A TALE OF FOUR AUSTRALIAN SPORTS HALLS

Michael Heenan[1]

INTRODUCTION

This is the story of four apparently simple buildings. It is the tale of four Australian sports halls. Their forms range from a heavy, low concrete structure; to a floating lightweight building using steel and plywood; to another with an ephemeral transparent form and no apparent mass; and, finally, to a building that looks like a grandstand at the side of a cricket pitch.

The buildings have won multiple Australian architecture, design, and building awards, and one went on to win the Best Sports Building award at the World Architecture Festival.

What is remarkable about the buildings is that all four—each designed by Australian architects Allen Jack+Cottier—were designed in response to the same, some might consider prescriptive, design brief from the New South Wales government. Or, more specifically, they were designed to meet a standardised briefing document from the NSW Department of Schools and Sport & Recreation NSW for indoor sports halls.

Each building takes its form from the landscape and the microclimate in which it is located, and each serves to educate its young visitors about sustainable building, as well as operate in a sustainable manner.

KEY WORDS

architecture, design, sporting facilities, multi-purpose, leisure facilities, natural ventilation, ESD

ONE BRIEF, FOUR RADICALLY DIFFERENT RESPONSES

Every school in New South Wales is required to have an indoor sports hall. Some are more attractive than others. Some are more innovative than others. Known simply as 'sports and recreation halls' or 'general purpose utility halls,' these halls are routinely oblong-shaped, brick-and-tin buildings that serve a multitude of purposes, from indoor sports, to drama productions and assemblies, to the occasional dance party for teenagers.

Allen Jack+Cottier (AJ+C) was commissioned to design four of these multi-purpose school facilities and in each case were highly constrained by the budget, as well as the specifics of a single brief that covered all four. Nevertheless—despite a multitude of challenges and restrictions—AJ+C were able to design four extraordinary buildings that are radically different from each other in terms of form, structure, materials, *and* the way they respond to sustainability issues.

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"As an architect in these sorts of things, you are highly constrained—we had a comprehensive briefing document that controls everything you do, that almost makes it standardised," says Michael Heenan, Principal and CEO of AJ+C, who led the design teams on all four projects. "We set out to understand that document *completely*—so that the pragmatic side became entirely known to us. Only at that point do you begin to lift it above the norm."

The results have sprung from differences that are driven in large part by the environment, the climate, the microclimate, and the sustainability issues of each site. These factors have, in turn, fundamentally shaped the response from both the architects and for the buildings themselves. All four buildings function as templates of shelter and sustainability, using frugal and often high-technology materials and simple forms to reduce energy consumption to a minimum, while at the same time educating their users about sustainability in the harsh Australian climate.

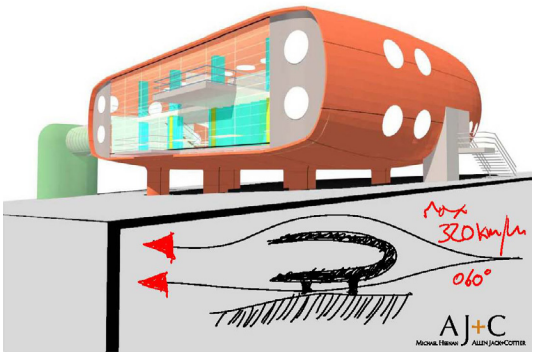
All four buildings are designed so they require no heating, no cooling, and often very little artificial lighting. They collect their own water and recycle it and they require very little power.

"Experientially, these buildings are designed so that you feel you are part of the landscape, you are part of the site—the breezes that flow across it, the daylight that comes and goes, the night sky," Heenan explains. "You are part of an ancient history of the site. You are not enclosed in a damp, dark, smelly sports hall—you are part of the landscape."

How Allen Jack+Cottier Works

Teams are formed around each of the projects, creating highly collaborative and innovative small groups that interact directly with the client. AJ+C has worked everywhere from Antarctica to Inner Mongolia—and most places in between—and it has designed entire new cities (the firm has done three to date).

Challenging one's method of thinking is central to the way Allen Jack+Cottier works. The firm always tests assumptions and relays that into a pragmatic way of thinking about the job at hand. For example, in the research station AJ+C designed in Antarctica, it had to deal with 90 m/sec winds that were constant from one direction only. The entire building had to



be shipped in containers across the wildest seas on earth. This not only informed the design of the building, but set AJ+C on a journey of exploration of materials that continues to this day, and is fundamental to the company's way of thinking about sustainability and design.

High-Technology Materials Underpin Low Energy Consumption

The practice's design philosophy is driven by the intersection of high technology and sustainability with low energy—AJ+C are always seeking new materials that can be used to reduce energy consumption and help buildings perform at their best in the harsh Australian climate. "We take inspiration from the possibilities inherent in the absolutely highest-tech materials available," says Heenan, "like carbon and other materials mostly used in the design of racing yachts and surfboards. These are materials that push the levels of tolerance and safety to their limits."

The research station in Antarctica gave AJ+C the ability to think about new materials and use them in different ways—but within the constraints of the briefs it had been given.

In Antarctica's extreme weather conditions, the site experiences days of all-day sun in summer (11° to 30° sun angle) and 24-hour darkness in July and August (–2° sun angle). Temperature extremes can range from –40°C in winter to +3°C in summer with wind speeds reaching approximately 90m/sec.

The design philosophy we developed during this project influenced our approach to the four sports halls outlined in this article.

MILSON ISLAND SPORTS & RECREATION CENTRE

"A simple functional brief and modest budget have been translated into a building of great clarity and formal expression that sits exceptionally well in its beautiful natural surroundings."

—Jury citation, Australian Institute of Architects
Colorbond Award for Steel Architecture 2012

Awards

2011 Australian Institute of Architects NSW Commendation for Public Architecture

2011 Timber Design Awards, Highly Commended: Interior Fitout Award—Commercial

2011 Master Builders National Excellence in Building and Construction Awards, National Commercial/ Industrial Award—under $5 million

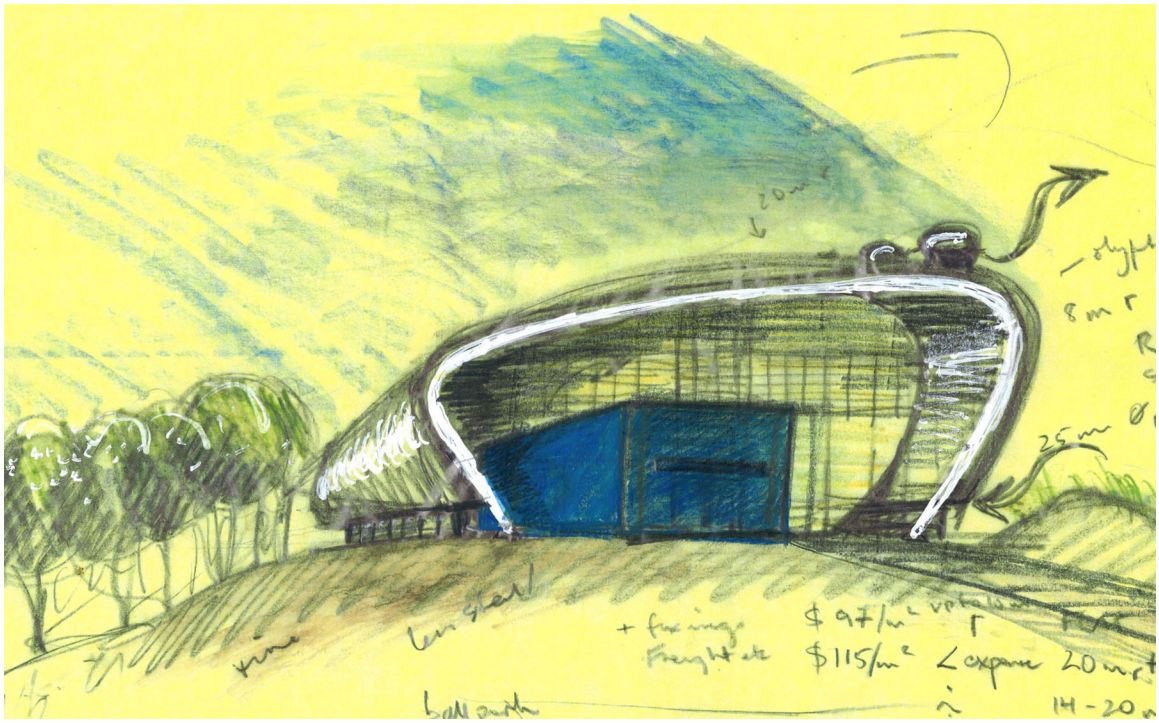
2012 Australian Steel Institute Steel Design Awards NSW, Winner of Buildings—Small Project

2012 Australian Institute of Architects NSW, Colorbond Award for Steel Architecture

2012 Australian Institute of Architects National Colorbond Award for Steel Architecture

Milson Island Sports & Recreation Centre is located on a remote island in the Hawkesbury River north of Sydney. The island is a holiday camp focused on health and social equity to which groups of young people—many from the inner city or remote rural areas—visit for weekly residencies. The highly-trained staff are experts in lifting self esteem as part of the treatment of depression and the prevention of suicide.

The brief was to design a robust, cost-effective sports and recreation hall. The 600 sqm hall would be used for a myriad of activities: group activities, conferences, sports, martial arts, fencing, volleyball, basketball, netball, dances, and musical events. The centre also had to be viable for other conferences and corporate groups to assist in generating revenue to support its main activities.



"The aim is for whoever comes here to participate and enjoy it, no matter what their mental or physical capabilities," says Heenan. "The focus is on sport and recreation, but it has other—equally important—purposes in allowing young people to heal in the context of the beautiful Australian bush setting."

Design Approach

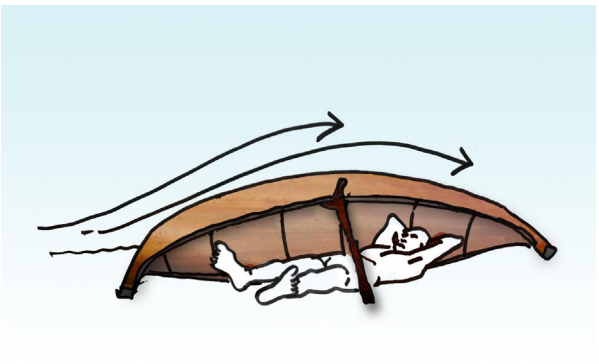
The design team and the team of consultants typically sit down together at the outset and begin a building's design via an iterative process that combines materials analysis and an environmentally-based analysis. "It's no longer an individual who designs these buildings," explains Heenan. "The design grows out of the team approach we have in everything we do. Our approach—consistent across all four buildings in this study—is always to do extensive structural analysis, materials research, and environmental modeling to create a building that works on a multitude of different levels."

From an environmental/sustainability point of view, the siting of the building is crucial and is a fundamental concern. The Milson Island Sports & Recreation Centre is in an extremely high-risk fire zone in the heat of the Australian summer.

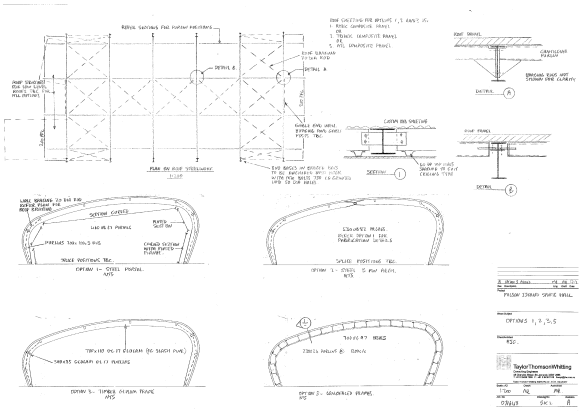
"We wanted to have the building surrounded by trees, but were told that was not possible," says Heenan. "We decided to resist this edict by measuring every tree—both trunk and canopy, on the site. For a few critical trees, we completed root and branch mapping. The entire building was then engineered to reduce the size of the restricted bushfire zone and many trees could remain."

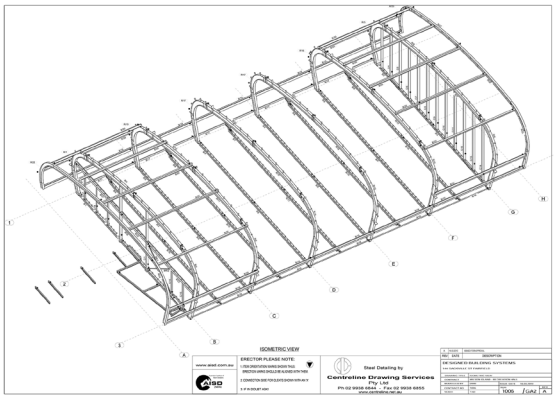
Heritage Studies

The studies performed before the design was developed include heritage studies. The island is largely natural bush and mostly uninhabited even by the original landowners, the *Darkinung* people. "We realised the ancient inhabitants of this land came across to the island on canoes that they made by peeling bark of a tree, tempering it in fire and folding it up," Heenan explains. "They never lived on the island but if they went over there for fishing, and were caught in a storm out there, it was by simply tilting this crude canoe on its side, propped up by sticks and a fire to leeward, that they were able to keep dry."



The upturned canoe signified the essence of shelter on the island and became the model for the building shape. The building requirements emerged from its materials and environmental and structural analysis, but the shape was formed from the notion of a simple canoe upturned.





For the framework, steel became the obvious option because we had to take the whole building out to the site on a barge and were restricted in both weight and size. Measuring the capability of the barge to transport the framework became part of the job—steel can be cut apart and put back together again and regain its strength 100%.

One of the breakthroughs achieved in this building was to use plywood to its full capabilities. A flat sheet of plywood doesn't have much strength, but a curved sheet has enormous strength. AJ+C integrated this principle into the entire building. The plywood skin inside the building acts in a number of different ways:

- It is smooth to allow the clean flow of air through the building.
- It functions as the acoustic absorption system for the room.
- It is the bracing of the building (meaning columns could be done away with).
- It hides the ventilation.
- It hides the lighting.

The plywood works on multiple levels—and everything else in the building is designed to do the same.

The metal sheeting on the outside and the plywood skin on the inside all contribute to its structural ability. The shape of the building also contributes to that, and in addition, the

side loads on the building were reduced significantly because of its shape and weight. As a result AJ+C were able to coax the maximum amount of building from the available budget.

The building also functions as a bushland theatre. "In a way, this is its most important function," says Heenan. "At night, the curved wing shape of the new building acts as a proscenium arch to define the place for the campfire, which is an important part of each camp. It works both for the audience inside looking out to the gathering space, and for the audience around the campfire looking back into the hall," he says. "When the campfire is lit at night, and the hall interior is illuminated only as a strip of lights, the building seems to magically float in the surrounding bushland," he says.

Attached amenities and storage modules service the bushwalking activities, the fireplace theatre, and the oval. They also serve to define a clear and strong entry space to the hall.

High Social Equity Values

The building is used for camps and residencies for young people as part of a powerful program for the prevention of suicide and the reduction of depression. "About halfway through the design process, I realised that the fireplace was what it is all about—more important even than the days of sport," says Heenan. "So we changed our design approach and put the fireplace at the centre of the design. We realised it was actually more important than the building itself. So our simple building became only the proscenium to the real thing—the group gathering around the fireplace."

ESD Approach

Because of the careful study of every single tree in order to save them to meet the bushfire regulations, AJ+C knew eighteen months beforehand which particular tree branches would have to be lopped off. The firm approached the job with a thorough respect for the environment.

In addition, the entire building is a direct expression of its thermodynamic modelling. It was tested at every season of the year, and at various times of the day, to set up a natural and significant ventilation system that responds to the prevailing winds.

Accordingly, the shape of the building was realised as a wing. A wing on an aeroplane gives lift—in this case, it provides suction. The design opened the top of that wing to create a significant suction—creating a breeze where it was wanted and when it was wanted—and creating a ventilation system. The entire building was lifted slightly off the floor/ground to allow the breeze to come through. The smooth skin has no visible fixing, lighting, wiring, or bracing and augments the flow of air over the building.

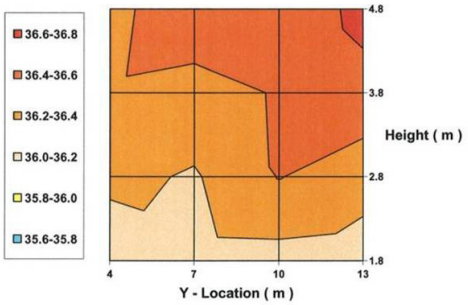


Figure 4: Thermocouple readings of air temperature at X = 6.15 m after 45 min of simulation time.

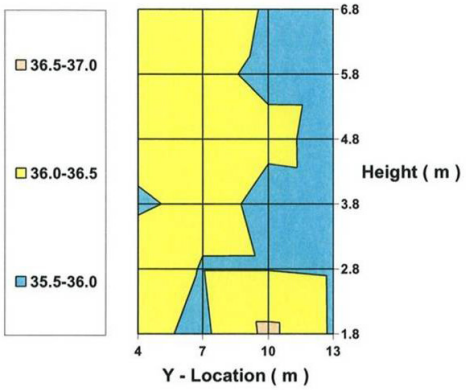


Figure 4: Thermocouple readings of air temperature at X = 22.15 m after 45 min of simulation time.

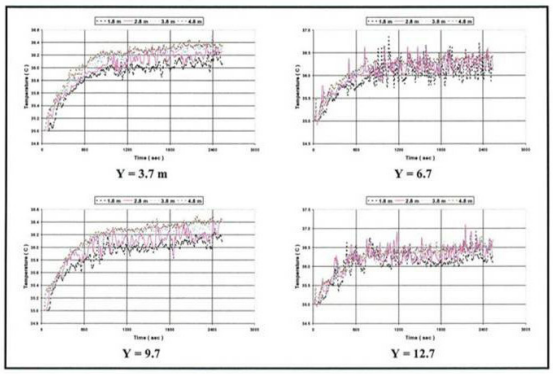


Figure 2: Air temperature as a function of time at different height at X = 6.15 m.

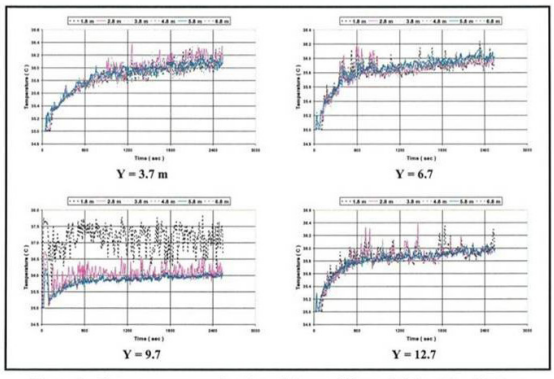
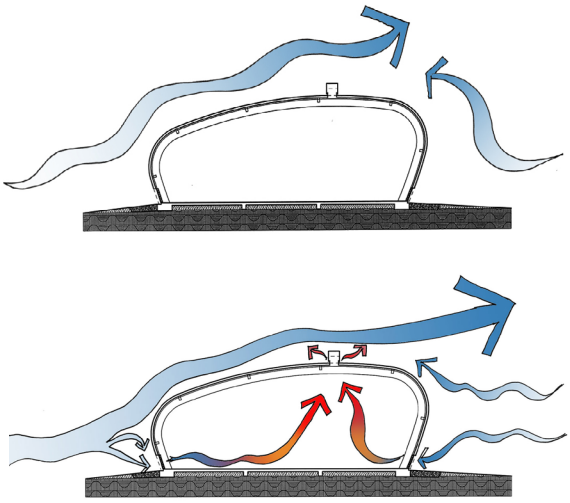
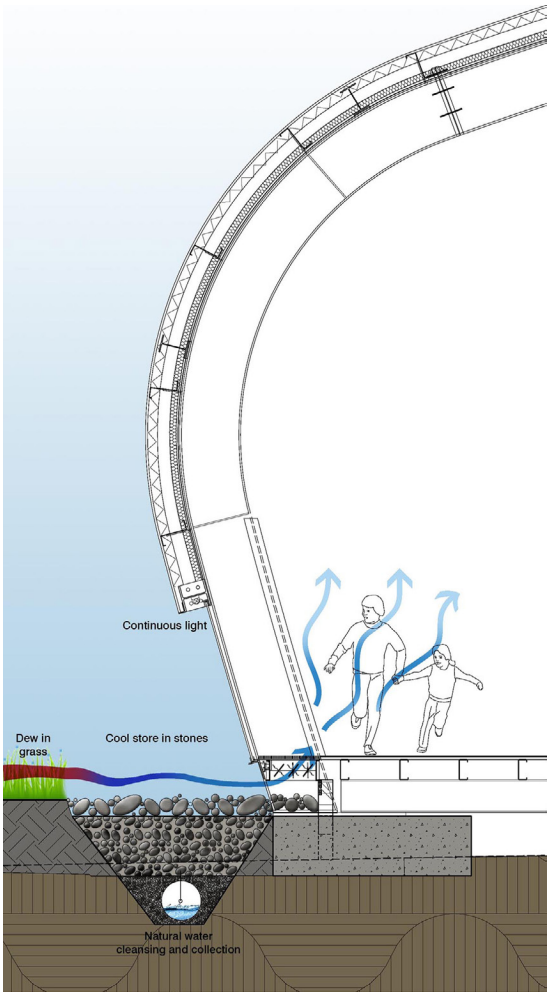


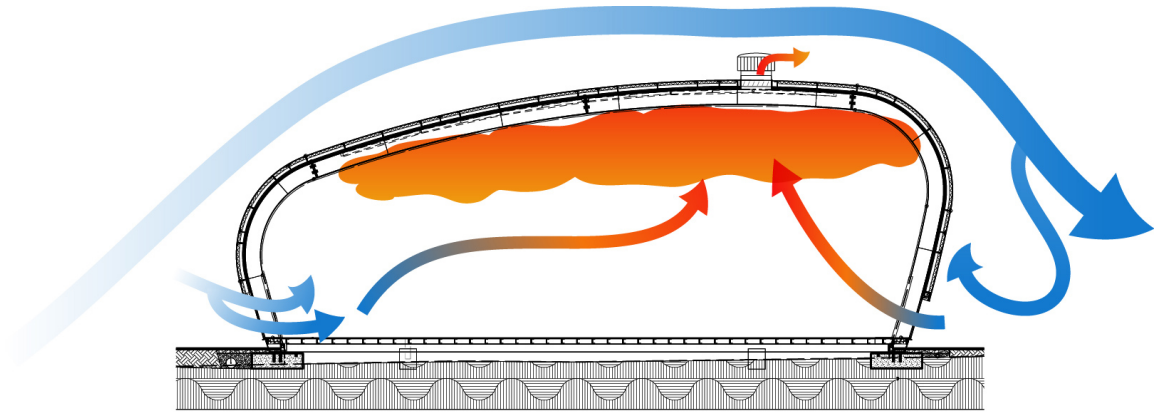
Figure 3: Air temperature as a function of time at different height at X = 22.15 m.



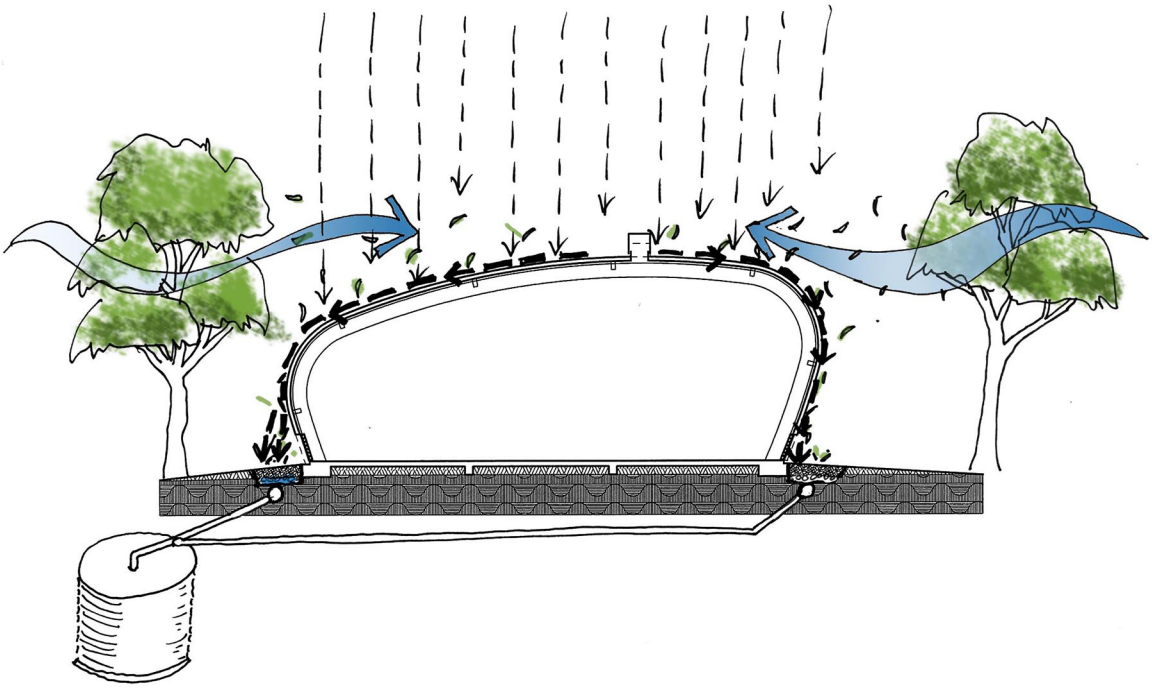


In summer, the heat generated at the site creates a convection current, which is assisted by the suction and the shape of the building, cooling the building down. An oversized river stone garden was used almost like a refrigerator. Overnight the garden cools to about 3 or 4 degrees Celsius below the rest of the surrounds. The dew in the grass assists in this process and the temperature of the air coming into the building is dropped.

In winter, everything is closed up to form a heat plume or blanket around the people inside.



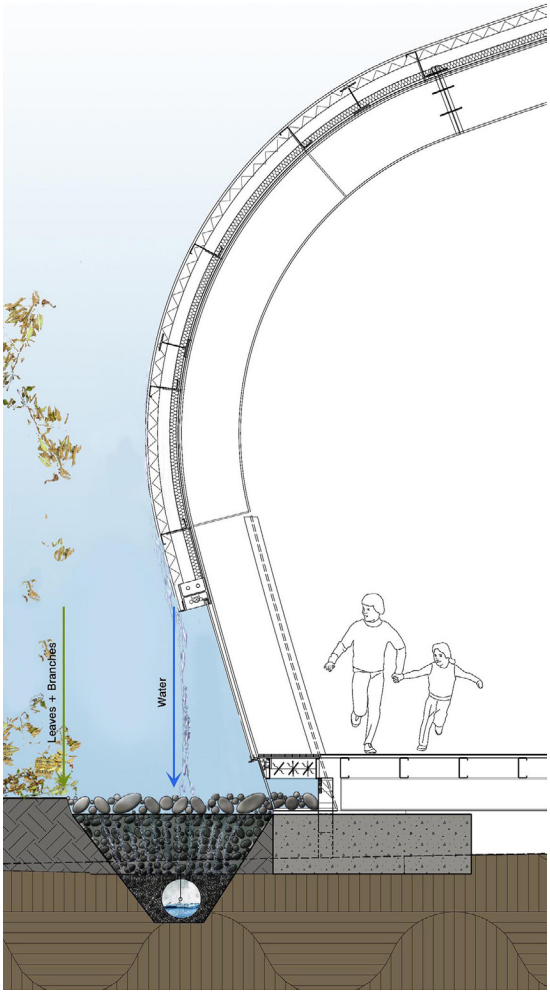
Rainwater is celebrated and collected, naturally separated from debris, and naturally filtered. "Although this building is sited on a waterway, water remains precious," says Heenan. "When it rains, you see and hear and smell the rain falling on the building and the trees and grasses—it's an amazing transformation."

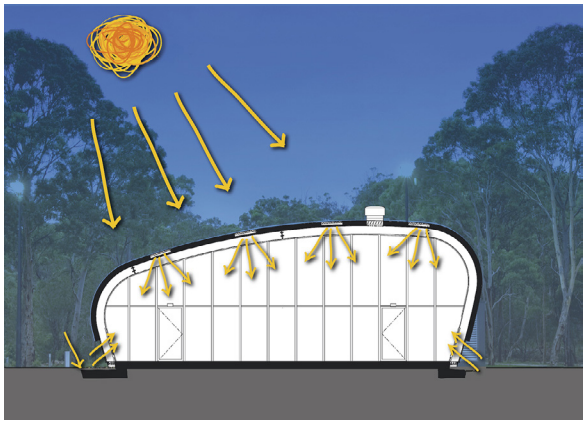


The shape of the building is specifically designed to separate the leaves and branches that fall on the roof from the rainwater. The water uses surface tension to stay on the sloping side walls and falls through six levels of different sized stones, which act as a filter. By the time the rain water passes through this natural filter, it is purified. Meanwhile the branches and leaves fall to the ground separately and can be picked up by hand.

A slot of glass—up to the eye height of a typical 12-year-old—connects them to the Australian landscape beyond. "We wanted them to know where they were and to enjoy their time out of the city," says Heenan. "This became difficult for the structural engineer because he wanted to take all the side walls of the building to the ground. In the end, we got what we wanted."

Amenities have to service the whole site—including orienteering and hiking and cricket—and these were plugged on to the outside of the building. You enter the building through these amenities blocks. This was used as a strategy to squeeze space, as well as to assault the visitor's senses with colour, before they burst into the larger space inside.





Light levels in the building are almost art gallery–like—it is rarely necessary to use lights during the day.

The visual quality of the building is also extremely important. "We particularly didn't want this building to be seen from the water—and the siting that we fought so hard for helped us enormously with that," says Heenan. The light colour of the exterior and the shadows that fall onto it from the trees camouflage it from the outside. "It blends with the trees and the sky," he says, "in fact there is one tree on the site which was the source for every colour used in the building."

"This building is a study in the simplicity and the essence of shelter," says Heenan. "You are always aware of this building on its site. It seems to float above its landscape in a delicate

sort of way and starts to talk to the site: the rustle of the leaves, the movement of the branches, the sound of the birds and the movement of the air. It is really the site that created this building."

BERRY SPORTS & RECREATION CENTRE

> *"This delightfully simple building presents a clear, clean image that demonstrates the rigour of its thinking and its craft. The structural resolution of bracing within the roof plane allows the wall elements to be surprisingly thin. During the day the starlight holes add colour and intensity. At night, they become a glowing array of abstract light spots visible from across the fields."*
>
> —Jury comments, 2008 Public Architecture Award,
> Australian Institute of Architects

AWARDS

2009 World Architecture Festival Award, Sports Category, Barcelona
2008 Public Architecture Award, Australian Institute of Architects NSW
2008 Blackett Prize for Regional Architecture, Australian Institute of Architects NSW

The Berry Sports & Recreation Centre is set on a beautiful agricultural site at Berry, south of Sydney, surrounded by gently rolling hills and grazing farm animals. The Centre comprises a collection of institutional buildings that cater to school and community groups, families, and the corporate sector. AJ+C were initially asked to complete a master plan for the whole site, including a dining hall and seminar centre.

The brief was to design a simple but robust multipurpose recreation hall within a tight budget. "We thought 'great—we can adapt [the Milson Island building],'" says architect Michael Heenan. "However, when you actually sit on a site, and think about a site, the building starts to tell you what it wants to be." The physical environment here was completely different, and the climate was completely different, so it turned out that the second brief generated a completely different design.

The Brief

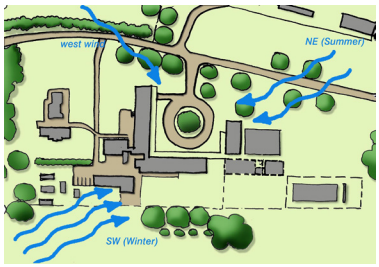
Again the brief was to design a multi-purpose hall for sports—netball, volleyball, basketball, theatre sports, climbing walls, performances, dancing. It was also to be used as a shelter at night and in inclement weather.

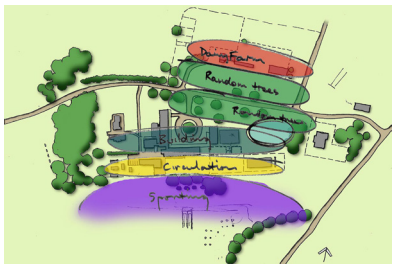
"As with the Milson Island building, everyone is there to participate," adds Heenan. "It's not for elite sports or sportspeople—it's designed to bring people who don't normally participate in these kinds of activities into the fold. And so the building has to respect that."

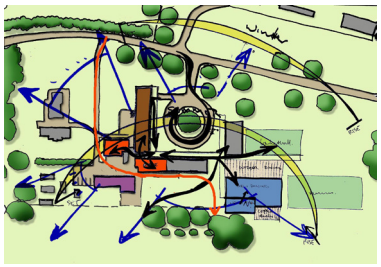
Design Approach

"In Australia we are used to abundant sharp sunlight and powerful blue skies. But here it was the night sky that made the most powerful impression on me," says Heenan. "It was like a sea of stars against a carbon-black background. We are so used to the spill of light in cities that we lose the context of the night sky—the ancient inhabitants of the land relied for their very existence on being able to see and interpret the night skies, they relied on the stars—for direction, seasons, storytelling, and communication."

The site is on a gentle downward incline on a piece of farmland at the edge of the established built area. The building was cut into the hill, reducing its visible scale and grounding the building into the landscape. The building has a simple form and scale, similar in appearance to an agricultural farm building. "For longevity and robustness, heavier solid materials were used, relating to the adjacent site buildings of masonry and concrete," says Heenan.

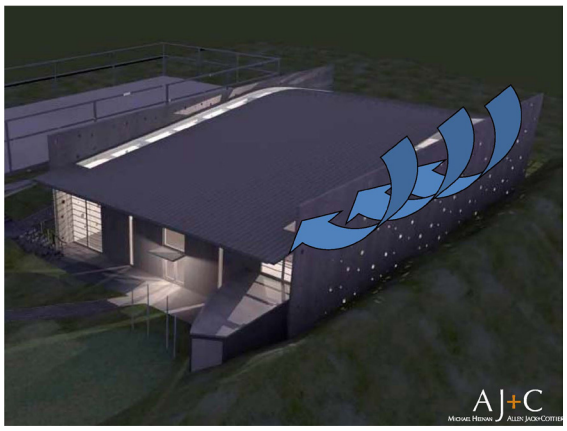






"The structural and materials analysis phase gave us a big advantage. We had already learnt to unload side forces on previous buildings," he says. "The materials analysis had drawn us to concrete or cement, because of its ease of erection and the quality of its finish; however, the structural analysis led us to think of thinning the concrete by introducing a Vierendeel Truss into the roof."

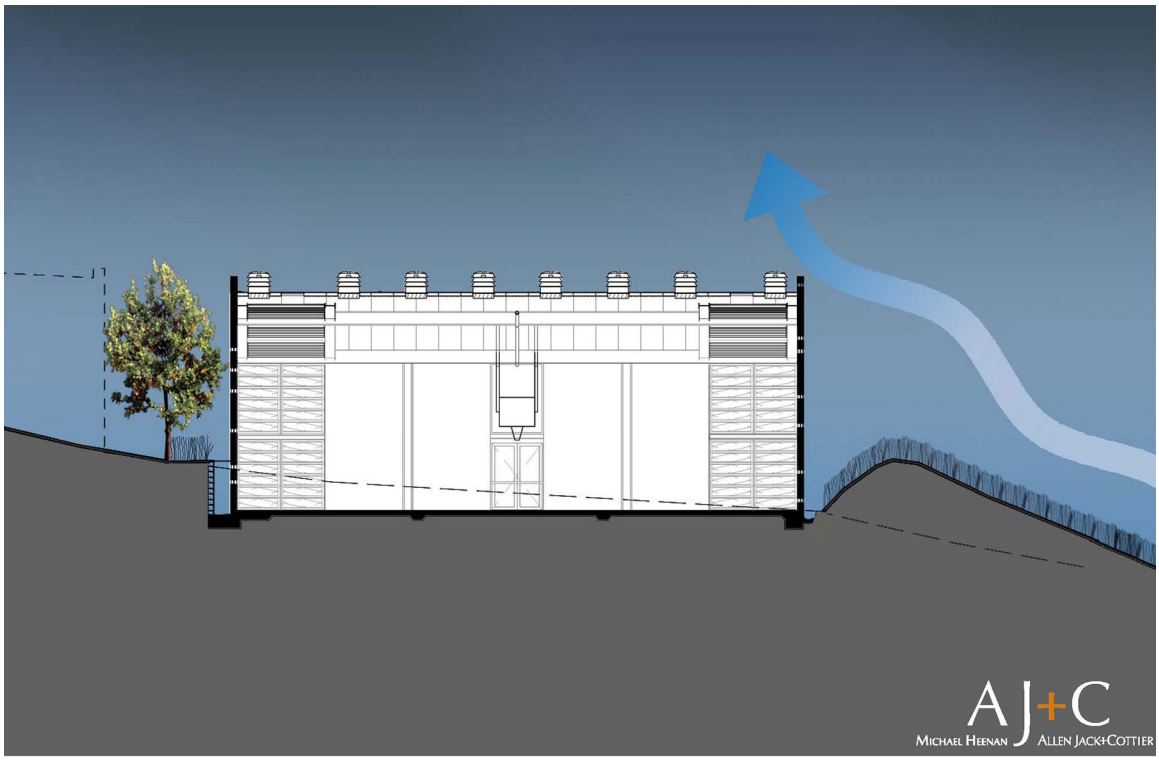
This meant that all the side forces would be taken along the Vierendeel Truss down to the end wall and unloading all the turning moments and the turning forces in the side walls.



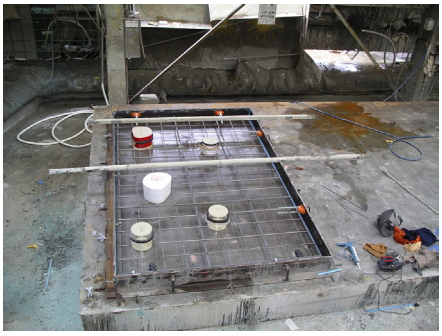
The inclusion of a Vierendeel Truss also allowed the architects to:

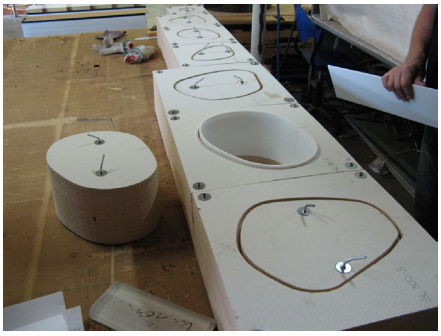
- Eliminate eighteen steel columns from the building
- Reduce the thickness of the concrete, and
- Unload the weight of the building.

AJ+C also sunk the building slightly and created a berm at the lower edge of the site. "This meant we ended up unloading side forces by 30 percent," says Heenan, "and saving significant amounts of money. We also took out a plan that would require 1.2 kms of purlins by using a composite roof system. This gave us a crisp, clean interior without any visible bracing, wiring, lighting, or fixings."



Once all the big savings had been made on the structure, AJ+C started to think about how light could pierce the concrete by way of shards of glass. The solution took an enormous amount of analysis, drawing, and prototyping. The firm tried many different ways, with the answer coming via a half-tonne prototype.





"If you try something different in building construction, it HAS to work—if it doesn't work, the whole building fails," says Heenan. "So this research is vital. In this image you see chamfers for the concrete blocks, stopping blocks and moving membranes to stop the capillary action of water through the model, sacrificial and permanent film and release mechanisms to make sure it is not damaged during construction."

"We designed and worked out how to make these windows, then commissioned them in six different sizes and three different colours," he says. "They were chosen to reflect the auras of receding and progressive/advancing stars in the sky."

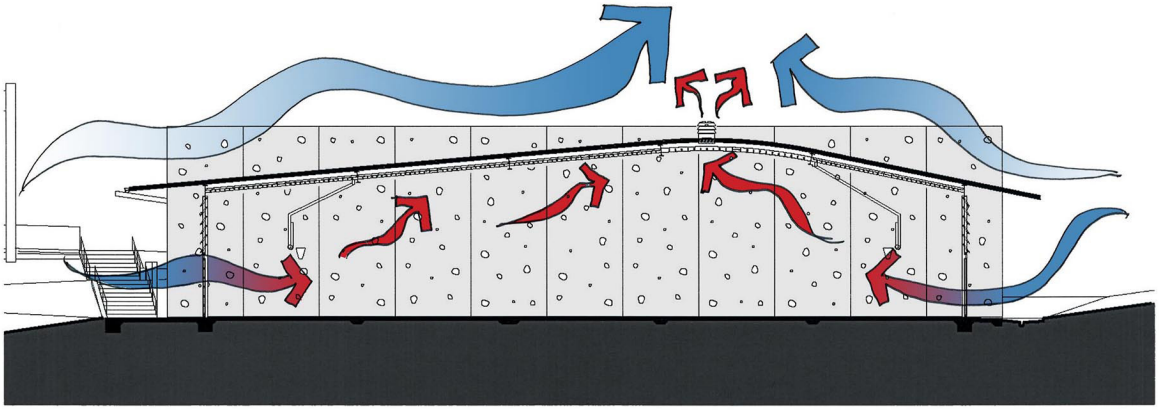
Before approving and having the windows fabricated, the architects regularly turned up at the factory to ensure the technical specifications and the quality of finish were as intended. The end result uses two panel designs which have been placed to give a random, scattered effect. "It's great to see the light coming through the walls, and vignettes from the inside to the outside, and beyond," says Heenan.

An Innovative Approach to a Tight Budget

Naturally, the job of an architect does not finish with the design, but with the delivery of the building itself. "Sometimes that means going beyond the role of the architect to become part of the construction process," says Heenan. At the end of the design phase, the building was over budget. By commissioning the concrete supply and fabrication, the steel work, and the roof supply, before going to contract with the builder, AJ+C were able to save some considerable costs. "That meant we were able to hand them over to the builder as fixed-cost items, thus reducing the risk and therefore the cost," he explains. This approach took these items out of the builder's budget and meant we were able finally to bring the building in on budget."

ESD Approach

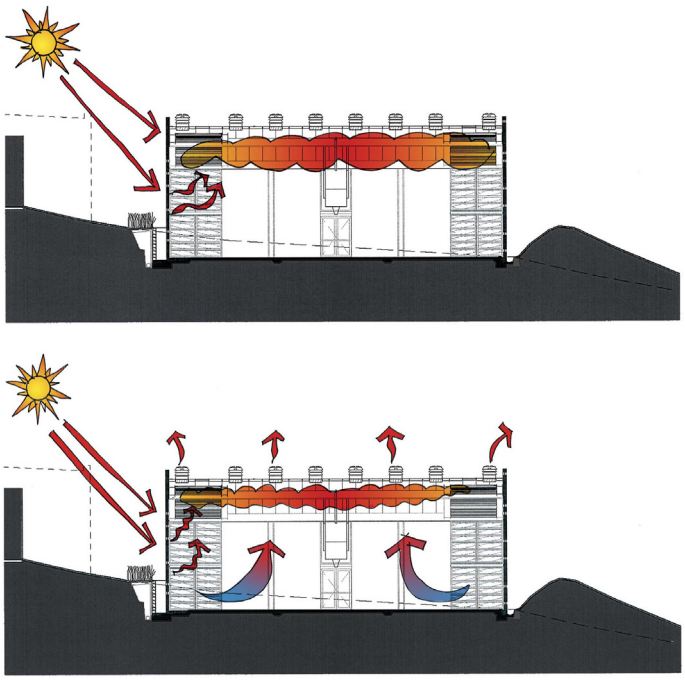
"This building works hard, both by day and by night. When you are on site you are always aware of it—of the weight and the shape and even the smell of the concrete, and how it reacts to the wind and the rain," says Michael Heenan. "So the building functions as a large 'breathing machine' with cooling and air that is turned on, and turned off, reacting to the prevailing breezes."



The entire shape of the building is the result of the thermo-dynamic modelling—it was tested through all the seasons and at all times of day.

Like the first building at Milson Island, it uses a 'thermal chimney' effect for ventilation. A significant ventilation system uses gigantic louvres electronically controlled to turbines on the roof.

Also as at Milson Island, it is the shape of the prevailing wind that creates a natural ventilation system. The building is ventilated in summer, forms a heat plume in winter, and is bathed in natural light to a point where it doesn't need lights during the day. Gradually in the

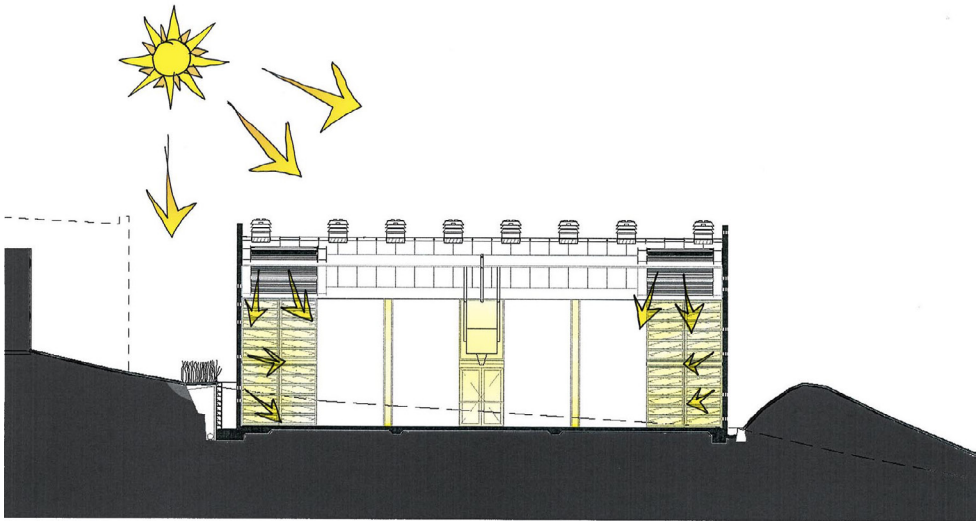


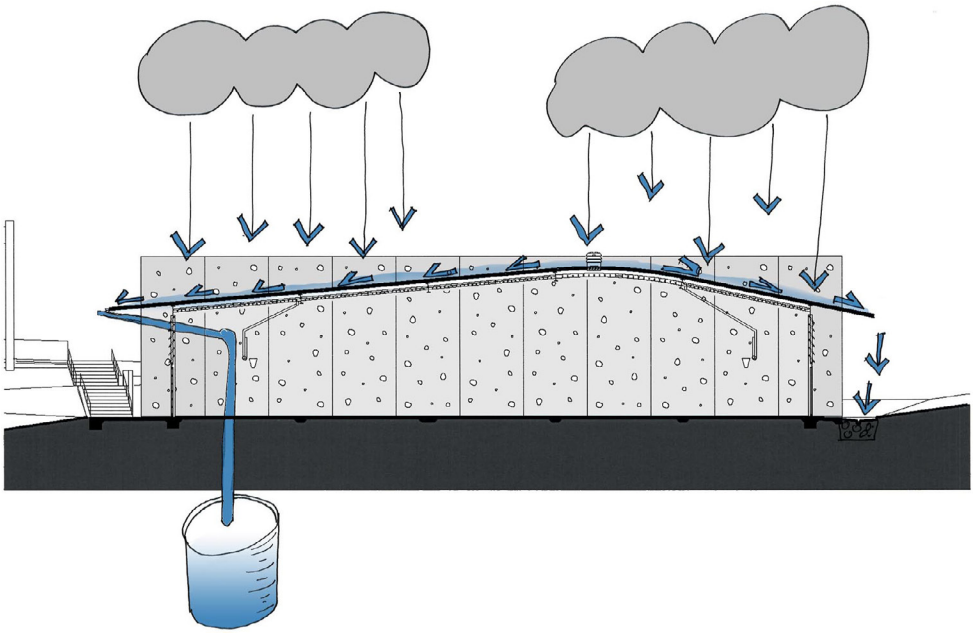
evening the skylights start to dim and electric lighting takes over. See film clip here: http://youtu.be/uOvYTCgrGRk

As with the Milson Island building, water is collected on the outside of the building, channelled down into filtration and collection points and made available for reuse.

The level of thinking and understanding of the environmental response of the building offers a valuable additional benefit: the building itself, like the one at Milson Island, is an educational tool.

In 2009, the building won the Sports Building of the Year at the World Architecture Festival. It was an unexpected triumph for a modest, low-cost sports building in rural NSW and it was up against the Wimbledon Centre Court Redevelopment and the home of the NY Jets baseball team (Jets Training Centre and Corporate Headquarters) As a result, hundreds of visitors—from Australia and overseas—visit the site each week, to see how an environmental building should work.





LAKE AINSWORTH SPORTS HALL

"The particular way the materials have been used to catch light, the curved form of the building, and the large roof overhang that allows a ground level pebble drain in place of gutters, reveals an interest in the poetic revelation of weather phenomena—not simply the mediation of climate."

—Jury comments, Commendation for Sustainable Architecture, AIA Awards (NSW) 2007

Awards

2007 Australian Institute of Architects NSW, Winner, Blacket Prize for Regional Architecture
2007 Australian Institute of Architects NSW, Commendation Sustainable Architecture
2007 Australian Institute of Architects NSW, Commendation Public Architecture

Brief

AJ+C was commissioned by the Properties and Grants section of Sport and Recreation NSW to design a sports hall for basketball, netball, and badminton, as well as meetings, dances, and theatre performances and films at Lake Ainsworth, NSW. "At last," thought AJ+C, "we can repeat what we had already done," remembers Michael Heenan. Unlike the previous buildings however, this location was in Australia's semi-tropics, up near Byron Bay on the far North East

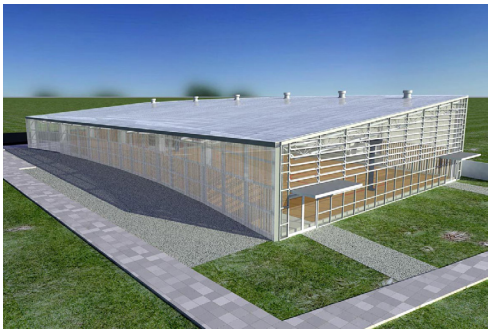
Site Plan
1:1000

Coast of New South Wales. The climate was characterised by intense wind, heavy rainfall, salt air, and monsoons. Furthermore, the building was to be used intermittently.

A preliminary environmental analysis showed there was a low diurnal variation (i.e., the temperature change between day and night wasn't large). This meant there was little benefit from having mass in the building. So again, a complete rethink was required. The fact was that simply by moving into a different climatic zone from the other two halls, a building with an identical brief became something quite different to the others, driven by the environmental and material analyses.

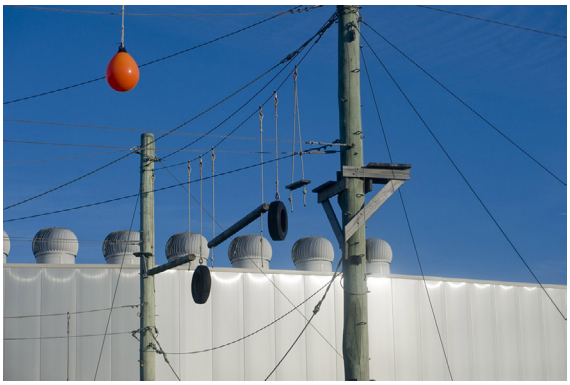
Design Summary

Lake Ainsworth Sports Hall is a building of light, a dramatic luminescent box-like structure reminiscent of the great European exhibition halls of the late 19th Century. The structure opens recreational space to new possibilities with a form stripped of stylistic convention.



The building's translucent skin responds to the changing quality of light throughout the day: reflecting the colours from morning to sunset, then glowing with light at night. It reaps the sunlight but avoids the summer heat with a transparent, insulating UV-resistant material. The material transfers as little as one percent solar heat and negates the need for any artificial lighting during the day. At each end of the building sit 'boxes' containing services, storage, and administration.

The way the building works is used to educate students about the basic principles of sustainable design. The theory is clearly evidenced in practice: the students open and close the louvres and control the turbines to respond to seasonal variations.



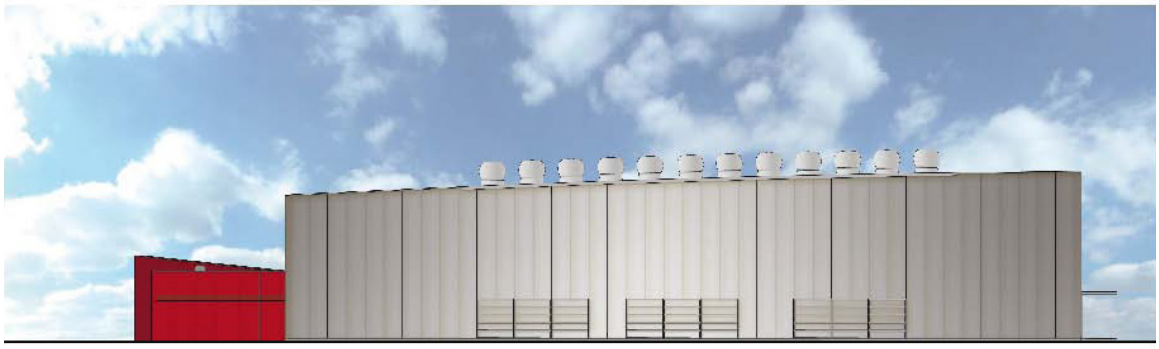
This building was achieved only marginally outside the budget of a brick and tin hall alternative, which would have had the lights and fans on all day. It uses less materials, less weight, and less steel, needs less artificial illumination, and produces significantly less greenhouse gas and ozone depletion during its lifetime.

Materials Innovation

AJ+C strove to create an ephemeral, almost translucent building, that had no mass; a building where its skin was to become a moderator of the powerful northern sunlight and blue skies (remembering that in Australia it is the northern aspect of a building is the warmest and gets the most sunlight—the reverse of the Northern Hemisphere).

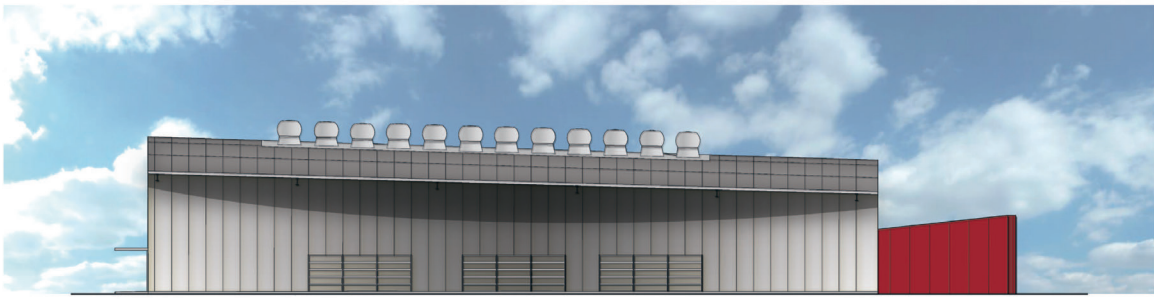
The single biggest issue this Southern Hemisphere building had to deal with is soaring daytime temperatures of up to 46 degrees Celsius and down to 8 degrees Celsius at nighttime in winter.

In the materials analysis, it was identified that a four-wall heat-stop cellular polycarbonate material could be infused with millions of tiny metallic mirror-like particles to diffuse light and deflect heat. And then a real breakthrough came halfway through the project when a factory was found in Israel that could vary the percentage of metal in the polycarbonate mix. AJ+C were then able to specify the eastern façade with 18 percent heat and 20 percent light,



with the south almost clear,

the west façade with 3.5 percent heat and 5 percent light,



and the roof with 1 percent heat and 3 percent light.

The process of understanding the details and capabilities of materials and the iterative experimentation with thermodynamic modelling led to a rare moment when the entire concept became manifest almost instantly. That is to say, the project moved from thinking about the programme and the frugality of materials to a simple study in light.

What looks like a very simple building without detail is, in fact, a sophisticated collage of materials that react to their different orientations, and in so doing, greatly impact and increase the efficiency of the thermal performance of the building. "We also discovered we could put the material on backwards without affecting its performance," says architect Michael Heenan, "so that the building was devoid of detail and the building was reduced to its most simple form and functioned simply as a moderator of the northern light."

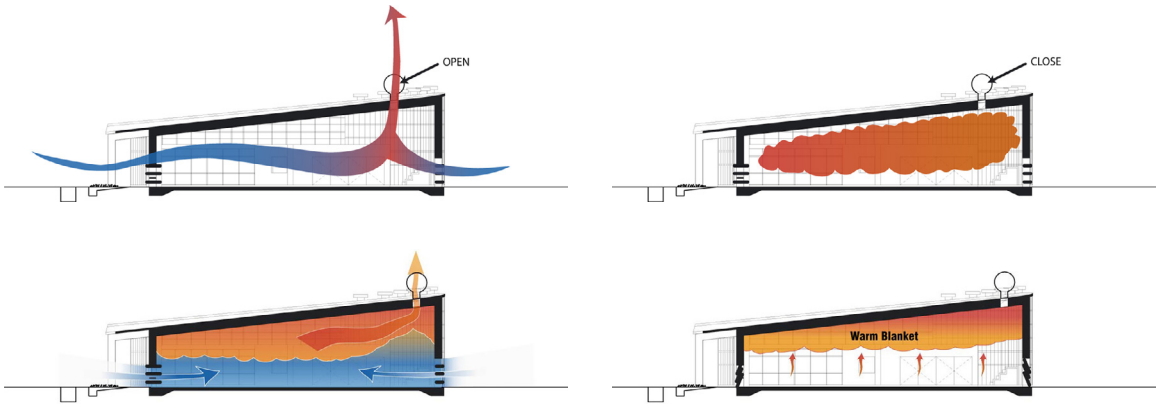
From the early morning the building starts to glow with sunlight on its exterior.

And then at night, it becomes a glowing lantern.

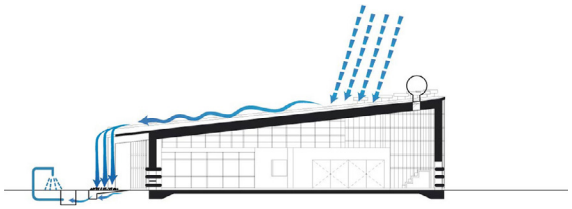
ESD Innovation

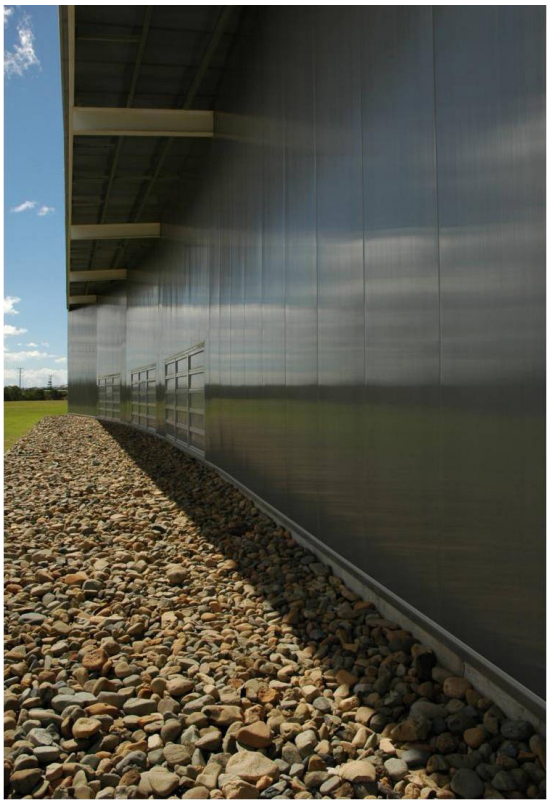
The building delivers a 100 percent saving on electricity and lights during the day, and offers 100 percent water reuse. Thermal performance is managed through the selection of materials and harnessing the natural elements to heat and cool the building. The building takes a reductive approach, using materials frugally to achieve less weight and steel than comparative sports halls. Wherever possible, AJ+C have used environmentally-certified products including forest-certified timber flooring, and low-VOC paints and joinery.

The main space can be closed off at each end to respond to outside weather conditions. A dozen giant, operable wind-driven turbines combine with banks of louvres to create a natural ventilation system that reacts to prevailing winds. The slope of the roof, the curve of the walls, and the 3D shape of the main mass are all integral to these flows.



As in previous buildings, the rain water is collected, filtered, and re-used across the site. Water shoots off the un-guttered roof to an overscale river stone garden which filters it before collection for future use.





The volume of rainwater, and harnessing and managing it effectively, is a real issue in the subtropics. You get tropical downpours of up to 6 inches in a day. The notion of filtering rainwater requires gardens that are four times bigger than the ones further south and the overhangs need to be three times bigger than the other buildings. "The water fall, the sheer force of the wind, and

the intense downpour is dramatic," says Heenan. "Here, the rainwater can even run uphill, so strong are the winds."

This building is completely recyclable/reusable. The entire building can be dismantled and re-used at another site, including the polycarbonate sheet skin. The entire structure is bolted, rather than welded together, providing complete transportability.

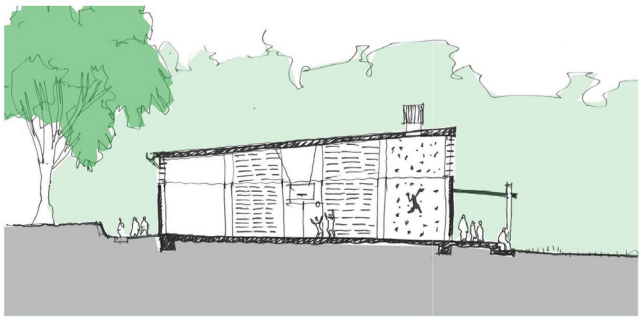
BROKEN BAY SPORTS & RECREATION CENTRE

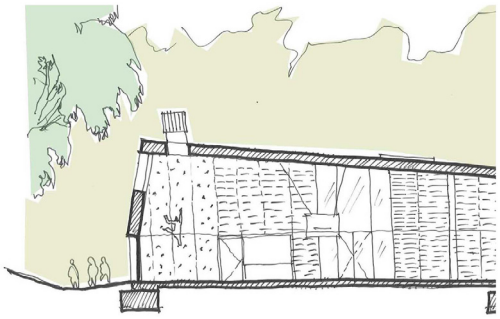
The final sports hall is located at Broken Bay, approximately one hour north of Sydney at the mouth of the Hawkesbury River, within a 600-hectare National Park. Access to the location is by a 20-minute ferry ride from Brooklyn Wharf. The oldest continuously operating sporting and recreation centre in the NSW Government's portfolio, it has been used continuously by groups of school children and young people since 1939.

The site houses a collection of 'natural' timber and sandstone buildings within a setting of eucalypts and lawn, sloping down to a beach, surrounded by 240 hectares of rugged bushland. It is self-sufficient in water supply and waste disposal.

The Brief

The brief was very similar to the earlier ones: it should be a new building that was more than simply a large hall. It should respect its environment, comfortably accommodate 200 people for evening recreation and program activities, including dances and various lessons (including fencing), hold activities during wet weather and games nights, and function also as an education tool for ESD principles. The design should also push the ESD and design envelopes, but without comprising budget constraints.

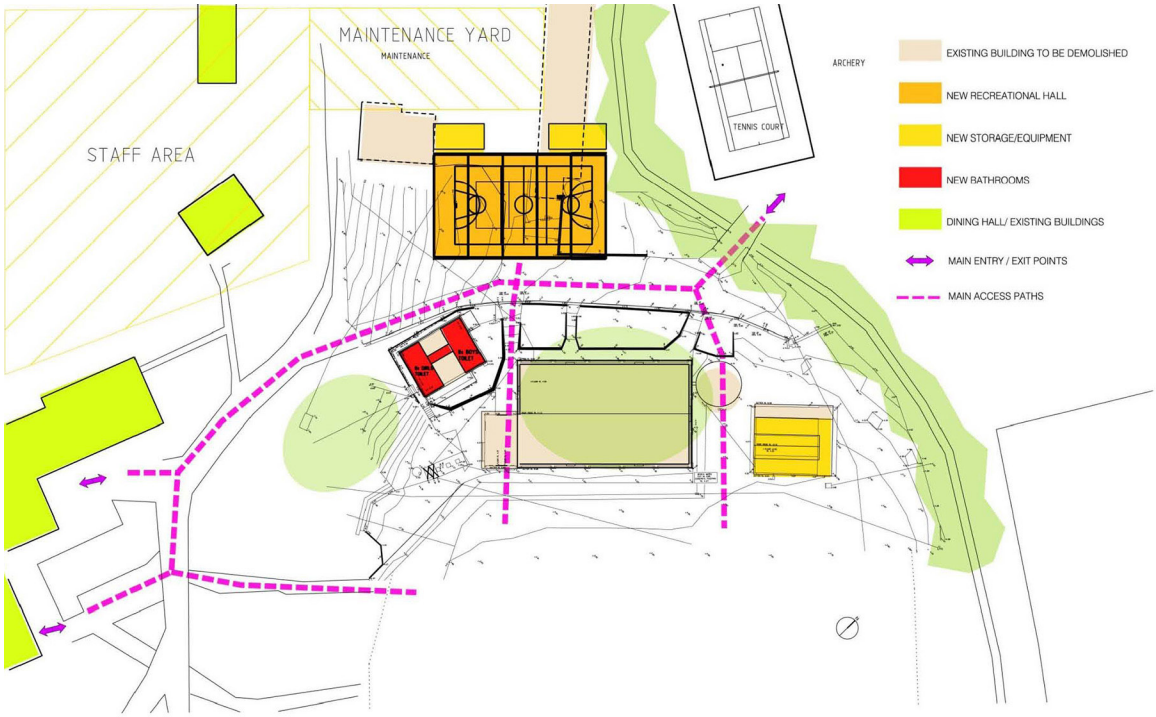


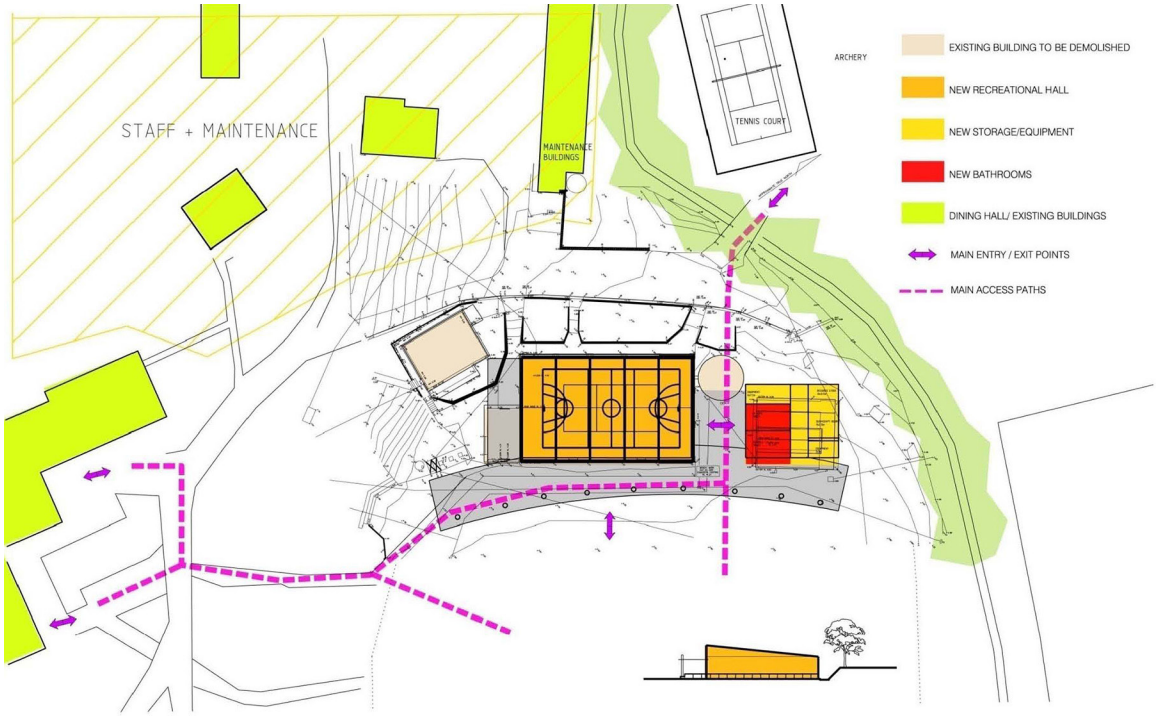


Design Approach

Each building's conditions generate the type of building it should be. "What you are doing is letting the building grow out of the site," says Michael Heenan. "The aim here was to transform a simple structure into a building that is both playful and appropriate for its predominantly school-aged users, one that provides excellent thermal comfort through passive means, all within a very tight budget."

Much like at Milton Island, AJ+C challenged the local fire department for the location on the site they had hoped to provide. In this case however the Fire Department would not let the building be built between the trees. Instead the building had to be shifted 25 metres away from where we had designed it to be.





Although 25 metres sounds might sound like a small distance, it had a big impact on the design. "Because of our iterative way of working, moving the site even 25 metres changed the building entirely," says Heenan. In this case, the architects had to move the building from under the protective tree canopy to exposure in the full sunlight and out into significantly more harsh conditions. The change was significant. "Our thermodynamic modelling showed stronger breezes, different directions and different levels of sunlight hitting the building. Even

the water flowed differently across the contours of the site," explains Heenan.

At Broken Bay the building was conceived as a 600 sq metre hall with a simple folded roof that addresses itself to a large, open oval and out to sea. "It's a building that bends over itself, and cradles a slightly bigger [piece] at either end to collect all the rainwater," says Heenan. "This simple form connects the hall to the oval, acting like a pavilion addressing the park, but also mimicking the shape of the surrounding hills beyond. The arch is vast, acting like an extended tree canopy, providing excellent protection from the environment in all conditions."

Materials Innovation

Every time AJ+C has created one of these buildings, there are advances in use of materials. "Here the polycarbonate used at Lake Ainsworth has been taken over by 100 mm thick double-walled material that gives an almost clear view to the outside, but functions like a fully insulated wall," explains Heenan.

Additionally a combination of simple materials, easily transportable on a barge, was used to keep the building costs down. The steel frame was prefabricated and metal roofing and wall cladding used. Two service pods flank the building's main body.

ESD Innovations

Natural ventilation is achieved through large operable louvres on the walls, coupled with large ventilators in the roof. A basic thermal chimney is thus created: cool air enters through the louvres, rises, and is expelled through the ventilators. The roof is also insulated, allowing warm air to coalesce in winter.

Good natural daylight is harnessed by skylights and large windows.

Because the building is in a remote area accessible only by water, this site is not connected to the metropolitan water supply. As a result, all water on the site must be self sufficient, collected largely from the huge roof and stored until use. Fluorescent T5 light fixtures are low energy and long life.

CONCLUSION

Allen Jack+Cottier's architecture practice and design philosophy is shaped by its strong focus on environment, landscape, sustainability, and high technology, always with a desire to explore the potential of new materials—opening up new possibilities for how we build, live, conserve resources, and limit our energy consumption.

Each of these four simple buildings responds in a very specific way to the challenges of its microclimate, and the specific opportunities offered by its site. All four were designed to essentially the same brief, yet the resulting buildings are radically different from each other in terms of form, structure, materials, and the way they respond to sustainability issues.

All four buildings function as templates of shelter and sustainability, using frugal and often high-technology materials and simple forms to reduce energy consumption to a minimum, while at the same time educating their users about sustainability in the harsh Australian climate.

TECHNICAL/MATERIALS INFORMATION

Milson Island Indoor Sports Stadium

'Supawood' Acoustic Slotted Plywood Lining—http://selector.com/au/suppliers/supawood-architectural-lining-systems
'Viridian' 10.38mm and 12.38mm Low E comfort Plus Clear 82 glass—http://viridianglass.com/Products/default.aspx
'Lysaght' custom orb roofing with 'Colorbond Ultra' finish—http://www.lysaght.com/
'One Steel' Structural Steel Framing—http://www.onesteel.com/home.asp
'Gerflor' Taraflex action Sport 50 Sports floor—http://www.gerflor.com.au/commercial-vinyl-flooring/commercial-vinyl-floors/taraflex-actionsport-50-multi-use-5-0,254.html
'Acromat' Sports Equipment—http://www.acromat.com.au/
'Austube' Lighting—http://www.austube.com.au/

Berry Sports and Recreation Centre

'Lysaght' perforated custom orb ceiling lining—http://www.lysaght.com/
'Supawood' Acoustic Slotted Plywood Lining—http://selector.com/au/suppliers/supawood-architectural-lining-systems
'One Steel' Structural Steel Framing—http://www.onesteel.com/home.asp
'Austral Monsoon' Stormglaze Aluminium Louvres—http://www.australmonsoon.com/index.php@option=com_content&task=view&id=112.html
'Hanson Precast' wall panels—http://www.hansonprecast.com.au/Products/ArchitecturalPrecastWalling.aspx
'Ritek Building Solutions' roofing panels—http://www.ritek.net.au/
'Ampelite' clear roofing panels—http://www.ampelite.com.au/
'Gerflor' Taraflex action Sport 50 Sports floor—http://www.gerflor.com.au/commercial-vinyl-flooring/commercial-vinyl-floors/taraflex-actionsport-50-multi-use-5-0,254.html
'Austube' Lighting—http://www.austube.com.au/

Lake Ainsworth Sports Hall

'Danpalon Australia' wall and roof cladding—http://danpalon.com.au/
'One Steel' Structural Steel Framing—http://www.onesteel.com/home.asp
'James Hardie' Exotec Cladding—http://www.jameshardie.com.au/products/exotec.html

Broken Bay Sport and Recreation Centre

'Stramit' roofing with Colorbond Ultra' finish—http://www.stramit.com.au/product-range-pages/66
'Supawood' Acoustic Slotted Plywood Lining—http://selector.com/au/suppliers/supawood-architectural-lining-systems
'James Hardie' Scyon Linea Wall Cladding—http://scyon.com.au/linea.html
'James Hardie' Scyon Matrix Wall Cladding—http://scyon.com.au/matrix.html
'Gerflor' Taraflex action Sport 50 Sports floor—http://www.gerflor.com.au/commercial-vinyl-flooring/commercial-vinyl-floors/taraflex-actionsport-50-multi-use-5-0,254.html
'Ampelite' clear roofing panels—http://www.ampelite.com.au/
'Austube' Lighting—http://www.austube.com.au/
'Acromat' Sports Equipment—http://www.acromat.com.au/