Energy conserving buildings – the human factor

With energy use in buildings being a major contributor to carbon emissions, reducing that energy use is a goal that is gaining considerable support. However, Genevieve Jones argues that if there is too much focus on using technology to achieve that goal, and not enough on considering human behaviour, energy use may actually be increased rather than reduced.

> *"Whatever their particular causes, environmental problems all share one fundamental trait: with rare exceptions they are unintended, unforeseen and sometimes ironic side effects of actions arising from other intentions." David Orr*[1]

Energy use in buildings is the result of a number of complex interacting factors including construction materials, structure, location, orientation, user expectations and lifestyle. Most of the emphasis to date has been on reducing energy use primarily by reducing thermal losses through conduction and ventilation, water and space heating and cooling. This is also important for reducing fuel poverty and premature winter deaths.[2] Expectations of indoor comfort have changed over time with increasing indoor temperatures in the winter and use of air conditioning in the summer. The investigators of occupancy behaviour in Dutch residences concluded that an energy intensive lifestyle in a very energy efficient residence can lead to a higher energy use than an energy extensive lifestyle in a less energy efficient residence.[3]

Much of the research and debate on thermal comfort neglects surface temperatures, for example those of walls and floors. If surface temperatures are low, occupants will give off body heat to the surfaces by radiation and conduction. In a British winter, this is likely to feel uncomfortable and therefore, if it can be afforded, the heating is turned up, which in turn increases heat loss through the walls and roof. Obviously, in warm climates or on hot summer days cooler surface temperatures such as those created by stone walls are more desirable. Thus thoughtful design of surfaces can lower the use of energy for heating and cooling.

Sun and daylight

The use of daylight can reduce energy use but the design of windows should take into account the possible uses of the room. Simplistic designs tend to have large south-facing windows to maximise the use of natural heat and light, but this can lead to overheating, glare and unwanted sun. For example, it is rare these days to enter a classroom and find daylight. Usually blinds are drawn and the lights are on long after the sun must have stopped being a problem. The daylight has been shut out with the sun. Changing needs such as the increased use of computers and whiteboards can further increase the use of blinds and electric lighting. Research on offices in Vienna found similar problems. In one office where energy use was monitored it was found that the south side used more electricity than the north side.[4]

A salutary example of the failure of a 'passive solar' design, which actually led to increased household energy use, is that of the conservatory. A survey by Tadj Oreszczyn of University College London examined user behaviour for over 1,800 conservatories.[5] 90% were heated either directly or indirectly in winter, and some were even air-conditioned in summer. So, while building scientists intended the conservatory to provide a temperature buffer for the house, the overwhelming majority of users are not using them in this way.

Passive solar housing: the technical-human interface

Low-energy building design in the Northern Hemisphere uses the sun for space and water heating and maximises daylight. High levels of insulation in walls, floors and roofs reduce thermal losses through conduction. Strategies for reducing heat through ventilation solutions involve careful detailing to stop accidental air leakage through joints, junctions and service intakes. Designs for fresh air however vary from user-controlled windows to the PassivHaus solution[6] of mechanical ventilation with heat recovery, which is usually automatically controlled.

A design that relies especially heavily on new technologies is the Sigma house, intended to comply with the UK government standard for zero carbon homes.[7] However, the concern is that these dwellings will require specialist servicing in order to maintain their design performance and users will be restricted from making internal alterations or repairs in case they compromise the airtight seals.

Researchers at Oxford University have noted that "Comfort may… be achieved in a wider range of temperatures …when it is something that individuals achieve for themselves… Ventilation controls... must not become so sophisticated that they are unintelligible to the people who must live with them day by day. This is a recipe for losing the potential gains from properties that are highly energy-efficient on the drawing board but lose most of those gains when in use".[8]

There is also a related concern that the low levels of ventilation required in these buildings can lead to health problems because of mould growth where humidity is high and from toxic off-gassing from furnishings and construction materials.[9]

Conclusion

Technical fixes aimed to reduce energy use, but that ignore human expectations and behaviour, can actually cause the opposite to happen. Part of the solution is to educate users but energy use in buildings should be reduced by increasing comfort through robust construction, without unnecessarily technical 'eco-bling'. This should include high levels of insulation, bio-regionally appropriate design,[10] low levels of accidental ventilation and simple user controls over their environment.

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(web links correct as of 15 September 2011)

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