Having played a role in building the hospital that stood as a beacon of children’s health in Melbourne for almost 50 years, it was fitting that a leading building services contractor was there again as its modern-day replacement was built just up the road.

In 1963, the Royal Children’s Hospital moved from its original 1800s location in the inner Melbourne suburb of Carlton to, what was at the time, a state-of-the-art facility in Parkville just down the road.

The project had been much anticipated. Under construction for six years, the building was designed by leading architects of the time, Stephenson and Turner, and featured the latest concepts in air conditioning and ventilation.

With great fanfare, it was officially opened by Her Majesty Queen Elizabeth II, and the facility declared “the very best possible buildings and facilities for the care and treatment of sick children”.

Over the years, it was expanded, refurbished and updated, as the latest medical equipment and healthcare strategies were acquired. However, it remained a building of its time, and by the turn of the millennium was considered to have reached its end-of-life as a leading medical facility.

In 2005, government funding was committed for a new hospital. In 2007 following an expression of interest invitation, the project was subsequently procured under a public-private partnership (PPP) model by the Children’s Health Partnership (CHP).

The consortium comprised Lend Lease as design and construct builder, Spotless Group as facilities management provider and financiers Babcock and Brown.

Norman Disney & Young (NDY) was appointed to the role of services consultant, and A.G. Coombs was appointed as the exclusive trade partner to Lend Lease for the provision of HVAC, central energy plant and specialist hospital systems, including medical gases.

This latter appointment had historical significance, as A.G. Coombs provided the mechanical services to the construction of the previous hospital – at the time the largest mechanical services installation in Australia.

**THE JOINT VENTURE MODEL**

PPP models are notorious for presenting all manner of challenges, and the new Royal Children’s Hospital was no different.

Mark Mitchell, general manager of A.G. Coombs Projects, says that the hospital required a different management approach compared to most models. It was necessary to explicitly quantify risk of the project’s unknown elements, and, given the extent of design development, to continuously refine the cost plan.

**For the children**

The construction of Melbourne’s new Royal Children’s Hospital presented some unique design and logistical challenges, writes Sean McGowan.
A prominent sculpture is on display in the hospital’s soaring atrium.
He says one of the biggest challenges of PPP projects, particularly of such large scale, is to deliver complex systems and services within fixed-cost, quality, and time parameters of up to five years after the original design and costing.

To address some of these challenges, A.G. Coombs elected to form a joint-venture partnership for part of the Stage One new construction works with AE Smith. The joint venture, known as RACAH, acted as a specialist subcontractor of A.G. Coombs.

And although the two companies are direct competitors in the HVAC&R market, this unique venture proved successful.

“The joint venture model was very successful, mitigating project risks around scale, program, and resource capability without reducing our ability to respond to the market on other concurrent project-delivery opportunities,” says Mitchell.

A HOSPITAL LIKE NO OTHER

The Victorian state government’s brief for the new hospital set out a number of key objectives for the project, establishing the terms on which a modern facility and its physical environment would be delivered.

As well as being both child-and family-focused, the facility was set to be an iconic building. Innovative and evidence-based design principles would enhance the healing environment and support clinical excellence.

It would also be operationally efficient – optimising the use of people and resources. It needed to feature flexible design and infrastructure that could adapt to new technologies and emerging trends in paediatric healthcare.

According to Keith Davis, director of health services for NDY, the brief also established a number of ESD targets that led the design team to adopt a philosophy focused on both “personal environment” and “ecological environment”.

It also led the CHP consortium to target a 5 star Green Star rating.

“Our focus was centred around providing a new world-class healthcare facility for children that integrated with and capitalised on the chosen new Parkville parkland setting,” he says.

“In ESD terms, the brief established a number of ESD targets that significantly influenced the infrastructure solutions adopted. The target reductions brief applied to potable water use, energy use and CO₂, with 1.5 per cent of carbon reductions attributable to renewable energy sources.”

Davis says the design team’s lateral thinking helped achieve the brief’s intent while providing greater value for money, to the betterment of the end project.

“It is indeed this process that provides the most opportunity to differentiate the services offering of the consortium,” he says. “I believe we demonstrated to the end client that we had fully embraced their functional goals and were committed to challenging the brief where

Nurses monitor progress of the original hospital’s construction in 1958.
we felt we could effectively improve value for money through savings in one area that could then be redeployed elsewhere – thus achieving an improved result."

A rigorous and holistic approach to environmental sustainability was applied in assessing and selecting solutions, with whole-of-life analysis also used. According to Davis, the final design solutions were motivated by a strategic decision to meet and exceed the minimum ESD targets defined in the design brief.

Along with a reduction in energy use and resource depletion, the strategy sought to use a trigeneration plant to improve overall system efficiency. Reductions in energy consumption and peak load enabled efficient sizing of the plant.

A focus was also placed on maintaining high levels of internal air quality and excellent levels of natural light without compromising solar shading requirements.

A number of other key concepts underpinned this strategy, including active chilled beams for office and consulting rooms, 600,000 litres of thermal storage, high-efficiency condensing boilers, and a biomass boiler system fuelled by recycled waste timber pellets.

However, one of the most significant challenges for the design team was applying the GBCA pilot health tool to a complex healthcare facility that didn’t represent the standard generic hospital model.

Not only was its scale substantial, but it also incorporated a major research facility in the form of the Murdoch Children’s Research Institute.

“The building was, in effect, a hybrid combination of hospital, commercial, retail and research functions that necessitated some extensive collaboration with the GBCA in relation to arriving at an acceptable method of assessment to support the 5 star rating targeted,” says Davis.

The specification of fluid coolers in the client brief also caused consternation, as they exceeded legislated maximum ambient noise levels under peak-load conditions and would have an adverse effect on neighbouring residents.

As there were 29 units that couldn’t be effectively sound attenuated, an
Excellent air-change effectiveness has been achieved.

The facility’s air-distribution systems include mixed-mode displacement ventilation to public areas.
alternative option was developed using 10 attenuated closed-circuit fluid coolers that satisfied all acoustic requirements.

According to Davis, the final result improved the energy efficiency of the water-cooled chillers, with lower condenser water temperature and reduced energy use at the expense of marginally higher water consumption.

The facility's air-distribution systems include mixed-mode displacement ventilation to public areas and the large lecture theatre, and active chilled beams in all office and consulting areas. Excellent air-change effectiveness has been achieved, enabling air quantities to be reduced to around two-thirds that of a conventional system.

Patient wards are provided with conventional constant volume ducted air conditioning; in oncology wards these are supplemented by terminal HEPA filters. Operating theatre systems also employ terminal ceiling HEPA filters, with two theatres serviced per air-handling unit.

Purafil gaseous air filters are also provided to the air-handling system intakes, to minimise the impact of helicopter fumes during landing and take-off. Higher performance filters are provided to critical clinical areas such as operating theatres, MRI suites and sterile zones for helicopter mode with bypass set up to prolong their useful life.

According to Kevin Wilson, Royal Children's Hospital project manager for A. G. Coombs Projects, most air-handling systems operate with 100 per cent outdoor air, to improve the IEQ and minimise the risk of infection by the use of return air systems.

Energy-recovery coils allow for energy reclaim back into the system.

“Areas served with active chilled beams are provided with 100 per cent outside primary air for better indoor air quality,” he says, adding that innovative pipework connection installation methodologies were developed for site efficiency.

The decision to opt for conventional air conditioning in ward areas is said to have been client-driven, and motivated by a requirement for optimum operational flexibility. Similarly, operable windows were considered but eliminated on the basis of clinical and legal consideration.

Areas served with active chilled beams are provided with 100 per cent outside primary air.

Below the building, a thermal labyrinth provides passive cooling and heating to the hospital’s atrium via low-level displacement. Chilled-water storage tanks with a capacity of 600,000L were provided to reduce peak cooling load by charging overnight using off-peak electricity.

The trigeneration system provides significant carbon emissions reductions. It comprises two 1160kW natural-gas-fired reciprocating engines and two two-stage 1267kW absorption chillers with associated heat recovery and control systems.

Along with meeting around 25 per cent of the base electrical capacity on site, it also provides chilled water for storage and domestic hot water energy.

Davis says the system was configured so that the two gas-fired reciprocating engines also supplement the standby diesel generator capacity that comes on line if part or all of the grid power is lost.

“While emergency diesel generators cannot be eliminated, their use is mitigated by the contribution from the cleaner gas power engines used for trigeneration,” he says.

Additionally, a 600kW fully automated biomass boiler was installed as an integrated part of the overall heating hot water system, utilising compressed waste timber pellets as its fuel source.

Its selection was in direct response to the briefed target of 1.5 per cent contribution by renewable energy sources. It was a first for Australia, and was seen as a demonstration project for the potential...
of biomass-fired heating plant in urban centres. Although it has yet to operate — due to a shortage in locally sourced waste timber pellets — the boiler’s application as an alternative heat source is forecast to achieve a reduction in greenhouse gas emissions of approximately 725 tonnes CO₂e annually.

A blackwater treatment plant was also incorporated to meet the required water target.

Designed to meet the requirements of the Department of Human Services and EPA Victoria, it treats selected flows from the hospital’s sewage for reuse as Grade A recycled water for toilet flushing, bedpan macerator water supply, mechanical services heat rejection systems and subsurface watering of external gardens.

Davis says a combination of risk management at the source, disinfection treatment systems, risk profiling of end uses and minimisation of backflow and cross connections serves to produce a log reduction for the entire scheme.

HISTORY REPEATS

The sheer scale of the project and its design and construct program saw the extended A.G. Coombs team peaking at around 250 personnel on site,
accompanied by associated drafting, engineering and project management services.

As BIM had yet to receive wide uptake when design commenced in 2007, workshop drawings and coordination using 3D CAD software were used for the benefit of services coordination, use of constructible libraries and prefabrication initiatives.

Sophisticated labour and materials management systems and strategies ensured safety and productivity across the workforces.

“The functionality and complexity of a hospital provides a number of unique challenges that needed to be assessed and planned for from day one,” says Wilson.

For example, the A.G. Coombs design and drafting team had to be flexible enough to incorporate last minute changes, due to the parallel paths of detailed services design and on-site construction.

One of the big challenges was a late design choice to incorporate the new technology IMRIS (intra-operative magnetic resonance imaging system) between two operating rooms. The special requirements of this system required intensive modifications to the existing design.
Areas such as this external garden show how the approach to holistic healthcare has changed in 50 years.
On-site logistics of deliveries, labour movement, crane lifts, and procurement of imported central plant infrastructure, equipment and consumable material use were also carefully managed, as were modifications to site access and sequencing.

Additionally, considerable use of off-site prefabrication helped achieve the mechanical services installation to program, and mitigated a number of site OH&S risks.

This strategy included the prefabrication of complete plantroom pipework systems, pump assemblies and headers, AHU CHW and HHW valve assemblies, Viega press-fit pipework fittings, and chemical fume cupboard exhaust flues. This measurably reduced the time and manpower spent on-site and respective costs to Lend Lease.

Mechanical services commissioning was also planned from very early on in the project, with the aim of a defect-free handover.

This saw commissioning procedures and work method statements for individual HVAC systems written up and approved well in advance of site commencement. This enabled the team to meet NEBB, IEQ, state brief requirements and NDY and Lend Lease specifications.

“The commissioning and interface of some highly complex services solutions required detailed management of not only our commissioning teams but that of the other services trades and their speciality equipment design and suppliers,” says Wilson.

Furthermore, Mitchell says commissioning resources maintained a presence on-site throughout operator training and the transition to operation phase.

“This process, combined with an ongoing service relationship between A.G. Coombs and Spotless, mitigated the construction team’s abatement risk and resulted in a functioning facility, on time,” Mitchell says.

A.G. Coombs Service is now engaged by the facility manager, Spotless, to provide mechanical and other maintenance services. It also provides an extended program of energy optimisation (tuning), carrying its knowledge of the detailed design, installation and commissioning into that process.

Following an intensive commissioning and completion phase that began in June 2010, September last year saw “technical completion”. Administration, staff and patients relocated to the new facility the following month.

As she did in 1963, Her Majesty Queen Elizabeth II officially opened the new $1 billion Royal Children’s Hospital on October 26 of last year. With a building area of 188,000 sq m, it has the capacity to treat an additional
The façade permits shading, but also excellent levels of natural light.
Patient rooms have access to external views, courtyards and gardens.

35,000 patients every year than the creaky building it replaced.

Its location within the natural setting of Royal Park provides most patient rooms with views of the greenery, as well as access to courtyards and gardens. Family-orientated features include accommodation and facilities for parents.

According to Davis, the most satisfying aspect of the project was the opportunity to work in a truly integrated design environment.

“It encouraged and supported innovative design solutions, provided they satisfied the basic criteria of adding to the value of the final solution for the Royal Children’s Hospital, and also satisfied the rigorous whole-of-life requirements in respect of the economic viability of the project,” he says.

For A.G. Coombs, its involvement meant the company had come full circle by returning to a project that was a catalyst for the company’s growth in the 1960s.

Wilson says large-scale and complex projects delivered in a PPP arrangement are both tremendously challenging and require a high level of expertise and commitment to deliver successfully. The fact that they extend over a period of years means they are also, in themselves, a journey for the project team.

“A.G. Coombs is very proud to have returned to Parkville for the construction of another new Royal Children’s Hospital,” says Wilson.

Stage Two of the project has now commenced, and will see some of the old hospital buildings demolished and replaced with a five-storey hotel, a childcare facility, gymnasium, retail shops and car park areas.

A number of buildings will be retained and refurbished, while the remainder of the site will be returned to parkland. This work has commenced and is due for completion in 2014.