Bio regional

Can green buildings pay their way?
In a case study of a new educational facility in country NSW, Lindsay Johnston shows they can.

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Environmentally Sustainable Design.

Interactive Learning Centre, Charles Sturt University.
Dubbo, NSW

Marci Webster-Mannison with Clark Walton. Architects
Lindsay Johnston. Review
Patrick Bingham-Hall. Photography

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It is emerging that educational buildings are leading the way in the exploration of innovative design and construction for low energy and thermally effective climatic responsive architecture. While there may be a dearth of examples of ground-breaking commercial buildings, and the countryside may still be littered with inappropriate residential buildings, many educational institutions are investing in good design and 'green' facilities. This is because universities, unlike many commercial developers, are in there for the long haul and will own and bear the cost of operation of their buildings away into the future. Many universities have a long-standing policy of non air-conditioning, and this is challenging designers to deliver thermal conditions that are within the 'comfort zone' of present day acceptability. It is also widely recognised internationally that payroll is a huge component of the lifecycle cost of any building and even a slight increase in productivity, or decrease in sick days, through the provision of a healthy, pleasant and comfortable working environment will pay for investment in thorough design and the capital cost of environmental features – 'green' buildings DO pay!

Leading the way is Charles Sturt University, strongly driven by its architect and director of design, Marci Webster-Mannison. Following the success of the published and awarded buildings at the Thurgoona Campus, Albury (*ar* 73, Spring 2000) the new Interactive Learning Centre (ILC) in Dubbo raises the bar to new levels of innovation. Again with the involvement of Ché Wall of Advanced Environmental Concepts, specialist consultants, the building employs what is probably a world first in the use of evaporative cooling 'shower towers' to induce cooling and air movement in hot dry climatic conditions. The user and environmental agendas of the building have been fundamental to the design concept and are beautifully married in a fine example of integrated resolution that can be read as soon as the building is viewed from outside, and experienced when one enters the main atrium space.

Context: Dubbo is 415km north west of Sydney at latitude 32.2˚S, west of the Great Dividing Range in the Western Plains region of NSW and at an elevation of 275 metres. It is a major agricultural and tourism centre on the Macquarie River. Summer temperatures are generally in the range 16˚-32˚C but can rise as high as 44˚C. Winter temperatures are in the range 3˚-16˚C but can fall as low as –5˚C. Annual rainfall is in the range 400-800mm with a mean of about 600mm. A characteristic of the summer climate is low humidity of around 36 percent at 3pm, as Dubbo is about 400 kilometres from the sea. The hot summer climate, high diurnal (day/night) temperature swings and the low humidity have been important cues informing the design concept of the ILC.

Project description: The new building is the first of a new campus at Dubbo for Charles Sturt University. It is located on a barren 70 hectare site with few features, no trees and minimum falls, on the outskirts of the city, behind two hospitals and adjacent to a TAFE College, a new senior high school and the University of Sydney's proposed Rural Clinical Education Centre. The ground within the curtilage of the new building has a slight fall to the north. The building is to form the focus of teaching, learning and support for the staged development of the campus. The architectural expression of the building sets out to represent an innovative educational approach that is inherently exciting and unorthodox. The building is 1600 square metres area and cost $4.28 million including roads and infrastructure. The actual building cost per sq.m is calculated at $1860, on a par with or below the cost of conventional education buildings of this nature.

User requirements: The educators involved in developing the brief for the project particularly wanted a building that would be unusual and that would set an invigorating physical context for their innovative educational objectives – making a clear statement that it was not a place of conventional (boring) education. The ILC accommodates a variety of activities in and around a central atrium including learning and teaching resource facilities, interactive video studios, seminar and tutorial rooms, independent study areas, computer laboratories, staff rooms and administrative offices. Many of the educational programs are offered through the medium of live two-way video tutorials by staff located at other campuses of CSU.

Building form: The ILC is (perhaps appropriately) an 'egg'-shaped building around an oval interior atrium. It appears from outside as a two-storey building, but has actually 12 different levels as the fall of the ground has been used to generate a split-level configuration of the section. Exterior walls are therefore curved and wrap around the atrium form, which is crowned by the highly visible and symbolic air intakes to the cooling 'shower towers'. The long axis of the building is east to west, to minimise unwanted low summer sun, and there is a long facade to the north, to maximise access to welcome winter sun. Sun control canopies are a feature over all windows, including those facing south, because they also function as wind deflectors. An unprotected corrugated polycarbonate screen to the main staircase faces due west and would seem to be a source of unwanted heat, but is an inexpensive solution using Ampelite Solasafe, which is claimed to have a thermal performance equivalent to good heat reflecting glass, but with less light transmission, which is not critical in this situation.

People circulation: The building is entered through a single secure entrance which leads, through an outer presentation area with toilets, to the inner oval atrium which has a novel, and very clever, helix spiral ramp. This curved ramp follows the curve of the atrium and provides the main access to all of the 12 levels of the building – the floor levels follow the rise of the ramp with all rooms located on the outside wall. It is also a social promenade, facilitates wheelchairs and prams and obviates the need for expensive lifts. A single staircase connects the top of the ramp to the ground floor level. A second external door exits from the atrium at ground level to a secure outside

01 The first building for Charles Sturt University's Dubbo campus is clad in reflective corrugated steel sheet interspersed with wind baffles and shade screens.

02 Dubbo's climate informed the thermal massing of the building, sited in a barren landscape with few remarkable natural features.

Shower tower air flow diagram

sitting and eating area. Each of the two entrances has an air-lock lobby to avoid loss of heat in winter or loss of 'coolth' in summer.

Air circulation: Another key feature of the design is the system of air circulation which is clearly manifest by the four 'shower towers' located in the central atrium. These have a structural function and are formed as tubular steel lattice towers that support the roof. Within each square structural tower is hung a square, off-white Ferrari-canopy fabric tube held in place through tarpaulin eyes with rope ties. Located above roof level are the four feature fly-screened air intakes to the top of each tower. Then comes the really innovative aspect – within the top of each of the four towers are large shower heads which cascade water in about 1mm rainfall sized droplets down the inside of the fabric ducts, inducing air movement down the ducts, cleaning the dust out of the air and, importantly, in hot weather reducing the air temperature through evaporative cooling – the system is called 'passive downdraft evaporative cooling' (PDEC).

In summer, cool air is emitted into the bottom of the atrium space through large round drums of metal mesh at the foot of each tower. A second cooling strategy is available in these 'shower towers' in the form of a mist spray from a secondary water circulation system with atomiser nozzles. The cool air in the base of the atrium is drawn upwards by natural buoyancy through permanent vent grilles at low level in each room and across each room to external wall vents over the windows at high level. The building management system (BMS) controls automatic dampers at the top of the shower towers, to control air intake levels, and the external high-level outlet louvres on the external walls.

Wind baffles are located on the outside to reduce the neutralising effect of prevailing winds. The only energy consumed by this system is that needed to drive the water circulation pumps and the BMS, otherwise it is a purely passive system.

Thermal performance: When I visited the ILC in Dubbo, it was the worst possible conditions for keeping a building cool – an uncharacteristically very hot late March day with high humidity. External temperatures were 40˚C in the shade. Another uncharacteristic difficulty was low equinoctial sun penetration onto the bottom of windows. The immediate impression upon entering the atrium of the building at around midday was one of coolness. The sound of the cascading water in the 'shower towers' was most pleasant and appeared to provide 'white noise' that blanketed individual voices and activities. A printout from the BMS at 1pm confirmed outside temperatures at over 40˚C and internal temperatures ranging from a best of 25˚C, though a median of 26.5˚C and a worst of 28˚C. Nevertheless, some staff, particularly those located in offices on the north side of the building, were uncomfortable although their individual room thermometers indicated 28˚C. The secondary mist spray system was not working due to a pump failure, but the users consider that it raises the humidity to an uncomfortable level anyway. A large vent in the top of the atrium is opened automatically by the BMS in extremely hot conditions to exhaust hot air out of the top of the building. The design of the wind baffles is under review to see if it can improve free air movement through the rooms (portable free-standing fans are currently in use).

Thermal mass: The provision of high thermal mass in the structure is a given for good thermal and energy performance in a climate like Dubbo's with high diurnal swing – significantly cooler nights and warmer days in an average range of 13˚C in winter and 16˚C in summer. The ILC is constructed with load bearing brick masonry consisting of 110mm single skin external walls, appropriately insulated and clad externally with sun reflecting light coloured corrugated steel sheet ('reverse veneer' construction), and internal walls of 240mm solid brick. Ground and upper floors are in-situ concrete. Night purging, in the form of through-ventilation on summer nights, cools down the thermal mass and stores 'coolth' for hot summer days, thus moderating internal temperatures against exterior heat. Warmth within the building during winter days is retained in the thermal mass into the night and through to the following day.

Insulation: As well as the external walls, the roof is also highly insulated. Glass fibre has been used.

Winter heating: The space heating source is natural gas fired boilers. Hot water is provided to a water filled hydronic loop of polyethylene pipes cast into the ground floor slab which heats the ground floor rooms and the main atrium space. Continuation of this system into the upper floors was considered too difficult given the multiple floor levels. The upper floors are, therefore, heated with conventional hot water filled radiators. While it would have seemed reasonable to use solar heated water for space heating, it is argued that water temperatures from solar at 40˚C are not high enough to allow radiators to function effectively, which requires 70˚C. During winter, two of the four 'shower towers' continue to operate to induce fresh-air movement into the building. This can be heated by opening vents from the top of the atrium into the top of each 'shower tower'.

Water: The water used for the 'shower towers' is rainwater harvested from the roof and stored in a 25,000 litre underground tank. The falling water is collected in large gratings in the bottom of each tower, filtered and recirculated into the underground tank for re-use. As at the Albury campus, a natural site water movement system is envisaged that will collect storm water and allow it to circulate by gravity from top to bottom of the site through reed beds and swales to storage ponds thus naturally cleansing it before recirculation for re-use in toilet flushing or irrigation, or release into the neighbouring creek. Water heating is by a Quantum heat exchanger system backed by electricity.

Landscaping: Work has begun to improve the site landscaping. The local council and community have assisted in planting 3500 trees and shrubs from selected naturally occurring local plant communities, which are particularly suited to salinity mitigation and ground water use.

Lindsay Johnston is a practising architect and specialist environmental consultant and a Conjoint Professor of Architecture at the University of Newcastle.

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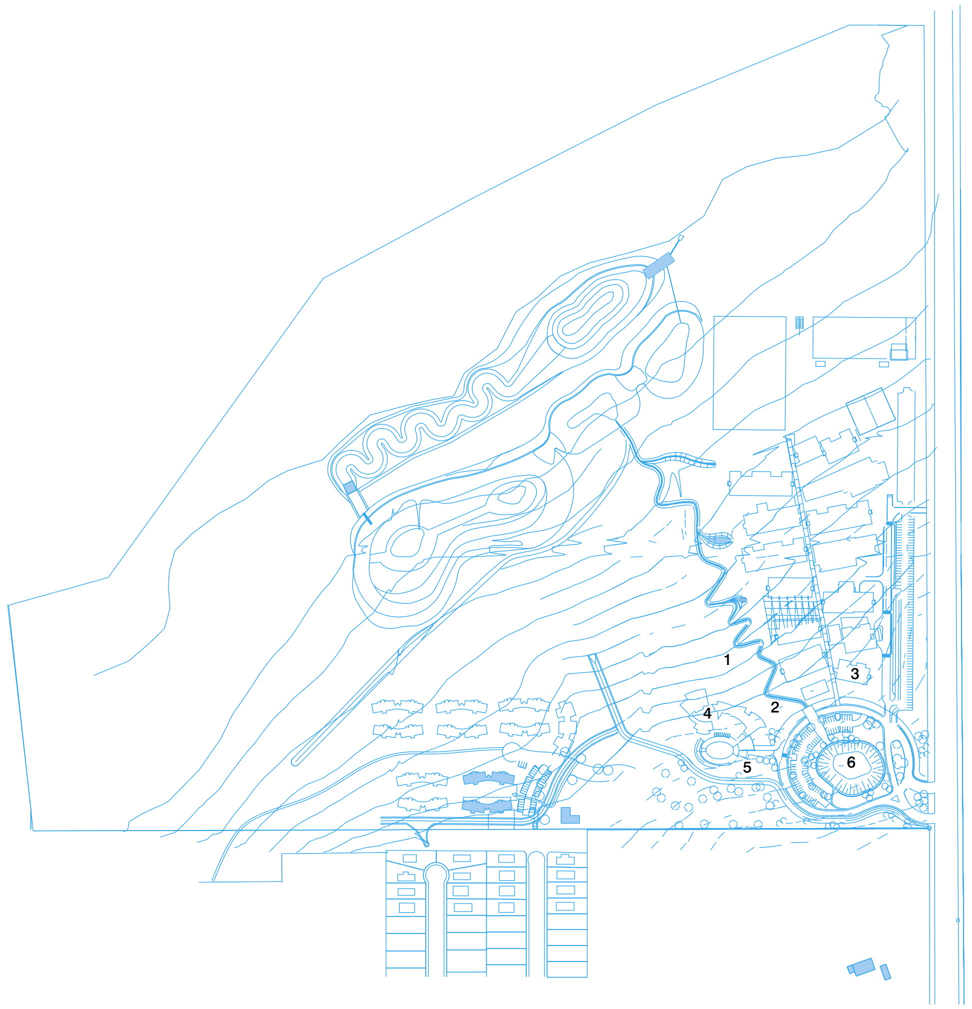
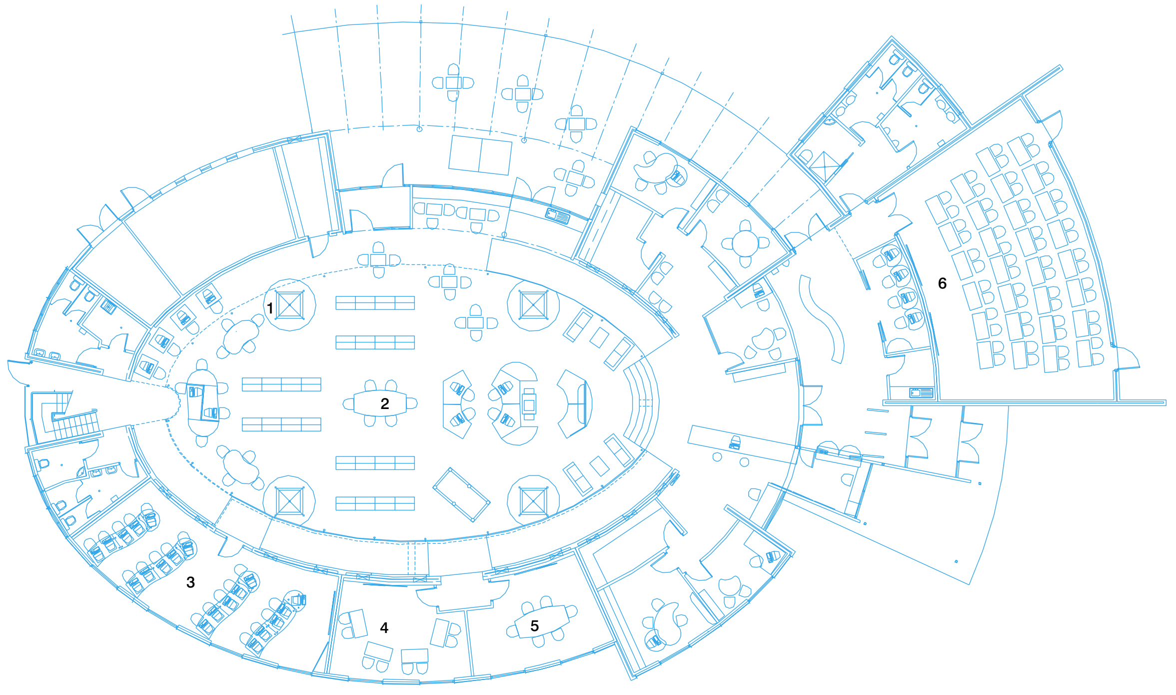
03 & **04** The distinctive fly-screened air intakes atop the shower towers appear above the building mass – a reverse veneer construction.

05 The four towers, punctuating the elliptical atrium, are the key to the performance of this building, representing a world first in environmental technology.



Site plan

1 Site of proposed community village
2 Artificial creek
3 Dubbo Senior High School
4 Proposed stage two
5 Interactive Learning Centre
6 Recycled water dam



Lower level plan

1 Passive downdraft evaporative cooling towers
2 Resource centre
3 Computing
4 Tutorial
5 Projects
6 Presentation room

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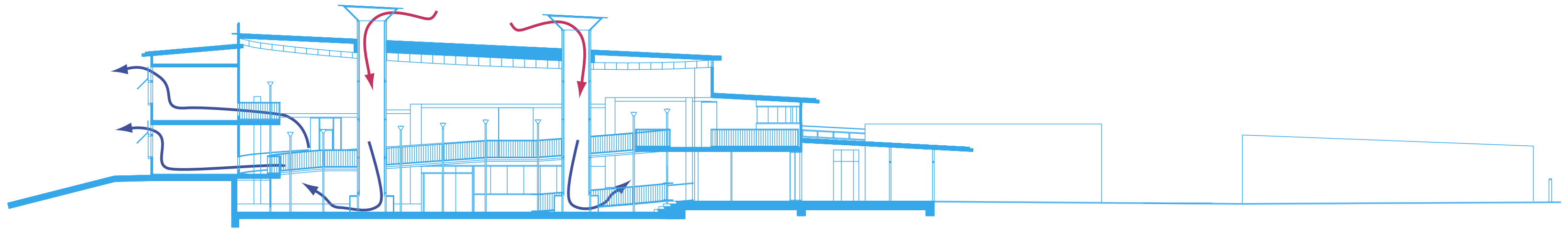

Section

Project Summary Interactive Learning Centre, Charles Sturt University, Dubbo, NSW ■ **Architect** Marci Webster-Mannison – in association with CA Walton & Associates ■ **Project team** Marci Webster-Mannison (design), Clark Walton, Daniel Walton, Craig Rosevear (design development and documentation) ■ **Structural, civil & hydraulic consultant** COR ■ **Project team** Livio Chiarot, John Karikios, Grant Potter, Sean Dywer ■ **Passive design, mechanical, electrical consultant** Advanced Environmental Concepts ■ **Project team** Ché Wall, Chris Arkins, Peter Reedy (Linclone Scott) ■ **Landscape consultant** Dubbo City Council, Troy Gully Landcare, Old Ganarrin Garden Centre ■ **Project team** Ken Rogers, Tim Olsen, Sylvia Besse, Peter Walkom ■ **Quantity consultant** Bruce Davies & Associates ■ **Acoustics** Escape Consultants ■ **Builder** Rawson Construction ■ **Construction manager** Bob Chapman

06 As well as supporting the roof structurally, the towers also shower water down the centre of the fabric tubes for 'passive downdraft evaporative cooling'.