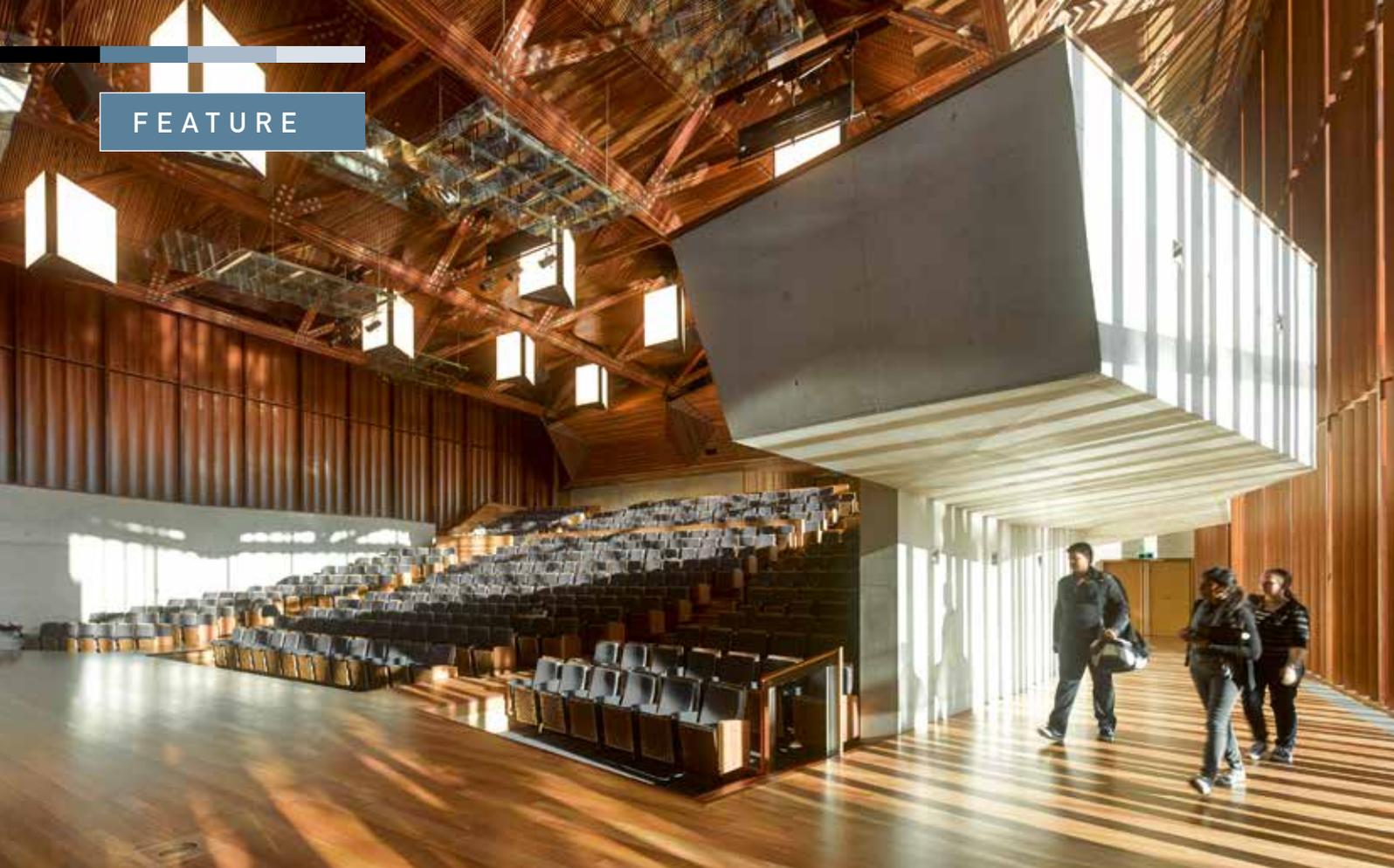


# EcoLibrium



## Big data

How analytics are impacting the HVAC&R world.



# Advanced Australian air

The University of Queensland's Advanced Engineering Building (AEB) is a purpose-built, active learning facility that encourages practical engagement with students by incorporating as many mechanical conditioning systems as feasible. **Sean McGowan** reports.

Officially opened in September last year, the Advanced Engineering Building (AEB) at the Queensland of University's St Lucia campus in Brisbane is the latest educational facility to be designed with a pedagogical bent.

As the flagship building of the university's faculty of engineering, architecture and information technology, it promises to deliver a practical active learning-style education for engineering students, as well as maximise global research opportunities for the university.

The award-winning design, by Richard Kirk Architect (Kirk) and HASSELL in collaboration, brings together the staff and students from the university's materials engineering disciplines previously accommodated across four sites on campus.

The building incorporates multi-use, active learning (pedagogical) laboratories that can be used for design, build and test purposes.

And it features a 500 seat lecture theatre – the largest on campus – that “will change the way the university presents lectures to students”.

‘ Outside air, particularly in Queensland, contributes significantly to the heat load of the building ’

## INTEGRATED DESIGN

Originally invited to join the Kirk/HASSELL team in 2009, WSP | Parsons Brinckerhoff (WSP PB) was given responsibility for the mechanical, wet fire and hydraulics services of the project.

Cundall was appointed as ESD consultant, while Aurecon was engaged to provide electrical, energy management, electronics, dry fire, façade and structural engineering.

Under the leadership of the architects, an integrated design approach was adopted and embraced by all members of the design team from the very early stages.

The approach was also instrumental in fulfilling a request from the university

to present the design process in a series of lectures to third-year architectural students.

This was particularly critical to the design of a precinct central energy plant by WSP PB, which was to be located on the roof level of the AEB.

It features a new chilled-water plant, which services the precinct via a variable primary/secondary hydronic loop configuration to deliver chilled water to the new building as well as to two existing adjacent buildings.

Mechanical contractor AE Smith was appointed to the project by main contractor, WATPAC, in 2011, and was able to further enhance the plant through the workshop drawing stage to suit the equipment offered.

Jonathan Ramajoo, M.AIRAH, is AE Smith's Brisbane engineering team leader. He says the position of the chillers in relation to the pumps and primary/secondary loop headers was reconfigured to enhance operation and improve maintenance access to the plant.

"This also helped reduce internal losses, which in turn reduced pumping resistance and power consumption," says Ramajoo.

## 5 STAR LEARNING

Tasked with achieving the targeted 5 star Green Star Design and As-Built ratings, WSP PB worked with the project team to achieve these goals as well as meet the university's brief to deliver a project that had the ability to inform and educate.

The initial brief called for a mixed-mode building using passive design principles. But as the design process evolved, a number of conditioning options were investigated, including the option of pre-conditioning.

This led the University of Queensland, WSP PB and Cundall to commit to incorporating as many variants of mechanical conditioning systems as could reasonably be included on a value-management basis into the design.

The result is a combination of systems used across the building, from central ducted and task-air systems to phase change with outside air pre-cooling and a displacement system in the main lecture theatre.

Zoned variable-air-volume (VAV) boxes, a popular method for cooling in Queensland, are used across the building. They use hot water coils that are served by a new central heating hot water plant located on the rooftop.

This central hot water generation plant also contains an energy storage tank, which allows for future connection to heat recovery such as a cogeneration plant.

According to WSP PB principal, Kevin Sheppard, task-air systems were provided for educational staff office areas, with dedicated air-handling units provided for each area served.

These systems utilise pre-conditioned air when appropriate supply conditions are achieved via a subterranean labyrinth proposed by the ESD consultant.

The labyrinth's size and form was designed to maximise contact area. It runs along the perimeter of both sides of the basement, with blockwork baffles used to further enhance the contact area.



WSP PB's precinct central energy plant is mounted on the roof.

The pre-conditioned air it supplies is utilised as outside air provision for a multitude of air handlers, and to provide conditioning to the building's central atrium when suitable conditions prevail.

Indoor environment quality (IEQ) in the building has been enhanced by the provision of 50 per cent additional outside air above code requirements, as well as through the use of low-VOC adhesives, sealants and paints.

VOC and CO<sub>2</sub> sensors were installed in most air conditioning systems to provide

constant monitoring of the air quality in the space. This information is used by the building management control system (BMCS) to regulate the amount of outside air brought into the building.

Mechanical services energy consumption is offset by the demand outside-air system, and the pre-conditioning of outside air via the labyrinth as well as the use of phase-change banks. When suitable conditions allow, energy usage is also offset by the mixed-mode operation of the building.

To achieve mixed mode, the building's weather station informs the BMCS to control operable facades, inducing air flow through the building, with air relief at the top of the central atrium.

"Outside air, particularly in Queensland, contributes significantly to the heat load of the building," says Ramajoo. "By monitoring and limiting the amount used by the building, the energy usage of the building can be reduced significantly."

A high level of instantaneous and historical data gathering was also critical to meeting the 'live learning' mantra. This required a multitude of sensors to be installed across the building to measure temperature, humidity, carbon dioxide levels, phase change and labyrinth performance.

"The quantum and location of these sensors was arranged to facilitate measurement of passive and active systems, and to afford the opportunity for experimentation for undergraduate and postgraduate course work," says Sheppard.

## THE CONSULTANT'S PERSPECTIVE

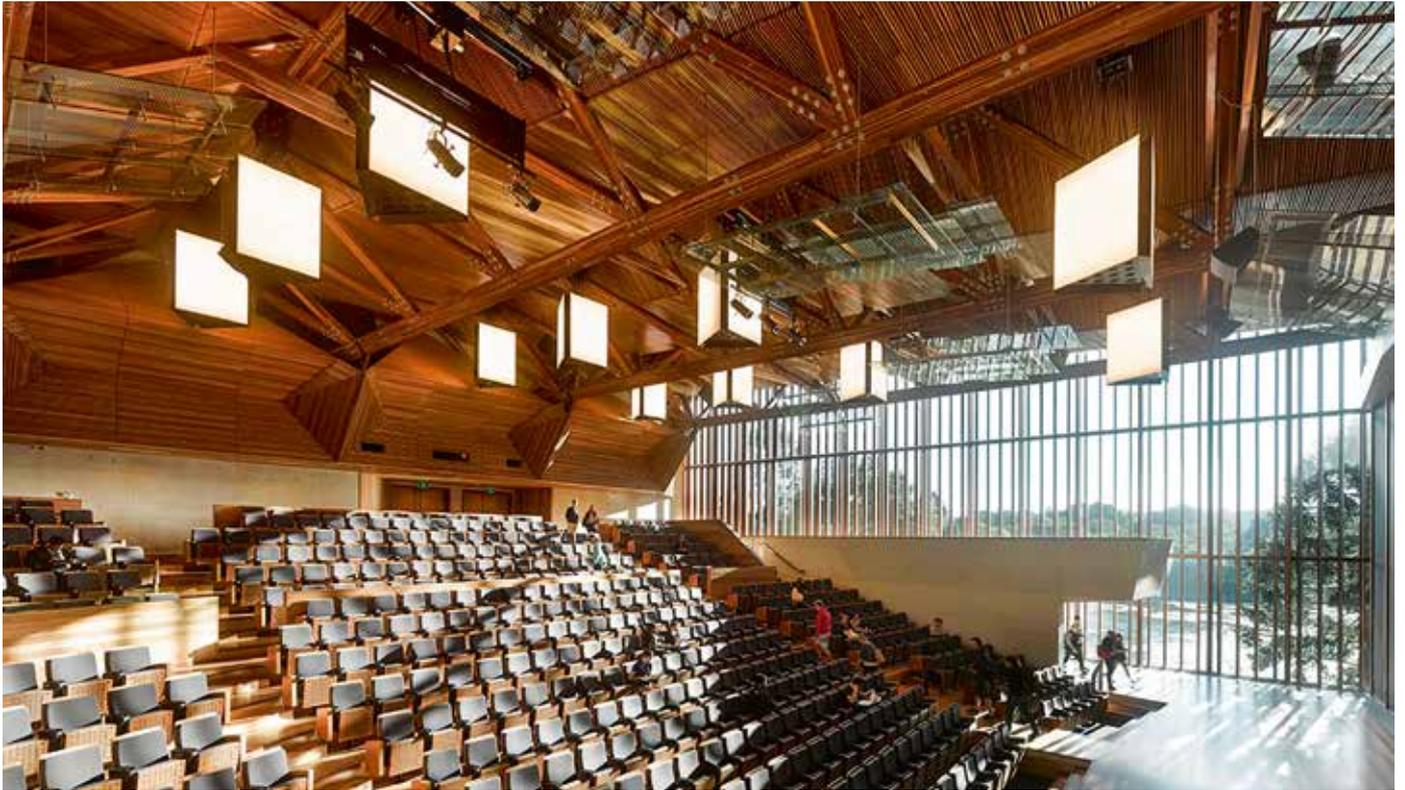
Kevin Sheppard, principal with WSP | Parsons Brinckerhoff shares a lesson from this project.

"A focus on integrated design should be included at the earliest stage of the project possible, before the design has progressed to the point where there is no turning back," says WSP | Parson Brinckerhoff principal Kevin Sheppard.

"This approach ensures that the best and most appropriate options for any particular project can be adopted."



A combination of HVAC systems are used throughout the building, from central ducted and task-air systems, to phase change with outside air pre-cooling systems.



A 500-seat lecture theatre will change the way the university presents lectures to students. The exposure of all services also enhances learning opportunities.

A set of live learning pictograms was also developed during the design process to enable input from the University of Queensland course coordinators, and to establish an acceptable level of data retrieval.

The building also features strain gauges and movement detectors embedded in the concrete structure. These provide real-time monitoring of stress and strain, and an insight into the structural performance of the building over time.

The BMCS gathers all the live building data from across the building, as well as from multiple services interfaces, and displays it on screens across the facility.

## EXPOSURE

The learning opportunities afforded by the building's careful mechanical services design are enhanced by the exposure of all services.

Hot-water-coil VAV boxes were specified in lieu of conventional electric heating boxes as an ESD initiative, and to meet the requirements of the BCA to limit the amount of electric heating used in the

building. Displayed in clear view, they have also proved to be a valuable learning tool, as students can see the VAV damper actuator and hot-water control valve modulate with heating and cooling demand.

The peristaltic service reticulation of both air conditioning and ventilation systems to the laboratories is also on display.

However, the exposure of services created a number of challenges for both WSP PB during design and AE Smith during installation.

A good example is the design of services in the 600 sq m super studio. Here, the balance of population, a fully glazed façade, zoning and fully exposed services required careful consideration of system layouts to achieve the comfort criteria with a minimum impact on aesthetics.

"Multiple options were developed and worked through as part of the integrated design process, with the architect and engineer sitting side-by-side to develop the final acceptable arrangement," says Sheppard.

## THE CONTRACTOR'S PERSPECTIVE

Jonathan Ramajoo, M.AIRAH, Brisbane engineering team leader for AE Smith, shares a lesson from this project.

"Early involvement of the contractor is key," says Jonathan Ramajoo, M.AIRAH.

"Providing lead coordination of building services during the construction phase helps to optimise plant and services layout and reticulation routes. If this can be highlighted during the design phase, further efficiencies in space, cost, construction, time and energy consumption can be achieved for the end user.

"AE Smith learned a lot from this project, which contributed to the successful design, assembly and installation of another project we are currently completing."



**External ductwork risers contain various ventilation ducts that reticulate between plant rooms. They also provide shading for laboratories.**

“The balance of system and aesthetics has worked well, with the super studio performing to a high level of comfort.”

For AE Smith, ensuring exposed services met with the aesthetic aspirations of the architect meant detailed coordination of services was critical.

“Building services are commonly concealed from the end user and occupant, by ceiling voids, risers and plant rooms,” says Ramajoo. “So when coordinating and installing building services, the primary goal is to ensure that it fits within these spaces as well

as to provide safe access where required for maintenance and service.”

To avoid a visual clash between the exposed services and the architectural finishes in the building, AE Smith worked closely with the architect to ensure particular contours were achieved during installation.

“The architect worked with us closely to provide guidance with the installation to ensure the arrangement not only fit but also achieved their vision.”

## EARLY RISER

Even the external ductwork risers and associated structure were used as an integrated design solution by the architects to provide shading to the laboratories.

Prefabricated by AE Smith, these risers contain various ventilation ducts that reticulate between the plant rooms and the six levels they serve. The risers

to present the design process in a series of lectures to third-year architectural students.

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An integrated design approach was adopted and embraced from the very early stages.

As well as ensuring the safety of the installation team, Ramajoo says this process considerably reduced the project work time for the managing contractor.

“This showed how modular design and off-site pre-assembly can provide efficiencies in construction in regards to safety, time and money.”

confirmed by the awarding of a 5 star Green Star – Education Design v1 rating from the GBCA.

Together with the new 6 star Green Star Global Change Institute building, it now forms a key part of the university’s carbon reduction strategy.

According to the director of major projects within the University’s faculty of engineering, architecture and information technology (EAIT), Professor David St John, environmental sustainability was an important goal in the design of the facility from day one.

“The future of engineering requires that engineers develop techniques that are much more sustainable, with reduced carbon footprints,” he says. “So it was a priority that as a training ground for the next generation of engineers, the Advanced Engineering Building exemplified this approach.”

An alumnus of the university, Ramajoo is pleased to have had the opportunity to return as a professional and contribute to a facility that will inspire the next generation.

“It was great to return to my university since studying there some three years ago,” he says.

“As a previous student of mechanical engineering at the University of Queensland, I believe this new engineering building will contribute in providing exposure of our industry to new students who may then become prospective professionals of HVAC.” ■

## PROJECT AT A GLANCE

### The personnel

- **Architects:** Richard Kirk Architect and HASSELL
- **Client:** University of Queensland
- **Contractor:** Watpac
- **Electrical, energy management, electronics, dry fire, façade and structural engineering:** Aurecon
- **ESD:** Cundall
- **Mechanical, wet fire and hydraulics:** WSP | Parsons Brinckerhoff
- **Mechanical contractor:** AE Smith

### HVAC equipment

- **AHUs:** Air Design
- **BMS:** Johnson Controls
- **Chillers:** AHI Carrier
- **Diffusers:** Holyoake
- **Fans:** Fantech
- **Fume cupboards:** Lab Systems
- **Grilles:** Holyoake
- **VAV boxes:** Celmec

## ADVANCING ENGINEERING

The Advanced Engineering Building at University of Queensland reached practical completion in mid-May 2013.

Given the nature of the building, a number of highly technical systems required ongoing fine-tuning and adjustment during the defects-warranty stage of the project, before the building’s official opening in September 2014.

The building has achieved a very high standard of ecological sustainability,



Live building data is gathered by the BMCS and displayed on screens across the facility.