				All such high standards are fully met.	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.				■		Building provides luxury accommodation for 5 generously appointed apartments.	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.				■		Preservation and restoration of over 90% of the existing structure	✓
The building displays a high level of community interest and political support for its future care and preservation.					■	Provision is made for opening the property on an annual basis for interest groups.	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.					■	A high degree of conformity to all local and state regulatory requirements.	✓

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Score: 80.97

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TOCAL VISITOR CENTRE, TOCAL, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.				■		capacity and heritage	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■		existing materials	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.				■		existing perfromance	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.		■				it is in a country location	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.	■					it is not	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.				■		it does	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.					■	it has proven such	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.		■				only bits are likely to be reusable	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.				■		limited capacity to change due to heritage controls	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.			■			the floor plate is limited but floor to floor in parts is high	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.				■		service access is relatively easy	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.				■		orientation was a given as it existed	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			■			this was part of the design parameter	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.					■	it does	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.				■		this was a design parameter an it works this way	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.					■	it has not been assessed but should meet it	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.	■					there is no BMS but has simple and effective control system	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.				■		it is part of a very historic property & is on heritage registers	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■		it has a strong rural aesthetic	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.			■			it already has achieved this as a function venue	✓
The building displays a high standard of construction and finish consistent with current market expectations.					■	this is proven by its high use	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■				it met all requirement when it was built but may not meet all	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.			■			this is evident by the favourable comments received	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.				■		this is evident in its wide acceptance and recognition	✓
The building displays a high level of community interest and political support for its future care and preservation.				■		the function centre and heritage interest will ensure this	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.				■		this will be controlled by the heritage listing	✓

BUHREC Protocol Number RO-1208 **Score: 70.85**

TOXTETH CHURCH AND HALL, GLEBE, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.					■		✖
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■			✖
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.				■			✖
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.				■			✖
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.				■			✖
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.				■			✖
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.					■		✖
The building has significant components or systems that support disassembly and subsequent relocation or reuse.					■		✖
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.					■		✖
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.					■		✖
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.					■		✖
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.					■		✖
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.				■			✖

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.					■		✖
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■		✖
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.				■			✖
The building supports efficient operational and maintenance practices including effective building management and control systems.				■			✖
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.					■		✖
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.					■		✖
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.					■		✖
The building displays a high standard of construction and finish consistent with current market expectations.					■		✖
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■					✖
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.				■			✖
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.				■			✖
The building displays a high level of community interest and political support for its future care and preservation.					■		✖
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.					■		✖

BUHREC Protocol Number RO-1208 **Score: 89.39**

BUSHELLS BUILDING, THE ROCKS, SYDNEY, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.				■		The building had a large floor plate, and an option for extendin	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■		Correct	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.					■	Correct, though modern plant, lighting will have a shorter life th	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.				■		Correct	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.				■		Correct. Near major road junctions, rail and bus	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.				■		Agree. Views/outlook by Sydney standards are limited	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.				■		Agree. Plan is big and can adapt	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.					■	Agree. Modern introductions - a/c, toilets - can be readily chang	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.			■			Disagree - spacial and structural transformations will lose the he	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.			■			Plate and height remarks are correct, but regular hardwood pos	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.					■	Agree	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.			■			Heavy construction and trad. Windows give reasonable therma	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			■			As per above	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				■		Heavy masonry walls and new insulation in the roof plane	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.				■		Correct. While a/c has been introduced the building operated w	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.				■		This has never been confirmed, but performance would be to a	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.		■				Agree	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.			■			Agree	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.			■			Agree	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.		■				Coffee/tea shop in base	✓
The building displays a high standard of construction and finish consistent with current market expectations.			■			Has always been easy to let, esp. to groups who want somethin	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■				Yes	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.			■			A superior workplace environment	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.		■				Existing structure used, a much better environment than the st	✓
The building displays a high level of community interest and political support for its future care and preservation.		■				Best appreciated by those who have seen the interiors.	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.			■			An office building in an office precinct, close to transport in Syd	✓

Score: 67.47

(DEFENCE BUILDINGS) SYDNEY HARBOUR FEDERATION TRUST OFFICES, GEORGES HEIGHTS, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.		■					✖
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.		■					✖
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.		■					✖
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.			■				✖
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.			■				✖
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.					■		✖
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.			■				✖
The building has significant components or systems that support disassembly and subsequent relocation or reuse.		■					✖
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.					■		✖
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.			■				✖
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.			■				✖
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.				■			✖
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			■				✖

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.					■		✖
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■		✖
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.					■		✖
The building supports efficient operational and maintenance practices including effective building management and control systems.				■			✖
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.			■				✖
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.		■					✖
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.				■			✖
The building displays a high standard of construction and finish consistent with current market expectations.		■					✖
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■					✖
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.			■				✖
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.			■				✖
The building displays a high level of community interest and political support for its future care and preservation.				■			✖
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.				■			✖

BUHREC Protocol Number RO-1208 **Score: 62.98**

(SULLY'S EMPORIUM) ART GALLERY, BROKEN HILL, REGIONAL NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.			■			original fabric is relatively sound and stable ground	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■		most of the existing elements were retained	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.				■		low level of maintenance	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.			■			located in a town centre	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.			■			near to transport facilities and accessible	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.					■	good precinct, large site, good view	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.					■	almost open plan	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.		■				concept of reversibility is not yet introduced	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.					■	opportunities foratrium and open area	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.					■	allows mezzanine level extension	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.			■			these needed to be carefully considered prior to insertion	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.				■		good building orientation	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.				■		has a front verandah for sun shelter	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.					■	made of bricks and wood	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■	traditional building envelope with capacity for thru ventilation	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.				■		no energy rating that time	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.		■				no BMS that time	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.				■		state heritage value - potential for conversion	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■		architectural value within the streetscape	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.					■	it was used as an emporium	✓
The building displays a high standard of construction and finish consistent with current market expectations.				■		good construction standard - despite deterioration and neglect	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.				■		fire and disability codes not yet well implemented that time	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.				■		potential for adaptation recognised	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.				■		supports ecological sustainability & doesn't disturb habitat	✓
The building displays a high level of community interest and political support for its future care and preservation.				■		public and private consultations throughout the process	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.				■		strict conservation control, adheres to master plan and zoning	✓

BUHREC Protocol Number RO-1208

Score: 79.25

MINT COINING FACTORY, SYDNEY, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.				■		not applicable	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■		good quality sandstone & joinery	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.		■				ditto	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.					■	located at south end of Macquarie Street near Hyde Park	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.					■	ditto	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.				■		ditto	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.				■		versatility is evident	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.	■					masonry and high heritage value not suitable for disassembly	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.					■	some workshop areas	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.	■					not applicable	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.		■				not applicable	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.		■				not applicable	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			■			conventional window wall ratio	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.			■			not applicable	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■	not applicable	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.		■				not applicable	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.	■					not sure what this means	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.				■		important historic building	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■		ditto	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.	■					not applicable	✓
The building displays a high standard of construction and finish consistent with current market expectations.			■			sandstone and joinery	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.				■		not applicable	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.				■		not applicable	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.			■			not applicable	✓
The building displays a high level of community interest and political support for its future care and preservation.			■			not applicable	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.		■				conservation plan was prepared in advance of changes	✓

BUHREC Protocol Number RO-1208

Score: 64.78

FORUM HEALTH AND WELLNESS CENTRE, NEWCASTLE, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.			■				✖
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■			✖
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.				■			✖
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.				■			✖
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.				■			✖
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.				■			✖
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.				■			✖
The building has significant components or systems that support disassembly and subsequent relocation or reuse.		■					✖
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.				■			✖
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.				■			✖
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.		■					✖
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.			■				✖
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			■				✖

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				■			✖
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■		✖
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.				■			✖
The building supports efficient operational and maintenance practices including effective building management and control systems.		■					✖
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.				■			✖
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■			✖
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.			■				✖
The building displays a high standard of construction and finish consistent with current market expectations.			■				✖
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.					■		✖
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.					■		✖
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.			■				✖
The building displays a high level of community interest and political support for its future care and preservation.				■			✖
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.				■			✖

Score: 74.40

GEORGE PATTERSON WAREHOUSE, SYDNEY, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.	■					the heritage building structure is timber and/or cast iron with v	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■		the building fabric not affected by fire was in good condtion	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.			■			the building is in good condtion	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.					■	the building is located on george street , sydney	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.					■	the building is located near wynyard station	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.	■					the building is constrained by its size and context	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.					■	the existing structure allows it to be adapted to other uses	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.		■				mainly the cast iron structure	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.					■	as a result of the fire there is a natural atria	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.		■				the building has an old structure	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.		■				the structure is exposed so is the services	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.			■			the building is orientated east west with long north facing walls	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.			■			the building has good deep windows which provide sun shading	✓

The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				■		the building has a traditional masonry façade which provides ex	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■	the glazed atria provdes excellent natural light and ventilation	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.			■			due to its use and its façade it would be able capable of achievi	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.		■				it has excellent operational procedures	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.				■		it has excellent heritage values and thru its use provides a posit	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■		the building relates well to the existing streetscape	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.		■				the building is well used by the local community	✓
The building displays a high standard of construction and finish consistent with current market expectations.			■			the building is well built	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.	■					due to its use the building has to comply with all standards	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.			■			for the type of use the building provides an excellent workplace	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.			■			there is no significant habitat disturbance issues	✓
The building displays a high level of community interest and political support for its future care and preservation.			■			the building is enjoyed by many	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.				■		the building conforms to current urban planning strategies	✓

BUHREC Protocol Number RO-1208 **Score: 62.67**

PRINCE HENRY HOSPITAL, LITTLE BAY, NSW

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.		■				it was solidly built, the additional load was not much	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.				■		built in 1935, it was still in excellent condition prior to reuse	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.		■				heritage buildings always require some more intensive mainten	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.		■				it is a suburban location, but nearby mixed use	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.		■				bus to city only a few doors away	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.					■	yes it had high amenity when constructed in 1935 and still does	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.				■		origially labs with big spans- ideal for most use	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.					■	there is nothing that can easily be disassembled/ relocated	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.					■	the original labs were designed for natural light	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.			■			the original labs had high ceilings and large rooms	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.				■		only two stories, the roof space and under floor provide adequa	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.					■	the original labs had northern orientation	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.					■	it does, now that sunshading and verandahs have been added	✓

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The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				■		the original building was (double) cavity brick	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■	the long sides face north/south; passive ventilation	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.					■	it has low energy demand, but 5-star is hard to achieve for a he	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.			■			no different to any apartment building	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.					■	it is heritage listed and its past is celebrated	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.				■		it has won architectural/ heritage awards	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.					■	the development has great amenity	✓
The building displays a high standard of construction and finish consistent with current market expectations.			■			it has won awards, and has high resale values	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.	■					of course it does	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.					■	it is now a residential building	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.				■		the newly planted native garden is compatible with ecological s	✓
The building displays a high level of community interest and political support for its future care and preservation.					■	the building is in private strata ownership	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.					■	prince henry masterplan specifies apartments	✓

BUHREC Protocol Number RO-1208

Score: 76.96

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GPO BUILDING, MELBOURNE, VIC.

When nominating your opinion to EACH of the following statements, please assume that the latest adaptive reuse intervention has yet to occur. Your responses therefore relate to the latent conditions BEFORE such intervention. Please rate ALL statements using ONE opinion option and provide the key supporting REASON.

How do you judge the following statements for the above building/facility?	strongly disagree	disagree	neutral	agree	strongly agree	What is the key reason that influenced your opinion?	valid response ?
The building's foundations and frame have capacity for additional structural loads and potential vertical expansion.				■		commencing in 1860 the building was designed as a major civic building without a view to expansion vertically or	✓
The building fabric is well constructed using durable materials, providing potential retention of existing exterior and interior finishes.					■	as above, it was designed to last the distance	✓
The building currently has a low maintenance profile with modest expected levels of component repair and replacement over its remaining lifespan.				■		at 140+ years old, even quality materials require attention. Some of the stone has poor lasting qualities and ageing	✓
The building is situated in a bustling metropolis comprising mixed use development and proximity to potential markets.					■	located in prime commercial retail centre of Melbourne	✓
The building is located near transport facilities and provides convenience for vehicular and pedestrian mobility.					■	served by Melbourne tram network on both of its street fronta	✓
The building enjoys a site with favourable plot size, access, topography, area, aspect and surrounding views.				■		minor additional free area only, a tightly controlled high profile heritage site	✓
The building's interior layout exhibits strong versatility for future alternative arrangements without significant disruption or conversion cost.					■	rigid layout for an original purpose not easily adapted to new c	✓
The building has significant components or systems that support disassembly and subsequent relocation or reuse.				■		as above first point, never intended to change and built accordi	✓
The building has sufficient internal open space and/or atria that provides opportunity for spatial and structural transformations to be introduced.				■		highly controlled heritage environment	✓
The building has large floor plates and floor-to-floor heights with minimal interruptions from the supporting structure.				■		high ceilings yes, floor plates small in comparison to contempor	✓
The building provides easy access to concealed ducts, service corridors and plant room space to ensure effective horizontal and vertical circulation of services.				■		building originally had minimum services, inclusion of contemporary services a complex matter	✓
The building is designed in such a way that it maximizes its orientation with good potential for passive solar strategies.					■	orientation not considered when this building designed, its formal civic presence was the prevailing driver of its design	✓
The building has appropriate fenestration and sun shading devices consistent with good thermal performance.					■	see above item	✓
The building has an insulated external envelope capable of ensuring good thermal and acoustic performance for interior spaces.				■		no wall insulation, 19th century solid brick and stone construction provides good thermal mass.	✓
The building is designed in ways that maximize daylight use and natural ventilation without significant mechanical intervention.					■	the original internal work space space was a top lit atrium,that changed a few years after its establishment.Large windows	✓
The building has low energy demand and is operating at or readily capable of achieving a 5-star Green Star® energy rating or equivalent.					■	very high energy demand to control internal environment for co	✓
The building supports efficient operational and maintenance practices including effective building management and control systems.			■			high volumes, interconnected spaces hard to get at areas work against efficiency of control and make maintenance difficult	✓
The building has developed strong intrinsic heritage values, cultural connections or positive public image over its life.					■	One of Melbourne's most famous architectural heritage buildings with an important social history attached to it	✓
The building has high architectural merit including pleasing aesthetics and compatability with its surrounding streetscape.					■	see above item	✓
The building provides relevant amenities and facilities within its neighbourhood that can add value to the local community.					■	it provided a postal service to the city and a civic reference poir	✓
The building displays a high standard of construction and finish consistent with current market expectations.				■		It displays high quality construction and finish consistent with fine heritage structures, not general current expectations	✓
The building complies with current standards for fire prevention and safety, emergency egress and disability provisions.		■				building requires high level of services to achieve compliance	✓
The building offers an enhanced workplace environment that provides appropriate user comfort, indoor air quality and environmental health and safety.			■			most workers and occupiers regard it as tired old fashioned and in need of modernisation and upgrade.	✓
The building's design is compatible with ecological sustainability objectives and helps minimize ongoing habitat disturbance.			■			building was designed in boom times, post gold rush when the advancement of the great golden city, Marvellous Melbourne	✓
The building displays a high level of community interest and political support for its future care and preservation.					■	emotional support for retention of building, heritage controls state and local government reinforce its importance and	✓
The building's current or proposed future use conforms to existing masterplan, zoning and related urban planning specifications.					■	meets all metropolitan and city of Melbourne requirements	✓

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BUHREC Protocol Number RO-1208 **Score: 86.30** page 2 of 2