house – hot humid

Home **Design for lifestyle & the future**

Brisbane

BLAKELY RESIDENCE

Conventional techniques and materials were used in the construction of this Brisbane house. It constitutes a low cost solution to the requirement for an environmentally friendly house that uses minimal heating and cooling equipment and is both pleasant to inhabit and "normal" in appearance.

Building type:	New home, Suburban site, All normal services, Heavyweight
Climate:	Subtropical: Brisbane, S-E Queensland
Topics covered	Suburban Sustainability
Orientation	Excellent
Design for climate	Excellent
Passive heating	Excellent
Passive cooling	Excellent
Insulation	Excellent
Thermal mass	Excellent
Glazing	Excellent
Shading	Excellent
Reduced water demand	Above average
Water harvesting	Above average
Water re-use	Above average
Material selection	Good
Energy use ñ PV	NA
Solar hot water	Excellent
Electric lighting	Good
BERS Rating	Better than ★★★★★

THE BRIEF

The requirement was for a family home with four bedrooms and an open kitchen/living/dining space with a large deck.

The family have an interest in, and knowledge of, passive thermal design principles. They wanted a thermally modelled house that made good use of natural daylight. They also wished to take advantage of the available views across a valley to hills that lay to the north-east and east of the site.

There was one key conflict in the design requirement. The clients wanted an open (floor to ceiling glass) "light, timber feel" to the house. However, they also wanted a "heavy weight" approach to controlling thermal comfort.

The plan of the house reflects the living habits of the family. It is essentially a long pavilion containing a row of rooms off one side of a hallway axis. The bathroom and kitchen are "lean-to" pavilions off the other side of the hall.

Being environmentally aware people, the owners wanted to explore a range of "environmental design" issues (such as choice of construction materials and stormwater/water use) which would not result in an unconventional home.

In the end, the design of the house was an exercise in implementing sustainable practices and technologies within the cost and "familiarity" constraints of a fairly normal home in the suburbs, site and climate.

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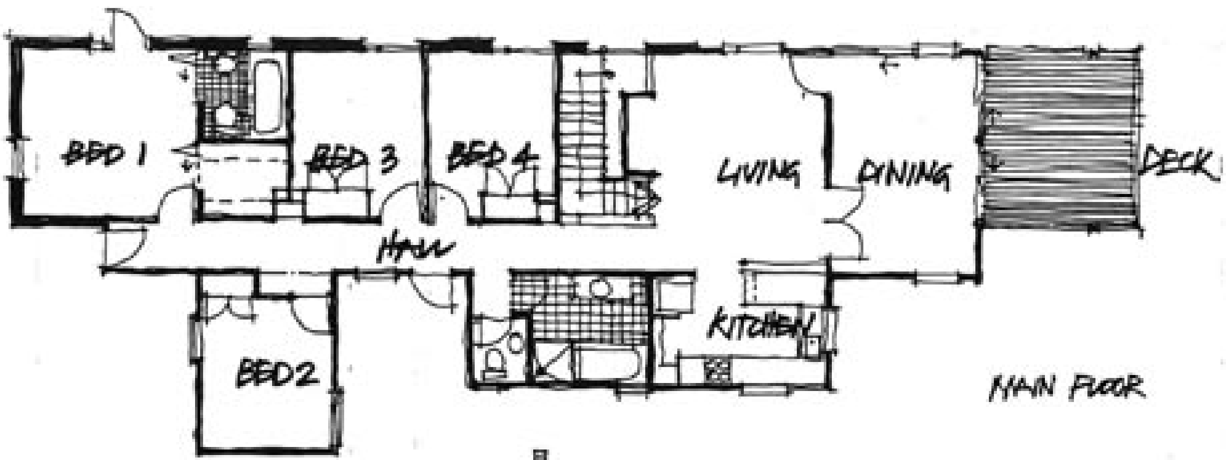
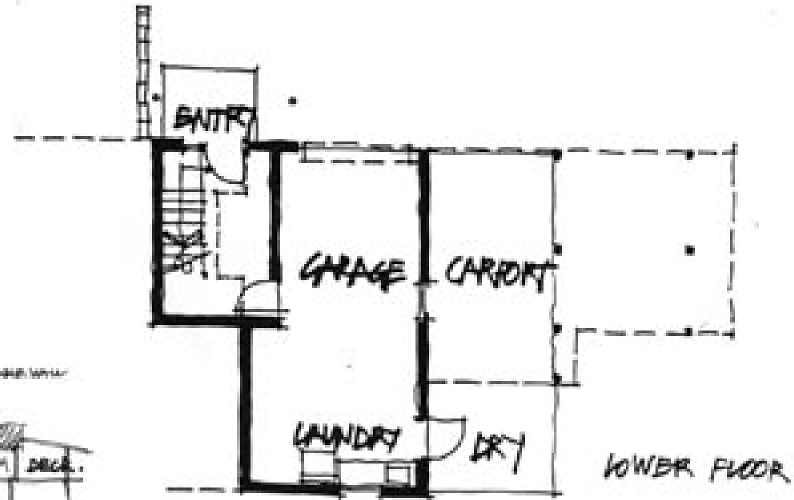
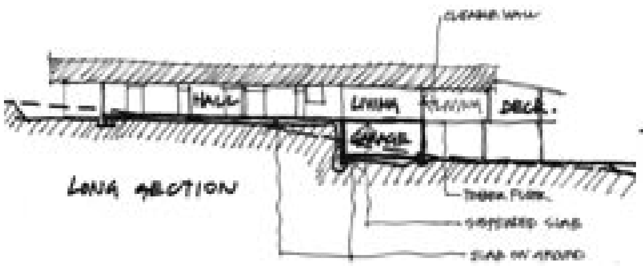






SITE AND CLIMATE

The site is located at The Gap, a north-western suburb of Brisbane. The area is characterised by a valley running west to east with a microclimate slightly different to the typical Brisbane climate. Brisbane is hot and usually humid in summer and cool, sometimes cold and dry, in winter. For at least 5 months of the year the climate is very pleasant.

The site is above a secondary valley that runs southeast allowing access to cooling breezes. Hills to the north and east restrict the usual cooling afternoon breezes from the north-east.

The site falls fairly steeply (4m in 30m) from west to east. It is located behind and above a house dug into its site at the street. Access is via a long narrow drive. This means that stormwater (run-off and seepage) was an important issue. The site had been completely cleared of trees and the density of the "estate" meant little overshadowing.

DESIGN CONTROLS

While the site has no special development controls, it was covered, like the surrounding "estates", by a "brick veneer covenant". This is greatly at odds with the basic concepts of more sustainable design. Interestingly, this is seen as a way of controlling quality. The issue was dealt with by partly cladding the house in lightly rendered block veneer although some minor legal "sparring" did occur.

BROAD DESIGN RESPONSES

In the design, special materials, construction details and technologies were kept to a minimum.

Energy efficiency measures included orientation of the house (long side to the north), controlling solar access, the use of thermal mass and good insulation.

Issues of stormwater control and water use efficiency were resolved comparatively simply using an "agricultural" system.

While the house is designed in detail for the specific site, context and people, the principles behind it (practices and technologies) are applicable for any house design.

SPECIFIC DESIGN SOLUTIONS

ORIENTATION

The site and its context allowed a simple orientation solution: a rectangle with long sides to the north and south.

Orientation to the north is preferred because for a good part of the day, especially during summer, the sun is at a reasonably constant height above the horizon. This means that solar access can be easily controlled with simple fixed shading devices such as eaves and window hoods.

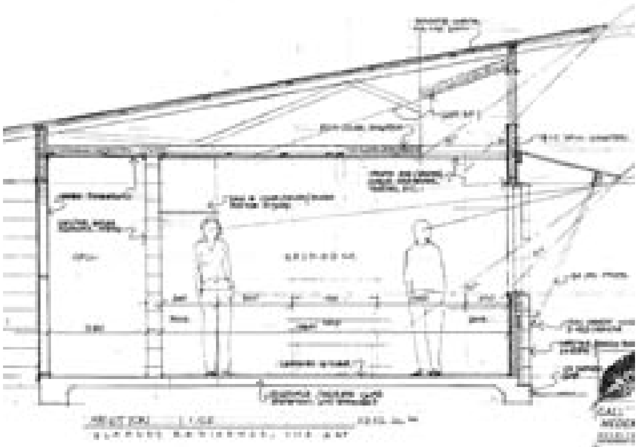
The western end of the house is tucked into the side of the slope to the west, providing good protection from the low hot western sun.

The east end of the house rises out of the ground, giving a lot of access to east and north-east sun. This will need more control in summer although bedrooms are protected by the verandah and living areas.

This orientation not only suits the sun but also suits the direction of prevailing breezes/winds in Brisbane. [See: Orientation]

VENTILATION

For passive thermal performance to work, ventilation needs to be tightly controlled. In summer there must be enough ventilation to cool the structure (especially at night) and to provide fresh air and air movement. However, there must not be too much, or excessive warm outside air may be brought inside.



The rooms of the house "drain" to a corridor that has doors at both ends and in the middle. The windows in the bedrooms are relatively small to minimise conductive heat loss and gain. Awning windows can be opened to allow good air flow through the hall when needed.

A roof ventilator (closable) is located near the refrigerator in the kitchen. This helps vent excess heat from the kitchen area in summer. The hall opens to the living areas which can be opened up, allowing breezes to be funnelled down the hall past the rooms.

The "thermal mass" part of the house can be separated from the "tropical/lightweight" part of the house by sets of sealed doors, to separate the air masses.
[See: Passive Cooling]

THERMAL MASS AND INSULATION

To resolve the conflict in the client's brief (mentioned earlier) the house was designed with two zones. There is a "thermal mass" section, incorporating bedrooms, bathrooms, living/dining areas, the kitchen and downstairs area, the entry and garage/laundry. There is also a "tropical" room extension to the living/dining/kitchen area that can be closed off from the rest of the house.

The "heavy" end of the house is naturally connected to the ground using an uninsulated concrete slab. As the ground drops away, the upper level, entry/living/kitchen becomes a suspended slab (uninsulated) over an enclosed garage on a slab on the ground. The heat/cool storage of the house is carried out by these slabs and the ground under them.

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The use of linoleum on the floors is critical. Carpets insulate the slab and so waste its thermal potential. Linoleum avoids the insulating effect of carpet and the perceptual "coldness" of tiling or stone. A dark colour would have been best thermally but the clients wanted a lighter, brighter feel to the house and the difference is marginal.

The external walls of the house are insulated, using a polyester/cotton material to R1.5. The comparatively small window/door glazed area ensures maximum possible wall insulation. This is cheaper than double glazing.

The ceiling is insulated to R2.5 with a similar material. Insulation is placed above the bottom chords of the roof trusses. A reflective foil "sarking" is placed over the roof battens, under the tin.

External glazed doors have wide timber frames, reducing the glazing area but retaining the perception of large openings.

A few insulation values were tested with thermal modelling to find a cost effective optimum. [See: Insulation Overview; Thermal Mass]

SHADING

Shading is provided to the north (less to the south) by the overhanging eaves and a long window hood that runs the length of the northern face of the house. Both windows and walls are shaded to control heat gain from the sun.

The width of the shading is determined by the angle of the sun and the orientation of the house. The shading devices also allow windows to be kept open when it rains.

As mentioned before, western shading is provided by the site but there is only one opening at the western end of the house - a deeply recessed door.

The eastern end of the house is very open and extensively glazed. The verandah roof provides a lot of shading from high morning summer sun. The "tropical" living area also protects the rest of the house with the separating doors providing additional shading.

Landscaping using locally endemic rainforest species is proposed to further moderate and fine-tune solar access. [See: Shading]

LIGHTING

Day light in all rooms was an important requirement, especially for bedrooms.

Small, high clerestory glazed panels are used. Raised parts of the ceiling, framed between the roof trusses, bring the light into the backs of the rooms (the walk in robe is lit over the ensuite). These high windows, mounted in walls, allow mostly reflected ambient light into the rooms, which is softer and carries less heat. The solution is simple, cheap and very effective.

Due to the clerestory panels, artificial light use is reduced. Lights that will be run for long periods of time are fluorescent.

STRUCTURE AND ENVELOPE

In keeping with the basic principles of the house, its plan, form and structure are simple, cost effective and material efficient.

The house has a simple geometrical and modular layout. The ceiling is mostly flat. The roof and walls are prefabricated radiata pine, treated where exposed.

Due to careful design and planning of internal spaces, the overall size of the house was kept to a minimum.

Secondary structures, such as boxed-in eaves or bulkheads were avoided. These take time to construct, require more materials and tend to "dull down" the expression of the house.

The architects attempted to construct a building that says something about the issues to which it responds and the resources that have gone into making it.

HEALTH AND MATERIALS

A few simple choices of materials were made that make the house a healthier place in which to live.

Linoleum was used on the floors and kitchen bench tops. It is inexpensive and does not give off volatile organic compounds (VOCs) like vinyl. It smells nice and has antibacterial and antifungal properties. It is very durable, non-combustible and comparatively, easily repaired. It is made of natural materials and so has less environmental impact in its manufacture.

Raw, high moisture resistant (HMR), hoop pine plywood was used for cabinet joinery in conjunction with solid hoop pine. This again reduces VOCs and the pine is from sustainably managed plantations in Queensland.

The pine is finished in almost natural tung oil. [See: Indoor Air Quality]

WATER

The broad aim was for the surface and ground hydrology of the site to not be greatly affected by the placing of the house on the site. The roof form allows most rainwater falling on the roof to be collected. It was proposed to take this water to a soakage system with a "stationary" overflow to the kerb and channel system. This proved too difficult for a number of reasons.

It is possible to retain some roofwater in small tanks for drinking and watering the garden. These have not yet been installed.

Because the site is steep and "above" other properties, there was some risk and concern about the proposed site drainage system. [See: Stormwater]

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WATER HEATING

An electric back-up solar hot water heater was installed. The cost of this was off-set by the State Government's assistance. [See: Solar Hot Water]

EVALUATION

The house was given a 5-star energy rating for passive thermal (heating and cooling) performance using BERS modelling software (Solar Logic). In theory it requires 40MJ per square metre each year to keep the internal temperature of the house in a comfort zone of 21ºC - 27ºC (based on real climate data). An "ordinary" house theoretically requires around 300MJ per square metre per year (8 times as much).

The house has been temperature tested by the children of the house for a school science project. Three thermometers were placed on the verandah, in the "tropical" room and in the "thermal mass" area. During a "cold snap" in winter, the interior of the house stayed above 17ºC when it was about 1ºC outside on the verandah. In a recent "heat wave", while the outside of the house was above 40ºC, the interior of the house stayed below 30ºC. No controlled "management" of the house was carried out.

In the end it is important to note that it is not the house that uses energy, but the people who live in it. The present occupants are concerned with environmental issues and in particular, are "energy conscious". The house provides them with an opportunity to easily reduce their energy bills without suffering to do so.

After a relatively short period of occupation, the house appears to be a fairly successful attempt to implement some key sustainable development practices and technologies in a cost effective way.

Regardless of the theory behind the design and construction, the house is very pleasant to live in. Everyone who visits it (not just designers or educated clients) expresses this.

Table A: Temperature ºC range and average for May 7AM readings

ROOM	RANGE	AVERAGE
Deck	4-15 (11)	11
Sunroom	6-16 (10)	12
Bedroom 1	16-22 (6)	20
Bedroom 2	16-24 (8)	21

Table B: Temperature ºC range and average for May 7PM readings

ROOM	RANGE	AVERAGE
Deck	12-18 (6)	15
Sunroom	14-20 (6)	17
Bedroom 1	20-24 (4)	22
Bedroom 2	23-26 (3)	23