ASB North Wharf – Integrated Design

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Robert is a building services engineer, passionate about integrating services into the building form with a strong understanding of multidisciplinary solutions in engineering design. This understanding is exemplified by Roberts’ track record of holistic design and his focus on effective communication of concepts and ideas to clients.

Since joining Arup in 2005, Robert has led multidisciplinary design team on some of the highest profile commercial and mixed use development including 200 George St, 8 Chifley Square, One Central Park and 39 Hunter St

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Brian Clohessy is a highly skilled and experienced architect who led the delivery of the new ASB Bank building in Auckland that includes an integrated ‘activity based working’ interior. Since joining BVN in 2005, Brian has been involved in complex and significant projects including the Challenger workplace in the Sydney Hilton Hotel and the new library and learning hub for Ravenswood Girls School on Sydney’s north shore.

Prior to coming to Australia in 2003, Brian worked on the concept design and documentation of projects such as the Mater Children’s Hospital in Dublin and was a team architect on a large mixed development of apartments and retail/commercial space in Limerick, Ireland.

Abstract

ASB North Wharf in Auckland, New Zealand provides a compelling insight into the future of HVAC. From project inception through to commissioning, the driver for the design has been to set new standards in terms of indoor environmental quality and energy performance. Conceived through collaboration between Arup, architects BVN Donovan Hill in association with Jasmax and clients ASB and KIPT the mechanical services design employs the first fixed bin displacement mixed mode ventilation system in Australia or New Zealand. Harnessing the local mild climate and cool breezes the mixed mode design empowers tenants with the ability to open windows when conditions are favourable through an elegantly designed red light / green light notification system. The shape and form of the buildings atria and funnel has been achieved through close collaboration between architects and engineer to ensure effective mixed mode operation. Furthermore the facades complex and apparently random shading system has been modelled to act in harmony with the mechanical system while ensuring excellent levels of visual and thermal comfort. The design has also leveraged exposed thermal mass with exceptional attention to detail with respect to exposed building services.

The result is a building which engages with its tenants and sets new benchmarks for the future of HVAC.
The Client Brief

The Client had a clear vision for the new headquarters for ASB Bank which was expressed to the team early in the design process. This process began in 2008 when Arup and BVN Donovan Hill were invited to explore different sites in Auckland with a view to establishing the next home for ASB and its staff. The vision statement included the following key aspirations:

- A building that would support ASB business vision to be ‘World Class’ for customers, colleagues and communities.
- An iconic building that is ‘World Class’ in every respect and is recognised as such by its occupants, the community and industry peers.
- A building that would meet its occupants’ workplace expectations, that energises people, provides transparency and encourages a team approach.
- A building that is visually transparent in every facet of its design composition, from the way customers, public and the community interact with it.
- A building that is recognised for putting its occupants at the centre of the sustainability equation, which underpins all design directives to create a modern, open, airy, free-flowing, exciting, relaxing workplace that promotes a sense of wellness that can be called ‘Our Home - World Class’.

The aspiration was well summarised by ASB CEO Barbara Chapman as an expression of wanting “this new workplace to promote wellbeing, individuality and fun, while also encouraging collaboration and sharing across teams”.

With this in mind and after an extensive selection process, reviewing opportunities at a variety of locations, the preferred site was determined to be within Wynyard Quarter (refer imagery below).

The Wynyard Quarter is Auckland’s new urban centre and has become the pedestrian and cultural connection with its working waterfront. The quarter has already been recognised with a number of international and local design and architecture awards, and future plans envisage it as a showcase of progressive and sustainable living.

The precinct sits alongside the harbour with a blend of restaurants and bars, fresh fish markets, commercial space, first-rate hotels and fashionable apartment living. The Quarter also includes park and recreational spaces which stretch out towards the old tank farm, the waterfront and Victoria Park and play host to a wide range of events and exhibitions.

Figure 1: Wynyard Quarter site context
Through the initial investigations the brief was further developed to include a series of cultural, architectural and services related aspirations. Of these the salient points which informed the mechanical services design included the desire to create a building that:

- Achieves world leading levels of sustainable and workplace design,
- Achieves a step change in energy efficiency
- Responds to the local climate
- Provides a superior office environment for its occupants.
- Achieves an enjoyable, comfortable and controllable workspace for providing a good occupant experience.
- Incorporates passive design principles

All members of the design team were charged with achieving these aspirations and the interface between mechanical services and architecture was seen as a key factor in realising this ambition. The brief considered all aspects of the workspace and the full spectrum of indoor environmental quality (IEQ) issues such as daylight, views, glare, aural comfort, thermal stability and air quality.

![Figure 2: Indoor Environmental Quality (IEQ) concept diagram](image-url)
The Project

The urban master plan for the Wynyard Quarter calls for two lanes connecting the waterfront in a north south direction through the ASB North Wharf site. The North Wharf building respects these lanes and expands on their urban intention to produce a highly accessible public realm that transforms a hitherto opaque commercial precinct into a porous and connected 24-hour accessible public space.

The spatial and workplace organisation of the development resulted in the site being divided into two, namely Building 22 to the West and Building 23 to the East. The workplace planning methodology is based upon the principles of Activities Based Working (ABW) which involves freedom of choice for work settings, a series of neighbourhoods or home bases and major shared spaces for a variety of work types – called at ASB North Wharf-boathouses. The strategic organisation is characterised by predominantly open plan workspace with breakout spaces to encourage collaboration.

ASB North Wharf has been designed for people – a process of determining what drives and motivates people, what makes their working life richer, what makes them feel dignified and respected and what drives a productive and efficient workplace; and this leads to an outcome which is about the creation of an internal community focussed on the business of the day in a human scaled and tactile environment.

ASB is a quintessential Auckland and New Zealand company and it is essential that the architecture of the building speak of this building in its “place” – it’s physical place and it’s cultural place.
The interior of North Wharf has been designed for function and with reference to the working waterfront of the Wynyard Quarter. Externally it reaches beyond its immediate context to find an appropriate endemic expression. New Zealand is a visceral natural country – its international symbolism is based on extraordinary landscape, of fresh air and of exotic nature.
Realising the Brief

In order to realise the brief the team set about defining the key parameters which would inform the building design. While many factors were considered the design team were instrumental in guiding the following attributes:

1. **Passive design and mixed mode**: based on an understanding of local climate
2. **Displacement ventilation**: based on a desire to help the client achieve a step change in their sustainability performance
3. **The Funnel**: to maximise mixed mode performance
4. **The Façade**: to provide excellent levels of thermal control while still maximising views and daylight
5. **Exposed services**: to thermally attenuate the building by harnessing thermal mass

Each item above influenced the shape, form and appearance of the building from outside and within. As a result the collaboration between mechanical engineer and architect was essential for the successful delivery of the project. The two roles were intrinsically linked with the architect needing to closely understand the constraints of the engineer and the engineer needing to understand the architectural drivers and provide strong visual communication of engineering principles.
Passive Design and mixed mode

During the concept design the team embraced first principles—the physics of how air, light and water work in the built environment—to incorporate and maximise the passive features of the site and building to deliver significant energy reductions and environmental benefits.

Climate

According to the Köppen climate classification, Auckland has a temperate, oceanic climate (type: Cfb). Such climates are dominated all year round by the polar front, leading to changeable, often overcast weather. Summers are cool due to cloud cover, but winters are milder than other climates in similar latitudes.

Auckland’s mild climate experiences average daily temperatures between 15°C in winter and 24°C in summer. Wind speeds remain fairly consistent with an average annual wind speed of 5.7 m/s. Southwesterly winds dominate in all seasons. Overcast skies, with rainfall, occur on approximately 180 days of the year. The relative humidity is generally high throughout the year, however the absolute moisture content is relatively low due to the mild temperatures.

Figure 4: Auckland humidity and temperature profiles
The attributes of the Auckland climate implies that it is well suited to a natural ventilation approach, where openable windows can be utilised for a significant portion of the year which aims to:

- Increase the productivity of building occupants due to real or perceived improvements in the indoor environmental quality and indoor air quality.
- Reduce building energy use and thereby also reduce the environmental impact caused by power generation.
- Reduce operating costs by decreasing the power used to mechanically ventilate and cool.

Figure 5: Installed openable windows at Project North Wharf

Arup conducted detailed analysis which demonstrated the feasibility of adopting a natural ventilation approach which illustrated:

- A 2% NLA opening on the windows and the chimney louvers in the final scheme will generally provide ASHRAE 55-2004 required thermal comfort (90% satisfaction band) for 95% of office hours.
- The natural ventilation will approximately be able to run effectively for 60% of the year.
- A 10-15% drop in the building HVAC energy usage is expected if natural ventilation of the perimeter zone if effectively implemented.
Figure 6: Results of analysis comparing opening area to % satisfying ASHRAE 55

Figure 7: ASHRAE 55 comfort bands
**Displacement ventilation**

A displacement ventilation approach was deemed to be the most appropriate solution to achieve the clients aspirations for a variety of reasons.

*How does it work?*

The principle of displacement ventilation is based on the supply of low-momentum air and the natural buoyancy in the room caused by heat sources (people, lighting, electrical equipment).

The low-turbulence supply air, which is cooler than the indoor air, is discharged at low momentum and velocity from displacement outlets and slides in a thin layer into the room at floor level.

The air contaminants are transported by the buoyancy above the heat sources to the ceiling zone and largely removed with the exhaust air. A small percentage only returns downward again with the back air flow into the room. As a result there are hardly any air contaminants in the lower pure fresh air segment from where the occupants obtain most of the air they inhale, which ensures a high standard of air quality.

In addition to the stratification of possible air contaminants in the room, displacement ventilation produces a pronounced temperature gradient. In the floor zone the air temperature rises at the warmer floor and due to a slight admixture of warmer indoor air. This is why the air temperature is already slightly higher here than the supply air temperature.

Higher air temperatures occur in the buoyancy flow directly above heat sources (occupants, EDP equipment, etc.). Outside this buoyancy flow region, there is a gradual, almost consistently even rise in air temperature towards the ceiling, reaching a maximum at the ceiling in the exhaust air.

![Figure 8: Displacement ventilation](image)

**Benefits**

The main reasons displacement ventilation was selected are as follows:

- High level of indoor air quality due to contaminant stratification and removal
- Works in harmony with a mixed mode approach
- High level of energy efficiency due to climate which allows frequent economy cycle at elevated supply air temperatures
- Buoyancy driven so able to adjust to and “find” the load in the space

**Application to Project**

Based on the clients understanding of future churn requirements the decision was made to adopt a fixed bin approach rather than the flexibility of a raised floor. This approach implied that Arup mechanical engineers had to work closely with BVN Donovan Hill and Jasmax to agree locations integrated into furniture and layouts which provided an even distribution of air. Importantly outlets needed to be positioned sufficiently away from seated occupants to avoid discomfort due to elevated velocity in the “near zone” adjacent to the outlets. Opportunities for integration were communicated by engineers in sketch form initially to provide inspiration for potential locations.

![Figure 9: Sketches to communicate options for displacement ventilation bin opportunities](image-url)
The final solution involved a combination of proprietary outlets and custom made outlets integrated into joinery. Arup nominated the level, size and density of perforations for the custom outlets to allow integration with architecture.
Central Plant
As the displacement system is “all air” it was essential that its design be well zoned and based on a low operating pressure drop to reduce energy consumption. The central plant design is characterised by the following features:

- Air handling units configured with separate units for centre zone and perimeter systems.
- Air handling units provided with economy cycle and return air bypass to allow dehumidification control.
- Heating provided via high efficiency condensing boilers with central air handling units distributing to the space.
- Plantrooms provided with a light positive pressurisation via the relief air system to protect plant equipment from salt and moisture laden environment.
- Cooling provided by high efficiency air cooled chillers.

The air handling unit zoning allow for mixed mode opportunities to be employed on a zoned basis. The control strategy for mixed mode operation utilises a simple green light / red light system. The building management system monitors outdoor air conditions including wind, temperature and humidity to determine when conditions are conducive to natural ventilation operation. When outdoor conditions are acceptable the green lights located at the perimeter of the building are activated and the perimeter zone air handling units turn off to save energy. Staff education programs to ensure windows are opened at these times are an integral part of the strategy. Furthermore the funnel design which propagates air through the building to provide passive cooling is also essential and is explained in the subsequent section.
Figure 11: System summary diagram

- **Roof Funnel Louvres**
  - for natural ventilation (c/w motorised dampers)
- **Spill Air**
  - Used when roof funnel louvres are closed
- **Air Cooled Chillers**
- **Natural Ventilation Light**
  - With red indicators the perimeter mechanical system is on
  - With green indicators the perimeter mechanical system is off
- **Windows**
  - Manual operable windows to control natural ventilation
- **Displacement outlet**
- **Ductwork reticulation**
- **Warm Relief Air**
- **Condensing Boiler**
- **Natural Ventilation Light**
- **Spill Air**

The Funnel

The design of the funnel that sits proud of the building roof is critical to successful operation of the natural ventilation scheme. Both the building and funnel form play a part in producing the required negative pressure to draw hot air out of the building at high level.

The preliminary investigations into funnel form looked at producing this negative pressure using a horizontal opening – this provides uni-directional operation. As the wind passed over this opening, from any direction, it would accelerate and consequently produce negative pressure. Weather-proofing of this solution proved a difficult task and thus the focus was shifted.

The final selected method, which was deemed to provide negative pressure more effectively and deal with weather proofing issues, was to place openings around the funnel controlled by motorised dampers. Openings are divided into quadrants that can open or shut to ensure openings on the leeward side of the structure are open in order to generate the negative pressure required to exhaust air effectively.

Wind modelling was conducted to verify the performance and pressure co-efficients produced by the building form under different wind conditions. This information coupled with bulk airflow analysis informed the shape of the funnel throat and extent of louvres.
Figure 12: The internal tapering shape informed by analysis which is coincidentally an abstraction of a volcano, giving the name of Rangitoto to the level 7 boathouse.
Figure 13: The funnel under construction and the light reflector and louvre cube installed (Top photo courtesy of Sean McCabe Photography)
The Facade

A high performance façade was an essential ingredient to operate in harmony with the displacement ventilation system.

The building envelope provides a membrane mediating conditions between the sometimes-harsh outdoor climate and the relatively more rigidly controlled office environment. The building fabric needed to be able to respond to daylight, thermal, acoustic and water tightness issues. Optimising its design meant using the best environmental performance based on the most cost-effective combination of materials and strategies. The building façade design was developed to respond to the desire for daylight, natural ventilation and potential views without compromising thermal comfort and energy use.

Facade description

Different façade options, based on performance and effectiveness, were considered for the building envelope during the concept stages of the design process.

The final design incorporates a single-skin façade with a solar and wind barrier—as a fixed external screen—and a weather-tight and operable inner skin. This dual system has the extra benefit of significantly reducing solar loads and improving thermal comfort, while also providing good potential for mixed-mode ventilation systems and wind control.

Facade optimisation

The building envelope was analysed to define the key parameters for each orientation of the building’s façade. The mechanical engineer for the project provided the architecture team a detailed matrix of rules for percentage of allowable shading for different times of year. This matrix was then studied in detail and analysed using Excel and 3D software Revit to allow multiple shading configurations to be tested in quick succession to inform the architectural design. It was this approach which allowed the unique shading system to be verified on the North facades of Site 22 and Site 23. In particular the analysis allowed the intended random appearance of staggered bark of trees, often vertical in nature, to be achieved.

Figure 14: Façade analysis tools utilising spreadsheet based assessments, Excel and IES
Utilising the analytical tools discussed above the final façade solutions were as follows:

- The majority of the North facade is glazed to allow expansive views to the harbour; since it will be exposed to northern sunlight, it is protected by solar shading devices.
- The East facade was studied and optimized to perform without external solar shading.
- The South facade is provided with good daylight quality with diffuse sunlight since it will experience no direct sunlight exposure.
- The West facade has been designed to be opaque to ensure protection against harsh afternoon solar radiation.
- The fully glazed and transparent walls of Waikokota Lane provide a visual and material break with the long façade of the north. To counter the visually heavy expression of the cone and the metallic louvres a lighter façade has been designed, punctuated by three yellow ASB portals.

Figure 15: North Façade of Building 23 and Building 22
Figure 16: Building 22 (right) and Building 23 (left) facades.
Exposed Services

The design principles of the interior mirror those of the business and Activity Based Working (ABW). The design approach of the building has been to make “transparent” the workings of the interior. With a transparent and inquiring culture comes a building that is literally transparent – the design of the services describes how the building works. The exposure of internal building fabric has an additional benefit of activating thermal mass and allows peak thermal loads to be lopped.

Within the atrium are large air risers looking very much like a component from a mercantile ship. These risers deliver the air to each floor from central air-conditioning plant located on the roof. From the risers emanate smaller ducts, which eventually arrive on the floor as “displacement bins”. For those that care to look, the delivery of air is made transparent as a building service throughout the interior.

Similarly, all the other services have been made visible – the data cabling and power travel throughout the building on organic winding cable trays, lights are on a regular spaced grid with power and other services travelling through their exposed support trays.

The exposure of services brings with it an elevated attention to detail and close collaboration between the entire design team. This process began with sketches to inspire potential reticulation options with the central atrium duct risers providing the most efficient path for reticulation of air.

Figure 17: Concept sketch options for ductwork reticulation
The documentation which followed required identification of every component on multidisciplinary drawings lead by the architect in partnership with the mechanical engineer. This included fixing methodology, bracket configuration, colour and materiality of every visible component. This was documented in detailed multidisciplinary drawings as illustrated below and also with specification describing the obligation for the Contractors on site.

Figure 18: Documentation illustrating rules for exposed services
Once on site and through the shop drawing phase BVN Donovan Hill and Jasmax lead the process driving meticulous detail implemented in a further collaboration with builders FCC and the various trade disciplines. The results are a building which is not only functional but beautiful.

Figure 19: Exposed services co-ordination and use of 3D modelling during design phase
Figure 20: Atrium risers and services co-ordination
Conclusion

The project demonstrates the future of HVAC which sees a greater focus on occupants, indoor environmental quality and amenity. It also showcases the broader influences of the mechanical engineer in the design process and the increasing need for engineers to engage with architects through close collaboration to achieve more than just a design of an air-conditioning system.

Mechanical engineers increasingly need to seek new ways to communicate concepts with powerful imagery demonstrating multidisciplinary understanding. Successful developments require integrated designs with all design team members empowered to influence decision making.

Finally HVAC of the future must be based on harnessing passive design principles founded in an understanding of the local environment. It is only through this understanding that true integrated and holistic design can be achieved.