

Green Adaptive Reuse: Issues and Strategies for the Built Environment

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Abstract Adaptive reuse is a powerful alternative to building demolition or destruction and can deliver a range of economic, social and environmental benefits to society that represent good value for money. It can extend the useful life of a facility through a change in function or purpose from that which previously applied and take advantage of the remaining physical life embedded in its materials and systems. When done well, the resultant projects are very successful, and much admired. This paper explores the issues that surround adaptive reuse intervention and proposes a number of strategies that can enhance the possible benefits that flow from adoption of this approach. Adaptive reuse is important to our future in an era of climate change where maximizing wealth and utility must be tempered against minimizing resources and environmental impact. It is argued that the concept of ‘green adaptive reuse’ is a valid strategy to both extend a facility’s life and reduce its carbon footprint, while helping to preserve important heritage values that define our cultural development over time. Coordinating adaptive reuse intervention with ‘greening’ initiatives can deliver opportunities for cost efficiency.

Keywords Adaptive reuse · Existing buildings · Intervention · Property management · Sustainability

1 Introduction

It has been said that the greenest buildings are the ones we already have (Jacobs 1993). This is a reference to the embodied energy within materials and systems that would be largely wasted through traditional demolition paradigms that may be invoked to make way for new construction and progress. Even adopting reuse and recycling approaches would rarely be as effective as leaving components in-situ

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where possible (Douglas 2002). Refurbishment is considered a more appropriate strategy compared to new build provided the quality of the existing facility is consistent with the aims of the revitalization (e.g. Bromley et al. (2005), Pearce (2004)). Achieving lower operating energy performance through implementation of green design principles and technologies may enhance the benefits of refurbishment further.

In many cases refurbishment also entails a change of function, as the original purpose of the facility may be obsolete or close to it. Known as adaptive reuse, such type of refurbishment would be appropriate for facilities that would otherwise be destroyed to make way for a different type of activity. Similarly, adaptive reuse offers opportunity to improve operating performance, and the term ‘green adaptive reuse’ is sometimes applied to highlight this outcome¹. So, given the alternatives, adaptive reuse is already able to better deliver sustainable outcomes for society by avoiding unnecessary waste, and green adaptive reuse is likely to be a further advantage provided a convincing value for money proposition is mounted.

The objectives of this paper are: (1) to discuss the issues that affect adaptive reuse implementation in practice, and (2) to propose a series of strategies that are capable of delivering economic, social and environmental advantage. Adaptive reuse has the additional complication of timing, as to undertake significant functional change too early or too late invites resource inefficiency. This paper begins by looking at recent research into adaptive reuse intervention, before moving onto a detailed examination of issues and strategies, and concludes with some practical recommendations for building owners and developers.

2 Adaptive Reuse

Adaptive reuse is not appropriate in all cases. It can be defined as a subset of refurbishment where a change in a facility’s primary function is involved. The timing of adaptive reuse intervention is critical, and requires an understanding of a range of obsolescence drivers that might conspire to make a particular facility of no further use to its owner, or prospective owners operating in a similar domain, despite displaying inherent capacity as a property asset. This position can be complicated by heritage control and constraints that may prohibit demolition, and owners may have no option but to seek a buyer through creative redesign of the facility for a different market (Rovers 2004).

Modeling of adaptive reuse potential (ARP) is necessary to identify opportunities for strategic intervention where appropriate. Suitable facilities are ones that were originally built using principles of ‘long life, loose fit and low energy’, with

¹For example, the Whitehead-Elniski Residence in Chicago (see story available at <http://www.jetsongreen.com/2008/03/whitehead-elnis.html>).

considerable remaining (embedded) physical life and structural integrity, but where their current functional purpose is waning.

Initial work by Langston and others (e.g. Langston et al. (2008), Langston and Shen (2007)) has led to a means of identifying ARP in buildings through estimating useful life. A model was developed to predict useful life as a function of physical life and obsolescence. Through application of traditional discounting techniques, expected physical life (itself an outcome of a separate model) was reduced by a derived annual obsolescence rate to arrive at expected useful life. The potential for adaptive reuse could then be calculated at any particular date in the facility’s life cycle, so the timing of the intervention could be optimized. The concept behind this research is summarized in Fig. 1.

Obsolescence was hypothesized to be a combination of physical, economic, functional, technological, social, legal and political criteria. Each criterion was shown to be capable of evaluation using surrogate estimation techniques. The calculated annual rate of obsolescence (akin to a discount rate) has lead to a range of useful lives arising between 25 (maximum obsolescence) and 100% (no obsolescence) of the expected physical life of the facility. Using this model, buildings can be compared and ranked according to their potential for adaptive reuse given their current age. High ARP scores mean more potential for adaptive reuse intervention.

Models, by definition, are intended to simulate reality. To do this they make assumptions that simplify the complexity of the final product while maintaining

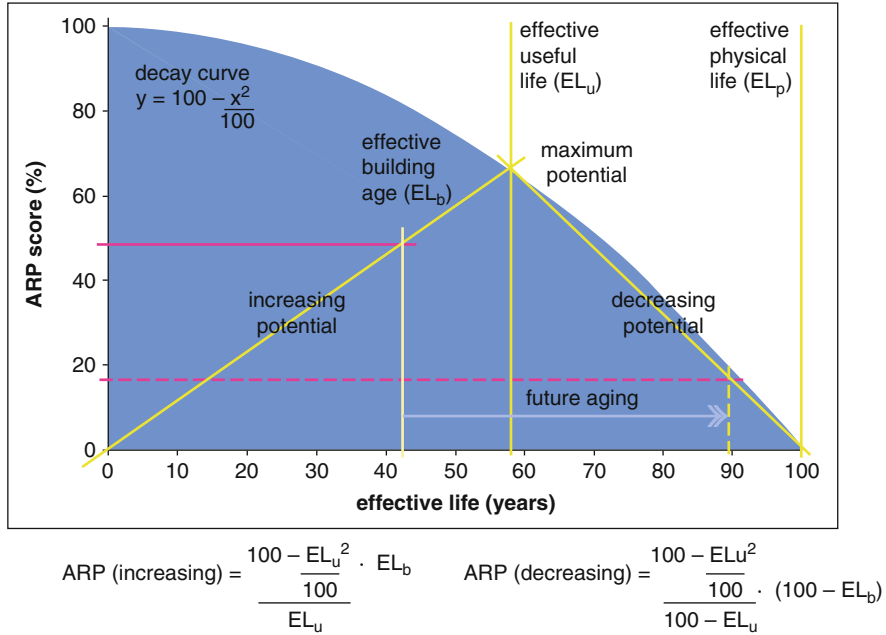


Fig. 1 Adaptive reuse potential model

reasonable forecasting accuracy. Langston (2008) has tested his model in hindsight against 64 adaptive reuse projects sourced from around the world. He found there was a strong correlation between predicted useful life and actual useful life, as shown in Fig. 2. The accuracy of the model is therefore judged by its forecast of the outcome, and provided this is robust, the inner workings of the model are validated. Such is the case here. When the regression line was modified to $y = x$, the value of r^2 fell only to 0.69971, which confirmed the model’s integrity.

Work by Bullen (2007) has tested attitudes towards adaptive reuse, although admittedly on a very small sample of building owners and managers in Western Australia. The sample in fact was drawn from 30 members of the Western Australian Sustainability Industry Group (WASIG) with 14 respondents. Nevertheless, as you would expect, the majority considered adaptive reuse to be preferable over new build provided the economics of the approach could be justified.

The top five drivers identified to support adaptive reuse were environmental sustainability (87% agreed), heritage significance (83%), effectiveness in meeting sustainability benchmarks (79%), technical ability of building to adapt (74%), and economic sustainability (70%). The top five barriers to implementation were constraint on creativity compared to redevelopment (85% agreed), estimating social viability (84%), compliance with building codes (67%), increasing urban density (65%), and estimating economic viability (61%). The top five opportunities for adaptive reuse were opportunity for technical innovation (89% agreed), expected

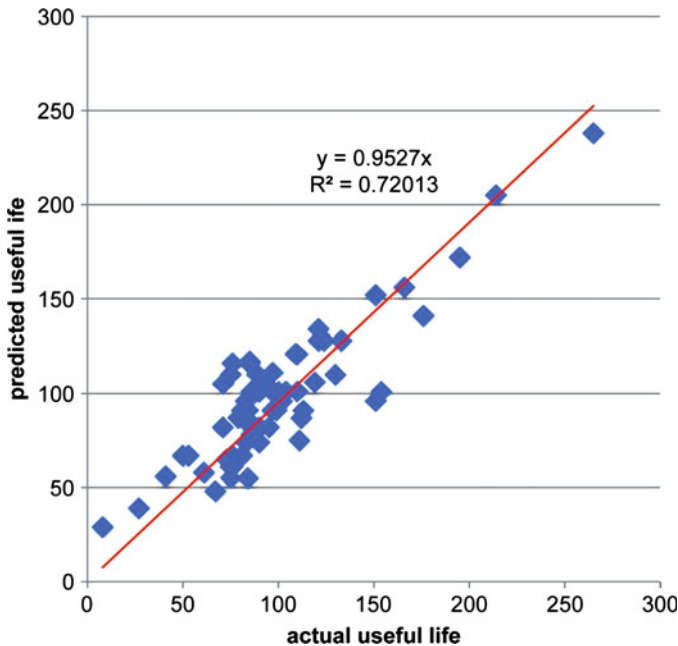


Fig. 2 Validation of useful life forecast

benefits of reusing (83%), enhancing community values (82%), visual amenity and cultural heritage (81%), and increased demand after revitalization (69%).

Despite the obvious limitations, the above will be used as a basis to explore issues of adaptive reuse implementation. Rather than rely on further opinion, this discussion takes the form of reasoned argument. In particular, further discussion is required on the proposition that “*older buildings may be unable to meet current sustainability standards*” (p. 29). This is critical to the notion of green adaptive reuse. Furthermore, a multi-criteria approach is needed to blend economic, social and environmental considerations into a single decision tool, as adaptive reuse includes intangible benefits (Bell and Morse 1999; Lutzkendorf and Lorenz 2005).

3 Issues

Adaptive reuse implementation demands an appropriate context. It is generally regarded that the following conditions must be met:

- The existing function or purpose of the facility has become inappropriate due to changing social expectations and/or market demand
- The facility has significant embedded physical life (or residual value) and structural integrity
- There is some compelling cultural, heritage or environmental value in the facility to support its retention
- An argument can be mounted to show that the proposed new use delivers a higher value for money ratio than alternative new build or sale options

The first point is relevant to adaptive reuse while the remainder apply to refurbishment more generally. Additional value can be achieved if the intervention enables the facility to improve its green performance. To some extent this is a given, as material reuse and avoidance of unnecessary waste generation is integral to an adaptive reuse strategy. Adaptive reuse will usually outperform other refurbishment strategies due to the increased in-situ reuse involved (Chusid 1993; Poon 2001). Operational performance, however, may have been poor, and intervention represents an opportunity to improve on this as part of the adaption where feasible.

It is also important that design consultants are able to show creativity and sensitivity to the project (Latham 2000). This is not always easy, and demands experience and skill. Creativity extends to finding imaginative new uses for the facility that can be demonstrated to be viable. Adaptive reuse differs from restoration as it provides greater ‘license’ for change, such as extension and integration of new build components, or even selected demolition.

Further to Bullen’s findings, political agenda can be a key driver. Revitalization of dilapidated areas of our urban environment and the desire to blend progress with heritage conservation goals are often the purview of government and local planning authorities. Linked to this is the opportunity for government funding to support projects that are seen as culturally significant. Such funding can make the difference between feasible and non-feasible projects.

A key issue is cost. The economics of adaptive reuse are not necessarily clear. Benefits can include social and environmental contributions that are not easily translated into financial terms, either for the facility owner, developer or other stakeholders (Maggs 1999). The identification of adaptive reuse potential is one thing, but realizing it is another. A sophisticated evaluation process is needed to express benefits (both tangible and intangible) against costs (capital and operating) within the context of an acceptable risk profile and time horizon. If the ratio of benefits to costs is less than 1, the project is unlikely to advance any further. If higher ratios can be achieved for new build solutions, then an adaptive reuse strategy will be hard to justify. So this analysis is critical to success.

Benefits may be related to maximizing wealth and utility. Costs may be related to minimizing resources and environmental impact. Hence adaptive reuse demands consideration of a wider range of issues outside of traditional return on investment. Nevertheless, adaptive reuse can be cost effective as a result of the reuse of expensive building elements and time for completion can be shorter (Saleh and Chin 2009), particularly where heritage constraints are not overwhelming. Use of a greening strategy as part of the adaptation provides opportunity to introduce future operational savings into the analysis and reduce the facility's carbon footprint.

Compliance with building regulations can be more difficult for adaptive reuse projects compared to new build, and can lead to increased costs. Compliance could relate to fire safety and egress, insulation and energy performance, disabled access, asbestos removal, occupational health and safety, car parking and the like. Planning controls may prohibit some alternative new uses or require time and effort in negotiation (Ball 1999). Many new developments also have these problems, but with adaptive reuse any discovered (latent) conditions during construction can introduce additional problems, and therefore it may be concluded that adaptive reuse increases the risk of time and cost overruns.

Sustainability is an interesting question in the context of compliance. Existing facilities usually possess both positive and negative attributes in regard to sustainability. They clearly perform well in regard to material reuse and embodied energy savings (Brandt 2006). They often have low technology solutions that lend themselves well to natural ventilation, natural light and thermal mass objectives. But their orientation may be sub-optimal, solar access may be limited, insulation may be problematic to add, and there may be problems with dampness and weather-proofing that are expensive to overcome. However, sustainability standards recognize these limitations and provide some flexibility to achieve compliance. While some projects may have difficult challenges, this should not be considered as a significant issue, and in many cases adaptive reuse solutions will achieve higher operational performance than their new build counterparts. Green adaptive reuse is an area that warrants further investigation. It is likely that the costs of greening existing buildings during adaptive reuse are lower than the costs of greening existing buildings independently, and so a value proposition should be easier to mount.

Most adaptive reuse projects are in the older parts of cities and surrounding communities and therefore tend to have more central locations with good access to

transport and markets (Myers and Wyatt 2004). While increased urban density may be an outcome, this is not necessarily a bad thing, compared to urban sprawl and disused or unsafe city precincts, and may actually be an opportunity for revitalization through preservation of cultural values that would otherwise be lost or diluted. From a sustainability perspective, greater urban density offers advantage over development of new land and the resultant loss of biodiversity that usually follows (Sustainable Construction Task Group 2004).

Heritage conservation and the celebration of cultural values attached to a facility or precinct are a prime motivation for restoration, refurbishment and adaptive reuse. However, the latter usually offers the most advantage in this regard, as it is able to blend preservation and revitalization to create interesting places for people to inhabit. Adaptive reuse offers potential to introduce new business opportunities, particularly where the historical context of the facility is sympathetic with commercial goals, as may be the case in tourism, hospitality, education and retail ventures. Reused materials add character to the architecture of the adaptation and provide connections with history that can attract visitors and clients alike.

So the key benefits of adaptive reuse centre round engagement of the community and a celebration of the past. This mix of old and new can be quite compelling. Many completed adaptively reused facilities are national landmarks and much beloved. Yet most of them are not recognized as leading environmental exemplars. Despite their contribution to sustainability in terms of material reuse and waste minimization, they have generally not introduced green principles and technologies over and above those that were part of the original design or accepted contemporary practice. To some extent this is because they don't need to, as they already may have comfortable internal conditions, a low reliance on energy for heating, ventilation and air conditioning, and ample natural light. But an opportunity may have been missed to introduce solar power and hot water, building management systems that can regulate the internal environment more efficiently, water catchment and stormwater run-off solutions, cogeneration, and waste recycling, to name just a few.

It seems odd that Bullen's results indicate the main opportunity for adaptive reuse is technical innovation, yet there is little evidence to suggest that this has occurred in relation to green building performance. The notion of green adaptive reuse appears still to be embryonic, and perhaps for reasons of economic viability have been left out or cut out of past projects. The problem may not be one of principle but rather one of evaluation. The sophistication of our triple bottom line assessment tools may be inadequate to account for the complexities of adaptive reuse, or the risks may just be too high for most clients.

It is generally regarded that high performance environmental buildings cost more than traditional solutions. Hopefully this premium will reduce over time. Nevertheless, it is also held that most adaptive reuse projects cost less than new build solutions of the same size. So it may be possible, therefore, to introduce green solutions with adaptive reuse intervention provided the two can be coordinated. This is an area that needs to be developed more seriously and be supported by government via incentives and successful case examples.

4 Strategies

Green adaptive reuse needs to become a priority. More concentration needs to be directed to refurbishment over new construction as time passes, and where appropriate adaptive reuse should be seen as preferable to demolition for facilities that are becoming obsolete. Green adaptive reuse is then an optimal strategy as it combines embodied and operational benefits in a coordinated fashion. It should be obvious that reuse and greening, if done separately, will cost more and involve greater disruption than if done simultaneously. Greening of our existing building stock is a contemporary imperative to help reduce greenhouse gas emissions and carbon footprints (Balaras et al. 2004). The cost efficiency of adaptive reuse for most projects can be used to offset the (often) higher capital costs of sustainable development, even though the level of greening is not likely to be as high as might be expected with more modern design solutions.

To some extent the blame for lack of green adaptive reuse examples lies with building designers. There are two quite different skill sets involved. Adaptive reuse requires engagement and understanding of historical connections and cultural sensitivities. Green building requires technical expertise in environmental modeling, comfort and energy performance. Combining these two pursuits demands multi-skilled designers or multi-disciplinary design teams who can integrate preservation and sustainability with creativity and flair. But when achieved successfully, the outcomes can be extraordinary (e.g. Holyoake and Watt 2002; Department of Environment and Heritage 2004).

Using the US Green Building Council LEED Platinum certification as a method for identifying high performance green buildings, it appears that several adaptive reuse projects have made the list. These are real examples of green adaptive reuse, but they represent less than 5% of the LEED Platinum list. They provide evidence that existing buildings are capable of meeting the highest current sustainability standards within acceptable budget constraints. Examples sourced from the Internet comprise:

- *Franklin Environmental Center* at Hillcrest, Vermont (information available at <http://www.middlebury.edu/administration/enviro/initiatives/design/hillcrest/>)
- *Boora Studio* at Portland, Oregon (information available at http://www.boora.com/projects/boora_leed_platinum_studio)
- *The Christman Building* at Lansing, Minneapolis (information available at <http://www.smithgroup.com/?id=1323>)
- *Alberici Corporate Headquarters* at St. Louis, Missouri (information available at [http://www.alberici.com/index.cfm/Projects/Alberici Corporate Headquarters](http://www.alberici.com/index.cfm/Projects/Alberici_Corporate_Headquarters))
- *Blackstone Station* at Cambridge, Massachusetts (information available at http://www.edcmag.com/CDA/Articles/Web_Exclusive/BNP_GUID_9-5-2006_A_1000000000000214697)
- *Center for Neighborhood Technology* at Chicago, Illinois (information available at <http://building.cnt.org/>)

- *First Regiment Armory Annex* at Portland, Oregon (information available at http://www.archiplanet.org/wiki/First_Regiment_Armory_Annex)
- *William A. Kerr Foundation Office* at St. Louis, Missouri (information available at <http://stlouis.bizjournals.com/stlouis/stories/2008/10/27/focus17.html>)

An appropriate strategy in a climate-challenged future is to make better use of the facilities we already have. This translates to a general shift towards refurbishment. But where obsolete facilities still have residual value, adaptive reuse is likely to be appropriate. Intervention techniques such as those described earlier in this paper can help to identify which facilities offer the most potential for adaptive reuse and hence tell us where design time and effort should be concentrated. When this intervention occurs, an opportunity is provided to incorporate a greening campaign to ensure that future operational performance is maximized. The combined effect of substantial reuse and ongoing operational efficiencies can make a difference to the overall impact of the constructed environment provided such efforts have widespread adoption.

Adaptive reuse is an international topic and is relevant particularly to those countries with a rich heritage of built assets. Projects may have heritage-focused or opportunistic characteristics, but in both cases respond well to sustainability ideals and strategies. Green adaptive reuse does not appear to be limited to specific building typologies or client classifications (such as public or private sector) but may attract stakeholders and financiers with more altruistic attributes.

Adaptive reuse potential needs to be justified and demonstrated through appropriate analysis. A multi-criteria framework comprising economic, social and environmental considerations is essential. A value for money proposition must be made, but not one restricted to financial return and short payback periods. The quantification of benefits that are intangible might sound like an oxymoron, but some objective analysis is necessary to ensure that vital social and environmental advantage are not undervalued or ignored. Such tools are now beginning to emerge.

Put simply, the ratio of benefit (wealth and utility) to cost (resources and environmental impact) gives an indication of value for money. The higher this ratio, the better the social outcome. This assumes that benefits and costs are considered broadly, not to specific interest groups, and are assessed over the full life cycle of the facility, not just the period of ownership of the initial investor. Such thinking needs to be embedded in the planning approval process so that society has some confidence that future facilities will be in line with international climate change adaptation principles and targets.

5 Conclusion

Green adaptive reuse needs to be at the forefront of our thinking about existing building stock. In most countries new construction represents around 1% of the total value of property assets per annum. On this basis it may take a century to upgrade

their performance, even if from tomorrow every new intervention delivered high environmental performance outcomes. A shift in focus to refurbishment of existing facilities in preference to premature destruction and new build is necessary from a sustainability perspective, and some evidence this shift is already happening is now becoming available, such as the recent decline in the proportion of expenditure on new construction compared to refurbishment in some western countries.

Adaptive reuse offers advantage over normal refurbishment where an existing functional purpose has become obsolete. Green adaptive reuse, defined as a merge of adaptation to a new purpose and the integration of green principles and technologies, is an opportunity to improve the performance of our existing building stock. Through this strategy a faster process of upgrade to higher standards of compliance can be achieved, while simultaneously preserving important heritage and cultural values. The assessment of such opportunities must take account of multiple criteria to demonstrate that value for money has been achieved and is higher than alternative new build options. This is the challenge for building owners and developers into the future. Positive action in this regard will help mitigate the damaging effects of climate change and assist governments in fulfilling international agreements on greenhouse gas emissions.

Facilities within a portfolio can be ranked and prioritized according to their potential for adaptive reuse. In fact, entire cities can be analyzed to identify which properties have reuse merit. By matching suitable cases with creative solutions, incorporating sustainable design and environmental certification, a quantum shift in the performance of existing building stock can be achieved. A practical recommendation for contractors is to increasingly seek out and pursue green adaptive reuse opportunities, as the frequency of such projects is anticipated to be on the rise.

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