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Case study: Queensland University of Technology Peter Coaldrake Education Precinct

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Cover image. QUT Peter Coaldrake Education Precinct (Image: Christopher Frederick Jones)

Project summary

The Queensland University of Technology (QUT) Peter Coaldrake Education Precinct, designed by Wilson Architects and Danish firm Henning Larsen Architects, is a dedicated teaching and learning facility for the Faculty of Education, used to educate the next generation of teachers.

The project incorporates a central atrium – an internal landscaped garden space located between the Peter Coaldrake Education Precinct and the existing library (Figures 1 & 2). The atrium is naturally lit with skylights and creates an active and climatically-controlled hub for the student and academic community. This covered garden space is usable in all weather conditions, providing comfort irrespective of seasonal changes. The atrium integrates nature, biophilic principles and environmentally sustainable design into the building fabric.

Integrated facade screening articulates the facade and controls direct sunlight, reducing solar gains while allowing daylight to illuminate deep into the floor plate (Figure 3). The design targeted the equivalent of a Green Star 5 Star – Design & As Built v1.1 rating and was modelled on predicted reduced energy consumption and greenhouse gas (GHG) emissions compared to reference benchmark building targets. Building services include a 75 kW solar array, water harvesting and bioretention along the pedestrianised campus Ring Road.

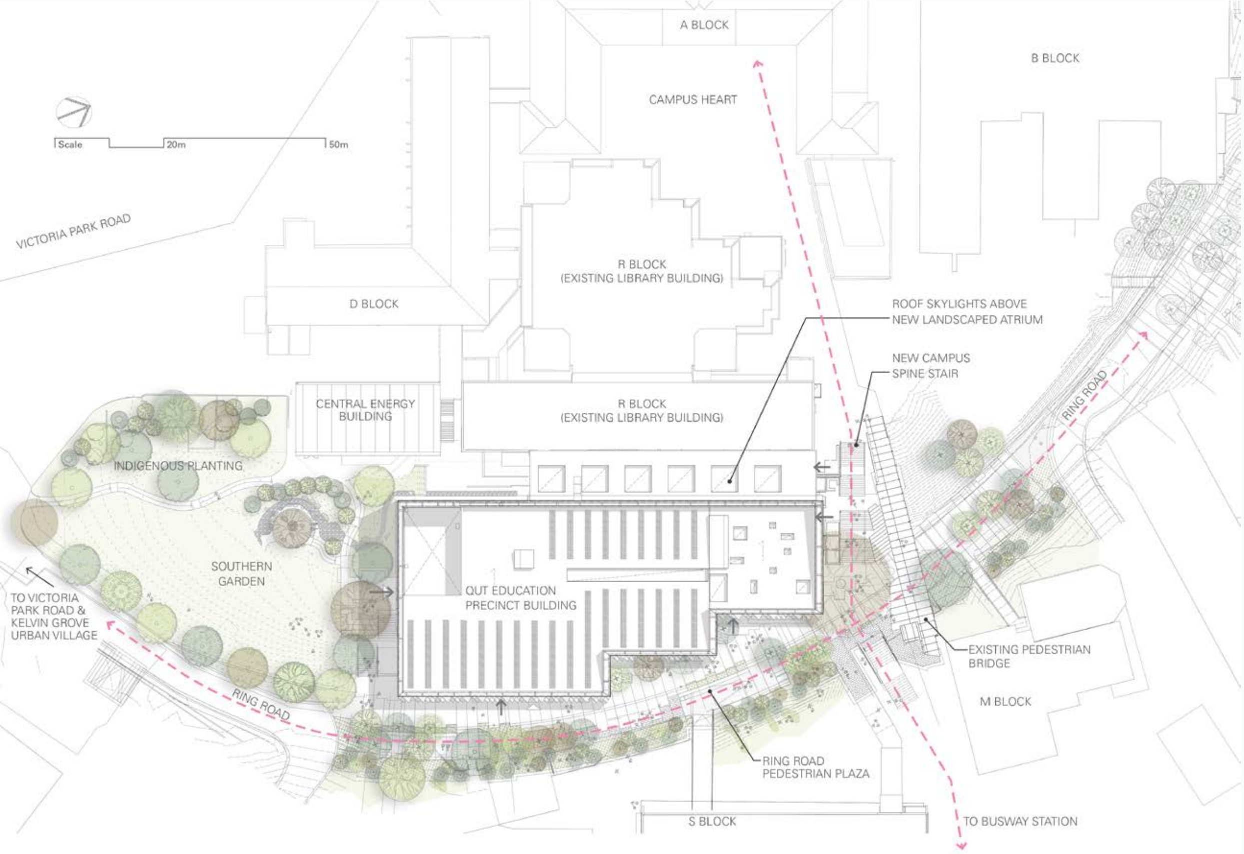

Figure 1. Site location plan: QUT Peter Coaldrake Education Precinct, QUT Kelvin Grove Campus (Source: Wilson Architects and Henning Larsen Design Report, 2016)

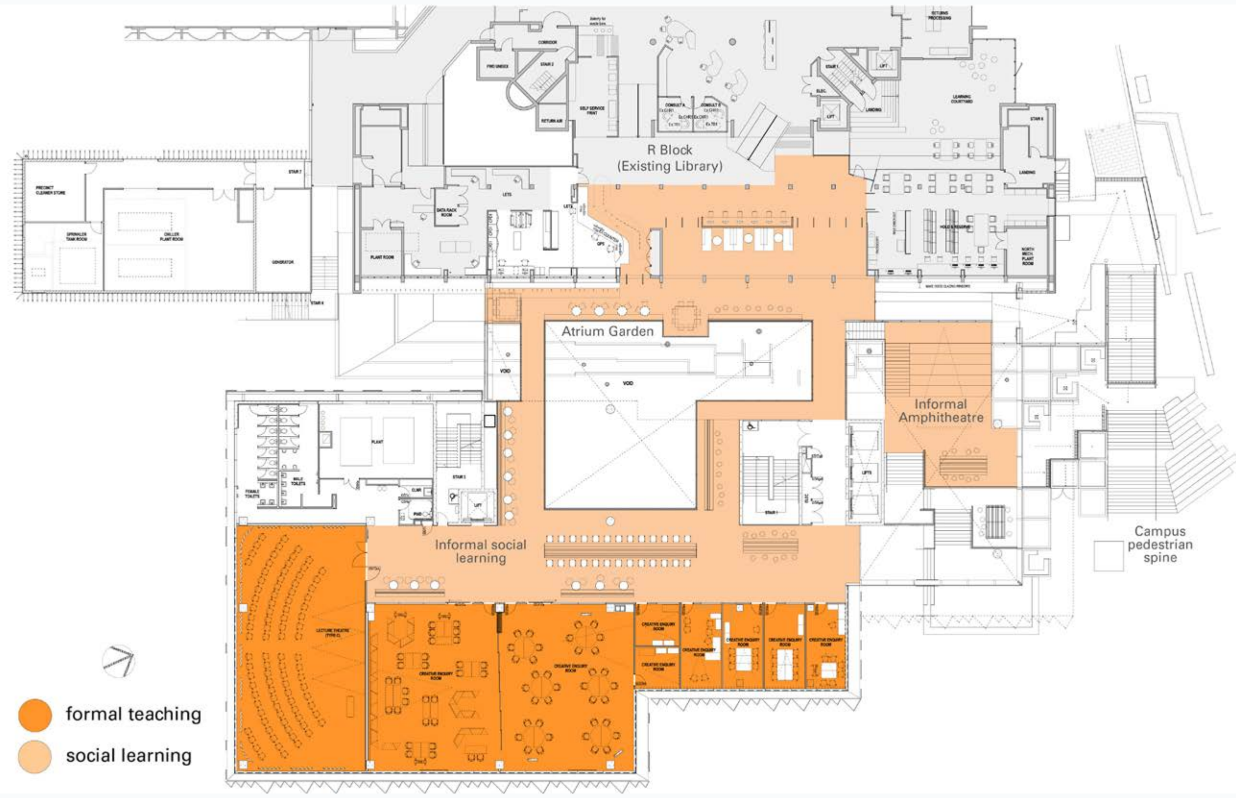

Figure 2. Level 2 floor plan: typical teaching level plan with connection to the existing library (Source: Wilson Architects and Henning Larsen Design Report, 2016)

Project details	
Project name	Queensland University of Technology, Peter Coaldrake Education Precinct
Project type	Institutional
Procurement type	Traditional lump sum
Year of design completion	2017
Year of project completion	2019
Location • Land + nation • Climate zone • Bioregion	• Country of the Turrbal and Yugara people • Climate Zone 2 • South East Queensland
Site area	
Gross floor area m^2	11,990 m2
Net lettable area m^2	7640 m2
Number of levels	6 levels
Number of occupants, visitors	Designed for a total student population of 1100, a staff population of 173 and a visitor population of 237 (these were pre-COVID populations at time of design).
Sustainability benchmarks and ratings achieved	The project was originally designed to achieve a Green Star – Design & As Built v1.1 5 Star rating. Post tender the university decided not to pursue the Green Star rating.

Project team	
Owner/client	Queensland University of Technology
Architects	Wilson Architects and Henning Larsen Architects
Consultants	• Acoustics: ASK Consulting • AV: QUT Audio Visual • Building surveyor: Certis • Electrical: WSP • Engineers: GS&A Technical Services • ESD: EComplish & DSquared Consulting • Facade: AECOM • Fire engineer and fire sprinklers consultant: Arup • Food and beverage consultant: Food Services Design Australia • Geotechnical engineer: Butler Partners • Hydraulics: Opus • Landscape: Taylor Cullity Lethlean in collaboration with Wilson Architects • Mechanical and lift consultant: Multitech Solutions • Project manager: Turner & Townsend Thinc • Project manager (QUT): QUT Facilities Management • Quantity surveyor: Donald Cant Watts Corke • Safety at height consultant: Height Dynamics • Specification writing: Hanimine • Structural and civil consultant: Opus • Surveyor: Bennett and Francis
Builder	Hansen Yuncken

Figure 3. View of eastern entry and new campus spine stair. Integrated facade screening controls direct sunlight (Image: Christopher Frederick Jones)

Integration

Positioned between the university library and the main pedestrian thoroughfare in QUT's Kelvin Grove Campus, the Education Precinct building provides a new social and academic focal point for the campus. The learning environment becomes a new campus hub providing a choice of settings distributed throughout the building such as informal student spaces, incidental amphitheatre, student social spaces, event spaces, student hub, a garden sanctuary, a learning commons or a student community space.

The space between the existing library and the new Education Precinct building is captured and transformed into a large, terraced internal garden atrium (Figure 4). The existing topography of the site was leveraged to connect the campus library to the Ring Road, establishing the Education Precinct building as a social conduit on campus, at once a thoroughfare and a destination.

Planted social spaces both indoors and out invite visitors to use the building as an informal meeting point, creating an active crossroads of campus life.

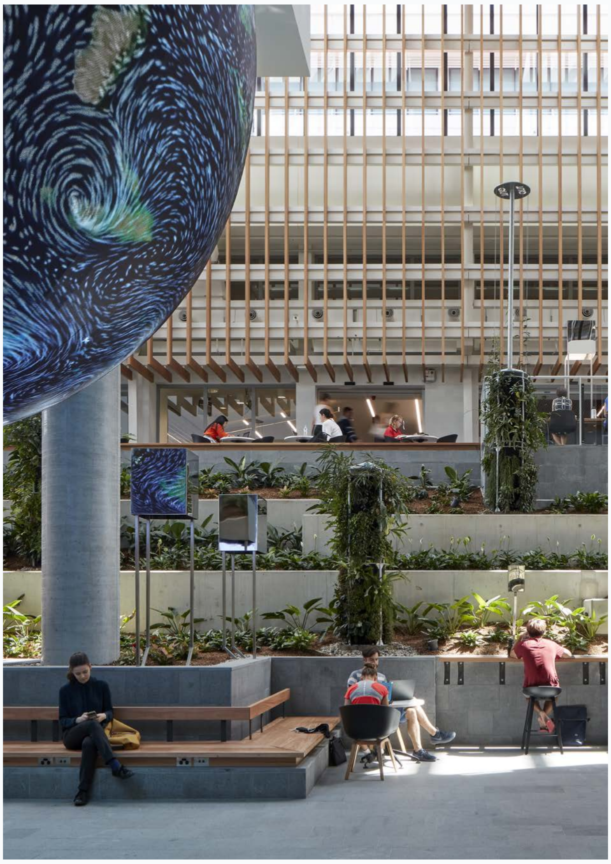

Figure 4. Internal atrium garden surrounded by social learning spaces (Image: Christopher Frederick Jones)

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Community

The intent for the project was to create a memorable, sustainable and connected facility that offers new teaching and learning opportunities. It also needed to integrate into the campus and provide a well-connected, accessible learning hub open to all users.

The Education Precinct building is located centrally in QUT's Kelvin Grove campus, directly adjacent to the established campus heart. An external pedestrian spine with a major new campus stair (Figure 3) traverses the steep topography (two storeys over 9 m height) with the building connecting the campus library and the Ring Road. It is also in close proximity to the local community with access to the Kelvin Grove Urban Village, several schools and a bus transit station. It scores a walk score of 71 (very walkable) and a transit score of 71 (excellent transit) in accordance with the Walk Score.

Through the living, social and technology-rich environment, users are invited to explore and make use of the building. Current visitation to the teaching spaces only – measured via people counters – is approximately 5000 people per week (personal communication with QUT, 1 Dec 2022, visitation survey taken for week 12 to 16 Sept 2022). Taking into consideration staff accessing workplaces and general transitional traffic and visitors, whole-of-building visitation would be considerably more.

Not only is it a learning commons on the campus, it is also a social destination and a community space, used as much by university students and academics as it is by the broader community including nearby school children and library visitors.

Country

Sited on the QUT Kelvin Grove campus, the project is located on Country of the Turrbal and Yugara people.

> 'The rich natural landscape where the Kelvin Grove campus stands today once supported a large Aboriginal community. Many local tribes were attracted to the large swamp area known at the time as York's Hollow, which provided an abundance of water, food and resources' (QUT 2020).

Figure 5. Indigenous edible bush tucker species and medicinal plants were integrated into the landscape planting selections in the southern gardens (Image: Christopher Frederick Jones)

The university's Oodgeroo Unit was consulted during the course of the project. The Oodgeroo Unit is the centre of QUT's activities in Aboriginal and Torres Strait Islander education, studies and research. It is important that the activities of the Oodgeroo Unit are well integrated into the whole campus and community while maintaining a culturally safe and comfortable sanctuary.

It is a mark of respect for Aboriginal and Torres Strait Island people to welcome visitors to their land, therefore there was a desire to maintain a strong connection to land and direct access to the outdoor areas. The project provides views onto natural landscapes overlooking an outdoor landscaped area with broader views across the cityscape and ranges.

The landscape architects, Taylor Cullity Lethlean and Wilson Architects, collaboratively developed a garden at the southern end of the site, specific to the cultural and social needs of First Nations students and staff and supportive of the general university community.

Indigenous edible bush tucker species and medicinal plants were carefully selected for the garden and integrated into the planting scheme.

Seasons can be identified by the selection and placement of plants for flowering season. The edible plants were identified within the project documents for future reference and identification. Of the 57 plant species, 19 are edible plant bush tucker (Figure 5; Table 1).

Description	
ACROSTICHUM speciosum	GREVILLEA Superb
ALOCASIA macrorrhiza	GREVILLEA baileyana
ALPINIA caerula	HELMHOLTZIA glaberimma
ANIGOZANTHOS Bush Pearl	HELICHRYSUM ramosissimum
ARCHONTOPHOENIX cunninghamiana	HIBERTIA scandens
ASPLENIUM australasicum	ISOLEPIS nodosa
AUSTRAMYRTUS dulcis	LEPTOSPERMUM Vertical Drop
BACKHOUSIA citridora	LEPTOSPERMUM madidum
BANKSIA Coastal Cushion	LIRIOPE Just Right
BANKSIA robur	**LOMANDRA Shara**
BANKSIA spinulosa	**MACADAMIA integrifolia**
BRACHYCHITON discolor	MELALEUCA Claret Tops
CALLISTEMON Little John	**MELASTOMA polyanthum**
CALOCHLAENA dubia	MELALUECA quinquenervia
CASUARINA Cousin It	MICROCITRUS australasica
CHEILOCOSTUS speciosus	MICROSORUM diversifolium
CORDYLINE petiolaris	MYOPORUM parvifolium Yareena
CRINUM pedunculatum	PANDOREA jasminoides
CYATHEA cooperii	**PARSONSIA straminia**
CYATHEA cooperii	PROIPHYS cunninghamii
DAVIDSONIA pruruiens	SCAEVOLA humilis Purple Fusion
DIANELLA caerula	STENOCARPUS sinuata
DORYANTHES palmeri	**SYZIGIUM Cascade**
ELAECARPUS bancroftii	**WATERHOUSIA floribunda**
EUCALYPTUS ptychocarpa	WESTRINGIA Low Horizon
GOODENIA ovata	WESTRINGIA Wynyabbie Gem
GREVILLEA Cooroora Cascade	WESTRINGIA Zena
GREVILLEA Fairy Floss	**XANTHORRHOEA johnsonii**
GREVILLEA Scarlet Sprite	

Table 1. Planting schedule – edible 'bush tucker' plant selections shown in bold text (Source: Wilson Architects landscape planting plan)

Water

Roof water is collected and stored in a 60,000 L water storage tank located beneath the internal amphitheatre steps and used for irrigation of the landscaped areas. The internal garden irrigation system consists of a localised, low-flow, low-precipitation drip line with secondary filters to reduce maintenance. The drip line is fed by a fertigated (incorporating fertiliser or nutrients within the water) system. Water-efficient tap fittings have high WELS Star ratings.

Water-sensitive urban design (WSUD) principles are incorporated into the bioretention pits (Figure 8) of the pedestrianised Ring Road, and into the planting beds (Figures 6 & 7). The bioretention pits were integral in the stormwater quality treatment plan associated with the Green Star rating system. The external landscape planting is predominantly native species to reduce reliance on water. Internal planting selection was based on performance in low light air-conditioned spaces to allow plants located on the lowest level of the atrium to thrive (see Well-being). Grey and black water treatment are not provided on the campus.

Economy

The Education Precinct involved demolition of two existing 1970 masonry buildings. They were not considered suitable for reuse largely due to the findings within a university asset condition report and functionality audit, limited flexibility to accommodate functional requirements and ongoing maintenance requirements. The existing buildings had split levels across half levels which made it very difficult to provide equal access across the whole site. Upon demolition, the site and buildings were found to be contaminated. This was not revealed in the hazardous material reports due to asbestos being buried under the existing floor slab and contained in concealed structure.

Project cost outcomes, budget expectations and value management were progressively monitored throughout the project without losing sight of the overall design objectives. A number of campus-wide benefits were included within the project costs, including the pedestrianisation of the Ring Road, upgrade of the campus pedestrian spine, a Central Energy building (that provides precinct chillers, a substation, sprinkler tanks, fire pumps and end-of-trip facilities) serving the precinct and the interconnection with the library. The value management process took into consideration the project vision and values established at project inception to ensure they were not sacrificed.

Figures 6 & 7. Bioretention basins were integrated into the garden beds along the pedestrianised Ring Road (Images: Christopher Frederick Jones)

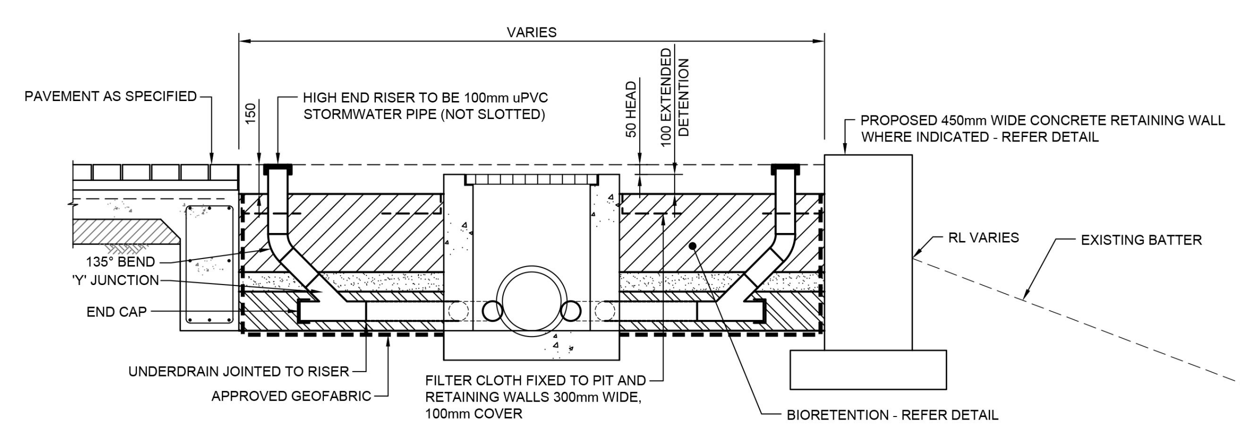

Figure 8. Typical bioretention basin section detail (Source: Opus (now WSP) civil engineering detail)

The construction cost of the main Education Precinct building at completion (2019) was approximately \$5090/m^2 (comparable to similar facilities). This included the construction of the main Education Precinct building, loose furniture fitout, the Central Energy building and the interface with the existing library. Separate to these costs were the demolition of the existing structures, decontamination of the site, the urbanisation and pedestrianisation of the Ring Road and the external landscaping.

Energy

During the late design stages, an energy report was carried out to provide preliminary estimates of the energy consumption and associated greenhouse gas emissions for the QUT Education Precinct building at the design development stage. This was carried out by the ESD and sustainability consultants with the proposed building compared to the performance of a Reference Building, which was consistent with the requirements of the National Construction Code (NCC) 2015 for a 'Standard Reference Building'. The report confirmed that the proposed building performance would exceed that of the standard reference building under the BCA Section J Alternative Verification Method JV3.

The energy report indicated a reduction in energy consumption of approximately 17% for the building at design stage relative to the reference building.

The results also showed a reduction in greenhouse gas emissions of 45% for the proposed building compared to the benchmark building (where the benchmark building has 10% emissions less than the reference building). The simulations indicated that the building would achieve a 43% reduction in peak electricity consumption when compared to the reference building.

Based on the construction documentation, the lighting power density (LPD) for the whole building is designed to approximately 4.1 W/m^2 (as calculated by the electrical consultant). This is around a 50% improvement on the maximum permitted power densities listed in section J6.3 of the NCC 2015, which also reflects the Green Star benchmark in the Energy credit for a reference building project. While the NCC lists LPD limits per space type, this LPD design rating is an average only.

The actual measured energy consumption is as follows:

Operational energy (calendar year 2021):

- Total metered grid consumption = 870,073 kW h per annum (vs 627,130 kW h per annum Energy model).*
- Energy consumption intensity = 114 kW h/m^2 per annum (or 410 MJ/m^2 per annum).

Lighting power density:

- Metered peak lighting demand = 33.7 kW (vs 35.8 kW Energy model).
- Lighting power density = 4.4 W/m^2 (vs 4.7 W/m^2 Energy model).

* Green Star energy modelling is modelling to a particular set of inputs and profiles for the purposes of assessing proposed building performance versus a reference building. This doesn't represent operational energy use. We normally find that operational energy use is approximately 30% greater than that determined by Green Star energy modelling (ie approximately 815,269 kW h per annum in this case). The meter readings include additional energy use of the external Ring Road lighting.

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Renewable energy (PV):

- Total metered PV energy generation (2021) = 101,252 kW h per annum (vs 113,910 kW h/a Energy model).
- Generation intensity = 13 kW h/m^2 (vs 15 W/m^2 Energy model).

Core operational energy sustainability principles implemented for the main building include:

- a roof-mounted 75 kW photovoltaic array which feeds into the building's power system
- external fixed sunshades with 40% transparency that control solar radiation, expected to reduce solar heating intake by up to 40% while enabling views to outside (Figure 10)
- energy-efficient LED lighting with motion sensor control
- high-efficiency chilled water air conditioning system comprising in-ceiling Variable Air Volume (VAV) terminal units
- HVAC zoning controls to minimise wastage with air conditioning units only serving one thermal zone
- atrium ventilation using spill air from adjacent conditioned spaces on pathway to return air ducts
- high-performance facade solution that provides an optimum balance between energy, thermal comfort, air seal barrier, access to daylight, views to outside and aesthetics
- an integrated building management system (BMS) that automatically records and monitors the building's resource use and establishes trends and profiles to assist with the ongoing control of energy use.

If this was rated as a NABERS office building, it would achieve 5.5 Stars. During the design stage, the project targeted a 5 Star Green Star – Design & As Built v1.1 rating and achieved 67 points (60 required). However, post tender the university elected not to pursue an As Built rating (Note: Green Star – Design & As Built is now a legacy rating tool).

The key sustainable parameters achieved in the Green Star design report were:

- Management – commissioning, tuning, construction, metering, operations
- Indoor environment quality – visual, thermal, acoustic, lighting
- Energy – modelling and demand reduction, photovoltaic array
- Transport – end-of-trip facility for precinct
- Water – water-modelled pathway, water quality treatment plan
- Materials – life cycle impacts, responsible materials, sustainable products, waste
- Land use & ecology – ecological value, reuse of land, heat island effect
- Innovation – daylight analysis, indoor garden, reference benchmarking

Well-being

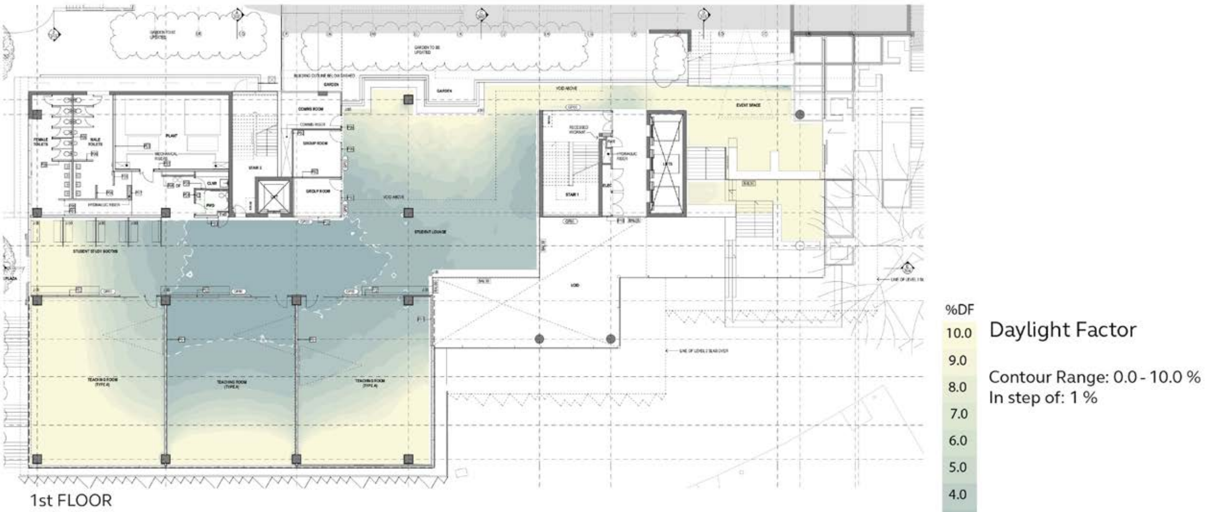
The desire to improve the well-being of users of the building was a significant driver in the incorporation of plants within the building. The ability of plants to absorb toxic compounds from the environment can benefit performance, perception and general health and well-being in the workplace. The most highly occupied social spaces can be observed to be the spaces directly adjacent to the living plants.

The internal garden (Figure 4) embraces the principles of biophilic design whereby our connections with nature are essential to wellbeing. Biophilic design replicates experiences of nature to reinforce these connections (refer *Environment* note Biophilic design: an introduction for designers). Within the project this biophilic approach incorporates natural materials, natural light, vegetation, views of natural landscape and other experiences of the natural world.

Extensive skylights provide sufficient light levels to penetrate the 5-storey atrium and allow for sustainable plant growth. A natural daylight and glare model study (Figure 9) was carried out by Henning Larsen's sustainability department to accurately establish daylight levels throughout the atrium. This informed the selection of low light tolerant plant species within the atrium garden, particularly where light levels are reduced on the lower garden levels. Full height glass curtain walls at either end of the atrium provide a visual extension of the landscape through the building and to the rainforest landscape outdoors. The location of air conditioning ducting and venting of warmer air above the plants provides for a more favourable environment for the planting.

A large central stair provides for ease of circulation and promotes the use of stairs rather than lifts. The stair shafts are lined in natural Forestry Stewardship Council (FSC) certified timbers (Blackbutt timber species selection used throughout). Internal floors integrate granite stone pavers to reinforce the connection between inside and outside. The indoor space is designed to feel like an outdoor space through the consistent materiality and the strong visual connections to the outside.

Planting extends throughout the upper storey open plan workplaces (Figure 11), complementing the biophilic effects of the atrium garden. Workstations are located at the perimeter adjacent to floor-to-ceiling glass, with light and glare moderated by manually operable glare blinds. External zig-zag shading devices are perforated to maintain views (Figure 10). Timber, sound-absorbing linings and acoustic canopies float below exposed concrete soffits to maximise ceiling height.
A proportion of the workstations are adjustable sit/stand workstations.



	Daylight Modelling Nominated Area (m2)	Area above 2% DF	Percentage of area above 2%DF
First floor	1068	911	85%

Figure 9. Internal natural daylight and glare model study to establish light levels at lowest levels in the atrium garden (Source: Produced by Henning Larsen sustainability department - Wilson Architects and Henning Larsen Design Report, 2016)

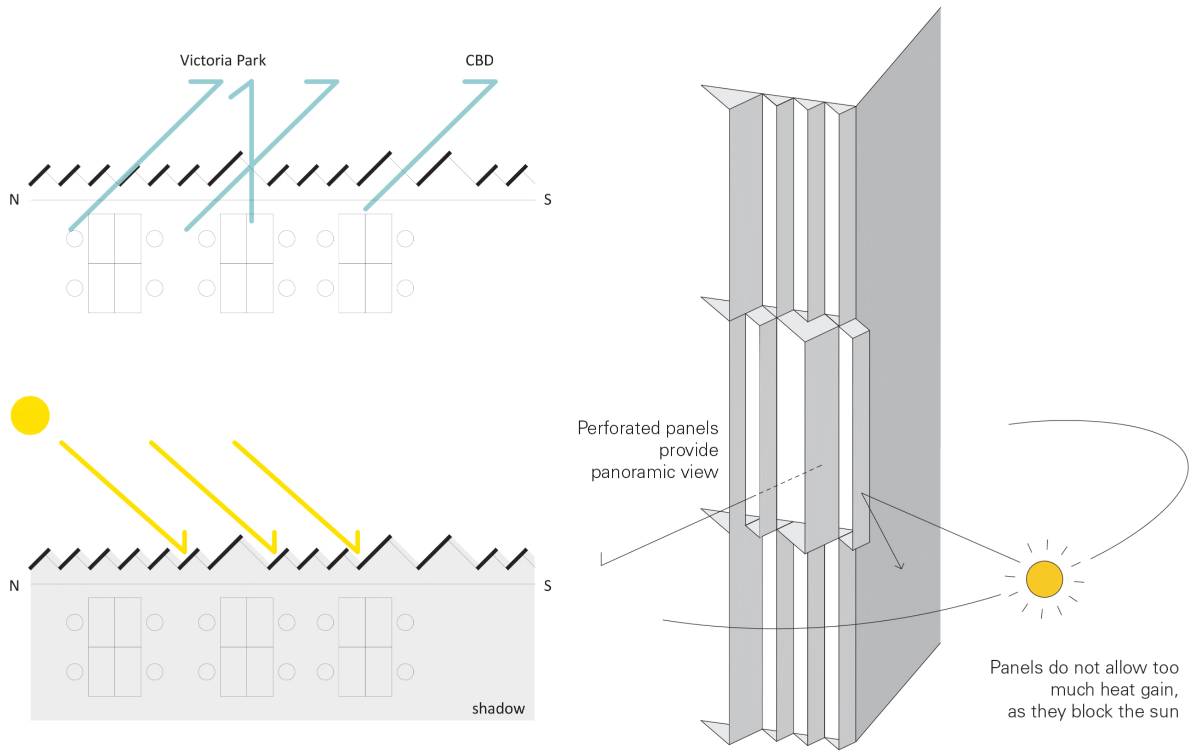


Figure 10. Sunshade modelling diagram illustrating angle of fixed zig-zag sunshades open towards views to the city and blocking morning eastern sunlight (Source: Wilson Architects and Henning Larsen Design Report, 2016)

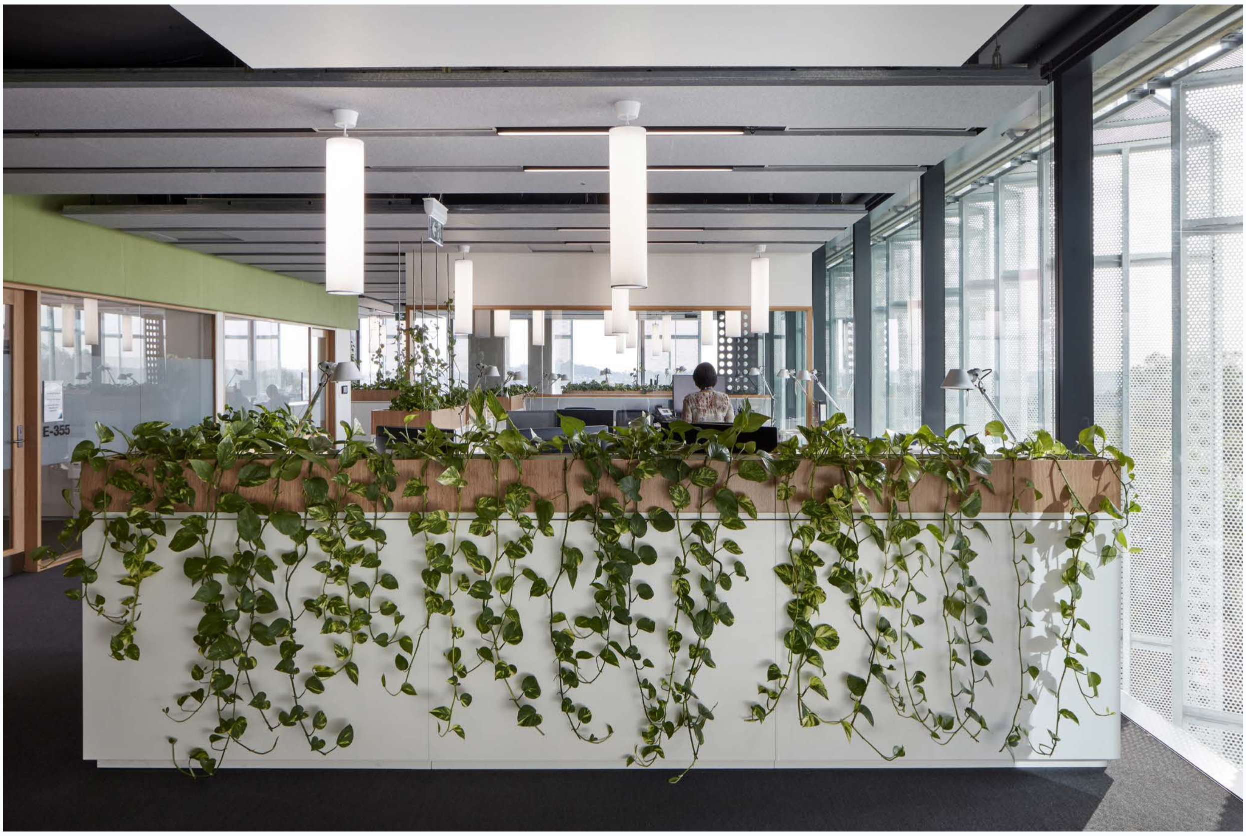


Figure 11. Internal planting within academic workplaces (Image: Christopher Frederick Jones)

Resources

Reinforced concrete was selected for the main structural frame based upon the large clear span requirement for the teaching space (see Change). Concrete was assessed as most suitable to achieve this, as well as to allow for future flexibility and satisfy seismic earthquake loading.

Internal material finishes were selected based on environmental credentials and certification with an emphasis in the public and accessible areas on natural materials. Granite stone pavers are used extensively in the external pedestrianised areas and seating plinths and continue internally on floors and vertical surfaces (Figure 12). Blackbutt timber lines the main vertical shafts and ceilings and has Programme for the Endorsement of Forest Certification (PEFC) and Forestry Stewardship Council (FSC) certification. Timber is also used on the top level function spaces (Figure 13) to line floors, walls and ceilings. The existing facade of the old library is 'disguised' with vertical timber fins to present a new natural aesthetic to the old library. Timber veneers to joinery are PEFC and FSC certified.

Environmental credentials and certification for internal finishes also included:

- Carpet finishes, rubber tactiles, plasterboard and fibre cement products have GECA Certification.
- Vinyl and Marmoleum resilient finishes to utility and staff common room spaces are GreenTag Certified.
- Acoustic linings and ceiling panels have 65% recycled content and are 100% recyclable.
- Fabrics and solid surface materials (eg Corian benchtops) have GreenGuard Certification.
- Toilet and shower partitions, whiteboards and laminate linings are GreenTag Certified for low emissions.
- Substrate board products in joinery are E0 GreenTag Certified.
- Furniture selections were prioritised towards GreenTag Level A, GreenGuard, GECA and AFRDI Green Certified.

External finishes are self-finishing and low-maintenance materials such as stone pavers, in situ coloured concrete and metal sheet cladding.

Figure 12. Granite stone lined floors, timber walls and joinery elements, an experience heightened by natural planting in the internal garden (Image: Christopher Frederick Jones)

Figure 13. Natural finishes were heightened on the top floor function spaces to include timber lined floors, walls and ceiling linings (Image: Christopher Frederick Jones)

Environmental certifications were listed in the materials selection and furniture schedules to inform the contractor of the certification requirements and serve as a record for future reference. The contractor provided the environmental certificates at completion and included them in the operation and maintenance manuals.

The university has a waste and recycling policy throughout its campuses which was adopted for waste stream collection of general and recycled waste.

Change

Educational facilities need to be flexible and adapt to changes in teaching and learning models and functional change of use. The main structural reinforced concrete frame, designed for a large clear span requirement of 11 m x 14 m to suit the university's optimum room dimension, allows for future flexibility throughout its design life. The design live loading of 4kPa allows for future functional use change and future penetrations. This live load for general loading is slightly higher than stipulated in AS/NZS 1170.1:2002 for a number of areas, but was proposed as a general load from a future use flexibility point of view.

To provide a level of flexibility for the learning and teaching spaces to adapt to changing pedagogy, all learning and teaching rooms are flat floored, consistently sized, column-free rooms based on a standard module of space and laid out in a grid arrangement within the limitations of the building structure. Beyond the minimum services provision, additional services solutions (AV, power and data) are provided allowing maximum flexibility to curate and use the teaching spaces now and in the future. Provision has been made for flexible power and data away from the perimeter walls and for projecting multiple forms of content in multiple directions and onto multiple surfaces. The fitout throughout is all loose fit and flexible to adapt in the future.

The base build included a whole empty 'shell' floor to allow for expansion and fitout in the future. As it turned out shortly after completion of the main building, this shell floor (level 4) was fitted out as a separate contract for additional academic offices and the Australian Research Council Centre for Excellence for the Digital Child.

Discovery

There is a delight of discovery when finding the internal atrium, unexpectedly sandwiched between two buildings. This feeling of delight is elevated once you discover the verdant garden space cascading down through the atrium and seeping into all corners of the space. The rainforest-like planting on either side of the glazed ends visually provides a sense of the outside blending internally through the building. The atrium space seems surprisingly calm and quiet, and yet is visually stimulating. Students and visitors occupying the space find their own unique places to meet, study and collaborate (Figure 14).

There is further surprise when discovering the 5 m diameter LED Sphere, hovering centrally within the volume of the atrium. The Sphere was introduced into the project part way through construction and showcases technology and facilitates interactions with teaching content in an entirely unique format. The sheer physical presence of the Sphere suspended within the space seems to defy gravity (Figure 15).

The connection to a natural landscape setting is ever present when sitting, working and socialising next to living plants and flowers.

The discovery of the 'education' within the building is permanently on display to all passers-by through the use of full height transparent perimeter walls and the consistency of granite paving flowing from outside to inside (Figure 16).

A whole-of-team 'Lessons Learnt' session was conducted by the university shortly after completion of the project. This session included the university's facility management (FM) team, the contractor, all consultants, project managers and key stakeholders.

Figure 14. Students finding their place next to living plants and flowers in the internal garden (Image: Christopher Frederick Jones)

Figure 15. 5 m diameter LED Sphere hovering over social learning spaces (Image: Christopher Frederick Jones)

Learning outcomes shared to inform future projects included:

- governance structures to be well established
- explanation of the procurement process, including early contractor involvement, to understand construction planning and decision making
- wide distribution of stakeholder objectives and project brief, to be understood by the stakeholders ensuring continued consultation with key stakeholders
- early integration of IT and AV functions
- consideration of BIM as an integral part of the design process and extending the process through construction and occupancy for FM use
- the knowledge that good outcomes are improved with participation and good collaboration between all project team members from design through construction and completion.

Wilson Architects and Henning Larsen Architects formed a successful collaboration through all stages of the project, at times working on 24-hour cycles given the time differences between Brisbane and Copenhagen. Each firm inspired the other with new ways of design thinking or new approaches to solution finding.

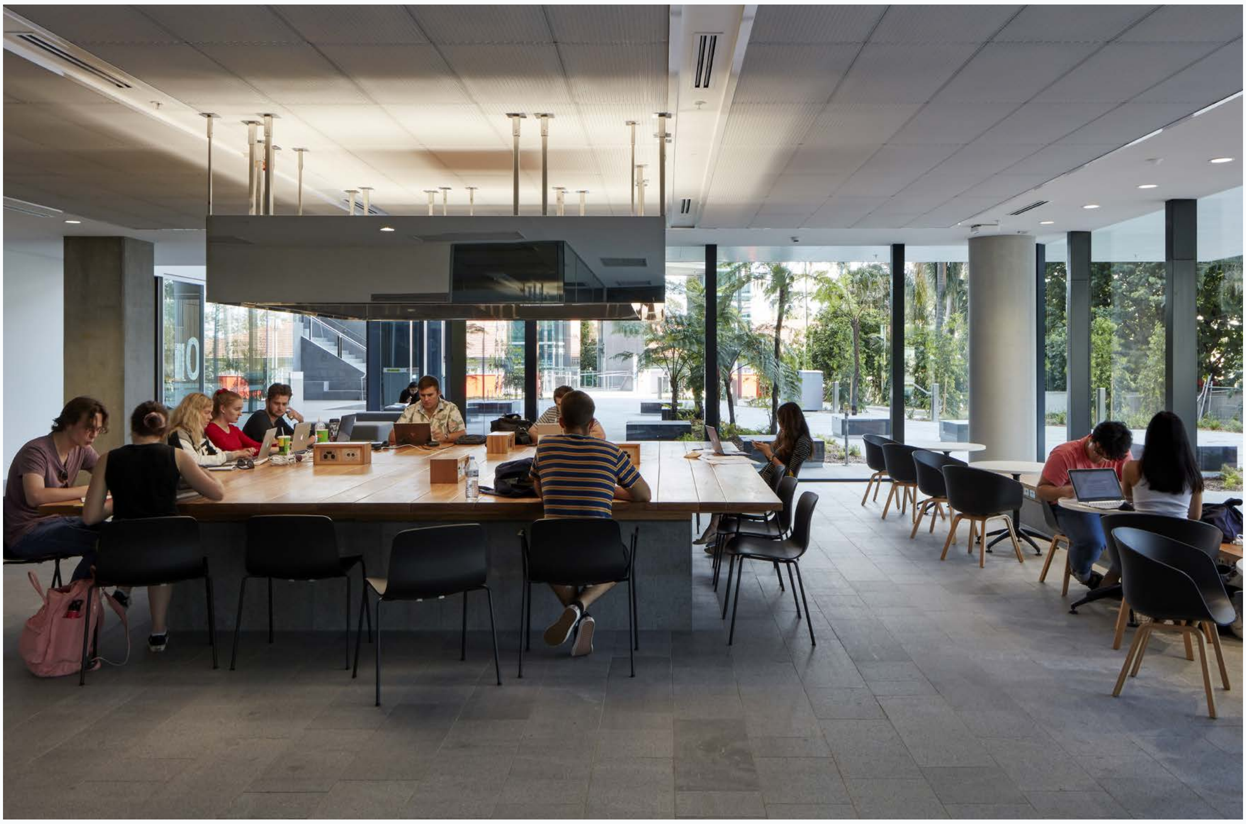


Figure 16. Internal and external spaces blend together through the consistent use of stone paving and full height transparent walls (Image: Christopher Frederick Jones)

References

ABCB (Australian Building Codes Board) (2015), *National Construction Code,* ABCB.

QUT (Queensland University of Technology) (2020), *'Campus to Country Positioning Strategy'* [PDF], a collaboration between The Office of the Pro Vice-Chancellor (Indigenous Strategy) (QUT), Facilities Management (QUT), Kevin O'Brien (BVN), Simone Wise (Urban Planning and Design Consultant).

About the Author

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John is a director of Wilson Architects and has been with the practice for over 30 years. He has encouraged the continued development of collaborative ventures with associated architectural firms. This project was a successful partnership with Henning Larsen based in Copenhagen. John has extensive experience in complex, large scale projects with a focus on educational learning and specialised research facilities. His experience in this particular area brings an ideal blend of experience and nuance to directing the briefing development phase through to managing full project delivery of design-focused outcomes.

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