Woodhouse Medical Centre PROBE 6

Mark Standeven, Robert Cohen and Adrian Leaman report on how Woodhouse Medical Centre, one of the first truly green buildings in the UK, has performed since completion. To understand the building's detailed design, readers should refer to the original article "Introducing the thick building", which appeared in the January 1990 edition of *Building Services Journal.*

Woodhouse Medical Centre is located in the village of the same name on the outskirts of Sheffield. Commissioned by two local medical and one dental practice, the building was constructed under strict financial and spatial constraints exercised by the Sheffield Health Commission.

Occupied in April 1989, the Centre comprises a rectangular, single-storey terrace of three units roughly on a north-south axis. It has a total floor area of 640 m^2, with the two doctors' units accounting for 270 m^2 each and the dentistry unit 100 m^2 (from here on referred to as practices A, B and C respectively).

Although the three practices have separate accommodation, they share responsibility for the building as a whole via a management company of which each senior partner is a director. The management company covers shared access and ground rent, while all other services are charged to each practice.

Since the Woodhouse Medical Centre building was conceived there have been many changes to the business environment of the general practices and the dental practice. Practice A is now fund holding, while practice B is entering its prequalifying year to become fund holding. Fund holding requires more administrative staff, and thus more office space.

Practice A has divided two larger rooms and practice B is planning a loft conversion to satisfy the need. Although not foreseeing the need for more space, the dental practice is having to rely more on private care and hence provide service at times suitable for its patients. Several evening sessions are now being run and more are likely.

Practice A employs five doctors, three practice nurses, three reception staff, two computer clerks, a fund holding supervisor and a practice manager. In addition, community-based professionals such as a physiotherapist, health visitor and midwife use the practice for clinics one or two days per week.

On weekdays the unit is normally occupied between 08.00 hand 19.30 h when the cleaner leaves, while on Saturdays occupancy is between 08.30 h and 12.00 h. Doctors on call are likely to pop in and out during the rest of the weekend. Surgeries operate between 08.30 and 18.00 h weekdays, and between 09.30 and 10.30 h on Saturdays. Practice B is almost identical, boasting 15 employees and four visiting nurses and physiotherapists. The unit is occupied weekdays between 08.00 hand 20.00 h when the cleaner leaves, and on Saturday between 10.00 h and 12.00 h, again with doctors making fleeting visits during the weekend and on weekday evenings up to 22.00 h while on call. Surgeries are run between 08.30 and 18.30 h on weekdays, and from 10.30 to 11.00 h on Saturdays. Although there are just two surgeries in the dentist's unit, four dentists, five nurses and two receptionists operate from the unit each week. Surgery times vary, but are normally between 09.00 and 17.30 h, with one or two evening sessions up to 20.00 h each week.

Construction details

Full details of the building's construction are outlined in the original article "Introducing the thick building"[1].

Essentially, the fabric is traditional brick/ block construction with very high levels of insulation. None of the practices report any problems with the fabric, other than a criticism of the plaster which is apparently easily damaged. This suggests that, generally, a high level of workmanship was achieved.

The doctors' surgeries have similar but not identical layouts. Consulting rooms are positioned off a central corridor which is successfully rooflit from two rows of ridge Velux windows.

The main difference is that the waiting room in practice A is single height and offset from the corridor, whereas practice B's waiting room spans the corridor. Here, the ceiling is cut away to reveal the rafters and to provide a clear space to the ridge-top Velux windows. Apparently, temperatures in the waiting room of surgery A were uncomfortably high last summer, which is probably due to the enclosed nature of the room.

Lighting and daylighting

The designers wanted to avoid references to an institutional interior; therefore the chosen luminaire throughout the Centre was a plain circular bulkhead luminaire with a translucent diffuser housing a single 9W PL compact fluorescent lamp (cfl).

Light output from these was low, and within the first two months practice A installed ceiling-mounted twin compact 24 W PL-L luminaires behind prismatic diffusers, removing the bulkhead luminaires from the consulting rooms. Practice B's response was to provide free-standing 300 W halogen uplighters for each of the consulting rooms.

In the dental practice, contrast glare between the 200 W examination lamp and the room conditions caused considerable discomfort, and four recessed luminaires each with a single 100 W gls lamp were soon fitted to each treatment room.

The current installed lighting load is estimated to average 8 W/m^2, compared with the 5 W/m^2 originally fitted.

During the PROBE survey, artificial lighting was in use in all occupied rooms, except for the central corridor. The combination of low glazed areas and blinds — the latter driven by the need for privacy — means that most consulting rooms have poor daylighting.

Light levels in one small perimeter office in practice B were measured at 260 lux with the ceiling lamp on, and 180 lux with it switched off. Daylight levels in the central corridor

were above 3000 lux.
Light levels in a typical consulting room in practice A were 400 lux with the lights on and 180 lux with them off. Again, daylight levels in the rooflit corridor were above 3000 lux.
The waiting room in the dental practice suffered from particularly poor daylighting levels and, even with all lighting on, illuminances of only 140 lux were measured.
Internal glazed openings above consulting room doorways are partially successful in borrowing light from the corridor, but seem to cause contrast glare in some rooms.
The results of the occupant survey suggest that occupants perceive that electric lighting has to be used rather too much.

Heating and ventilation

Each practice unit is heated by a domestic 1phw radiator system served by a condensing gas boiler with a seven day programmable timer. There are no room thermostats, but each radiator is fitted with an adjustable thermostatic radiator valve (trv).
The heating system seems to be operating satisfactorily in all three units. Practice A operates the system for 24 h/day at a low boiler thermostat setting, while practice B uses the seven day timer to provide heating from 06.30 h on Monday and Tuesday mornings and 07.30 h on the remaining weekdays. Heating is off for one hour at lunchtime, and on weekday afternoons from 13.30-18.00 h.
At weekends the heating is on during Saturday surgery and for one hour each afternoon and on Sunday morning, adjusted according to season. In all units staff seem to make regular use of the adjustable trvs. Practice A reports that some radiators fall to warm when certain other radiators are on, but this could be due to the low thermostat setting.
Practice A has had considerable problems with leaks from its boiler, while Practice B has fitted a timed water shut-off valve to isolate water supply out of hours (a safety measure to preclude damage from water leaks).
Practice A reports occasional cold starts to the week following cold weekends, but comments that the building quickly warms up once patients arrive. By Tuesday morning temperatures are again comfortable. The practice sometimes uses an electric fan heater in the most northerly consulting room.

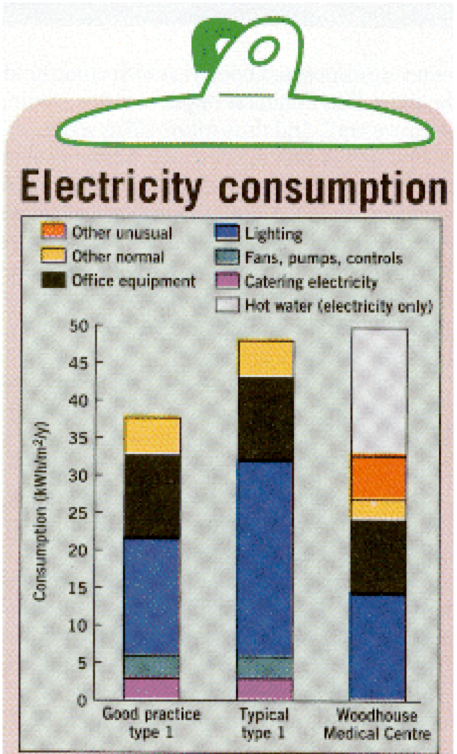


FIGURE 1: Annual electricity consumption. Note the energy for hot water.

Heat recovery

In each unit there is a two-speed Bahco mechanical ventilation with heat recovery (mvhr) system. The designers intended this to provide winter fresh air and reduce ventilation heat loss by means of heat recovery.

Staff in all three practices seem confused as to what their mvhr system is supposed to do. 66% of occupants thought the system should be used during winter and summer, 28% said summer only and just 3% winter only. Just over 20% also thought the system cooled the building in summer, which it cannot because there is no actual means of bypassing the heat exchanger for summer ventilation.

During the PROBE survey, ventilation air flows — even at the higher of the two speeds — were barely noticeable. In the dental practice the system appears to have been permanently switched on since occupation but is no longer functioning. Until recently, one of the doctors periodically serviced the system in Practice A, but the other two mvhr systems had been untouched since occupation. According to the survey results, winter air quality appears to be satisfactory despite a change of the air filters being long overdue.

The occupants would have benefited from a simple fact sheet or reference card to explain the mvhr system. As none of the three mvhr units is used as intended, the fan power may actually outweigh the financial benefits of heat recovery. Frequent entry and exit by patients during winter weekdays probably provides a significant supply of cold outside air into the building, bypassing the heat recovery system entirely. It also seems strange that the mvhr units were not installed with time control.

Mechanical cooling

In response to overheating last summer, practice A has recently installed two split dx air conditioning units to serve one consulting room and the staff room — only financial constraints have prevented the wholesale application of air conditioning in that unit.
The perceived need for air conditioning seems to be an unfortunate consequence of poor summer ventilation, due to:

- varnish-sealed trickle ventilators;
- a tendency not to open windows (possibly due to external noise or cross-talk problems); El very difficult access to opening Velux rooflights (3-4 m above floor level) which have never been opened;
- the lack of a clear ventilation path to exploit the stack effect through the consultation rooms into the corridor (possibly due to noise privacy requirements).

With a little thought and a few minor physical changes, including automated Velux openers, the original natural ventilation strategy could be revived in the two surgeries. The use of weather-tight rooftop ventilators would cut out the risk of rain ingress, and permit secure night-time ventilation.
A comment from the occupant survey ("We have had to install additional air conditioning units. . . The original system has always been inadequate") further suggests that occupants believe the building to be mechanically ventilated, and have therefore not felt it important to optimise natural ventilation.
As with the mvhr systems, a document clearly describing the design intent of the seasonal ventilation strategy might have prevented this confusion.
As the dental practice has no rooflights, buoyancy-driven natural ventilation is not available. One room receives ample cross ventilation (although it is south-facing), while the other apparently suffers considerably with only a single window serving a room depth of nearly 5 m. Hence a perceived need for air conditioning by the dental practice.
The dental practice has also suffered from several burglaries, and would have preferred more robust window frames than the existing ones which were levered apart during the entries. Although window security bars offer good protection, they also now severely restrict window opening.

Heating systems

Hot water is provided by electric under-sink heaters — there are 12 in each doctors' practice and three in the dentistry — serving hand basins with conventional taps. There is a sense of blanket application without careful consideration of actual requirements. Each unit is separately switched and has its own circuit breaker. None is fitted with time controls, and consequently they operate for 24 h/day. The manufacturers quote standing losses for the unit at 0.5 kWh/day, which equates to an annual loss of 5000 kWh at the Woodhouse Medical Centre. The installed units provide insufficient volume to meet the larger but less frequent cleaning and washing up demands.
The dentists and nurses wash their hands very regularly — 40-50 times per day — and sense that this is costing them while the gas heating boiler sits idle. The need for the hot water taps to drip slightly (to release pressure) was also irritating. One undersink heater apparently ruptured in practice A (possibly due to a non-dripping tap), and was replaced by an instantaneous tap unit heater.
However, the installation costs of a gas-fired system may have been difficult to justify for such generally low use, and standing losses from gas boilers could exacerbate summer temperatures unless carefully isolated.
As a general comment, it seems that the strategy of using 27 point-of-use electric

waterheaters is debatable. Instantaneous water heaters (without storage) may have been more efficient for the intermittently-used hand basins in doctors' consulting rooms, and time-switched hot water storage could have been provided for the dentists and cleaners to avoid unnecessary 24-h operation.

Spray taps could also have been used to reduce actual hot water consumption in hand-basins, and ideally the capacity of the units for the cleaners' sinks should have provided sufficient hot water for a number of buckets.

Occupancy survey results

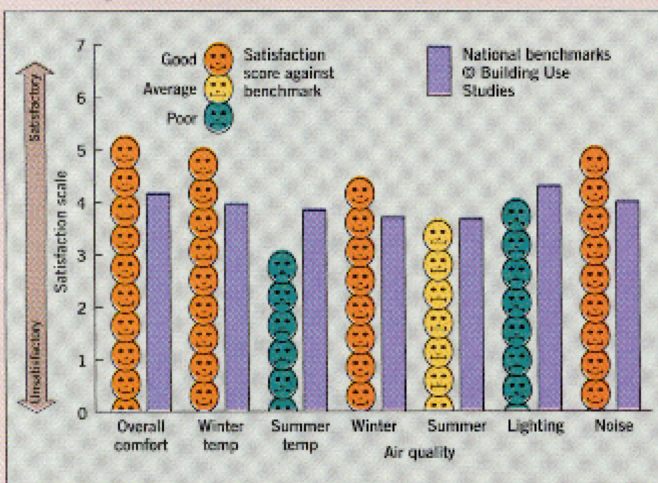


FIGURE 2: Overall satisfaction scores compared with national benchmarks.

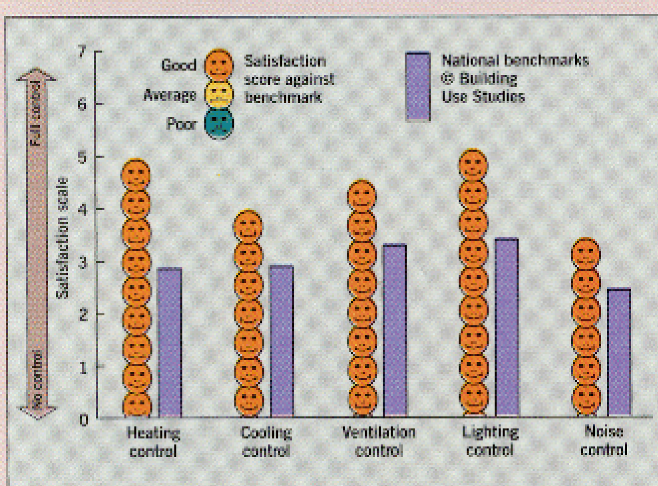


FIGURE 3: Occupant satisfaction with the building's control strategies.

Energy consumption

For the year February 1995 to January 1996, electricity standing charges of £44 per unit account for about 4% of total electricity cost, while gas standing charges of £39.90 per unit account for 20% of total gas cost, but soar to 34% of the gas cost for unit C.

The Woodhouse Medical Centre's performance relative to an EEO type 1 office shows that, although electricity consumption is higher than good practice, gas consumption is sufficiently low to ensure that overall CO_2 emissions are comparable with the good practice office.

A breakdown of the annual electrical consumption of 50 kWh/m^2 is shown in figure 1. At 17 kWh/m^2, hot water represents the largest single use of electricity and reflects the considerable number of hand washes per staff member per day, together with cleaning and washing up. Standing losses from the 27 point-of-use water heaters amount to 8 kWh/m^2, which is nearly half the total.

At 14 kWh/m^2, lighting energy consumption is lower than for a good practice office which reflects the low average installed load of 8 W/m^2. However, in the rooms with the halogen uplighters in unit B the installed load is 17 W/m^2. Office equipment accounts for 10 kWh/m^2, which is similar to the figures for equipment use in a typical office.

Occupancy issues

A standard PROBE questionnaire was distributed to members of staff, with a minor modification to establish occupant knowledge of the mvhr system. In all 31 were returned — an excellent response rate of 82%. A fifth of respondents were doctors or dentists, a quarter nurses and the remainder support staff.

The majority of respondents (93%) had worked in the building for more than one year and had the same work area for that period. 56% worked five or six days per week. The remainder were part-time, but 95% spent at least five hours at their work area in any one day. Most staff were female (77%), and aged over thirty. 46% had window seats.

Overall comfort, winter air temperatures, winter air quality and noise are all significantly better than the Building Use Studies (BUS) benchmarks. Overall comfort is the best yet recorded by BUS (a total of 55 buildings) and winter temperatures second best (figure 2).

There is no significant difference between the benchmarks and Woodhouse Medical Centre for overall summer air quality and lighting, but perceived summer air temperatures are much worse and the centre falls into the lowest 10% of buildings surveyed.

The large discrepancy between winter and summer conditions is unusual. Currently, it is not possible to exploit fully the potential for summertime natural ventilation inherent in the central double-height corridor due to detailed design oversights. If these were resolved it is likely that summer conditions could be improved.

Answers to the more detailed questions confirm that the building is hotter in summer than the benchmark. Paradoxically it is both more draughty and stuffier than benchmarks in both winter and summer despite achieving the best overall comfort marks.

Perceived personal control of heating, ventilation, lighting and noise are all significantly better than benchmarks, and control of cooling is also better (figure 3). These results reflect the fact that work areas are shared by only a few people and the means of control are straightforward and familiar — adjustable trvs, openable windows, blinds and light switches.

Using previous PROBE buildings as benchmarks, perceived quickness of response to control of the same conditions is also significantly better. This is probably due to the small size of most work areas and the good provision of methods of simple control.

Perceived productivity gains of staff at the Woodhouse Medical Centre average 3·8%, which falls in the top 10% of the 55 buildings surveyed so far. This is clearly a very good result, and is probably linked to the high overall comfort and good control of conditions expressed by occupants.

ARCHITECTS' FEEDBACK

It's quite rare to have the chance to reconsider a building some years after it was designed, *write Brenda and Robert Vale.* We agree with all the comments in the PROBE survey, but feel that some of the shortcomings-need to be explained.

Back in 1987, when the building was being designed, the choice of techniques and components was more limited than today. For instance, the light fittings originally specified were discontinued by Philips while the building was still under construction. In a day we had to find fittings at the same price, capable of taking cfls, and there was a very limited selection available.

With regard to both lighting and ventilation, we could have made more use of rooflights in the various rooms, but these were too costly given the limited budget. We have made more use of such passive ventilation strategies in our later buildings.

With respect to the difficulties with opening windows, after working on the Woodhouse Medical Centre we gave up specifying UK timber windows and turned to much more robust Swedish ones.

Hot water provision by gas was avoided because of the need to provide small amounts of hot water to nearly every room in what is a long, thin building with the potential for long, dead legs. Instantaneous electric water heaters would have been preferable to storage heaters, but we could not find suitable units.

As regards the installation of air conditioning, this is clearly rather an extreme response to the severe summer of 1995. The building had run since 1989 without it.

There has certainly been a gradual increase in the building's electricity consumption. We examined the fuel bills for practice B in 1991 and found that it used some 55 kWh/m^2 of gas and 21 kWh/m^2 of electricity.

Some of this rise may reflect the increasing computerisation of general practices since the building was designed.

Brenda and Robert Vale are practising architects and lecture on architecture at the University of Nottingham.

Key design lessons

Comfort and control

Overall comfort is the best yet recorded. The use of simple means to control environmental conditions within small work areas shared by just a few people results in very good levels of perceived control and quick response to any changes. If this is linked to the high perceived productivity gains of Centre staff, then some important lessons for the design of environmental systems and their control in larger buildings are apparent.

Highly insulated, the Woodhouse Medical Centre scores well on winter comfort.

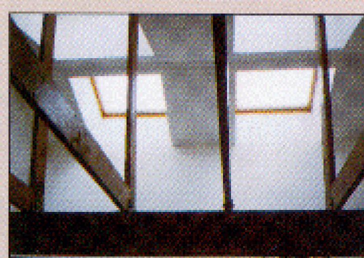
Energy consumption

The Woodhouse Medical Centre achieves an outstandingly low heating energy use, but the emphasis on minimising heat loss may have led to a neglect of the higher cost and CO_2 emissions of employing electric lighting for a building which is occupied predominantly during conventional office hours. Daylight provision is generally poor, except for that in the central corridor.

The daylight level in the central corridor was high at 3000 lux, but was poor elsewhere.

Heat recovery

The design intent of the seasonal ventilation strategy is not clear to the occupants. There seems to have been an inadequate explanation of the purpose, limitations and requirements of the mechanical ventilation with heat recovery (mvhr) system. Night cooling is not possible because the mvhr has heat recovery which cannot be bypassed.



The inaccessible Velux windows have never been opened, causing overheating and...

...the inevitable but excusable response: dx coolers bolted on to the outside of a green building. Despite provision for passive stack ventilation, the building users took the fit-and-forget route to solving their problems.

Ventilation

Natural ventilation paths from windows to the opening rooflights are generally inadequate, but the form of the building provides real potential for stack and cross-flow natural ventilation. The design intent for summer (natural ventilation via openable windows) also seems to have been compromised by external noise, privacy and security concerns.

Water heating

The case for installing 27 point-of-use electric water heaters in a single storey 640m^2 building is debatable. However, detailed capital and running cost calculations would be necessary before suggesting that a gas-fired alter-

References

[1] Edwards N, "Introducing the thick building", *Building Services Journal,* May 1990.
The PROBE team would like to thank Dr Paul Hodgkin, Kay Elwood, Diane Ridge and John Lenton for their kind assistance during this survey.