AORANGI HOUSE – WELLINGTON'S RECYCLED BUILDING

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INDUSTRY PAPER (Case Study)

ABSTRACT
This paper examines the refurbishment of Aorangi House, a 12 storey office building in central Wellington. The author was the Project Architect on this refurbishment.

The case study demonstrates how an out-dated commercial office building can be refurbished to meet modern standards for high quality office space. Constructed in 1970, the office space was vacant due to facade issues such as leaking, excessive cooling, chronic solar gain; and internal space issues such as lack of air handling systems and other facilities. The owner engaged consultants specialized in green buildings to plan the refurbishment of the building for a new lease of life as good quality office space.

Different possible methods for the upgrading of the building were explored, with the selected proposal being to revitalize the external façade: retaining the structural façade, insulating the external envelope, replacing the glazing with new double glazing and installation of external sun shading. Internally, the fitout was stripped out back to the core and a new air handling system was retro-fitted into the office spaces, to complement the natural ventilation.

KEYWORDS
Existing building; Retrofit; Natural Ventilation; Improving performance; Innovation case study.

INTRODUCTION
Aorangi House is a 12 storey office building on the periphery of Wellington's CBD that has recently been refurbished. Originally constructed in 1970 to designs prepared by Structon, a Wellington practice of architects and engineers, until 2005 it was inhabited by the Department of Statistics. It then remained largely unoccupied, was unsuccessful at being re-let and was purchased by Prime Property Group with the intention of restoration and possible conversion into apartments. Total demolition and reconstruction were not considered due to excess cost, and yet the building required considerable work and expense to bring it up to a suitable letting standard. Helen Clark's 3rd Labour government had introduced gov^3 rules, requiring that any new building a Government department moved into had to be 5 GreenStar rated, and therefore reuse by a Government department seemed extremely unlikely.

In 2007, the decision was made to totally refurbish the building as office space, due to discussions between the owner (Prime Property Group) and a potential tenant (Beca). While Conservation House (Architecture +, 2006) was a complete reworking of a redundant Chase Corporation cinema space into a new life as quality office space, Aorangi House is the first major office building in Wellington to have been refurbished as offices to such a major extent, with the emphasis placed foremost on Environmentally Sustainable Design (ESD) principles. As such, the building 'recycling' leads the way for other similar commercial buildings to be refurbished using similar design principles.

Background

Storey's 2007 paper at this conference noted that there were very few new office buildings being constructed in Wellington over the last 15 years, despite a 60% leasing rate by Government for large buildings (Storey, 2007). Following the Clark government's dictum of a necessary 5 GreenStar rating, Storey notes that the choice for owners of existing redundant buildings came down to two options: Retain or Replace. However, demolition rates of 'modern' buildings in the Wellington CBD have been very low, with most redundant office space being steadily converted to apartment space as the inner city population steadily urbanizes. Buildings have not so much been replaced, but removed from the commercial grade office stock altogether. With a move to apartment buildings now being purpose designed, not converted from older office space, there will be a coming tide of commercial office space to be refurbished.

As Storey noted, while the "Case for Going Green" seemed very persuasive there were very few existing office buildings undergoing such 'green' refurbishment. 2007 saw the completion of Wellington's first 5 GreenStar purpose built office building for Meridian (by Studio Pacific and Peddle Thorp Architects), alongside the slightly earlier completion and arguably greener construction of the Department of Conservation's headquarters (by Architecture Plus – and pre-NZGBC). The DoC Building was far more than just a refurbishment: like Architecture Plus's current project Willis Central (for Telecom) it involves a total strip down to just the structural frame (re-used), along with major new construction work to create an entirely different building. Since the SB07 conference and Storey's call to action, there has been a significant move to GreenStar in terms of new buildings (in Wellington: including BNZ, Customhouse, Willis Central) and yet not much action on refurbishing older buildings - until now. Aorangi House's refurbishment is significant for the extent of simplicity in the refurbishment, and does not involve extensive additional construction. It is achievable, and with careful design, this process can add significant value to an aging property.

DESIGN

The owner, Prime Property Group, engaged consultants specialized in the design of ESD buildings to give the existing worn out building a new lease of life. Studio Pacific Architecture and Beca were commissioned as architects and engineers for the Aorangi House Base Build Refurbishment ('Base Build'), with the agreed brief being to completely refurbish the building suitable for high quality rentable office space and to aim for a 5 Greenstar performance level. A lengthy, tenant-initiated, design outline specification had been drawn up by project managers V+R Consultants, and although GreenStar was not a prerequisite, a high performance level of ventilation and vastly improved temperature control were requested. Initial sketch plans by architect and engineer were included as part of that lease agreement, and this can be seen as one of the key points in the success of Aorangi's refurbishment: that both leasor and leasee knew what was in agreement, leaving few items up to chance or change.

Subsequent to that Base Build work, interior teams from Studio Pacific and Beca were commissioned to work on the actual Beca fitout, and while this Fitout work has not specifically targeted GreenStar compliance, the same contractor was being used and so many synergies of construction took place. This Fitout agreement was much more flexible, and so changes to the Beca Fitout could (and did) take place as the job progressed. While Studio Pacific were in a dual role, Beca were in a triple role - as consultants to two contracts, and as tenant as well. The pressure was on to perform.

The recycling of the building from un-lettable to well-liked 'Home of Beca' has been echoed in the winning of an award of a NZIA Wellington Award for Architecture (for Sustainable Architecture) where the judges noted that: "Intelligent sustainable interventions have here been applied to an existing multi-storey building, resulting in a synergy between efficiency and innovation. A fine example of responsible design upgrade." (NZIA, 2009)

Environmental Performance

38 years on from its construction, the building's condition was sound, but degraded. A structural façade composed of solid concrete walls and individual window openings was hidden behind simple strips of curtain wall glazing running vertically. In theory this was a weather-tight solution, but after 38 years the early curtain wall system had issues due to leaking both air and water, as well as excessive heat gain and a complete lack of thermal insulation. In short, like the porridge of the 3 bears, the building was either too hot, or too cold, and the task of the team was to get it just right.

Reasons for this are simple, and obvious. There were existing perimeter heating pipes with finned radiator elements, but cellular offices rendered the effects negligible. There was no air ventilation system in the 12 storey high building and opening windows were the only means of gaining fresh air, despite being in the direct line of Wellington's famous Norwesters. Structurally, it would have been difficult to pump air in through a 'standard' VAV system, and environmentally, massive air movement was not a desirable option. The poured concrete wall had been well plastered with a layer of quality render both externally and internally, but a lack of thermal insulation to either side ensured that night time cooling of the façade was still affecting the inhabitants well into the next day. The opening windows had started to leak and also overheated hugely when the sun was directly on their external face. There were no seismic frames for the glazing to flex into. External mirrored films and externally mounted air-conditioning units were also affixed in some areas, adding to the overall appearance of the building – but not in a good way.

Architectural Concept for External Facade

A number of different methods for the upgrading of the building were explored, with the main options narrowing down to three: insertion of individual window units into the façade; recladding the entire exterior with a new glazing system; or the simpler selected proposal of installing new vertical strips of double glazed façade. The first option would have enabled a far greater proportion of the façade to be insulated, but came at the expense and potential leakage points of multiple flashings (at least 4 flashings for each of the 270 windows). The second option would have seen one continuous system installed over the entire façade, but at greater cladding expense and with more complicated junctions between old and new.

The third, medium option was selected therefore to maximize the available external wall surface for insulating and to minimize the weather sealing points to the glazing: one continuous flashing down each side of strip windows to the 11 floors of office space. After much deliberation, a German engineered Sto system was specified that incorporates 100mm thick insulation fixed securely to the façade with fully bonded rear face adhesive and numerous thermally insulated screw fixings, covered externally with a 3 coat Sto render system. This is the first time in New Zealand that an external insulation of this scale has been employed using the Sto system, although it is common in Europe. It is an innovative yet extremely simple solution to the common problem of lack of insulation amongst similar office buildings. As an externally insulated façade system (EIFS), the solid concrete structure behind the insulation provides a very stable substrate, without any of the issues of flexible timber structures seen in domestic housing. The existing concrete plaster is also very water resistant as is, and has only been further improved by the application of the over-cladding. This system enables the thermal mass of the existing structural facades to be exposed internally, while insulating from the effects of solar heating and night time cooling on the external skin.

External Sun Shades

A key part of this external refurbishment was the incorporation of shading louvers to the external façade. Studio Pacific's experience with the Meridian building (Barbour and Marriage, 2007) has shown the importance of thorough northerly solar shading, and a number of different options were explored to maximize the reduction in solar gain without ensuing visual obstructions internally. In the end a simple double horizontal louver blade was installed to the north façade, while the east and west facades were much more interesting. In order to capture a maximum of morning and midday sun shading to east and west, an inverted L shape was devised on Beca's solar shading team advice, to gain the maximum effect. Internally, these sun shades are barely noticeable, and yet the effect they have on the internal solar gain is considerable. They have however had a very significant visual effect on the building, turning what was a very flat façade into one that is visually a lot more dynamic.

Windows and Glazing

While the original building had closed panes top and bottom, and a pair of opening panes in the centre, the decision was made with the new glazing system (by Wight Aluminium) to fix the large single central double glazed panel, and have opening panes above and below. This allows for a limited through flow on each window, as well as across the widths of the floor plates. Beca dictated optimal ranges of glazing to look for, with the double glazed panes being selected composed of 6mm Panasap green exterior and clear glass inner pane. External spandrel glazing is simply back-painted single glazing in red or black, over a 25mm polystyrene insulating layer.

Although one of the initial requests in the lease had been for the installation of trickle ventilation through every window, tests in a prototype window system showed that noise (rattling) and leaks (air, not water) were going to be major issues. Instead, a simpler system of double tongue latches to opening panes combined with automated opening panes (3 window pairs per floor) has been installed, with the automated panes connected to a weather station installed on the roof. Panes are automatically opened when internal temperatures or CO2 levels reach certain uncomfortable levels, and are automatically closed when weather conditions (ie rain, excessive wind) dictates. This is a development of work undertaken on Meridian by Studio Pacific and Beca, where entire areas of façade are automated, only here just selected panes are automated, a play-off between cost and functionality. "It is an intelligent building, but it also needs intelligent staff," according to Beca senior manager Stefan Waldhauser (Schouten, 2009). In a building full of engineers, this should not be a hard task.

	Description	Solar Control Glazing	External shading	External Insulation
Base Model	Clear double glazing, exposed concrete soffit, no external shading, no wall insulation, mixed mode – natural ventilation through windows / VRF cooling system, perimeter convector heating	No	No	No
Option 1	As base model but with solar control glazing to all facades	Yes		
Option 2	As base model but with high level of external shading		High	
Option 3	As base model but with medium level external shading		Medium	
Option 4	As base model but with medium level external shading and solar control glazing	Yes	Medium	
Option 5	As base model with 80mm wall insulation to exterior			Yes, 80mm
Option 6	As option 1 model, with insulation	Yes		80mm
Option 7	As option 2 model, with insulation		High	80mm
Option 8	As option 3 model, with insulation		Medium	80mm
Option 9	As option 4 model, with insulation	Yes	Medium	80mm
Option 10	As option 5 model, with insulation	Refined	Refined	100mm

Table 1: Options, adapted from Beca Modelling Methodology, (Masters and Waldhauser, 2008).

Computer Modeling
Beca spent considerable time working on computer modeling the effects of the external facade on the internal environment. Primary concerns of the Beca team were to find the best balance for the façade performance in terms of shading, daylight, overheating, energy consumption and thermal comfort. (Masters and Waldhauser, 2008). A total of 10 different scenarios were run to test against these factors, which included variations on thickness of external insulation, amount of external shading, ventilation through windows, and position of internal blinds. A base model of the building as it existed was also modeled for comparison.

Option 10 was the Architect's preferred arrangement of external shading – refer Table 1. A shading model of level 11 was created using IES version 5.8.1 modeling software with overshadowing from the existing surrounding buildings also included in the model.

Figure 1 – External façade shading detail, East façade. Photograph: Guy Marriage

Results showed that Daylight availability (necessary for GreenStar points under IEQ-5) was not sufficient under any scenario for 3 points (90% of NLA above 2.5% daylight factor), but under most of the options tested the Daylight availability exceeded the 30% threshold necessary for a single GreenStar point. This is limited due to the existing structural façade frame to the window area, which could not be enlarged for obvious structural reasons. Options 1, 5, 6, and 10 performed well (options 5 - 10 include a minimum of 80mm external insulation).

The overheating risk using the same thermal model was also tested, to assess the potential for natural ventilation to decrease the reliance on the mechanical system for space cooling. Here Option 5 performed poorly, and many of the options fell outside the target zones. Energy consumption was also tested, along with CO2 emissions, and options 5 -10 again performed well. The summary noted that Option 10 would "provide the best balance between each ESD criteria" which recommended that the following items were incorporated into the façade design:
- Wall insulation to all external walls
- Solar control double glazing with high visible light transmission but low solar factor
- Horizontal external sunshading elements to the north
- Horizontal and vertical sunshading elements to the east and west facades. (Masters and Waldhauser, 2008).

INTERNAL BASE BUILD WORKS

Internally, the pre-existing Department of Statistics fitout was stripped out completely, returning the building to a bare concrete shell outside the fully retained core. A key element of the project, to get fresh air into the office floors, mean that intake and exhaust ducts had to be run through the office space and exit the building. Running ducts was not possible vertically due to a need to maximize floor space, and so the decision was made to run the air ducts out through the rear, south façade. Suspended ceilings were not reinstated so as to let the thermal mass of the concrete slabs act unimpeded as heat sinks; having the welcome side effect that resultant ceiling heights were much higher to the underside of the bare slab.

Initial seating studies were undertaken early on, crucial in a office refurbishment, to ensure that the floors could work well with open plan seating. Design decisions were made to keep desks away from external windows, to allow democratic decisions to be made on floor about who has windows open or window blinds up or down. This also reduces issues such as sunshine glaring on desks, draughts from open windows, and permits air circulation to reach the central core area. Base building decisions to install centrally-located hub services such as kitchenette, meeting rooms and informal greeting spaces at the centre of the building were retained and enhanced by fitout design decisions, enabling a 9m perimeter clear zone for open plan seating.

Central core areas have been refitted with standard suspended acoustic ceilings, but otherwise the majority of the ceilings have been omitted: left largely open and available as a heat sink for thermal modulating. The exposed concrete ceilings have been repainted, fitted with 40% coverage of acoustic panels, and used to enhance daylight coverage throughout the perimeter zone. A significant advantage is the extra height gained, with a rise from the previous 2450 to a significant 2800 typical height now: lighting continues to be suspended at 2500. Careful placement and consideration of ducting runs has reduced visual clutter to a minimum.

Air handling

Similar exploration of possible solutions were undertaken on possible air handling units. There was no room within the ceiling cavity for variable air volume (VAV) units, nor any desire to cut large voids through the structure to carry large volumes of air. Chilled beam ceilings were considered but the installed system is a minimal and inexpensive combination of variable refrigerant volume (VRV) units. However: these are not anticipated to operate very often. Standard ventilation via opening windows and a continuous exhausting of stale air via the central hub (fresh air is supplied to the hub automatically when central meeting rooms are occupied) means that the building is planned to operate at very low levels of mechanical air handling. The ceiling mounted VRVs are anticipated to operate only in extreme days of approx 20-25 days per year. As the building has only been occupied since July, monitoring is still ongoing. Waldhauser notes that in 8 months of operation, the air handling system has not yet had to be turned on …..

Level 6 Reception

Office floors to the building are largely identical on upper floors, with the primary exceptions being level 1 (bicycle and car parking), level 7 (Beca staff floor) and level 6 (reception). As the reception floor is the location for highly specified meeting rooms, the training room and board room, this floor alone is supplied with a more traditional air conditioning system. Tempered air is supplied to meeting rooms, and as meeting rooms are arrayed around the periphery, each meeting room has one or more automated opening panes that are triggered by CO2 or temperature buildup when occupied. These systems are operating purely on demand, and in practice are often turned off.

WC facilities

Although features such as waterless urinals have not been installed, nor rooftop rainwater retained for grey water uses, all sanitary fixtures were replaced with new, low flow cisterns, pans, taps etc in a major refurbishment of plumbing facilities within the building. Waste pipe work had rusted, and has been replaced with new HDPE drainage systems, along with new Fusiotherm fresh water supply plumbing. Previously the building had used a centrally located rooftop boiler to supply the hot water to taps in each of the 12 bathrooms down the core, but the time lag and associated loss of hot water was unacceptable. The system has been rebuilt as a series of individual circuits, with a small electric on-demand system on each floor supplying hot water to both the kitchenette and the local WC. The boiler is retained to supply only the perimeter heating pipes on each floor.

Bicycle parks and Changing rooms

An important part of the GreenStar programme, and a relatively easy way of gaining GreenStar points, is the provision of excellent showering, cycling, and bicycle storage facilities. The adaptation of 2 car parking spots into a facility for cyclists has proved to be one of the most popular parts of the building refurbishment. Traditionally in corporate buildings, cyclists are often appallingly catered for, and the NZGBC is to be applauded for the attention to this area. Parking has been provided for 35 bicycles under cover, and 4 spacious shower / changing rooms have been provided. These bike parks have been largely full since day 1, indicating that the 10% threshold of cycling staff has already been reached. Fortunately, there are further carparks that can be converted into additional bicycle parks with little effort, if the cycling fraternity increases. Showers, lockers, and bike parks are recognized as an important issue in Green Star, and rightly so. More lockers have been installed by Beca as tenant, in excess of Green Star requirements, to cater for the large increase in staff biking or running into work.

Materials

The Base Build specification was a key component of the GreenStar initiative. John Fletcher of Keyway Construction notes that “seventy per cent of construction waste had to be recycled or reused. This included aluminium from the old cladding and windows, partitions, pinex ceiling panels and copper cabling” (Schouten, 2009), as well as having to use environmental choice certified carpets and paints. Fletcher further notes that “This all required extra management. It’s like all the requirements for safety when they came in about 10 years ago. I expect that once you’re used to it, it will become easier and easier” (Schouten, 2009).

CONCLUSION

As a building refurbishment of a central CBD building, what has been achieved at Aorangi House has been significant. The largest project to date of owner Prime Property Group, the refurbishment has shown that full scale refurbishment of a inner city office tower is easily achievable and the results are desirable. At a cursory level, electricity usage has been greatly reduced from that at the previous office, while gas for boiler running costs has also been reduced. A full analysis is not yet available, until a full calendar year has elapsed.

External insulation to the outside façade (including roof and floor slab) is a big step to take, and a costly one, but when undertaken with glazing replacement (from single glazed to double) and glazing system replacement (from outdated/leaky to sophisticated), then the thermal results are exceptional. Obviously, a quality external insulation and plastering system must be used, and extreme care and attention paid to new glazing systems installed, but the installation of external sun shade louvres is never going to be a simple bolt-on after-party solution. The façade system selected needs to be carefully designed and installed to get the best of every separate case.

Greatly increased comfort levels are anecdotally apparent in the new building, although POE surveys were not undertaken with the previous tenants and have not yet been undertaken with the new tenants. Despite strong wind conditions, opening windows are still sufficient for air intake. Automated window controls are not proving as intelligent as the users are: manual control is preferred. The exposed slab, external sun-shading and external insulation is having the desired effect of controlling internal temperatures. The new VRV system installed may end up being superfluous to requirements on all but the harshest weather: subsequent refurbishment projects such as this may aim for complete deletion of air handling from the scoping brief.

While the key driver for work on this site was a combination of NZGBC requirements coupled with client / tenant agreement on a Green building, the combined team approach to the building refurbishment has ensured a seamless connection between old and new, and a building likely to be cheap and simple to run for the next 40 years.

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