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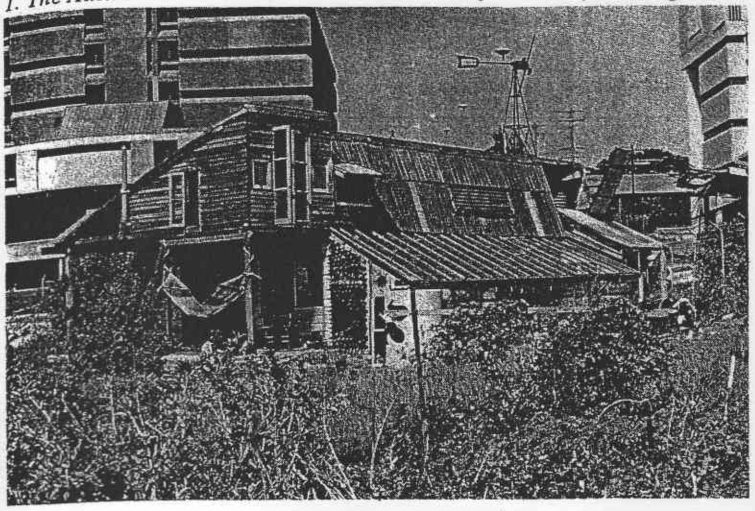
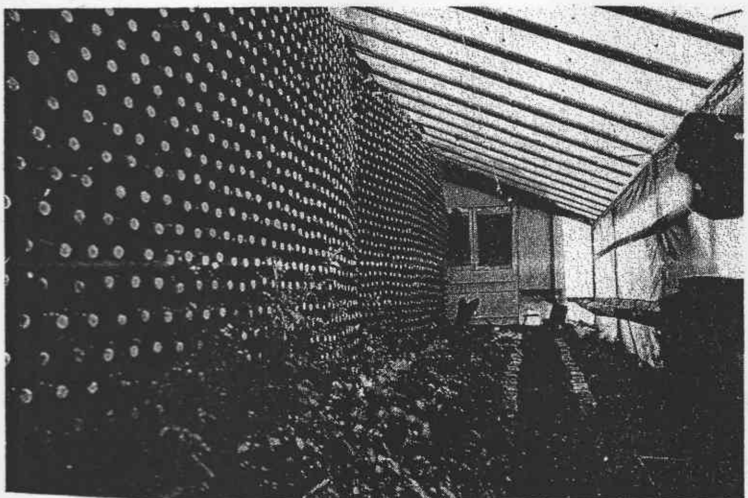
1. The Australian autonomous house surrounded by University buildings.

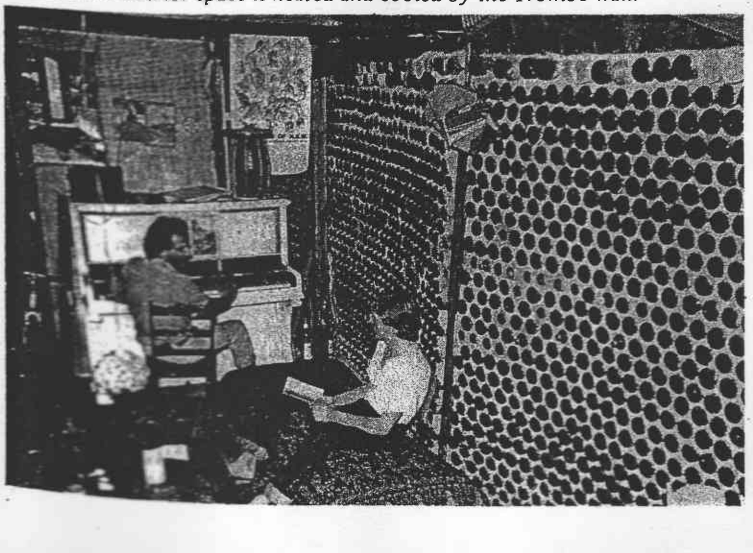


Australian Autonomy

2. The greenhouse is an extension to the Trombe wall.



3. The main interior space is heated and cooled by the Trombe wall.



During 1974 some 2nd- and 3rd-year architecture students at the University of Sydney built an experimental autonomous house – a house self-sufficient for all of its energy requirements, supplying all its own heating and cooling, generating its own electricity supply, collecting and heating its own water, producing its own food supply and recycling all its wastes. In this article we look at how the project was conceived, designed and built, and at the workings of the technology used.

The project was initiated by a senior lecturer at the School of Architecture, Colin James, and adopted with enthusiasm by his students. There had been precedents – early farm-houses in Australia were almost totally self-sufficient – but the art of self-sufficiency died with the advent of cheap power authorities and cheap transport. This autonomous house was to be the first in Australia to give its owners a standard of living comparable to present housing, while still being self-sufficient.

Motivations

The original starting-point was the awareness of the damage being caused by conventional techniques of centralised power generation and the need to develop decentralised, more ecologically responsible energy systems, relying on the sun, the wind and recycling.

The students were concerned at being at the mercy of the giant power monopolies, which are responsible for some of the most destructive environmental changes in Australia and use their position to arbitrarily increase costs and guarantee future energy squeezes. They opted instead for low-impact technology in the design of the house, which would give them financial and environmental independence and, more importantly, complete control over their own life-style and welfare.

With these ideas as a basis, a group of students researched the alternatives (mostly gathering information from the USA and UK) during the first term of 1974. (Five of these students now live in the house.)

Design process

At the beginning of the second term, 16 students continued with the programme to design and build the house. A number of problems had become apparent from the research and had to be resolved in the design. Firstly, becoming self-sufficient was not as simple as plugging alternative energy devices into an existing house design. Secondly, the students had to alter their own extremely wasteful energy habits nurtured on years of cheap fossil fuels.

The overall design was kept essentially simple: a rectangular plan, with the long side facing north; an open communal area; and kitchen and shower/ablution facilities to the west. Private areas were to be divided off the main communal area or added as lofts into the roof truss system as desired. Covered verandahs to the east and west, and a greenhouse along the north wall, double the house's overall area to 96m²

The succession of students who have worked on, or lived in, the house have all tried their ideas on it; this constant metamorphosis, and the concept of frugality, give the house an air of impermanence, although closer inspection reveals features of real permanence – particularly the components that make up the energy systems **(1)**.

Energy technology

None of those working on the project were technologists, amateur or professional, and they did not really come up with any startling new devices. They worked instead on the principle that 'sensible design is the best way to avoid misuse of energy,' as Colin James puts it; 'Good siting, good insulation, sensible construction the proper use of colour and the proper use of windows and other openings' are vital for energy conservation.

Trombe wall

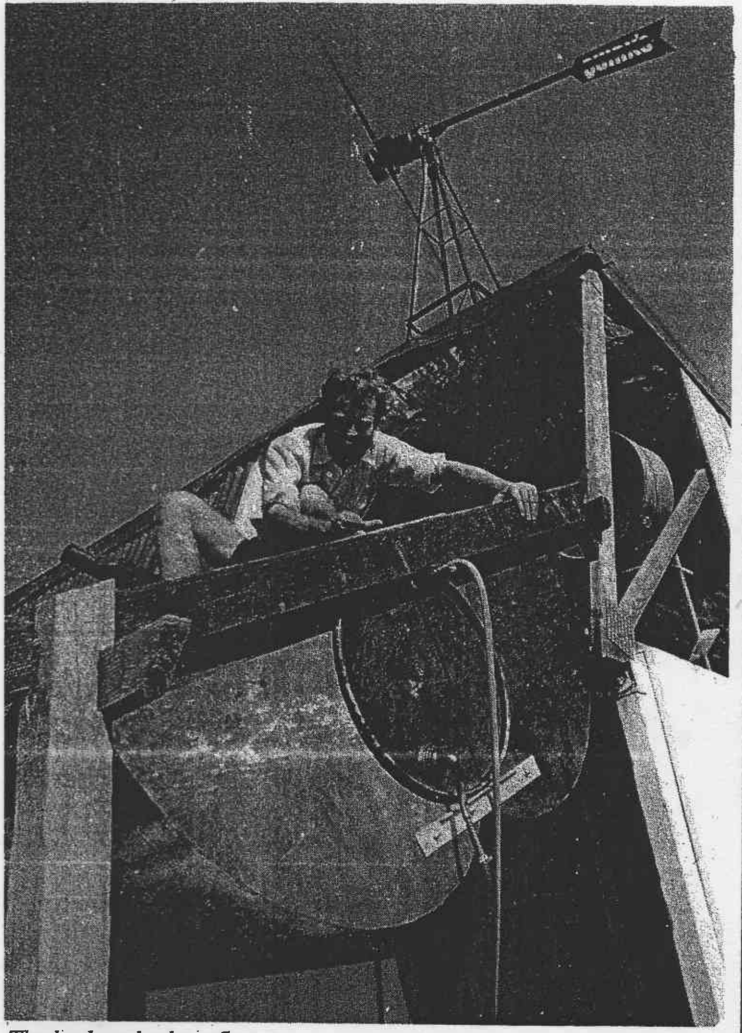
For the heating and cooling of the house the Trombe wall effect (see 'Solar home in New Jersey', *AD* 11/76 pp653-6) was chosen for its simplicity and to enable the designers to test the use of water-filled beer bottles as a heat storage medium. (The dark glass of the bottles absorbs the sun's heat and the liquid contents help retain it.) The design called also for the maximum use of natural ventilation, with a large number of doors and windows that can be opened to channel cooling breezes or sealed to prevent heat loss.

By enlarging the thin glazed space on the outside of a Trombe wall to a greenhouse, also heated by the bottles, the students could grow some of their own vegetables. A further advantage is that the greenery in the greenhouse provides fresher air for the rest of the house, the vegetation acting as a natural air freshener **(2)**.

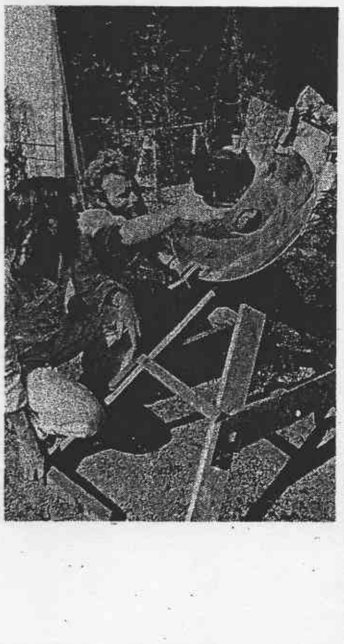
Cooling the house

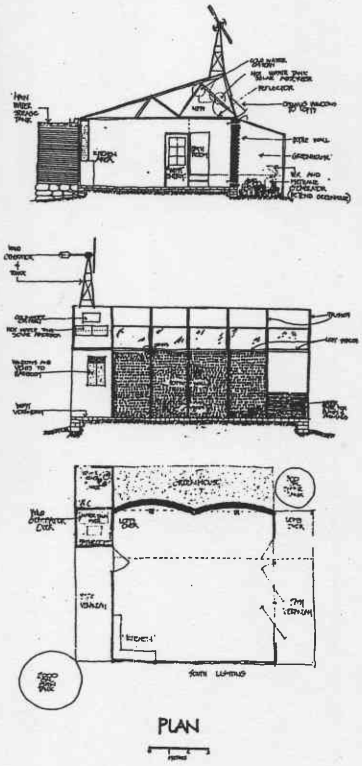
On hot days, glass panels are taken from the roof of the greenhouse and shields removed from a few small openings in the base of the beer-bottle wall. The heat radiated by the wall causes the air in the greenhouse to rise, drawing air through the holes in the bottom of the wall and creating cooling draughts in the interior of the house on the other side **(3)**: this improves cross-ventilation from cool

The solar water-heating unit is made from a discarded oil drum.



The backyard solar reflector.





n and two sections of the original ign. The shape and look of the use have since changed as new idents have added features to suit nging requirements.

shady areas of the verandahs.

Heating the house

Heating the house is achieved in the opposite way. The bottle wall and greenhouse act as a solar space-heating system. When heating is required, the greenhouse roof is left undisturbed and the wall radiates heat inwards to warm the interior of the house. Vents in the bottom and top of the wall facilitate warm air circulation, but on very cold nights a fuel stove needs to be used as well. All the roofs and walls other than the Trombe wall are insulated with glass wool.

The cooling system could be improved by having an insulating curtain between the wall and the interior, and the heating system, which is inadequate for heating the house for long periods, would be more effective if a masonry floor were to replace the wall. Its dark surface, insulated at the edges and exposed to northern sunlight, would act as a heat store and gradually release heat overnight and on cool days.

Storing food

An old-fashioned 'Coolgardie Safe' (evaporative cooler) is used as a cold food store. It is a perforated metal box with a tray for water at the top and a tray underneath. Cloth is draped over the sides of the box and water trickles down the cloth, evaporates and draws heat from the inside of the box. This old method was found to be quite satisfactory, although residents are now working on plans for a solar-powered refrigerator.

Water cycle

The roof area provides sufficient rainwater run-off for the residents. The water is collected in a 2 000-gallon tank, which sits on the ground, and is pumped by hand up to a 400-gallon header tank.

Sink water and the water from the small northern roof and the greenhouse roof is collected in another tank for garden watering. Bath water is re-used in the lavatory.

A revolutionary system is used for the water-heating unit, whereby the tank (a 44-gallon discarded oil drum) is heated directly by almost parabolic twin reflectors, which concentrate the sun's heat on the drum. Special plastic film over the reflectors minimises heat loss. The entire unit is mounted in the north roof space above the shower and kitchen **(4)**.

There is also a dish reflector near the back door. The tea water in the blackened kettle hanging from a chain in the focal point of the reflector gets too hot to touch, but not hot enough to make a good cup of tea. A propane gas burner is used to finish the job **(5)**.

An improved system planned for the future will comprise a longer, narrower, copper tank, with an increased reflecting area, a raised header tank and roof gutter supplying it, and a filter to clean the rainwater.

Bio-cycle

The recycling of wastes from the house and its residents is connected to the production and cooking of their food. A greenhouse and outdoor garden supply vegetables and fish and poultry farming is planned. Eating raw foods or sprouting seeds to eat can cut down on cooking requirements.

A methane digestor system was designed to convert all human and organic wastes into a nitrogen-rich fertiliser and generate methane gas for cooking. It is intended that food scraps, human wastes, sawdust, ash and grass clippings should in future go into a Clivus composter to provide compost for the gardens. Timber offcuts and waste paper can also be used in a fuel stove.

The methane generator poses some problems. The gas is dangerous and difficult to store properly and it is uncertain whether the unit can kill the bacteria in the tank properly. Furthermore, a one-house system is inevitably oversensitive and prone to fluctuations according to variations in its occupants' wastes. This type of facility would be better shared among a small number of self-sufficient houses **(6)**.

Wind power

It was decided that a wind-generated electricity supply would be used. This 12-volt 300-watt system incorporates a conventional impeller and generator, with special lighting (lead/acid) batteries for storage. A more expensive 100-volt 3 000-watt model would be sufficient to power all conventional appliances of a house, whereas this unit was designed to power five lights, a small transistor radio and a small freezer unit or television **(7)**.

It has occasionally been necessary to resort to candles or kerosene lamps for extra lighting, since the poor location of the propellor (mounted on the roof and surrounded by higher buildings) means that the speed and direction of the wind are irregular. It could be better located on top of one of the tall buildings nearby or on a higher pylon. It would also help to use a rotor that spins on a vertical axis – such as a Darieuse or Savonius rotor.

Materials

While the sketch plans for the house were being drawn up, a set of principles of construction evolved in which the need for ecologically responsible and sympathetic materials was stressed (low energy content, recyclable, naturally occurring) as well as a need for 'loose fit' and for adjustments in the design as it progressed.

The degree to which the house

could be genuinely self-sufficient depended largely upon the qualities of the site and the resources available and how these corresponded with the requirements of the occupants. Few sites would have all the prerequisites for self-sufficiency, so this meant developing what was available and rationalising the usage of what must be supplied from external sources.

A loan of some university land was negotiated in Darlington, a suburb of predominantly University-owned buildings. The house itself was built entirely from scrap materials scavenged, begged and borrowed from demolition sites, rubbish tips and builders, except for a few things which were paid for or donated by companies.

Unfortunately, it became more and more time-consuming to find and collect these 'free' secondhand materials as time went on. One of the greatest problems with recycling is the extra time needed to recoup old materials, as the construction industry is in no way geared to re-use its products.

Sources

The seven timber columns along each of the north and south walls were gathered from building sites where the demolishers thought the timber was of no value. The timber roof trusses spanning the whole of the house area except the greenhouse were donated by a local firm, and galvanised iron for the roof and old timber for the walls was gathered and repaired. The galvanised iron required some patching, re-cutting and re-bending, and with small job lots of timber being used, the walls took on a patchwork look (although waterproof) (8).

Beer bottles for the north wall were collected one step ahead of the garbage man in a local suburb and laid in a mortar bed, like common bricks, with their necks pointing north into the greenhouse, which was itself built from an old one purchased cheaply from the city's market gardens.

The other walls were built from timber stud framing, old windows and scrounged shingle and weatherboard. The fibreglass insulation was donated by a company and the wind generator lent by a lighting firm.

Construction

As the building process is often more important than the end product, the students' experiences in building the autonomous house told more about self-sufficient housing than the end product itself. They were concerned, as architecture students, with the need to build any design that evolved, since the designer and owner of any shelter should be involved in its construction.

The actual construction was undertaken in mid-1974 by 17 2nd- and 3rd-year students with little prior building experience. The complexity of the problem and the number of variables involved precluded the traditional practice of working from design drawings and resulted in the house progressing according to what materials came to hand and the people who were present to put them together.

The design was obviously altered during this process: lofts were added to the roof trusses and there are plans to extend the verandahs over the south wall to provide a cooler area in summer.

As the occupancy of the house has changed, so the performance requirements were redefined. The nature of the house means that it will never be 'finished' in the conventional sense. The house as it is now is a reflection of the needs of the present occupants, and as such it does not present 'the answer' – but one specific view in a wide range of alternatives.

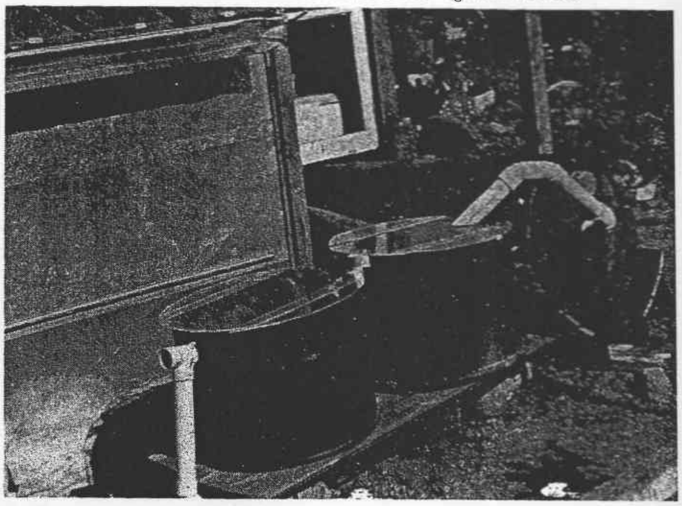
End product

On reflection, the building process taught the participants that the building was still not well enough integrated with its systems: it was oriented more towards heating than cooling and some of the systems are too awkward, inefficient or dangerous to be run on a single-house basis.

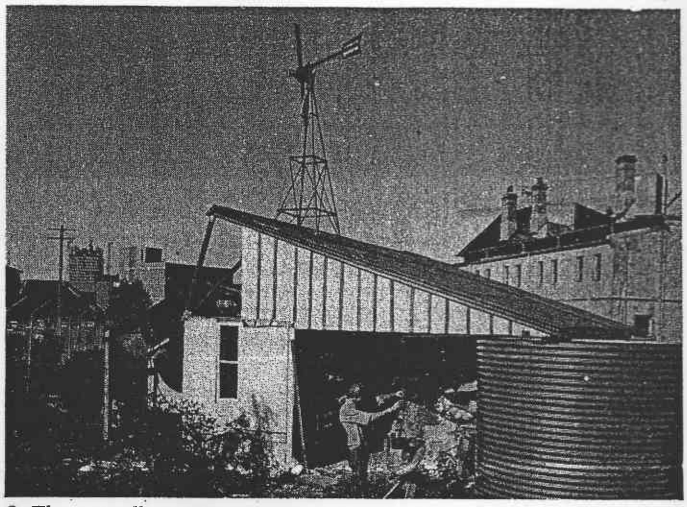
The end product is probably not a very efficient autonomous house, but it is the first in Australia and all its designers and builders are now far more informed about the need for autonomous houses. Another related project is now planned for a series of inter-connected self-sufficient houses, sharing the difficult energy systems, but maintaining a decentralised basis using energy sources that are non-polluting and already decentralised – the sun and the wind.

Further information on the Autonomous House and all aspects of low-impact technology is available from the Alternative Technology Unit, Architecture Department, Sydney University. ATU is currently publishing a number of news-sheets and compiling an information network. News of similar projects would be welcomed.

6. The methane generator utilises human and organic wastes.



7. The wind-powered electricity generator is situated on the main roof.



8. The secondhand materials used give a patchwork look to the house.