Passive design is the foundation of any green building, such as this Steiner School in Germany.

Passive building, active occupant

Of all the considerations designers of green buildings must keep in mind, one is key: buildings are for the people who use them, writes **Ania Hampton**, M.AIRAH.

Passive design is the very foundation of any green building. The approach uses the sun's energy to provide comfort and light, and to replace services otherwise provided by mechanical means. It includes features such as solar heating and cooling, thermal mass, natural ventilation and daylight.

As designers, many of us have been guilty of imposing our own beliefs or ideals upon a client, and delivering a building that doesn't adequately meet their needs and requirements. Fundamentally, a building is for the occupants. If the space delivered does not meet the needs of its occupants and does not provide a habitable, usable and easily controlled facility, it has failed – however green it may appear on paper.

Building owners and users are becoming better versed in sustainability-speak, and will often request high sustainability standards for their building. Clients are looking for a building that will use minimal energy without compromising their level of comfort.

> A successful passive building is a true delight for designers and occupants alike, but a poorly performing one is guaranteed to come back and bite you'

They usually know there will be some compromises, but they expect that comfort will be maintained every day of the year, usually with minimal input from them.

They have been "conditioned" by air conditioning: press a button, instant comfort. Many clients do not anticipate the level of hands-on user control that is required for passive systems to work properly.

A passive building requires an active occupant. Active occupants are in tune with their surroundings. They tolerate a wider range of "comfortable" conditions, knowing that a constant 22.5°C is unrealistic in a low-energy building. They are willing and able to modify their building to maintain their necessary comfort: they'll turn on a ceiling fan, close a window, open a blind and switch lights on and off (just as they do at home). They know what needs to be done, and they do it.

It would be wonderful if all building users had high levels of motivation and ability, but reality often beats even the best of intentions. Here are some typical complaints:

- "I'm really keen to use our building's natural ventilation features and try to get the kids to help me. But try looking after five toilet-training toddlers: it's just easier to switch on the air-con." – Ghada, child care worker
- "Every time I walk past his classroom, he has the lights on. I've tried pointing out that our classrooms are identical, that we both have enough natural light and we should be teaching the kids to use less energy, but he just doesn't care." – Andrew, teacher
- "I left the window open when I ducked out for a quick meeting. It went way longer than expected, the cool change came through earlier than forecast and now tomorrow's presentation is soaked and scattered about the office." – Brian, marketing manager with a corner office
- "I'm always hot and stuffy, and want the windows open. But Debbie, who sits next to the windows, complains about the draught and shuts them again." – Huang, accountant in open-plan office
- "We've tried having the windows open, but with the noise from the kindergarten and street, plus a crying baby, I can't hear a word the poor mother is saying." – Helen, maternal health nurse

> Many clients do not anticipate the level of hands-on user control that is required for passive systems to work properly

- "Of course I close windows overnight. No one told me they needed to stay open to cool the place down." – Bernard, cleaner
- "We were warned that the new building would be warmer, but school policy is that male teachers must always wear ties and long pants. It's unbearable in there." – Marcus, science teacher

Simple, effective shading systems are key to a successful passive design.

COMMON COMPLAINTS – THREE CASE STUDIES

As it is with many buildings – passive or not – problems in building operation can usually be traced back to miscommunication at the briefing stage.

The office building

The brief: A state-of-the-art building to showcase environmentally sustainable design (ESD) for a government tenant/client. Reduced energy consumption was the driving factor, as well as staff consensus that the building was to "breathe" and "not always feel like you're stuck inside the office". The site presented several constraints, not least that the main façade had to face west.

The design: The building utilises a sophisticated mixed-mode natural ventilation strategy, with automated windows and louvres (with manual override) for natural ventilation. Reed switches sense open windows, and motors close them before conventional air conditioning and heating taking over. Automated blinds sense the sun on the western façade and provide solar protection in the afternoon without compromising daylight the rest of the time. High levels of exposed thermal mass stabilise internal temperatures.

The complaint: Staff hated the fact that they had no control over the windows and doors (or felt they didn't). They proudly showed their inventive methods to trick the air conditioning into thinking windows were closed when they weren't, thus increasing HVAC energy use. Friction developed between staff who wanted the windows open and those who didn't.

Staff complained about the blinds not working properly and comfort not being maintained, with the building especially cold in winter.

In retrospect: Although the office lay-out had been designed for effective natural ventilation, there were pockets of very low air movement, and without mechanical cooling these areas became unbearable.

As a relatively new product in the market, the external blinds still had some flaws. The exposed thermal mass was not located where it would receive direct sun, and so in winter it became very cold, producing uncomfortable radiant cooling effects.

It turned out that the client's "staff consensus", as put forward in the brief, was actually a vocal minority and that most staff admitted they would have preferred a conventionally conditioned building.

Seating was rearranged so that staff who wanted open windows could sit next to them. Window openings were limited so that the entire office was not affected by an open window.

The HVAC control strategy was reset to provide mechanical conditioning at all times. When the system operated in economy cycle, "window" staff members were advised through the company's intranet and could open their windows. This turned out to be quite simple for the IT department to set up.

The understanding was that energy use would be monitored and that if it was still excessive, windows would be locked shut. This did not prove necessary.

Automatic solar sensors for the blinds were replaced with simple timers.

Carpeted screens were installed between workstations and exposed thermal mass to protect staff from radiant cooling effects.

The school building

The brief: The redevelopment of a two-storey primary school block, which included classrooms and a covered courtyard. The building had to be naturally ventilated, with no air conditioning.

The design: Natural ventilation and daylight were facilitated through pop-up clerestory windows and openings designed specifically for cross-ventilation. Blinds and louvres were selected to allow portions of windows to be opened, depending on requirements. External automated blinds protected the western façade. The courtyard cover was designed to allow airflow within the courtyard and to expel hot air trapped beneath the canopy.

The complaint: Too hot.

> 'A passive building requires an active occupant. Active occupants are in tune with their surroundings'

What went wrong? The natural ventilation strategy relied on teachers and/or students operating windows, louvres and clerestory openings, which many did not. Additionally, airflow within the courtyard was lower than necessary for good cross-ventilation.

Teaching staff were not consulted during the design phase – the facility manager spoke on their behalf.

The increasing use of computers in classrooms caused higher than expected internal temperatures. Blinds were often drawn to reduce glare, obstructing airflow. The problem might not have been so bad had the blinds that had been specified been installed, because they could have allowed upper sections of windows to be opened while preventing glare at the working level. However, due to capital and maintenance costs, these were replaced with traditional blinds.

In retrospect: The building form and surrounds meant that successful natural ventilation was always going to be a challenge. The design team was overly optimistic about how well their design would perform, despite the obvious difficulties. Rather than hoping for the

Giving users manual control over cooling elements such as fans can help raise occupant satisfaction.

best, perhaps they would have done better to have counselled the client against hoping for too much.

Teaching staff should have been consulted during the design phase. Subsequent training of staff has improved satisfaction but issues are ongoing.

The original blinds were a key feature in enabling ventilation during computer use, and their deletion should have been more strongly challenged.

The community building

The brief: A council-operated community centre – including maternal healthcare nurse (MCH), kindergarten, occasional care and offices – was to be the benchmark green building for the municipality. Incorporating the highest level of sustainable design, the building had to use minimal energy, with air conditioning only to offices and MCH suites.

The design: Despite difficult site constraints, the building was carefully designed around passive building principles – solar gains in winter but not summer, night purge and cross and stack-ventilation using louvres, clerestory windows and ceiling fans to aid circulation. Insulation and thermal mass were used to stabilise temperatures and reduce heating and cooling loads.

The problem: Staff complained that the unconditioned areas of the building were too hot.

What went wrong? Key shading features were deleted by the council during construction, resulting in excessive early-morning solar gains.

Despite assurances to the contrary, staff were not trained in the operation of the natural ventilation features. Additionally, staff had from the outset expressed a desire to have the childcare rooms fully air conditioned, despite the council insisting they would accept a naturally ventilated space.

The cleaner was closing the louvres overnight.

In retrospect: This was a clear case where the building owner (the council) did not sufficiently consult with the actual users of the building. Staff repeatedly petitioned for air conditioning, which was eventually retrofitted. A short training session for staff in the operation of the natural ventilation features, as initially recommended by the building designers, resolved many of the complaints.

COMMUNICATING WITH STAFF

A successful passive building is a true delight for designers and occupants alike, but a poorly performing one is guaranteed to come back and bite you. Services engineers are not often invited to early stakeholder and project control group (PCG) meetings.

But if a passive building is on the cards, it is imperative that they attend. After all, the engineers will be responsible for delivering the passive systems, and ultimately accountable if the building occupants are not comfortable. Useful strategies include:

- Talking to the people who will be actually using the space not their representatives.
- Listening with your eyes and ears. Actions speak louder than words – what are occupants really telling you? Are their daily tasks already too onerous to bother about opening windows as well? Would a naturally ventilated breakout space be better?

> ‘If the space delivered does not meet the needs of its occupants and does not provide a habitable, usable and easily controlled facility, it has failed – however green it may appear on paper’

- Ensuring occupants are engaged right from the start and have ownership of their building. Surveys are useful to anonymously assess user attitudes. Identify any problems or misgivings early on and tackle these head on; time spent now will result in a better overall outcome.
- Tackling occupants’ perceptions of thermal comfort. Users can be encouraged to dress more appropriately for the weather and tolerate a wider temperature band. Instilling a sense of pride, responsibility and ownership in occupants will motivate them to operate it successfully. These attitudes must come from the top: management must show that it is committed to sustainable behaviours before staff can be expected to follow suit.

DESIGN CONSIDERATIONS

Keep it simple. If you can’t explain the passive strategy of your building to children, then it probably won’t work in practice. In a mixed-mode building, users should be able to manually operate windows and air conditioning. This works best in small offices where consensus is either easily obtained or where definite metrics are agreed to, e.g. “When the thermostat on the wall shows

26°C, we close the windows and turn on the air con".

The greater the number of mechanical and electronic devices, the more sensors, automated motors, switches and control logic required, the more likely it is that your building will not work. A sophisticated system that gets out of control can create more complaints and use more energy than just having a simple, robust system to begin with.

As Adrian Leaman once said, "Intelligent buildings are those that don't make the user look stupid."[1]

USING MODELLING

Modelling (computer simulation) of your building can help to optimise building fabric, ventilation openings, thermal mass and control strategies. It can help quantify expected operational parameters and determine if the proposed strategy will meet a given comfort target.

> Intelligent buildings are those that don't make the user look stupid

However, modelling can also provide a false sense of security. A building model will make many assumptions about the building's occupation, inhabitants and use. It will probably use an average year of weather, which may not account for the temperature and humidity extremes of an actual year. It will assume users know how to operate the ventilation systems constantly and perfectly.

And the results are numbers on a piece of paper – how people actually feel in a space can never be perfectly simulated.

Modelling is a very useful tool but needs to be treated as just that – a tool, not an end.

KEY FEATURES AND OPTIONAL EXTRAS

A passive building is not worth its name if it doesn't contain at least three key features:

- Ceiling fans
- Shading features, including blinds (just go for simpler ones, as long as they don't constrict natural ventilation systems and still control glare)
- Insulation and good quality glazing.

Unfortunately, every project has a budget. When push comes to shove, be willing to give up:

- Sophisticated new technology
- Non-essential automation
- Very-high-performance materials – e.g. if you need argon-filled low-e double glazing, consider reducing your glazed area.

But never, never compromise on commissioning, training and post-occupancy evaluation.

TRAINING BUILDING USERS

Training occupants how to use their passive building effectively is just as crucial as designing its passive features in the first place. There are many strategies to encourage building-user engagement, but the three indispensible ones are: the building user's guide (BUG), training and familiarisation sessions, and post-occupancy evaluation.

A BUG must be straightforward and in plain English, be short and pithy (i.e. not run into chapters), and must be kept in a place where it can be easily found. Individual information sheets should be located at the point of use (e.g. next to light switches or louvre controls). A BUG should contain photos and simple diagrams of the items being controlled.

As many staff as practicable should be trained in the operation of the building's passive systems. This will probably mean performing the same sessions a number of times, for different staff.

Training sessions should be split into small groups so that everyone can have a turn at operating things and ask questions.

The sessions should be performed one to two weeks after occupants have moved in, giving them enough time to settle in, find where things are, and possibly experience some slightly unpleasant conditions that will make them eager to learn about their control systems.

Post-occupancy studies are vital. During the first year, you need to be in contact with the occupants at least once each season. A quick visit or call to ask, "How is it working? Are you happy?" can identify problems that can hopefully

Intelligent buildings such as this zero-emissions house are those that don't make the user look stupid.

be quickly resolved. More training may be required, particularly as summer moves into winter and vice-versa. Most importantly, you'll learn what works, what doesn't and how to do it better next time.[2]

A building that eschews full air conditioning in favour of a fully or partly naturally ventilated approach can provide a comfortable, healthy and effective place to live, work and learn.

> Never, never compromise on commissioning, training and post-occupancy evaluation

But to achieve such a building, good design is not enough. Just as important is that the building be useable by the occupants and meet their fundamental needs for that space. Achieving both is not only possible but actually not that hard.

It is only necessary to engage the building users from the start of the design process, during the design process, and again in commissioning and post-occupancy. Done properly, the result will be a passive building with active occupants. In other words, a high-performance environmental building that really works.

Notes

[1] Personal communication by Adrian Leaman to Gerard Healey reported in "Identifying Skills to Support Appropriate Use of Integrated Controls", Achieving the Green Dream Conference, AIRAH, 2010

[2] More information on post-occupancy evaluation can be found in the Soft Landings Framework www.bsria.co.uk/services/design/soft-landings

About the author

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