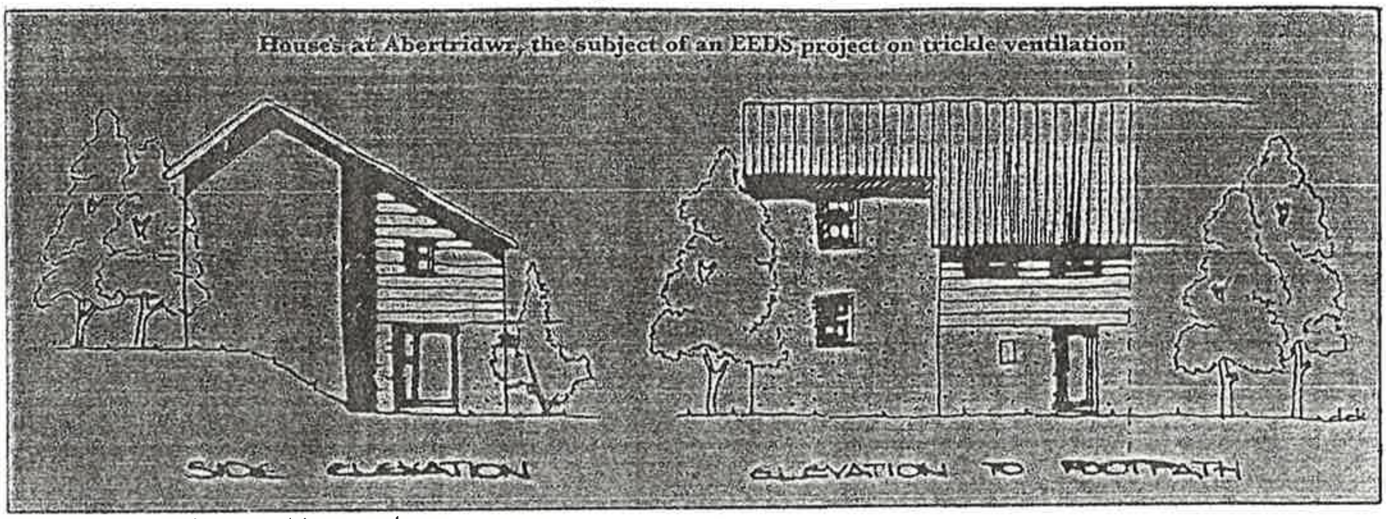
FOCUS ON HOUSING



Houses at Abertridwr, the subject of an EEDS project on trickle ventilation

Design features for low energy housing

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WE HAVE MOVED a long way in house design since those halcyon days prior to the six day war. In 1974 the average three bedroomed terraced public authority house had a design heat loss of about 10kW. This represents an average reduction in the fuel bill of well over 50% in real terms.

Basically this has been achieved by a concentration on the thermal improvement of the major components of which the house was built, for example its insulation. However, although these significant reductions in energy use have been achieved there are still a number of serious problems associated with the thermal aspects of modern housing design, for example the problems caused by condensation.

Low energy research bears fruit

During the same period a deal of research into low energy housing has been carried out, most of whose results are now available. It is therefore perhaps an appropriate time to take stock to review what we have learnt and where we are up to. Such a review leads one to realise that there are still problems concerned with fitting energy efficiency into its correct perspective in housing design, which in turn is associated with the consideration and application of a body of understanding rather than a set of components. There are we believe three issues for consideration.

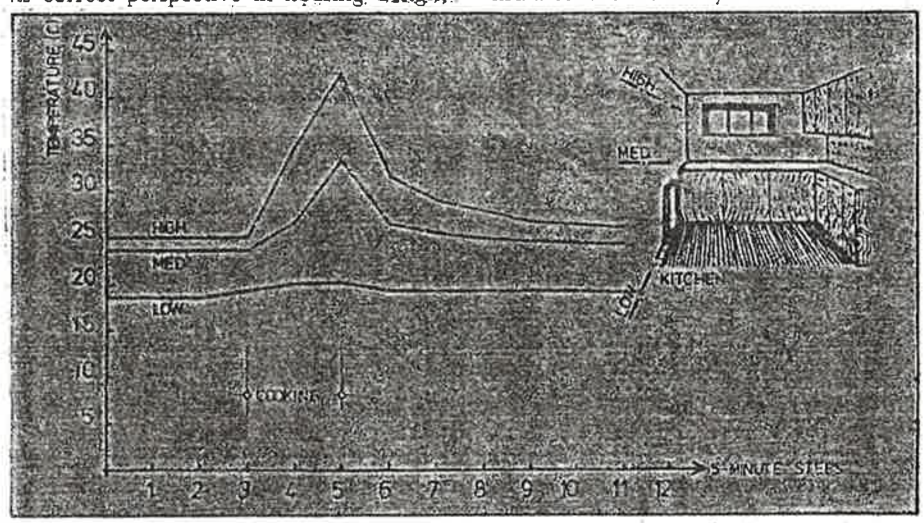
- Firstly, how people use their houses: can one discover a spatial logic which fits with an energy logic, and furthermore does a consideration of such a logic lead to new thoughts on the way houses should be heated.
- Secondly, our initial thoughts on energy efficiency were to make our houses climatically rejecting, ie to make them well insulated and thermally stable with smaller windows inwardly looking. More recent thoughts on the use of passive solar gains suggests that a more interactive approach with the external climate would be more profitable.
- Thirdly, there is the whole question of ventilation and air quality – can ventilation still be allowed to happen by accident or should it be properly designed.

Taking these in order:

Spatial logic and heating systems

The sensible planning of spaces is fundamental to all aspects of housing design, including low energy. If energy efficiency is to be achieved without any disbenefits then the logic of the spatial design must fit in with the logic of low energy use. The first step to achieving this is to gain an understanding of the way in which people use spaces and what peoples' needs are for space heating. From research we find that what people need (which is not necessarily the same as what they want) are heated spaces rather than heated homes. There are certain spaces which have a priority for heating. These are spaces in which people need to be warm and comfortable, and where they can achieve these conditions quickly from 'cold'. Such spaces will generally be occupied during what is the normal heating period of a day, eg the living room and kitchen.

Many of the spaces in our houses remain unoccupied for the most part of the heating period, eg bedrooms. These spaces need not



Kitchens can be heated by the cooker: temperature profiles as a result of cooking

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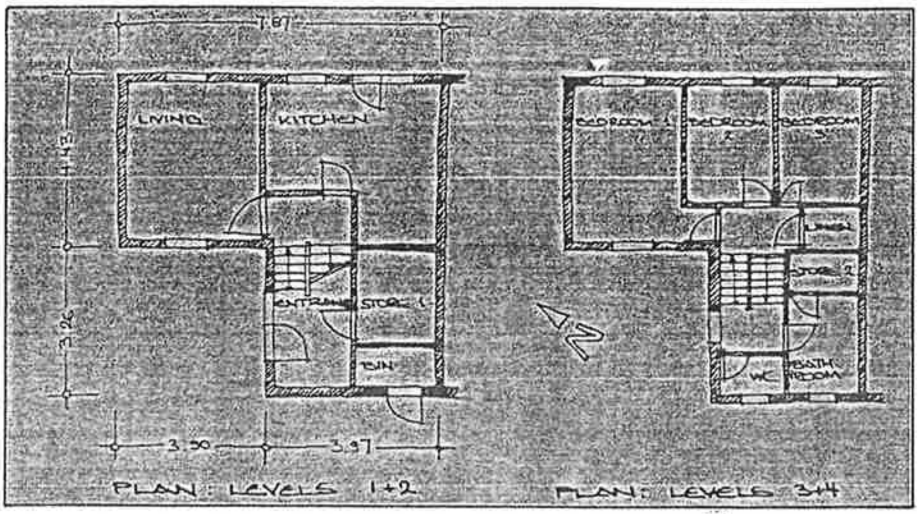


necessarily be heated directly, and can be heated indirectly from the heated space (of course the degree to which this approach can be applied will depend on the size of the house, number of rooms etc).

In general the logic of the above approach is that spaces on the ground floor are a priority for heating, and therefore should be heated directly, while those on the first floor are heated indirectly, usually being preheated for evening use.

To achieve this space heating profile, space must relate sensibly and the construction must allow the passage of heat from one space to another, by convective and conductive means.

There therefore arises a difference between the concepts of a heated space and a warm space, ie a space need not be heated directly to be warm. This potential for not heating first floor spaces leads us away from whole house central heating (which incidentally many people cannot afford) and opens up other options. For example, the kitchen can be heated from cooking, the living room by a direct heater, fuelled by gas, off-peak electric or solid fuel (the provision for, not necessarily of, a flue being a good idea).

If we look at this approach to domestic heating in the light of some of our research work experiences with whole house central heating we find that people will attempt to achieve thermal comfort in the priority spaces while in the bedrooms etc the temperatures will 'float' depending on the degree of control or lack of control in these unoccupied spaces. These floating temperatures can (in low energy houses) result in overheating, in terms of occupants' temperature requirements for these spaces and therefore can lead to a reduction in space heating efficiency. Not heating the spaces directly will mean a reduction in the capacity to overheat rather than a reduction in comfort levels.

Insulation and passive solar design

The tradition in low energy design of houses has been to reject the outside climate. The external walls have had insulation installed, usually in the middle either filling or partly filling the cavity thereby providing an energy efficient and thermally stable internal environment. The inner leaf of the construction has been used to provide stability to the internal thermal environment and windows have been small to reduce heat loss. Solar radiation has been for all intents and purposes kept outside the building, warming up the outside wall and providing comfort in external spaces, bearing in mind that people live around as well as inside their buildings. This method has been successful in achieving energy savings provided the spatial logic and energy logic are compatible, as discussed in the previous section. The results of the Department of the Environment's *Better Insulated Houses* programme endorse this.

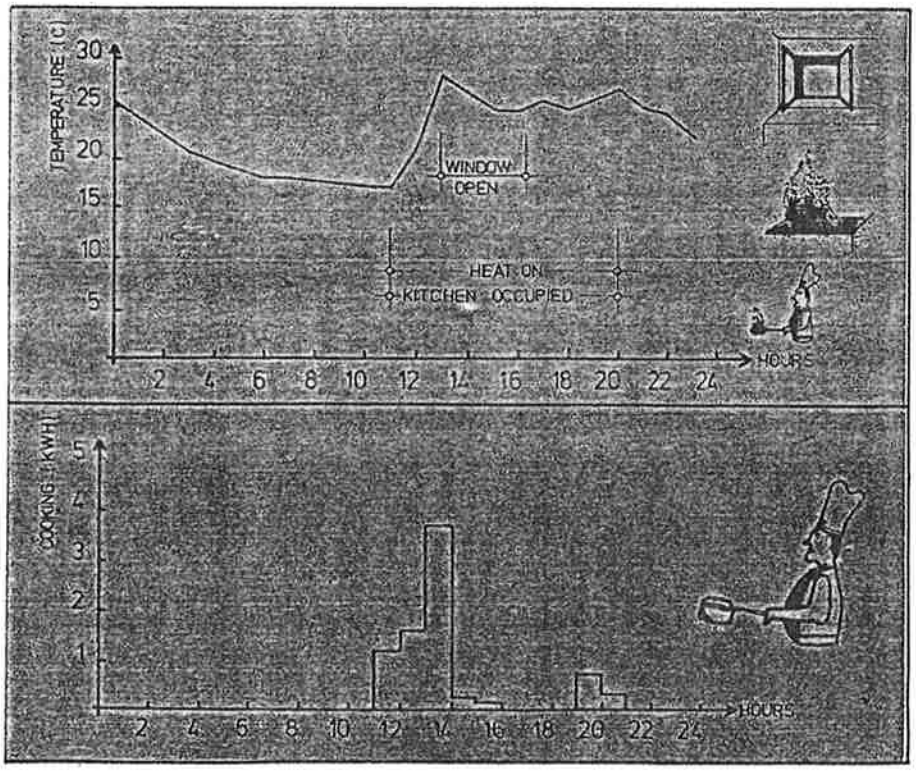
The modern trend in low energy house design is to interact passively with the external climate by designing houses that intentionally collect solar radiation gains for the purpose of heating the internal spaces. Our energy efficient and thermally stable walls are being replaced by areas of glazing, or added on to with conservatories. In order to make passive solar design a success we must overcome the two main problems.

Firstly we must be able to design houses to get the solar gains in. This is concerned with the orientation of houses and the sizing and positioning of areas of glazing.

Secondly, what do we do with the gains when we get them, how do we avoid overheating, and how do we integrate their use into the overall space heating strategy.

Again we need to refer back to our thoughts of the previous section on a spatial/energy logic. From this the most sensible approach is to use the solar gains for heating unoccupied spaces either preheating them for later use or to use the unoccupied spaces as a buffer to heat, or reduce the heat loss from occupied spaces (bearing in mind that the process of moving warm air from one space to another by natural convective means will need to be integrated into the ventilation profile of the house).

Designing houses that interact with the climate, ie Passive Solar, is inherently more difficult than the design of houses which simply reject it, and there is currently little evidence to demonstrate that for the UK climate the theoretical benefits can be fully



One reason for not installing the central heating boiler in the kitchen: the combination of cooking and boiler operation causes overheating

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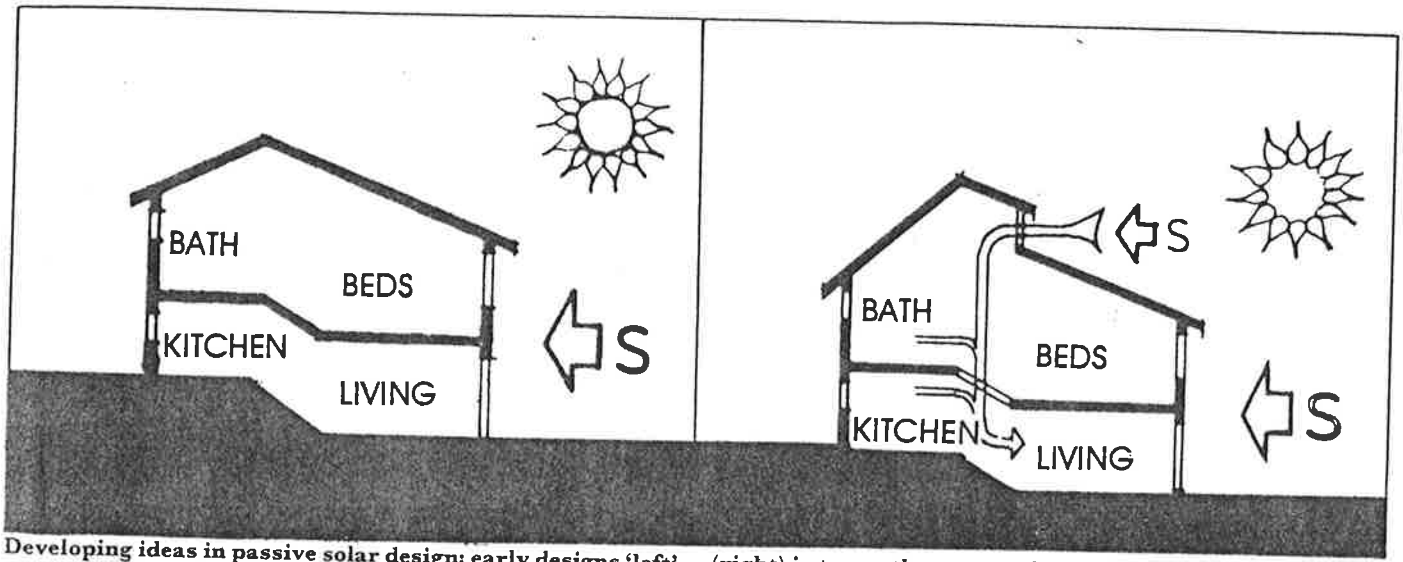


Developing ideas in passive solar design: early designs 'left' used solar gains for direct heating of living spaces, which can cause overheating problems. A more sensible approach (right) is to use the unoccupied spaces as a buffer, warming living areas indirectly. This also serves to preheat the unoccupied spaces for later use.

realised in practice. This is an area where current research activities will hopefully provide some sensible and realistic guidelines over the next few years.

Because of site and spatial design constraints not all houses will be able to be orientated to suit the optimum collection of solar gains. Therefore a typical site would include a mix of climate rejecting houses and passive design solar houses.

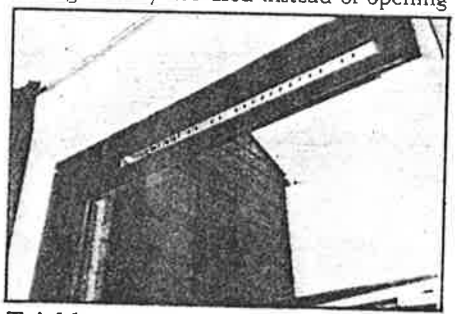
Design for ventilation

In modern low energy houses it is important that ventilation be designed and not just 'let happen'. Low energy design with its increased thermal insulation and draught sealing measures has produced houses with often dangerously low air infiltration rates. Therefore the traditional school of thought which assumed that ventilation would occur, as it were by default, is not now valid. In modern houses whole house infiltration rates are typically 0.5 ac/h.

Research has shown us that with warpage of front doors, service entries to the bathroom, loft access etc, air flow paths can typically take the form of air entering the hall area through the cracks around the front door and leaving through bathroom and landing areas, using the stairwell as an air flow 'highway', and without penetrating into the living rooms where it is needed.

If ventilation is to be designed we must consider the forces that produce air flow patterns in houses. The majority of our houses are predominantly naturally ventilated and it is the interaction of stack effect and cross (wind driven) ventilation that provides the driving forces. Both are affected by spatial planning. Stack effect will predominate at low wind speeds. The degree of wind effect will be dependent on the orientation of the house in relation to the direction of the prevailing wind. For example if the houses are in a terrace which is parallel to the prevailing wind then the stack effect will normally dominate.

We must design for points of air entry and exit, and paths for internal circulation. Windows are insensitive to winter requirements for ventilation; opening a window can typically double the room ventilation rate. They therefore incur a large energy penalty during the heating season as well as reducing air temperatures. Trickle ventilators installed in the window or window frame offer a more controllable solution, without a significant energy penalty or reduction in internal air temperatures. In fact they may result in energy savings if they are used instead of opening windows. Internal air circulation is dependent on using the existing spaces and passages between spaces, and in particular on the positioning of the stairwell. It may also prove necessary to install grilles in internal doors to allow the passage of air.



Trickle ventilators at Abertridwr

It is important to differentiate between summer and winter ventilation. In summertime trickle ventilators are not enough and openable windows are needed. Openable windows are also needed as a safety valve during winter to get rid of any build up of smoke, moisture etc.

Related to ventilation is the problem of condensation. Condensation cannot be prevented from occuring. It can however be dealt with when it does occur. Our research on condensation in dwellings has indicated that the use of trickle ventilators can help reduce the harmful effects of condensation, ie mould growth. It will still occur on windows, eg in the kitchen and bathroom. In rooms that have a high level of moisture generation, in addition to having adequate means of ventilation, the windows in these rooms must be considered as condensation traps and have suitable drainage facilities to deal with the situation.

Summary and conclusions

This article has presented three areas of thought concerning the energy efficient design of houses and groups of houses, based on the need to understand the way in which people use spaces and sympathetic to the constraints of costs, site and buildability. It has not been concerned with giving solutions but rather presenting a view of the body of knowledge from which a range of solution can be developed.

To summarise some of the major points of the discussion:

- it is necessary to fit the spatial design logic to the energy use logic and not to treat energy conservation as a set of independent components, ie an architectural solution is required;
- the size of the house and number of bedrooms will determine the need for upstairs heat emmiters;
- There will be a mix of climatic rejecting and climatic interacting solutions in future house design;
- Ventilation must be designed and not just left to happen and condensation must be accepted and dealt with.

By combining what we have learnt in research and practice, one can suggest ways for a more exciting and energy efficient housing future.

As well as holding the chair in Architecture at UWIST, Professor O'Sullivan is chairman of the Watt Committee Working Group on Passive Solar Design. Dr Jones is a lecturer at the Welsh School of Architecture, UWIST.