WALKING ON SUNSHINE

Hampshire children walk in corridors of power! *Mark Bowman* reports on a school with air pre-heating built-in.

Passive solar heating with a difference is working at Netley Infants School in Hampshire. It uses conservatory spaces on the south-east face to preheat the supply air. The difference is; there is no additional building or services cost so the payback period is zero.

The ingenious process called solar ventilation preheat works on the principle of using passive solar gains to offset the heat loss associated with ventilation. As the space heating load is based on ambient temperature any pre-heat of the incoming air will reduce the energy required to raise the incoming fresh air to comfort temperature.

Solar ventilation pre-heat is particularly appropriate to low energy buildings where conductive losses have already been reduced by good insulation and thus ventilation losses have become the largest component of heating demand. It differs from conventional passive solar systems in that the conduction and ventilation losses are dealt with separately. The main advantage is that there is no threshold above which the available solar energy has to rise before it can be utilised, unlike systems such as Trombe walls.

The physics of the system were devised by Dr Nick Baker of Cambridge University. The original work was done for another project with the same architect, Dennis Goodwin, on a school at Locks Heath. Unfortunately this was shelved (although now it is back in the programme) but that effort was not wasted as it formed the basis of the Netley school scheme.

It was decided early on to use passive solar gains because active solar systems are uneconomic in this country. The only other efficient alternative was a super-insulated building which the architect felt would not provide a suitably pleasant environment for a school. The use of windows would have to be restricted and, generally speaking, the larger the windows the more enjoyable the room becomes. A feeling of being enclosed could make the first steps in education faltering ones.

With a passive solar scheme the choice is limited. Direct gain was ruled out as there are problems with control leading to local overheating of occupants. A Trombe wall was not chosen partly for the same reason as super-insulation; ie that with a lack of awareness of the outside the building becomes less enjoyable. Energy conservation is important but people must like being in a building; a great big wall on the southern aspect of a building could ruin the working environment. There were also the slow response and the temperature threshold problems to add to the list.

It was decided to use another indirect

system with a buffer zone of a conservatory to reduce the heat load associated with ventilation. This has the advantage of being cheap: conservatories are £100/m², school buildings are £400/m². Moreover, the conservatory space is still usable and there is no "temperature threshold" unlike other indirect systems like a Trombe wall or circulating sunspace. With these systems if the solar intensity is below a critical value, the energy cannot be utilised, since the temperature of the air in the collecting space is below room temperature.

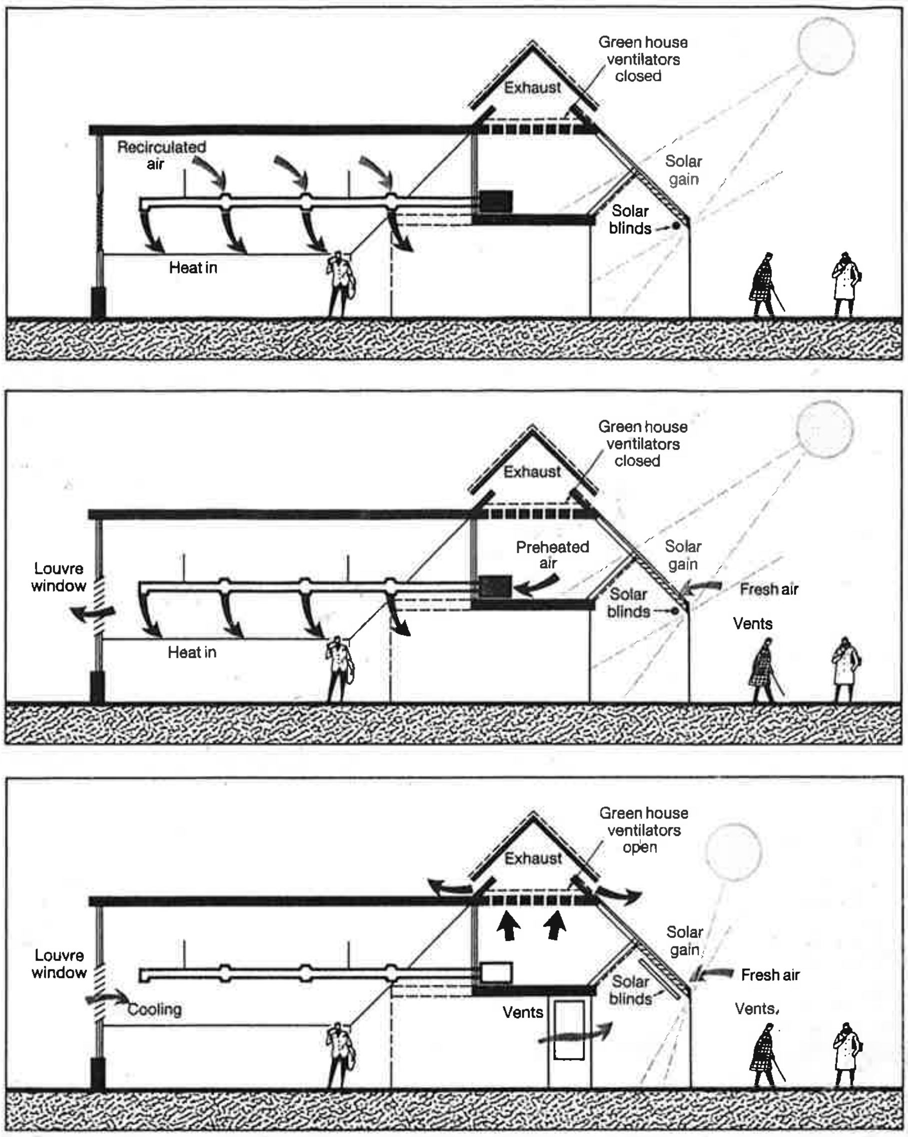
Working together as consultant and architect Nick Baker and Dennis Goodwin made a series of decisions which dictated what type of heating system would be used and how it was controlled. Natural ventilation was too difficult to control so mechanical ventilation was chosen. However, rather than have a separate ventilation system they decided to incorporate the ventilation into the heating scheme; of course the controlled pre-heated ventilation would only be required in the heating season.

A warm air heating system was the only choice. This was compatible with the fast response, lightweight, highly insulated classrooms. Ventilation for the summer months was neatly provided for by roof-top ventilators working on the stack effect. There are also ventilators provided in the north wall of the classroom.

The heating load on the classrooms was low, about 4½ kW, so Nick Baker conceived the heating/ventilation unit as a small fan coil unit mounted over the door. The fresh air inlet from the conservatory, for use when the room seemed stuffy would have been controlled by a manually operated damper and the heating would have a simple warmer/cooler dial control. The staff would have full control with fast response and the kids could see exactly what was happening. The county architects have a philosophy of keeping things simple and having maximum contact of the user with the building.

Unfortunately the minimalist user-operated ideal turned out more complicated in reality with perhaps a degree of over engineering. Each classroom has an air handling unit but this became much larger and was placed on the mezzanine floor. These are remotely operated with a green button to be pressed for fresh air and the warmer/cooler knob; both on the wall next to the light switch. The green button incorporates a time delay which returns the fresh air damper back to recirculation after 30 minutes.

Running down the centre of each classroom is a circular section duct containing the supply and extract ducts and the lighting trunking. Normally the extract slots on the top take the return air and pass it back through the heater battery. When the green button is pressed the dampers change to allow the air to come in a supply grille on the ahu in the conservatory: thus taking in preheated fresh air. In winter the ventilators in the north walls of the classrooms are kept shut, since the pre-heated fresh air is provided from the conservatory, via the air handling units. The preheating is very effective as I found on the day I visited, the temperature outside was a couple of degrees below zero, it was a reasonably sunny day and in the conservatory it was 22°C at mid-day. The conservatory is double glazed with an extruded polycarbonate type of ribbed dual sheet made in Austria by Rohm plastics. This was as cheap as single glazing at £25/m² but with a low U-value of 0·2 W/m²K. It is marketed in the UK by Thermoclear.



Top: **Winter warm up mode recirculation.**
Centre: **Fresh air demand mode using solar preheated air.**
Above: **Summer cooling mode.**

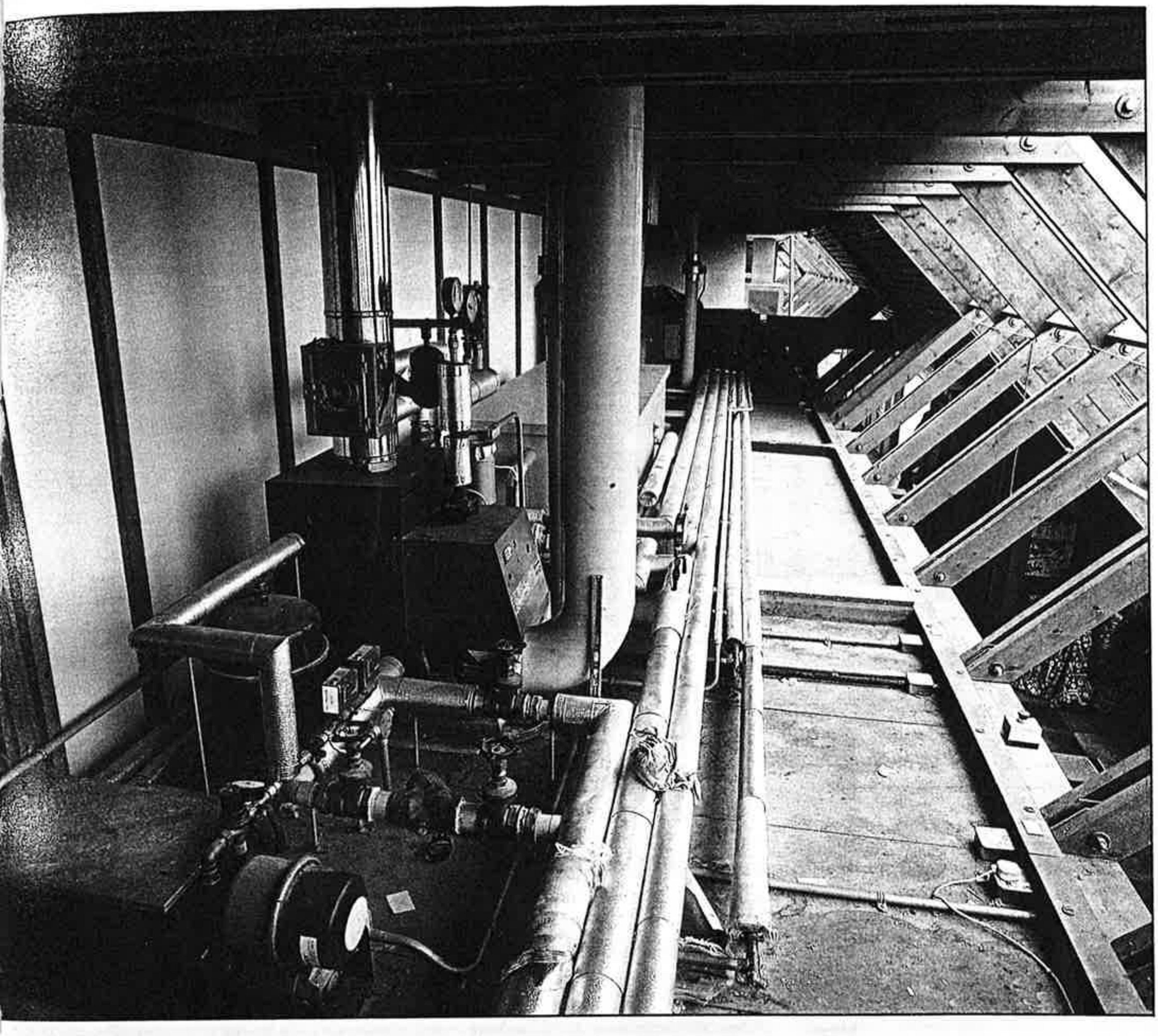
The conservatory is not oriented to the south as one would expect but to the south-east. This is beneficial, because even though, a school is ideal for passive solar heating, as it is occupied from 09.00 until 16.00 it needs heat early in the day for warm up. The sun is perpendicular to the conservatory at 10.30 in the morning. The loss of solar radiation compared with south facing is not great (10%), the sun supplies radiation when it is needed most and south-easterly orientation minimises the possibility of summer overheating.

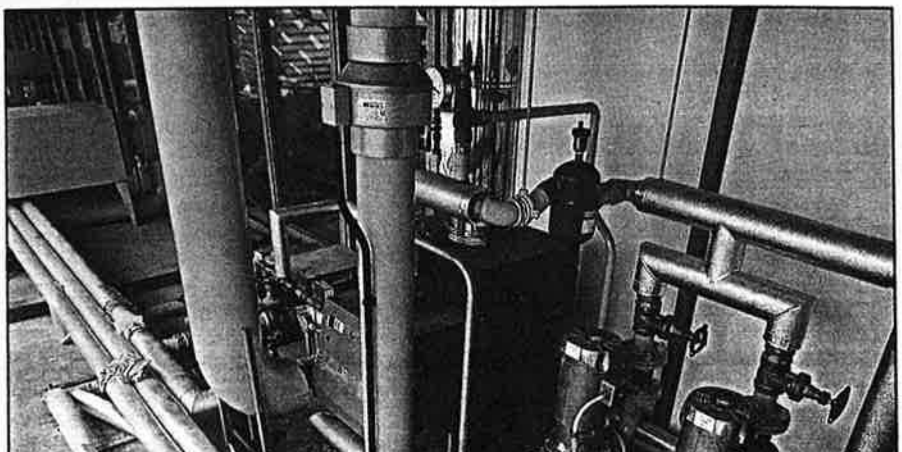
In summer the air handling units do not operate. Overheating of the conservatory is prevented partly by white roller blinds in the lower part of the conservatory and partly by automatically opening dampers (greenhouse ventilator type) which connect the conservatory to a ridge vent running the whole length of the building. The ventilators on the north side of the classrooms are opened and even on a calm day the cool air from the north side is drawn by stack effect.

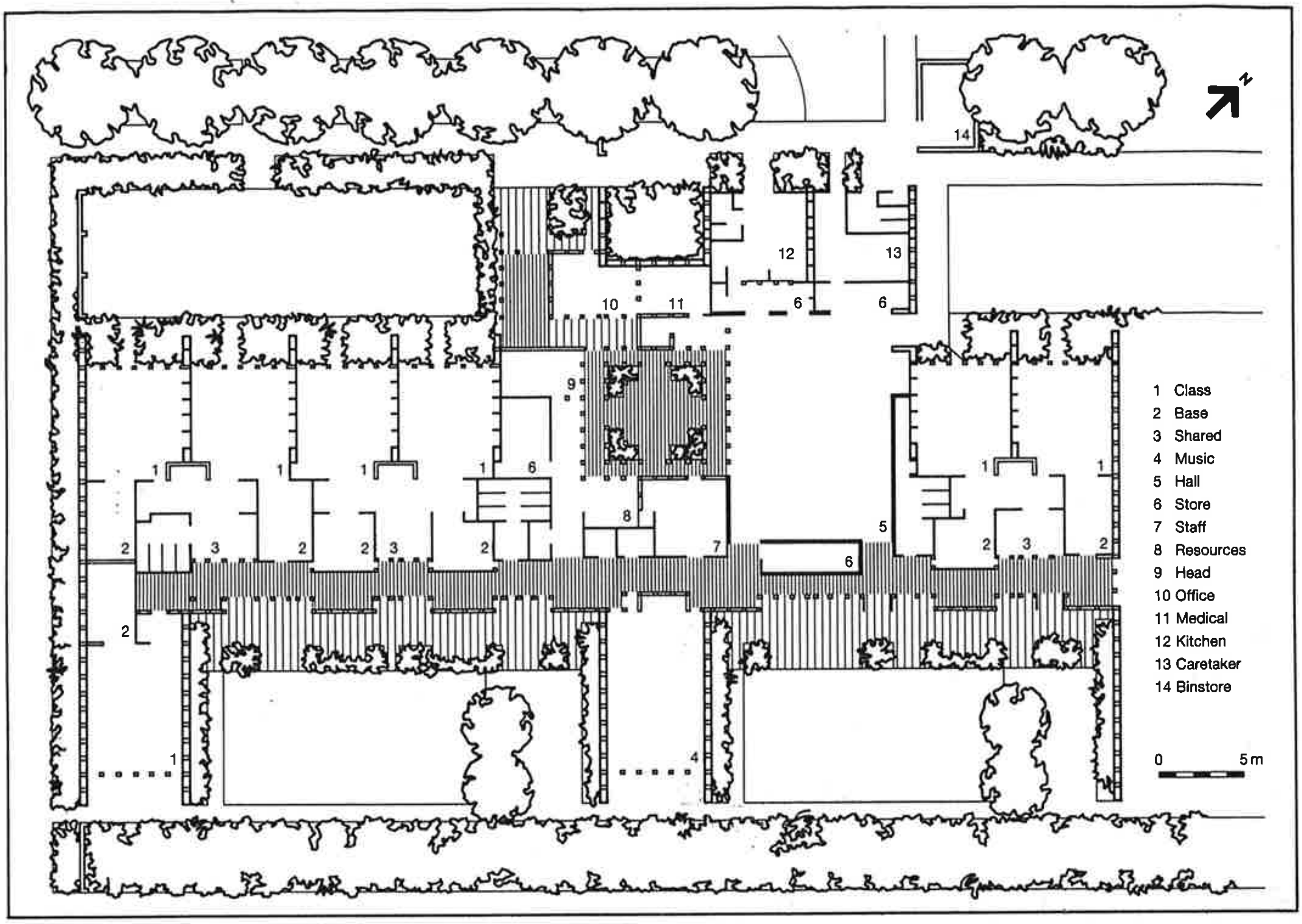
The atrium in the centre of the building is not part of the solar preheat system but just a glazed courtyard. It receives very little solar radiation and what it does receive can be controlled by blinds. This makes it cool in summer and useful as a heat dump if the doors are opened. In the winter, of course the glazing reduces the heat loss from what would otherwise be outside walls. The room is used as a reception area.

The heat for the air handling units is provided by two lphw heating systems each with a high efficiency Hamworthy Wessex 55 gas-fired boiler these also serve a wet heating system for the offices on the north side of the building. The hws tanks and f&e tanks were not positioned in the roof void but placed on the mezzanine floor in the conservatory to take advantage of the heat

Top right: **Boiler plant on mezzanine floor in the conservatory.**
Right: **Clever building services hide behind a traditional structure of brick and timber.**
Far right: **Feedtanks are on the same level as the boilers necessitating pressurisation.**







available. This meant the heating systems had to be pressurised but the feed water and hws water got a useful preheat.

There is no storage of hot water because the pattern of use in a school makes it uneconomic. Instead an Andrews gas-fired instantaneous water heater was used.

Chris Martin of Energy Monitoring Company is checking the effectiveness of the heating system and the extent to which it is being used. The monitoring has not been running long enough to draw any conclusions but some faults have occurred.

The use of the green button fresh air control was found to be very rare, this seemed puzzling until it was realised that the classroom doors were being left open. This is a major problem as the conservatory should be treated like the outside to preserve the usefulness of the solar ventilation preheat. The architect went to some length to make it seem like the outside with the floor of paving slabs, similar to the external walkway, and green colour coding of walls. It is to do with the fact that in public buildings like schools people expect everything to be heated including the corridors.

Door closers and draught sealing seem to have solved that problem but leaking dampers allowing fresh air to come in without using the button mean it is still hardly ever pressed. Complaints of cold classrooms by the staff meant that the heat control dial was often turned up to maximum. The lack of heat was because of various faults like boiler failure, lack of heat supply to the individual ahu or poor sealing causing leakage of outside air into a classroom.

The monitoring has indicated problems with the optimiser control and unreliable frost protection. This sort of heating seems to need very fine control and the ability to tune it as the project proceeds. In future Nick Baker thinks a small on-site computer would be better as changes can be easily made with a few lines of program and the control can be to the exact level desired. Anomalies like the greenhouse dampers being open with the boiler firing concurrently could then be ironed out.

The monitoring has not progressed enough to evaluate a saving yet but the original estimate of a 66% saving in fuel costs compared with the Dept of Education and Science (DES) optimum although optimistic is almost attainable. At present the annual energy consumption is 160 kWh primary energy unit/m^2, the DES maximum is 300 kWh peu/m^2. However, with time and some more trouble shooting, the design team thinks this will reduce to 120. Because there was no extra cost for this saving the project demonstrates well that such preheat schemes are practicable.

Netley Infants School
Architect Dennis Goodwin
Energy consultant Dr Nick Baker
Quantity surveyor John Duggan
Structural engineer Malcomb Gates
Mechanical engineer Stuart Hidden
Electrical engineer Tim Cummins
both of Roger Fuller and Partners.
M & E subcontractors A Buckett & Son
Contractor Bryan Vear Builders
Gross area 992 m^2

	Costs
Contract sum	£395 000
M&E services	£80 000
Mechanical	£50 000
Electrical	£30 000

Principal services suppliers
Air handling units: VES Andover
Boilers: Hamworthy
Controls: Staefa
Optimiser: Satchwell