Innovations in Green Building Design

John Macdonald
Director
DesignInc
We do not inherit the earth from our forefathers; we borrow it from our children.

*Chinese Proverb*
• Energy/Greenhouse Gas Emissions

• Indoor Environment Quality
  - Daylight, Thermal & Visual Comfort
  - Indoor Air Quality

• Water Conservation

• Renewable energy sources

• Products and Materials Selection

• Waste Management

• Social Aspects

Key ESD Issues
Melbourne  1 Jan – 8 Feb 2002

Daily Maximum/Minimum Temperature
BIOMIMICRY is the art of echoing the processes of Nature.

- A revolutionary new science that analyses nature’s best ideas and adapts them for human use –
- the architecture of termites is no different from that of our own bodies
- the bubble spider has developed an aqualung far in advanced of ours,
- The lug worm bridges between the aerobic and the anaerobic worlds
- In Ecological Architecture is copying the processes of nature rather than copying Nature itself and takes this way of seeing nature into an art form
1. Variable pressure & gas exchange with outside
2. Buoyancy forces driven by metabolic energy from colony
3. Colony comprising termites & fungi, both producing heat

Section showing gas exchange in termite mound. This mound is a device for harvesting wind energy to power its ventilation system.
A face for all seasons ... west
Active Facade
A face for all seasons ... east
... north
... south
Shower Tower

- **Water In**: At the beginning of the cooling process, water from the phase change material is fed in at 17 deg C.
- **Air In**: Air is drawn in through louvres at the top of the shower tower by the falling water which displaces air in front of it.
- **Evaporative Cooling**: As the water droplets fall within the shower tower, they evaporate slightly which uses up energy. This process gradually cools the water droplet as it falls.
- **Shower Towers**: 5 tubes of lightweight fabric 13 metres high + 1.4m in diameter.
- **Air Out**: Air drawn in at the top of the shower tower is cooled and used to supplement ground floor cooling.
- **Water Out**: At the end of the cooling process, water is piped back to "phase change" material at 13 deg C.
- **Retail + Public Space**: Location for the shower tower.
Shower Towers
Displacement Ventilation

- Exhaust
  - High level exhaust exit ensures complete emptying of warm air in ceiling spaces.
  - Exhaust plenum at slightly negative pressure, induced by north flues.

- Boundary layer created by displacement air supply.

- Occupant and equipment heat plumes

- Healthy air
  - 100% outside air supply to sealed access floor plenum

- Temperature gradient

- Floor diffusers
  - Floor mounted, user-controlled air diffusers with ‘twist’ outlets, encourages air to mix, improving circulation.
Displacement Ventilation
Single elements ...
Edge Space – North Balconies

- **Sun Control**: High angle sun protected by 1 m balcony extension and light shelf. Glare controlled by internal blinds and screens at window line.

- **Landscape Planters**: Vertical greenery to balcony sides screen low angle sun, filter glare.

- **Shared Space**: Edge space for breakout, social interaction and circulation. Deep splayed window reveals reduce glare.

- **Micro Climate**: “Green” north edge provides opportunity for daily interaction with nature.

- **City Outlook**: Low angle sun.
Edge Space – North Balconies
Winter Garden

- **northern sun**
- **timber shutters**
  - Opened in winter for filtered light and vertical air movement.
  - In summer, shutters track sun for full shading.
- **glass louvres**
  - Adjustable glass louvres allow the sun’s heat to be trapped during winter for a warm winter garden environment.
  - In summer, louvres are opened for maximum ventilation.
- **city outlook**
- **double height**
  - Encourages air movement and social interaction between floors.
- **landscape**
  - Tree provides glare control + movement for visual pleasure, shade and healthy air quality.
  - Access to nature enhances productivity by relieving stress.
Phase Change Capsules
Water Recycling

- MWR PLANT has five processes:
  - 1) Holding tank of
  - 2) 200 micron filtering.
  - 3) Ceramic filtering
  - 4) Reverse Osmosis
  - 5) chemical dosing.
Microturbines
Roof Top Outdoor Recreation
Green Roof
The Double Vortex by Cameron Robins
Performance & Appearance
Site Plan Strategy

OFFSET SITE PLANNING - ALLOWS SOLAR ACCESS AND SITE VENTILATION

BUFFER ZONES PLAN

SUN APK ACCESS - TALLER BUILDINGS TO THE SOUTH.

Building Massing:
4 staggered buildings of different heights, oriented east-west to allow for mixing in winter sun.

1 (7 storeys)
2 (7 storeys)
3 (4 storeys)
4 (4 storeys)

Urban courtyard
North balconies
Private central courtyard
Private central courtyards
North balconies
North balconies
Service courtyard
Shared pedestrian "green spine" connects buildings and landscape
Water tanks
Hill access
Landscape
Sunset winter
Sunset winter
Sunrise winter
Sunrise winter
Design Source

Site Plan Strategy
Light & Air
high level light and ventilation to pod units

Thermal Mass
exposed concrete ceilings and masonry walls provide thermal stability and reduce heating and cooling demands

Cross Ventilation
“single loaded” corridors allow cross ventilation

Weather Protection
south walkway screens provide weather protection and reduce wind pressures, and effectively prevent uncontrolled heat losses

Grouped Venting
roof top ventilators and grouped exhaust ducts and services

Renewable Energy
photovoltaic and flat plate solar collectors to north roofs

Self Shading
summer sun excluded by ‘pod’ architecture and projecting balconies

Winter Sun
northern winter sun and balconies to all living spaces

Solar Shading
façade and roof forms angled for optimal solar panel placement and self shading to lower levels

Thermal Mass
high levels of thermal mass, insulation, double glazing and window sunshading minimise heat loss and gain

Water Recycling
treated grey water reticulation supply system recycles water for landscape irrigation and toilet flushing

Water Storage
roof water storage tanks

Social Spaces
recycled timber, ‘green spine’ provides winter sun penetration and summer and social meeting space shade
Solar Shading
Facade and pod/roof forms angled for optimal solar panel placement and self-shading to lower levels.

Varied Facade
North facades combine offset balconies with solid bedroom walls for self-shading and visual variety.

Building Massing
4 staggered buildings of different heights oriented east-west to allow for maximum winter sun to all units.

Thermal Efficiency
Solid east/west walls, use insulated structural precast coloured concrete for maximum thermal performance.
Solar Balconies
Water & Landscape Systems

Water Recycling
- Treated grey water reclamation supply system recycles water for irrigation and toilet flushing.

Water Storage
- Roof water storage tanks with wet downstream system to eliminate pumping.

Water Smart Landscaping
- Landscape treatments are used as a natural filter for stormwater, together with hardy native plants, bioswales, and water efficient drip irrigation.

Water Efficient Fittings
- Minimum AAA water efficient fittings throughout.
Greywater Reuse
Simplified schematic of the 6 step greywater reuse system for garden irrigation and water recycling.

Water & Landscape Systems
Urban Courtyard
Energy Generation Use

Solar hot water
flat plate solar hot water panels
to pod roofs of buildings
1 and 3.

Photovoltaic panels
pv solar panels to pod
roofs of buildings 2 and 4
and to pod mansard roofs.

Energy efficient systems
efficient lighting systems,
individual metering and
energy efficient lifts reduce
overall energy consumption.
Pod Balcony
Pod Unit
Skylights
Typical Apartment
Material Selections & Longevity
Greenhouse Emissions
Geoscience Australia
Geothermal Heat Exchange
David Penington Bio21 Institute
Building Organisation
Active Public Space and Climate Control
Natural Light & Interactive Elements
Redistributing Light & People
Breakout Cafes
shading devices

... Research Environment
North West Facade ... shape and shading
Passive Design & Active Integration
Swinburne University
Vortex Centre
SUMMER CONDITIONS

Day:
- Roof shower
- Water pumped to flow down building's exterior
- Displacement airflow
- Water bottle to cool building
- Temperature: 35°C

Night:
- Evaporative cooling through night purging

Temperature:
- 26°C
Gosford Water Factory
Scotch College Centre for Science and Sustainability
Bio Climatic Section
Atrium Concept Sketch

- Natural light penetration
- Breakout study areas
- Bio-wall air filtration teaching wall
- Visual connection between staff and student areas
- Interactive display foyer and study areas
Zero3
Kinglake Ranges Wilderness Camp
Pipe Cabin - External Entry Elevation
Kahramma Education Park
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  - Daylight, Thermal & Visual Comfort
  - Indoor Air Quality
- Water Conservation
- Renewable energy sources
- Products and Materials Selection
- Waste Management
- Social Aspects
CH2
Daily Maximum/Minimum Temperature

Melbourne  1 Jan – 8 Feb 2002
Analogies + Hybrid Designs
BIOMIMICRY is the art of echoing the processes of Nature.

- A revolutionary new science that analyses nature’s best ideas and adapts them for human use –
- the architecture of termites is no different from that of our own bodies
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1. Variable pressure & gas exchange with outside
2. Buoyancy forces driven by metabolic energy from colony
3. Colony comprising termites & fungi, both producing heat

Section showing gas exchange in termite mound. This mound is a device for harvesting wind energy to power its ventilation system.
**Day Mode**

- **wind turbines**: The exhaust plenum is at slightly negative pressure, induced by north flues 'stack-effect' and wind-powered turbines.

- **vertical planting**: Green north facade and roof top assists shading, glare + air quality. Access to nature enhances productivity by relieving stress.

- **shading + light**: Light shelf + balcony floors provide horizontal shading from northern sun. Ambient and direct day light bounces off external and internal light shelf.

- **exhaust**: High level ceiling exhaust ensures complete emptying of warm air in ceiling spaces.

- **chilled ceilings**: Chilled ceiling panels absorb radiated heat from equipment and occupants. Occupants experience comfort by radiating heat to chilled ceilings overhead.

- **roof top energy**: Includes photovoltaic cells, solar hot water panels and a gas-fired co-generation plant.

- **healthy air**: 100% outside air supply via vertical ducts deliver air floor by floor to sealed access floor plenum.

- **thermal mass**: Thermal mass in concrete slab absorbs excess heat from the space.

- **displacement air**: Fresh air fed at low speed through controllable floor vents.

- **city outlook**: Air and water falls to provide cool water for building recirculation and cool air to supplement ground floor and retail cooling.

- **shower towers**: Air is piped to phase change plant for re-cooling.
A face for all seasons ... west
Active Facade
A face for all seasons ... east
... north
... south
Shower Tower

Air is drawn in through louveres at the top of the shower tower by the falling water which displaces air in front of it.

evaporative cooling

As the water droplets fall within the shower tower, they evaporate slightly which uses up energy.

This process gradually cools the water droplet as it falls.

shower towers

5 tubes of lightweight fabric 13 metres high + 1.4m in diameter.

At the end of the cooling process water is piped back to "phase change" material at 13 degC.
Shower Towers
Displacement Ventilation

- Displacement air
  - Boundary layer created by displacement air supply.
  - Occupant and equipment heat plumes
- Healthy air
  - 100% outside air supply to sealed access floor plenum
- Floor diffusers
  - Floor mounted, user controlled air diffusers with ‘twist’ outlets, encourages air to mix, improving circulation.
- Exhaust
  - High level exhaust exit ensures complete emptying of warm air in ceiling spaces.
  - Exhaust plenum at slightly negative pressure, induced by north flues.
- Temperature gradient
- Undulating concrete ceiling line.
Displacement Ventilation
Single elements ...
Edge Space – North Balconies

- **city outlook**: High angle sun protected by 1m balcony extension and light shelf. Glare controlled by internal blinds and screens at window line.

- **landscape planters**: Vertical greenery to balcony sides screen low angle sun + filter glare.

- **micro climate**: “Green” north edge provides opportunity for daily interaction with nature.

- **shared space**: Edge space for breakout, social interaction and circulation. Deep splayed window reveals reduce glare.

- **balcony**: Relief air duct.

- **office**: Relief air duct.
Edge Space – North Balconies
Winter Garden

- **Double Height**: Encourages air movement and social interaction between floors.

- **Timber Shutters**: Opened in winter for filtered light and vertical air movement. In summer, shutters track sun for full shading.

- **Glass Louvres**: Adjustable glass louvres allow the sun’s heat to be trapped during winter for a warm winter garden environment. In summer, louvres are opened for maximum ventilation.

- **Landscape**: Tree provides glare control and movement for visual pleasure, shade and healthy air quality. Access to nature enhances productivity by relieving stress.

- **City Outlook**:
Phase Change Capsules
Water Recycling

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Light & Air
- high level light and ventilation to pod units

Thermal Mass
- exposed concrete ceilings and masonry walls provide thermal stability and reduce heating and cooling demands

Cross Ventilation
- "single loaded" corridors allow cross ventilation

Weather Protection
- south walkway screens provide weather protection and reduce wind pressures, and effectively prevent uncontrolled heat losses

Grouped Venting
- roof top ventilators and grouped exhaust ducts and services

Renewable Energy
- photovoltaic and flat plate solar collectors to north roofs

Self Shading
- summer sun excluded by ‘pod’ architecture and projecting balconies

Winter Sun
- northern winter sun and balconies to all living spaces

Solar Shading
- facade and roof forms angled for optimal solar panel placement and self shading to lower levels

Thermal Mass
- high levels of thermal mass, insulation, double glazing and window sunshading minimise heat loss and gain

Water Recycling
- treated grey water reticulation supply system recycles water for landscape irrigation and toilet flushing

Water Storage
- roof water storage tanks

Social Spaces
- recycled timber, ‘green spine’ provides winter sun penetration and summer and social meeting space shade
Building Form

Solar Shading
Facade and podium forms angled for optimal solar panel placement and self-shading to lower levels.

Varied Facade
North facades combine offset balconies with solid bedroom walls for self-shading and visual variety.

Building Massing
4 staggered buildings of different heights orientated east-west to allow for maximum winter sun to all units.

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Treated grey water reclamation supply system recycles water for irrigation and toilet flushing.

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Roof water storage tanks with wet/dry piped system to eliminate pumping.

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Greywater Reuse
Simplified schematic of the 6 step greywater reuse system for garden irrigation and water recycling.
Urban Courtyard
Energy Generation Use

Solar hot water
- Flat plate solar hot water panels to pod roofs of buildings 1 and 3.

Photovoltaic panels
- PV solar panels to pod roofs of buildings 2 and 4 and to pod mansard roofs.

Energy efficient systems
- Efficient lighting systems, individual metering and energy efficient lifts reduce overall energy consumption.
Typical Floor Plan
Pod Balcony
Typical Apartment
Material Selections & Longevity
Greenhouse Emissions
Geoscience Australia
Geothermal Heat Exchange
David Penington Bio21 Institute
Active Public Space and Climate Control
Negative Space & Pod Architecture
Natural Light & Interactive Elements
Breakout Cafes
Research Environment
North West Facade ... shape and shading
Passive Design & Active Integration
University of Adelaide
School of Engineering
Vortex Centre
SUMMER CONDITIONS

Day:
- Water is pumped to flow down the building's exterior.
- The temperature is labeled as 20°C and 35°C.
- Displacement airflow is indicated.

Night:
- Evaporative cooling through night purging is shown.

Roof shower:
- Water is pumped to cool the building's exterior.
Gosford Water Factory
EnPark Dubai
Scotch College
Centre for Science and Sustainability
Bio Climatic Section
Atrium Concept Sketch

- Natural light penetration
- Breakout study areas
- Bio-wall air filtration teaching wall
- Visual connection between staff and student areas
- Interactive display foyer and study areas
Aerial Perspective View

- Greenhouse
- Roof plant with PV panels
- Cross flow turbine
- Roof lights
- Solar trough canopy
- Ecology roof garden and natural water treatment
- Bridge connections to campus
- Living wall facade
- Experimental 'bubbles'
- MORRISON STREET
- Glazed winter gardens
- Vegetated sunshades
- Landscaped student terraces
- Existing school
- Cardinal Pavilion
Kinglake Ranges Wilderness Camp
Pipe Cabin - External Entry Elevation