TROPICAL SUSTAINABLE DESIGN CASE STUDIES

Edge Hill State School Environmental Interpretive Centre

Project type: Institutional

Location: Edge Hill, Cairns, QLD Australia
Year Completed: 2006

- **Education for a sustainable future and valuing biodiversity are key themes delivered in the Centre's programs**
- **This case study is written for the students, to help them understand why the building is special**

OVERVIEW

Edge Hill State School has a focus on respecting diversity and developing critical thinking and creativity to be global citizens in a sustainable world. The school is well resourced with excellent facilities including the new Environmental Interpretive Centre.

Education for a sustainable future and valuing biodiversity are key themes within programs delivered from the centre. All outdoor and environmental education programs are linked to the school curriculum, team building and leadership objectives. Strong links are fostered with local communities by providing information about environmental issues and serving as a venue for community forums.

The Centre is a large open plan space used to support larger groups of students or support community events.

This case study is targeted at the students of the school, helping them understand why this building is special.

PLANNING AND MANAGEMENT

The planning of this building was a team effort between the school, the architect and other specialist consultants like the structural engineer. The project team met to discuss the building objectives, including cost, size, use and sustainable design goals. Drawings were then made of the building so that everyone could see what it would look like.
For this building project, a Construction Environmental Management Plan (CEMP) was prepared to detail the planned sequence, methodology, program and environmental management of all construction work. The CEMP also ensured that the project complied with all the relevant environmental legislation. The CEMP covered aspects such as:

- A soil erosion and sediment control plan
- Dust control
- Noise control
- Vegetation clearing and weed control
- Hazardous materials
- Engagement of a competent Environmental Officer
- Environmental training of employees and subcontractors, where appropriate
- Stockpiling
- Temporary fencing and access control and
- Waste management

A building maintenance manual and electronic security manual was provided to the school at the end of the project.

SITE

The site is located within the school campus. The building overlooks sporting fields and swamp wetlands to the east, beyond the school boundary. Areas of lawn and trees within the school grounds are located to the south and west. The site was previously freshwater swamp land but had been filled, typical of reclaimed swamp land. This reclaimed fill is underlain by silty clay soils.

DESIGN

Cairns has hot humid wet season summers and warm dry season winters. The Environmental Interpretive Centre has been designed and built to be a comfortable building even during the hottest days. It is a healthy space that is naturally ventilated, and when you are inside the building it feels nice and cool naturally. It doesn't need air-conditioning because it uses passive design principles. These principles work with nature – particularly the sun and natural breezes – to keep the building cool.

The building is rectangular in shape and situated so that the short walls face east and west and the long walls face north and south. The east and west walls are short because they get the most sun and this helps prevent heat from coming through. Only small windows are used on these walls because the sun's heat travels quickly through glass. Not all heat can be stopped so the walls contain insulation that reflects heat back and slows down the transfer. The building also uses light weight building materials that don't hold the heat (in industry terms they have a 'low thermal mass'). This

building uses a lot of timber, which has a low thermal mass, and very little concrete, which has a high thermal mass. Finally, the rooms next to the hot east and west walls are the store rooms and kitchen – rooms that are not used regularly. On the western side, there is another school building close by that blocks some of the afternoon sun.

Air movement over our skin makes us 'feel' cooler, even if the temperature remains the same. This building has lots of windows and doors that open to the breezes, so wind can easily come into the building to help staff and students feel cool and relaxed. The breeze comes through all of the louvre windows, which are high enough to go from the floor all the way to the ceiling. The louvres and large doors are placed along the entire length of the North and South facing elevations. The louvres are especially good at catching and steering breezes. They will catch and steer the monsoon breeze that is our prevailing hot summer wet season breeze, and the South Easterly breeze that is the prevailing breeze during our dry season warm winters.

The cool breezes cross through the building, ventilating it and keeping it healthy. This passive design principle is called 'cross ventilation'.

Another design feature of the Environmental Interpretive Centre is the roof, which is like a big hat. Just as children are not allowed to play outside unless they have a hat on, a building needs a big hat to protect it from the sun's rays. The brim of a hat shades your face and a special part of the roof called an eaves overhang shades walls in a similar way. The Environmental Interpretive Centre has a big eaves overhang which performs this function but also prevents rain from getting onto the walls and in through the windows and doors. The roof also has to block the sun's heat, so white and light colours are used because they reflect rather than absorb the heat.

The roof of the Centre also vents out heat that may come into the building. Heat rises and the ceiling is specifically designed to let heat escape. It is made up of panels that have gaps in between, and the heat finds the gaps as it moves up. When it moves through the gaps and goes up towards the roof, it encounters a massive roof vent that draws the heat through and expels it out into the atmosphere. This is an excellent way of getting rid of uncomfortable heat and keep the building cool. The roof vent and heat drawing system is a very special and effective passive design principle.

Another aspect of the passive design of the Centre is the floor – which is raised off the ground. This helps keep everything in the building cool and dry and away from water, mozzies, sand flies and toads. It also helps people feel more comfortable if the buildings are raised above the ground, because the building is better at catching any wind to cool it down. The Environmental Interpretive Centre is raised off the ground and wind can go underneath it to keep the floor cool.

Along the wall that faces North, called the northern elevation, there is a very long verandah. In a tropical climate we can be outside for most of the year and verandahs keep us comfortable– out of the rain, in the shade and able to catch a breeze. When it gets very hot during the wet season, the monsoon wind comes from the North. Because this verandah faces North, it can get this wind. In Cairns, we have other sea breezes that come in from the ocean, and katabatic winds that come down from the mountains and hills around the city. These can also be taken into consideration when designing a building.

The Environmental Interpretive Centre is ventilated very well. The air in a tropical climate is very humid; in other words it holds a lot of water. A well ventilated building does not trap moisture and water from condensation. This prevents mould and keeps the timber and steel dry (so they don't rot and corrode). This type of building design has a good 'whole of life cycle cost' because it will function well for a long time and be easy to maintain in our tropical climate.

Finally, the architect designed the building to maximize natural day light. Light comes in through the windows and doors, which can reduce the need to use electric powered lights.

MATERIALS

A tropical climate is tough on buildings. They have to perform well to keep off the sun and rain, and need to be built to last a long time and not cause too much work to stay in good condition. The architect and engineer designed the Environmental Interpretive Centre to be strong and resilient, not only for cyclones but lots of rain, very hot sun and moist salty air.

The main structural frame is made of steel and timber. This frame is light in weight compared to alternate methods that use heavy concrete. Almost all of the cladding including the roof sheeting, external and internal walls and the floor is steel and timber. Steel uses a lot of energy to manufacture but is fully recyclable so at the end of its life the steel in this building can go back to the steel manufacturers for re-use.

Steel can come in many profiles. The main structural steels are posts and beams. Steel is also rolled into thin sheets known as custom orb or Colorbond. It's used to clad the roof and some of the external walls. Steel is also used in the walkway and verandah balustrading.

The steel and other metals need to be galvanised or finished with coatings to protect them from the humid and salty air so they are corrosion resistant.

Timber is wood from trees that has been prepared for use in buildings. Wood is a natural carbon store. In other words, the trees have breathed in the carbon from the atmosphere and stored it in their wood. It is important to use wood that comes from forests that are with the Forest Stewardship Council of Australia. These trees are specially grown and harvested in a sustainable way for the production of timber.

There are timber beams, roofs, walls and floor frames. There are also timber sheets called plywood where thin layers of wood called veneers are bonded together in a special way to make them strong. These large timber sheets are on the walls and floor. Even the external wall cladding is a plywood with a decorative finish. The timber decking on the verandah is a hard wood, meaning it is very resistant to the weather and scratches.

Timber used in the joinery, cabinets and kitchen is called fibre board and particle board. These are made from small chips of timber that are bonded. It is important that no chemicals are used in the adhesives that release a gas into the air we breathe. This type of gas is made of volatile organic compounds (VOCs) that can make us sick. Also, the boards need to be a special type that is highly resistant to moisture because the hot humid air in the tropics can cause them to deteriorate.
Fibre cement (FC) sheeting is used to clad the large roof ventilation gable.

The structural and concealed timber needs to be resistant to termites.

There are different types of plastic used in the building. Unplasticized polyvinyl chloride (uPVC) that

is manufactured in Australian does not contain a dangerous heavy metal that is toxic called lead. uPVC is rigid, chemically resistant and some of it is used for pipework and the window louvre fixtures. In the tropics it is important that uPVC is also ultraviolet (UV) light stabilised otherwise our strong sun light will cause it to deteriorate faster.

Also some of the floors are 'Terrasafe', a PVC flooring that has a recycled content. It has low VOC emissions and is made from raw materials with no heavy metals, no solvent based inks, no phthalates, no formaldehydes, no polychlorinated biphenyl (PCB) or components rated as carcinogenic.

Polypropylene is used in the Centre as floor covering backing. This plastic is recyclable and the type used is ultraviolet (UV) light stabilised.

The louvre windows have an aluminium frame that is powder coated to give it colour. The glass is toughened so it is impact resistant.

The insect security screens on the doors and louvres are called 'Crimsafe': a coated steel mesh mounted in a powder coated aluminium frame. A steel vermin mesh is also laid across the open ceiling panels.

In a tropical climate we use insulation to repel the heat. Insulation that looks like a shiny sheet has aluminium foil over an air-cell, foam or blanket. It is called a reflective foil insulation (RFI). The shiny foil reflects radiant heat and also stops condensation (moisture). The air-cell, foam or blanket uses the air and material to slow down the heat and stop it from passing through. The Environmental Interpretive Centre has RFI underneath the roof sheeting and behind the wall sheeting.

Our tropical climate also means we have to take extra care to seal all cable duct openings from ingress of moisture, dust and entry of rodents and insects.

Because we live in a place that has cyclones our building designs, materials, products and the work carried out to install and apply them has to be carried out to meet the National Construction Codes and Australian Standards for a cyclonic region. Even the solar hot water system on the roof has to be attached using a cyclone fixing kit.

ENERGY

Sustainable tropical buildings reduce the demand they have on electricity. Air-conditioning uses a lot of energy and the Environmental Interpretive Centre has largely reduced the demand it has for electricity because it does not need to be air-conditioned. This is achieved by implementing the principles of passive design to naturally cool the building.

Passive design has also allowed lots of natural sunlight to enter the building so we don't need to turn on as many lights. The lights that are used are energy saving compact fluorescent lights (CFL) or light-emitting diode (LED) lights.

It is also important to use appliances like refrigerators and dishwashers that are more energy efficient and use less electricity.

Photo Voltaic (PV) panels placed on the roof harvests the sun's solar energy and converts it to

electricity using an Inverter. The Inverter converts the direct current (DC) electricity collected from the PV panel to alternating current (AC) electricity that we can use safely to operate our appliances. The Environmental Interpretive Centre has a solar hot water system. This means the PV panel on the roof is generating electricity to make hot water for the Centre's use.

WATER AND WASTE

The Centre meets the minimum requirements set down by the Codes and Standards relating to the efficient water appliances. Toilets have dual flush buttons. The operator can choose to use the half flush option that doesn't use as much water in one flush. Also taps may be fitted with water flow restrictors that reduce the amount of water that flows from them.

OWNER/ USERS STATEMENT

"Edge Hill State School is justifiably proud of its Environmental Interpretive Centre. It provides an opportunity for students to appreciate both the concept and aesthetics of a well-designed and sustainability focused building.

As all other buildings in our school precinct are fully air-conditioned the Environmental Interpretive Centre demonstrates that a building can be attractive, purposeful and comfortable and still be environmentally friendly.

The Environmental Interpretive Centre is used by community groups as well as for school purposes. A common reaction from users is how comfortable the building is even in the hot, humid months and how much they appreciate the use of large banks of windows to let in light and to allow users to enjoy the view of the playing fields and adjacent Cairns Central Swamp wetlands." *Paul Campbell, Principal, Edge Hill State School.*

PROJECT TEAM

Base building architect/ designer: Project Services, Department of Public Works: Max Beikoff
Project manager: Q Build/ Project Services
Builder: Q Build

Photography courtesy of Emma Thirkell and Belinda Allwood

For more information visit: **www.jcu.edu.au/tsd**
www.greenbuild.com.au

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