WHOLE BUILDING RECYCLING AS A WASTE REDUCTION PRACTICE

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TE WHARE WĀNANGA O WAIRAKA

ABSTRACT

This paper considers strategies for whole building recycling in New Zealand. Assumptions about waste and recycling potential that are made in the process of improving construction systems usually relate to the development of new practices that may be generally characterised as reductive. These are often effective, and make significant contributions to the overall efficiency of the wider building industry. However, the tradition of uplifting, removing, relocating and restoring – and in this process, recycling – a whole building is well established as a practical and economic alternative to demolition and salvage, in which only a small proportion of all the original material is likely to be recovered. The "relocatable", in which space and volume as well as material is recycled, can be seen as a sustainable practice for reduction of waste and resource depletion, and also sustainable for its social function. The argument for expanding the practice is developed in this paper through case study examples with a focus on three elements: material recovery (including energy), irreducible waste by-products from the usual recovery process, and identifiable social advantages. It is argued here that waste is minimised through the element of direct personal commitment commonly encountered during the period of the building's recovery. Case studies are supported by research that has had access to the files of some of Auckland's leading house removal companies.

INTRODUCTION

This paper has its origins in a relatively disparate collection of intersecting research interests, all of which have roots in housing research. Auckland is an increasingly complex city where perceptions of sustainable urban paradigms are shifting. Our perceptions now bear on concepts of heritage, density, social norms and habits, transport and non-transport energy efficiency; from these new positions innovative ways of thinking about traditional practices in the house building industry are being generated. Many of Auckland's recent residential typologies, such as medium and high-rise apartments, which were once reserved for the least wealthy (Schrader, 2005), are now embraced with enthusiasm by their occupiers in all age and income sectors of the market. For the City, the advantages of higher densities are recognised by a majority; the need to limit sprawl and make more effective use of urban land is no longer a battle for the advocates of the compact city, but reflects a shared understanding of a legitimate strategy for the city's continuing rapid growth (ARC, 2000; Syme, McGregor and Mead, 2005).

However, intensification of the city is now obstructed by our history of suburban housing development. To intensify the urban mass, after all vacant land has been developed it becomes necessary to liberate suburban space that, in the new perceptions of density, is perceived by market forces to be under-capitalised.

Moving buildings from place to place has been an accepted custom in the New Zealand housing culture from the earliest period of European settlement, and is a distinguishing characteristic of our housing system (McLaughlin, 2002; Isaacs, 2009). The standard building method associated with housing is based on single storey, lightweight timber construction, on timber pile and bearer beam foundations; almost 90% of houses in New Zealand are built in this form (DTZ, 2009). It has never been difficult to relocate these buildings (Belich, 2001), and we have a general agreement that this practical and technically feasible system of building redistribution is unaffected by other, possibly conflicting notions of 'place', 'permanence', or the desirability of spatial continuity. We endorse a rationale that supports the practice, and in doing so tacitly accept other consequences,

in order to subscribe to a particular collective logic: the 'relocatables' satisfy an instinct to waste nothing; to retrieve, to build on previous invested effort, to apply ingenuity, and to preserve and retain memory. None of these motivations are unfamiliar in the housing culture of the tangata whenua, where essentially similar practices are commonplace. This practice may be attributed to a residual pioneering culture applicable to both Māori and the nineteenth century settlers from Europe (Fairburn, 1989; Bassett, 1990).

RELOCATIONS AND SUSTAINABLE BUILDING PRACTICE

The relocating of houses might also be considered an ultimate form of recycling, and thus have implications for the general narrative of sustainability. In pursuit of sustainable outcomes, recycling whole buildings is a process that achieves low waste of resources, minimal waste to landfill, minimal resource depletion, and has, in the common course of the process, the potential social benefit of high levels of user participation. Significant personal satisfactions are derived from house relocations: recycled buildings are less expensive, can be occupied more quickly, and anecdotally, deliver a sense of personal investment from participation in the process, which then contributes to a powerful perception of ownership (C. Walker, personal communication, August 22, 2008). The alternative, of demolition and limited component recycling, with additional costs of handling and further loss by attrition – including damage to materials, and unusable off-cuts – acts against economic material recovery, and reinforces the argument for relocating the entire building.

Houses that have been 'relocated' are not generally stigmatised by market prejudices, despite their exclusion from most new sub-divisions. Rather than penalise relocated houses, market perceptions appear to extend approval, particularly for the rimu heartwood framing (which is no longer obtainable), the recovery of hardwood flooring and fireplaces, and original doors and windows; their occupants are even tolerant of out-dated room layouts. The primary structure and spatial organisation of the house is retained: only components of the building that need attention in the short term, or those that would have to be renewed with or without relocation are affected. Thus, a common and an arguably vernacular understanding is evident, resulting in a residential 'relocations' building sector that manages between 2,600 and 3,200 house removals each year, and an industry that accounts for up to 12% of New Zealand's annual housing supply measured by total numbers of consents granted (Turner, 2010).

RESEARCH APPROACHES: LITERATURE AND EXAMPLES

If the principle of the relocation of houses is broadly accepted, it is useful to examine the practice in detail, to consider its contribution to reduction of waste in the building industry and to quantify where possible the primary costs and benefits of the process.

The subject has attracted remarkably little attention in academic literature, and only occasional reference in popular works and in the general media. Brief references occur in studies of architectural conservation (Salmond, 1986). Where settlements were often expected to be temporary, the practice of moving buildings was considered to be part of a historic residential system of supply (Arden and Bowman, 2004). Others in the field of building history make passing references to relocations as an aberrant part of the New Zealand story: no writers have paused to reflect on the environmental or economic issues that frame the practice (Dunstall, 1992; Salmond, 1986). Particular (and spectacular) examples of buildings shifted and relocated, such as St Mary's Cathedral in Auckland in 1982, and the Museum Hotel in Wellington (1993) are celebrated in the media as engineering proof of our natural native skills; and a widely shared interest in motor vehicles, in this case the trucks that provide the moving power is more the centre of attention in two recent books on the 'relocatables' industry than the buildings in transit (Carter, 2010; Dawson, 2012).

In this study I focus on the 'first order' issues of material recovery, waste avoidance, and recycling. However, it is recognised that a full analysis needs to extend into parallel factors, as

suggested by Mitharatne et al (2004) to acknowledge the variables that make up a complete study of life-cycle costs, and thus justify or otherwise the initial proposition of a building relocation. Research by the Department of Architecture with Genesis Energy in 2012-13 for the Tomorrow Street project identified and recorded some of these variables, or second order factors in household (operational) energy use. In addition, third order items (including banking, interest charges, and insurances) are seen as expenses that in some cases tip the commercial decision one way or the other: there are fewer certainties, and therefore greater risks in any dealings with old buildings than there are in developing a new housing subdivision. Here, factors that affect construction and demolition, and by extension sustainability are examined through two case studies of buildings recovered through relocation.

Case Study A: No 62 Walters Road, Kingsland, moved to Waitoki in 2011

The Waitoki house is a typical example of a late Victorian single bay villa that had occupied the site of 62 Walters Road, in Kingsland for about 100 years. The house was in the path of plans to enlarge the public concourse in front of the adjacent Eden Park stadium for the Rugby World Cup in 2011, and was removed along with six neighbouring houses. The building was sold at auction, cut into two pieces, loaded and transported 45 kilometres by road to Waitoki, where it now occupies a large semi-rural site. Its modest architectural qualities are intact and it functions in Waitoki as a house for a young family. The owners, a plumber and his partner, were also the developers, and have invested the re-sited villa with energy and time, but minimal capital expenditure.

Figure 1. The Kingsland-Waitoki villa re-sited
Source: Authors own

The technology involved in the relocation process is not sophisticated. The principal tools used are chain saws, wrecking bars, sledgehammers, and manually operated jacks. Up-lifting and relocating a house is only possible at all in the context of New Zealand's light-weight timber-framed building tradition, in which most houses are attached to the ground by wire dogs and galvanized perforated straps onto short timber piles. In the course of all relocations, new foundations are designed to current standards and constructed on site prior to the move. Structural framing can tolerate a small degree of distortion in the course of the move, usually without causing irreparable damage to the more fragile components of the building (fibrous plasterwork, glass, etc.) or to the integrity of the building's primary structure (C. Walker, personal communication, August 22, 2008).

Concurrent repairs on the Waitoki villa included replacement of iron roofing, guttering and

roof flashings, and small sections of external cladding, as well as repainting of the exterior, a level of renovation that usually applies to pre-1940 houses. Re-fitting of service elements (bathrooms, kitchens, laundries, and re-wiring in older houses) has been carried out, and as is often necessary with pre-1920s houses, most internal wall linings have been replaced. The on-site operations included new electrical circuits, telephone and television connections and insulation to current standards.

Energy costs of removal and relocation vary widely in this industry. For the Waitoki case study these can be estimated fairly accurately. Distance of travel is a relatively small factor, and is estimated for this energy audit as an averaged consumption of fuel based on two 400Kw diesel engines running for 22 hours at 90% capacity, representing the energy used in a 50km transit and including the engine in operation while stationary for rams and hydraulic positioning manoeuvres. Other energy is consumed during site works by diggers, piling rigs, small electrical equipment, and by temporary lighting since much of the relocation activity is conducted at night.

Standards of repair work generally have to meet the durability requirements of the New Zealand Building Code, thus upgrading the building to current standards, but these are subject to unpredictable interpretations by local councils. At Waitoki the re-fitting programme was measured to include the complete renovation of one bathroom, one large kitchen and utility, 66% re-wiring, 100% relining of internal walls, and 20% of windows and external doors replaced with new single glazed timber frames and sashes. Most of the original ornate ceilings are repaired, and insulation has been installed to the roof space, external walls, and below the floor. The brick chimney has not been rebuilt.

The majority of relocations are not early twentieth century villas such as that relocated to Waitoki; most are single-storey suburban houses in serviceable condition produced in the post-1945 building boom by companies such as Keith Hay Homes. Houses originally built for the Housing Corporation or for other government departments are now frequent, and often preferred candidates for relocation. The second Case Study illustrates this preference.

Case Study B: 379 West Coast Road, Glen Eden

The development by Land Development and Civil (LDC) is an example of an enterprising start-up company taking advantage of a strong housing market in Auckland, but motivated by a conviction that the quality of houses built between 1945 and 1960 was superior to present-day standards and that their recovery is worth the effort involved in comprehensive reinvestment. The company has previously carried out a similar development, also on West Coast Road, for 11 relocated units.

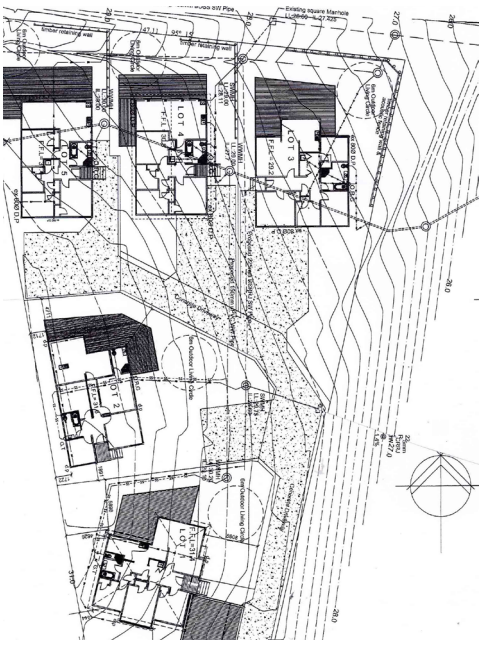

Figure 2. 379 West Coast Road: aerial image prior to development (far left, Source: Authors own) and the project site plan (left, Source: Daniel Thomas at Land Development & Civil)

LDC's policy is to avoid classic villas, but sources older houses in low-density suburbs where redevelopment programmes, including in this case the Hobsonville Point project, are demanding large cleared sites. The West Coast Road project consists of a 2,314m^2 site which was zoned for industry and bought with one existing but dilapidated house. LDC's application for resource consent for residential use was not resisted by Council, or by the neighbouring residents. Figure 2. illustrates the site before development, and the site plan, which is now approximately 70% completed. The site has been rearranged to provide 5 units including the existing house in a new position. Three of the units, ex-NZRAF staff houses, were relocated from Hobsonville, and the fourth came from Point Chevalier. All five houses are well-designed, in generally good original condition, and represent a period of house building in New Zealand when high quality materials and workmanship were taken for granted.

LDC's philosophy is based on maximising recovery of the fabric, which in all these houses includes the repair of windows and doors, rimu weatherboard cladding and internal secondary elements – the doors, cupboards, second-fix skirtings and architraves. The houses comply with current Code standards for drainage and foundations up to the new bearers; for the superstructure, further upgrading to meet Code standards becomes expensive if the developer makes any significant changes to internal layouts because additional bracing is a likely requirement. For this reason gib board internal wall linings are retained, with external walls insulated with a wool-mix insulant blown into wall cavities. All floors are either tongue and groove rimu or matai, and are to be sanded down for varnishing.

Figure 3: Case Study B: a work in progress: one of the re-sited houses
Source: Authors own

The houses will be sold under separate titles, with the access road owned jointly in a separate lot. In their finished condition LDC can claim that these houses are more substantial than other market products, with a prospect of life-cycle durability exceeding that of new houses. They can also claim these to be houses in which both the structural and finishing materials used are superior to those available to the current building industry. The company, with the statement "Engineered solutions for people & environments" in its title, supplies renovated housing that emerges from a building process designed and managed to generate less waste, and that contributes significantly to reduced resource depletion, including, particularly, energy resources.

COSTS AND BENEFITS: THE CASE STUDIES

Relocations involve small building companies, self-employed tradesmen, and often, as in Waitoki, the owners themselves, all of whom have a greater propensity to recycle materials, and are considered more likely to embrace a culture of waste minimisation. This serves, simultaneously, to reduce costs and waste and to meet unquantifiable social objectives of sustainable building.

The current estimate of on-site and embodied energy in new houses is between 3,500 and 4,000 kWhrs per square metre (Vale, 2008). For an average relocatable house of 100m^2 with five main spaces, 250-300m^2 of new 10mm plasterboard is required, and approximately 220m^2 of insulation will be used in external walls and roof spaces. A further 100m2 of under-floor insulation is recommended but is not usually required for a building consent. Including on-site energy consumption, transportation, embodied energy in replacement materials and re-wiring, a fully insulated relocatable of this size with new services and internal finishes can be supplied for an estimated total of re-invested energy of 55-65,000 kWhrs, or approximately 600 kWhrs per square metre. Calculations are based on tables of energy coefficients produced by the Victoria University of Wellington's Centre for Building Performance Research.

Details of ground and site works on the West Coast Road site (excavation, levelling works, drainage, timber and concrete retaining walls, fencing – some of it 2.0m 'acoustic' close-boarded – and access road construction) are more difficult to estimate at this stage of completion, suggesting that an updated assessment of the project will be necessary at a later date. The Kingsland-Waitoki house is also unfinished, but site works including fencing and access paving will add, eventually, to the total material investment.

These estimates of the energy required for a renovated relocatable house show substantial savings over that typically invested in new houses of a similar size, where the first order total of energy invested and embodied would be approximately 400,000 kWhrs. If, however, new house sizes are represented by those being built at Hobsonville or Flat Bush at approximately 240m^2, the total energy investment per unit is nearly one million kWhrs, or about 15 times the new energy used to re-supply one of LDC's houses in Glen Eden.

CONCLUSIONS

A report in the Sydney Morning Herald's Weekend magazine investigated the phenomenon of demolition and waste in Sydney's northern suburbs (Hawley, 2003). When bathrooms, kitchens and electrical installations became out-dated, the entire house, often less than thirty years old is demolished with little or no attempt to salvage materials. The market rationale is simple: the building is not worth re-investing in – tastes and styles change, and property values are maintained only if wholesale re-development is undertaken. Apart from metal roofing the building materials are not of high enough quality to be recycled. Private freehold property ownership is by far the largest capital asset for most householders, and maintaining the value of the asset is a high priority. Housing supply in Auckland does not need to follow this pattern; however, although we follow Australia in many building practices, we should be clear about the fundamentally unsustainable nature of this new suburban paradigm. I have argued here that much of our older existing stock is recyclable, and our housing traditions are open to the idea of renovating and relocating on a large scale.

To summarise this analysis, it is suggested, firstly, that technical objectives of sustainability are satisfied by the low-tech process of shifting and relocating whole houses, with an estimated investment of new energy a small fraction of that required in standard new house-building, and significant reductions of new materials necessary for the process. For the 'big picture', and in the context of Auckland's severe housing shortage, these houses present a supply-side alternative that prevents the net loss of existing housing in the course of urban consolidation, where sites are being developed over earlier low density footprints. Relocated houses can also mitigate some of the problems of affordability, particularly if supply and ownership systems are modified by, for instance,

not-for-profit housing providers such as the Housing Associations used in the UK.

Without developing this area of the argument in detail, there are many legislative settings that could be adjusted to encourage more relocations and fewer demolitions. Some of the practical options are:

- Requiring demolition consents to be justified on more demanding terms
- Relaxing some consent procedures for relocated houses
- Applying preferential rates of goods and services taxes (gst) for industries that contribute most effectively to sustainable development
- Removing covenants that block or obstruct relocatables in some new developments
- Underwriting the practice through the planned recycling of government housing stock at low prices

In addition, by raising construction standards to enable whole building renovation in the future, we would 'future-proof' the houses we are building now. A more detailed audit of energy, material and labour resources used in LDC's Glen Eden project is programmed for next year when accounts for the development are complete.

GLOSSARY OF TERMS

Tangata whenua: Refers to the original Māori settlers of New Zealand, meaning people (*tangata*, a group of people) and land (*whenua*, incorporating the concept of land as the mother to the people). 'Land' in this culture is treated as a communally-owned resource for food gathering and includes forests, rivers and sea beds. See: Williams' definitive *Dictionary of the Māori Language*.

Rimu, Matai: Māori names for common New Zealand coniferous tree species ***Dacrydium cupressinum***, known as **rimu**, and ***Prumnopitys taxifolia*** (**Matai** or **Black pine**) which were widely used in the first half of the twentieth century for housing construction: rimu for weatherboard claddings, floors, facings, doors and secondary fittings, and matai, particularly for flooring.

Keith Hay: Keith Hay Homes were popular in the period 1950-1975 in Auckland, for being affordable, well built, and offering rapid supply to site, usually as a prefabricated standardised unit. Hay himself was the first volume house builder to see the economies possible with ***pinus radiata*** (an imported softwood conifer, fast-growing and produced from local plantations) in preference to rimu, and other native coniferous species. Because it is a true softwood, pinus radiata can be nailed more quickly. In 1949 the principle of off-site construction, and a 'relocatable' process, pioneered by Hay, contributed to meeting the high demand for new housing in Auckland in the post-1945 period. He was also a prominent local politician and a leader of the Auckland Christian community. See: Margaret McClure, the Dictionary of New Zealand Biography Volume 5, 2000.

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