The Interactive Window System was a sterling effort by Colt International, aimed at developing an integrated and modular product for use in naturally ventilated buildings. Milton Park Ltd piloted the system in a passive solar building completed for Marston Book Services. How well has the building performed?

BY THE PROBE TEAM

PHOTOGRAPHS: BILL BORDASS

PROBE 16: Marston Book Services

Back in January 1996, Marston Book Services moved into its low-cost, naturally ventilated office at Milton Park. With its attached warehouse facility, the (pre-let) building was specifically tailored to Marston Book Services' role as the distribution arm of the academic publisher Blackwell.

The 13·5 m-deep, two-storey, open-plan office (962 m^2 treated floor area) has been analysed in a previous issue of *Building Services Journal*[1]. Readers are advised to refer to this for the building's design details.

The building represents the first full-scale application of the Interactive Window System. This product was developed by the building's architect, David Lloyd Jones, with assistance from the BRECSU and the site's developers, Lansdown Estates and Milton Park Ltd. Environmental control specialist Colt International then turned the original idea into a fully-fledged product.

In addition to the offices, the PROBE investigation also studied the attached distribution warehouse, a conventional, clear span industrial building with a gross internal footprint of 5028 m^2, in addition to 1840 m^2 of inserted mezzanines. It has enough capacity for 4·2 million items (mostly books), with associated infrastructure to handle 1000 orders per day.

Each order averages ten books in consignments ranging from single items up to pallet loads. Incoming books arrive at the north end of the warehouse, are unpacked on the ground floor and then shelved on 10 m-high bay racks by wire-guided fork lift trucks. Marston Book Services needed its new facility to rationalise its operations and to meet the needs of an increasingly competitive market. The office workers and most warehouse staff work a routine five-day week, from 08.00 h to 17.00 h. Some staff arrive at 06.00 h and stay on late. Cleaning is from 18.00 h to 19.30 h.

Typical day shift occupancy is 53 office staff, with 46 in the warehouse. There is also a regular 22.00 h to 06.00 h night shift of seven forklift operators, and a Sunday warehouse shift from 10.00 h to 18.00 h. At the peak of the academic year (August to November), temporary warehouse staff work two extra shifts: from 04.00 h to 12.00 h, and from 17.00 h to 21.00 h.

Most office staff are clerical and work on screen for an average of 6 h each day. Hours of use are routine, and most equipment is switched off at the end of the day. However, five out of 35 pcs and 10 out of 16 printers (in 'econosave' mode) were still on in the evening as some clients send information overnight.

Servicing arrangement

All the space is naturally ventilated except for the mechanically ventilated core of toilets and changing rooms. A single supply and extract air handling unit (ahu) is shared between the two buildings. Hot water is provided by local electric immersion heaters.

The offices are served by perimeter radiator heating from two 50 kW gas-fired atmospheric boilers and a dilution flue in a plantroom at roof level, accessed from within the warehouse. From the primary circuit, four separate pumped secondary circuits supply:

- ☐ constant temperature to the toilet ahu, currently set at 22°C via a three-port valve;
- ☐ constant temperature to the reception door heater unit and adjacent meeting room;
- ☐ two separate compensated circuits, with internal temperature correction, to perimeter radiators on the ground and first floors.

Control is via two optimum start compensators in the boiler room control panel, programmed to run the heating and the toilet ahu from 05.40 h to 18.30 h on weekdays and 14.00 h at weekends (whether or not the offices are occupied), with an earlier start for the heating if necessary.

This central control is intended to be fit-and-forget, so there are convenient push-buttons to give an hour's extra heat on each floor, plus an ambiguously-labelled switch near reception which runs all the heating until the next programmed off time. Only the radiators in the cellular offices, meeting rooms and circulation areas have thermostatic valves.

The warehouse has ten high-level 50 kW gas-fired warm air heaters along the ridge (one per each 8 m bay) pointing alternately north and south. Each heater has a room thermostat at the southern perimeter at low level, which is normally set between 12-15°C and adjusted by the warehouse manager or the night shift.

Heat is blown down to low level by some 20 destratification fans towards the perimeter, all of which are manually controlled by a single switch and activated before the heating is actually brought on. The warehouse includes a number of enclosed rooms, such as offices on the mezzanine, a computer room and a rest room (which includes a series of vending machines as well as some food preparation appliances). The main area is ventilated through the three loading doors and a row of windows above and at the north west corner, all under manual operation.

Most of the windows on the west facade now have shelving in front, and are difficult to reach. All the upper fanlights are also out of arm's reach, and are seldom opened.

Lighting design

In the offices, electric lighting is to a design level of 400 lux. Recessed fluorescent luminaires were used, under automatic control via timers and occupancy sensors (for groups of four to six luminaires in the open-plan areas, or for individual rooms). Sensor delay time is typically 15 minutes. Perimeter light fittings are daylight-linked, with lighting elsewhere manually switched.

The warehouse space is generally lit by high-bay SON lamps, 250 W over the main area and 150 W above the mezzanine and main aisle, at an average installed power level of some 5 W/m^2. This is enhanced by daylighting thanks to translucent strips set in the roof.

All lighting is switched on automatically every day at 07.00 h ready for the morning shift. For safety reasons switch off is manual. The night shift switches off the lighting at 04.00 h Monday to Friday, the warehouse manager switching off at 06.00 h on Friday, while the Sunday shift turns off the lighting at 18.00 h. The warehouse manager also switches off the lights when daylight becomes adequate, and calls in on Saturday morning to check the building and switch off the lighting.

The reception/dispatch area under the mezzanine is rather patchily lit by a sparse grid of fluorescent reflector fittings. These were part of the occupier's independent fitout, with an installed power density of 4·4 W/m^2.

The glare from sun and sky is disappointing in view of the care devoted to the window system. This is due to diagonal sunshine coming past the ends of the light shelves, and bright spots on the blinds in bright sunshine.

Re-lamping was overdue at the time of the PROBE visit. Half the fittings had only one tube of each pair working, some having been damaged by forklift trucks. Lux levels ranged from 300 lux under a well-functioning fitting to 30 lux in the rectangle between four poor ones. A month later, the lamps were replaced – levels improved to 600 lux below the fittings and a minimum of 80 lux inbetween.

External lighting illuminates the building, car park and goods yard. It includes SON lamp standards, floodlighting and illuminated bollards. The total connected load of 5 kW is left on all night for security reasons, and is switched off at 08.00 h.

The Interactive Window System

The Interactive Window System arose from the difficulties which the architect and the developer – Milton Park Ltd – had suffered on previous projects in finding a window which worked really well in naturally ventilated offices[2]. Particular issues included:

- good manual or motorised operation;
- an ability to accept blinds, sunbreakers, tilting light shelves and acoustic treatment as clip-on accessories, tailored to orientation, exposure and occupant requirements.

The windows come in four main sections:

- an upper motorised fanlight with an individual switch for each window;
- on the south and west facades, a transom which supports an external, horizontally-projecting sun-breaker louvre, an internal adjustable light shelf of translucent aluminised polyester film and an open-weave roller blind;
- a middle, top-hung, manually-openable canopy action window;
- a lower fixed-pane vision panel.

The windows are normally under individual occupant control, but all the upper windows on each floor can also be collectively overridden open or closed by accessible push-buttons near the staircase. In addition, the top floor also has a central row of motorised rooflights under manual push-button or automatic temperature control. Manual control is normally used, and a rain sensor closes the rooflights when necessary.

The PROBE Team measured daylight factors of 3% or more at perimeter workstations, and 10% under the first floor rooflights.

So how has the Interactive Window System performed? Occupants regarded the windows as successful in the main for ventilation, and particularly liked the performance of the upper motorised window, although some whistling occurred in high winds. However, the central window element performed poorly, as only a small wind was required to blow it shut.

The window hinges do not have sufficient resistance, and there is no slit-catch position.

CO_2 emissions and electricity consumption data

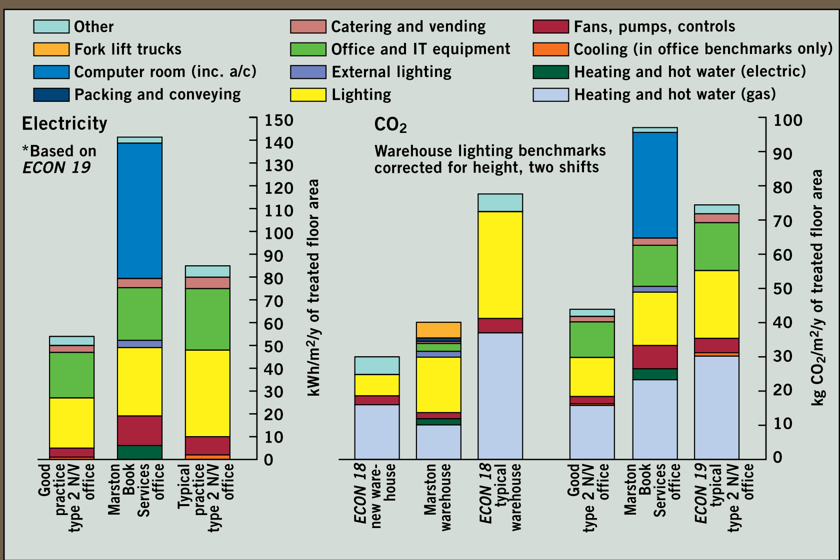

FIGURE 1: End-use energy breakdown at Marston Book Services. Conversion factors are gas: 0·2 kg CO_2/kWh and electricity: 0·52 kg CO_2/kWh. All electrical energy consumption is based on 1997 data. Although not shown, the electrical consumption of the warehouse (42 kWh/m^2 of footprint area, or 31 kWh/m^2 including the mezzanine) can be considered close to the 'improved' benchmark in *ECON Guide 18*.

Consequently, people sitting by the windows cannot control the draught, and feel that too much of the air goes over their heads.

Operational issues

Initial occupancy seems to have been straightforward, but it involved some additional fit-out by others, including the reception area, the extra mezzanine on the north side of the warehouse, the high bay racking and goods handling equipment. The offices proved to be chilly near the fire doors (see box "BRE pressure test"). Extra radiators have been fitted.

A persistent problem has been the lighting controls in the offices. Initially, they did not work properly and caused a lot of annoyance. Modifications to installation and programming ultimately improved most aspects, but the photoelectric control of the perimeter lighting finally required major attention by the manufacturer in late 1997. The perimeter lights now tend to go off in sunshine only.

Unfortunately, there are few light switches for the occupants to use, and the programmers are not very user-friendly. They have therefore been adjusted to generous but wasteful default settings, while some of the office lights have been transferred to the circulation lighting zone.

The building is now looked after by the operations director and the warehouse manager, who personally adjust programs and settings as necessary. The local contractors who installed the m&e services have been retained by Marston Book Services for maintenance. These contracting concerns understand Marston Book Services and its operations, and provide a good level of service.

Energy and water consumption

The office and warehouse are compared independently with the DETR's Energy Efficiency Best Practice Programme benchmarks from *ECON Guide 18* (industrial buildings) and *ECON Guide 19* (offices). For shared services, external lighting is apportioned in relation to total floor area, and toilet ventilation (fans and heating) in relation to air volumes.

As ever, energy consumption is not a high management priority. Having procured what they understood to be an energy-efficient building (and which has proved economical in operation), Marston Book Services has not monitored performance closely. This would have been difficult in any case, given that the offices and the warehouse were not originally separately metered. At the suggestion of the PROBE Team, office sub-meters were installed by the landlord early in 1998. These have provided valuable feedback information.

More effort has been devoted to environmental management. Waste paper and cardboard is segregated, compacted and sold, avoiding heavy disposal charges.

Electricity consumption: offices

Electricity is on a maximum demand tariff, with an available capacity of 130 kVA, a tight fit with the maximum demand of 115 kVA (with little seasonal variation). This had been as high as 128 kVA until three of the forklift trucks were provided with spare battery packs. Annual electricity consumption for 1997 was 484 000 kWh, with the following estimated split based on the sub-metering carried out this year:

- ☐ 332 000 kWh for the warehouse (66 kWh/m^2 of footprint area);
- ☐ 19 000 kWh for external lighting;
- ☐ 57 000 kWh for the computer suite;
- ☐ 76 000 kWh for the offices (79 kWh/m^2 of treated floor area).

At 6 kWh/m^2/y of treated floor area, electricity for office hot water is close to the typical benchmark[3] of 7 kWh/m^2 where water heating is electric (figure 1).

For fans, pumps, controls and boiler ancillaries, electricity consumption is 13 kWh/m^2 – relatively high in relation to the benchmark for a 'Type 2' naturally ventilated, open-plan office. This is due to a variety of reasons. First, the heating pumps and flue dilution fan run for relatively long periods. Second, the toilet fans run for long hours in order to accommodate the warehouse shift patterns. Third, there is the consumption by the controls and security systems in a relatively small building.

At 30 kWh/m^2, lighting energy consumption is between typical and good practice levels in *ECON Guide 19*. The installed power density in the offices of 13 W/m^2 is a little above the 12 W/m^2 regarded as contemporary good practice, but the efficiency (2·7 m^2/100 lux) is relatively good and power density in the ancillary areas is relatively low. However, the good daylighting and automatic control have not restricted the operating hours of the lighting by as much as had been hoped. The need to close the blinds to avoid glare has required the switching levels of the photoelectric control to have a generous setting.

Circulation and toilet lighting is automatically activated for 12 h/day, regardless of need. Occupancy sensors also switch on lights in cellular offices and meeting rooms regardless of daylight levels.

At 23 kWh/m^2, the power consumption for office equipment is between typical and good levels for a Type 2 office. However, this masks the combined effects of a typical occupant density with relatively routine hours of normal use, but a relatively high proportion of equipment left on overnight.

Although the computer room is modest, with equipment drawing an average 3·5 kW, spot metering suggests that the split-system cooling has been relatively inefficient, consuming an estimated 55% of the 60 kWh/m^2.

At 4 kWh/m^2, power consumption for catering and vending is between the typical and good practice benchmarks. It includes two relatively efficient vending machines, plus the occasional use of coffee makers.

Other uses account for 6 kWh/m^2. This is slightly higher than typical, owing to the relatively generous external lighting which operates from dusk until 08.00 h.

DESIGNERS' RESPONSE TO THE FEEDBACK STUDY

From the engineer

While energy was a key feature of the brief from the developer, Lansdown Estates, all the usual commercial criteria had to be met for this pre-let building, *writes Michael Carver.*

As the building services designer, SVM is very pleased with the high level of end-user satisfaction the building has achieved. This has been achieved by considerable discussion between the landlord and tenant in developing the designers' brief.

The brief demonstrated the need to understand occupant objectives, so often not possible in a normal speculative building. This was quite a difficult task when the building itself was to be used by Marston Book Services as a medium for change within the organisation.

Minor changes to the systems could overcome the impact of energy consumption of toilet extract and flue dilution fans, but it is doubtful if the effort would be repaid in a realistic period. We do accept, however, that more user-friendly controls are necessary to allow occupants to get the best performance out of the lighting controls and other systems.

My own philosophy is that the designer should seek to minimise energy use, but having approached the optimum should look to ensure a high level of occupant satisfaction.

From the architect

The head office and distribution centre for Marston Book Services was the first project undertaken by Studio E Architects, *writes David Lloyd Jones.*

Many of the lessons learned have been applied to subsequent buildings, in particular the Doxford Solar Office (see 'Solar so good', p14) . At the Doxford Solar Office, for example, air leakage is minimal.

Marston Book Services was the first application of the Interactive Window System. Evidence that the system is on the right track is seen from the number of purpose-designed generic cousins that the product has spawned.

This PROBE report suggests that, with a little design tweaking, it could still become a viable open package of complementary components that would give the specifier a wide choice, while offering the user great versatility, performance and economy.

David Lloyd Jones AA DipRIBA FRSA is with Studio E Architects. Michael Carver CEng MCIBSE MConsE FRSA is md of SVM Consulting Engineers.

Electricity consumption: warehouse

The warehouse electricity consumption figure of 3 kWh/m² for fans, pumps and controls includes the heater fans, destratification fans and a proportion of the toilet ventilation system. This is less than the benchmark of 5 kWh/m² in *ECON Guide 18*[4], owing to good insulation and airtightness, low set-point temperature and short hours of operation.

The lighting benchmarks for distribution buildings in single-shift operation span a wide range, from 25 kWh/m² for typical operation to 12 kWh/m² for improved and 5 kWh/m² for new build using widespread occupancy sensing controls. The improved benchmark seems the most appropriate here: it could reasonably be doubled to take account of the night shift, and increased by 20% to take account of the added height of the building.

On that basis the actual consumption of 42 kWh/m² of footprint area (or 31 kWh/m² including the mezzanine) can be considered close to the "improved" level.

While relatively low in terms of installed power, the warehouse lighting has long hours of use. It is all on two switches, and much of the lighting – particularly over the racking – is only occasionally required.

More demand-responsive controls, taking into account occupant requirements, appropriate presence detection and daylight-linking could have given a major reduction in electricity use, though it would have cost more. From experience in the offices, however, it might not have been convenient.

Other electrical consumption is accounted for by IT equipment (4·5 kWh/m²), hot water (1 kWh/m²), heating (2·5 kWh/m²), catering and vending (1·1 kWh/m²), mechanical handling (11 kWh/m²) and 3 kWh/m² for external lighting on a *pro rata* basis.

Gas consumption: offices

As is so often the case, the gas bills provide little useful information, with all but one of the readings for 30 months having been estimated. However, this reading and the external temperature-related performance of the new sub-meter readings have enabled a consumption profile to be assembled.

Consumption for the 12 months from 15 January 1997 was 366 000 kWh. This is apportioned as 240 000 kWh for warehouse heating, 90 000 kWh for office space heating and 36 000 kWh for toilet air tempering (19 000 kWh to the office and 17 000 kWh to the warehouse).

The office total of 113 kWh/m² rises to 122 kWh/m² for a typical degree day year in the Thames Valley, and 135 kWh/m² for the standard 2462 degree day year used in the energy benchmarks[3,4]. This is closer to the typical benchmark rather than the good practice benchmark in *ECON Guide 19*, disappointing for a low energy design. This is due to long programmed hours of operation, including weekends, poor airtightness of the fabric and heating operating (albeit at low compensated temperatures) in mild weather.

Marston Book Services reports that if the heating is switched off in mild but changeable weather, the office can often be cold in the morning. This situation may be exacerbated by high air infiltration.

The toilet ahu is also the tail-that-wags-the-dog, being shared between two uses at different times and requiring heat for air tempering when nothing else does. Had the unit incorporated a heat recovery system, this situation might have been avoided. As it is, the supply air temperature could probably be reduced from 22°C to, say, 18°C.

On the other hand, the warehouse total of 51 kWh/m² is well below the *ECON Guide 18* value of 80 kWh/m². This is due to relatively good insulation and airtightness values, a lower temperature setting than the 16°C benchmark, mild weather during the monitored period and relatively high internal gains, particularly from lighting. Information is lacking to correct this for degree days.

Water consumption

Water consumption in 1996 and in the past six months has averaged 1550 m³/y, but in 1997 it was over 50% higher, probably owing to the floods. Ignoring this and taking account of the shiftwork, water consumption equates to some 12·9 m³/y/head. This is virtually identical to the norm, while the BRE's suggested good practice level is 10 m³/person.

The occupant survey

Building Use Studies (BUS) carried out a survey of all 55 office staff in 1997 (figures 2 and 3). 32% of the staff are male, compared with a 52% dataset average. 62% say they have window seats (norm: 64%). 47% are under 30 (norm: 35%). Almost all work standard hours, mostly at vdus for six hours or more each day.

On average, staff rated winter temperature to be good – in the top 20% of the BUS database – and very stable. Winter air quality was excellent – the best building in the BUS dataset both overall and for lack of odour, but reported to be slightly dry and stuffy.

Summer temperatures were slightly too hot, but better than typical. Air quality was good for a naturally ventilated building, but perceived as being more still and stuffy than typical, and again odour-free.

The overall impression of the lighting was slightly worse than average. Occupants perceived too little natural light (though slightly

Results from the occupant satisfaction survey

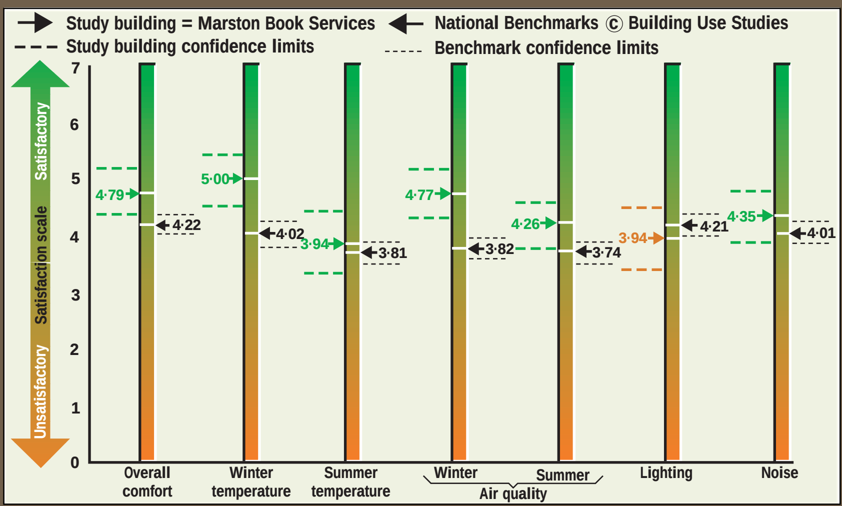

FIGURE 2: Overall satisfaction with comfort conditions at Marston Book Services.

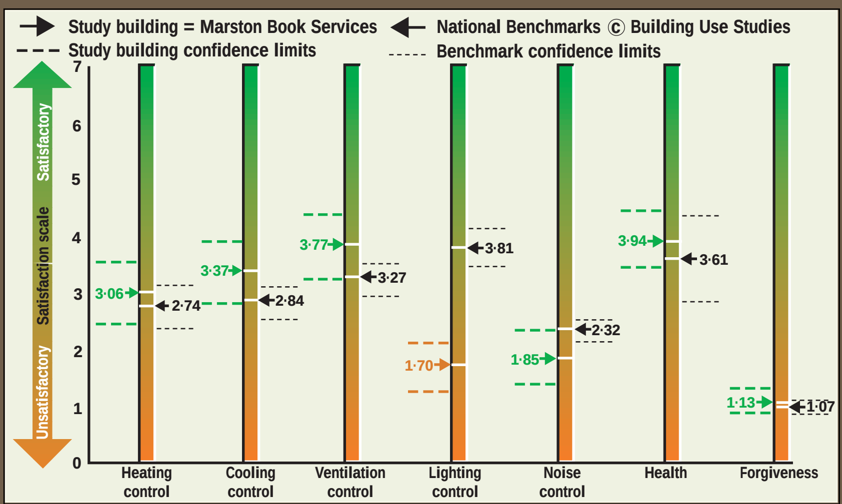

FIGURE 3: Occupant satisfaction with the building's health, management and control strategies.

more than average). Anecdotal comments suggest that this perception largely reflects frustration at the blinds having to be closed and the electric lighting used if the sun or sky is too bright.

Indeed, occupants complained of high levels of glare from the sun, sky and electric lighting, and too much electric lighting. The latter is common where there is intensive computer-based working in an imposed background level much over 300-400 lux (measured levels were over 500 lux).

The reported glare from sun and sky is disappointing in view of the care devoted to the window system. This seems to be due to diagonal sunshine coming past the ends of the light shelves and bright spots on the translucent blinds in bright sunshine. There are no blinds on the north facade, but bright skies can still cause problems with contrast glare and reflections in computer screens.

Occupants disliked the poor light switching, with its uncontrollable and intrusive automatic occupancy-sensed system and lack of overrides – even in cellular offices. Negative comments were also made about the photoelectric switching. Occupants also requested more control over the lights, particularly at workstations, and a better way of reprogramming for weekend working.

Since the occupant survey, the lighting control has been recommissioned. Although the occupants were aware of improvements, the overall situation has not changed dramatically. Overall, occupants still feel that the lights are on too much, and that the photoelectric switching is too abrupt.

Occupants considered the occupancy sensors capricious and wasteful (in that they turned on the lighting regardless of whether or not it was actually needed). If there were only a few people in the office, a sensor might not see a person who would then be forced to wave their arms around for the lights to work.

In spite of the open-plan offices, perceptions of noise are better than typical. However, the perforated ceiling at the perimeter of the ground floor – designed to provide access of room air to the thermal capacity of the floor slab – carries flanking noise between enclosed rooms and into the open offices.

During interviews, warehouse staff generally agreed that the building provided a good working environment. Heating and ventilation attracted the most criticism, with stratification a major problem all year round. The destratification fans do not solve the problem, partly because the mezzanine blocks any downward flow on the north facade.

Ventilation was also a problem away from the northwest corner. Roof ventilators would have been desirable, but the client did not want the risk of rain falling on the stock.

The poor lighting under the mezzanine was also noted, but it is important to point out that the building designers had no hand in this.

Overall, comfort in the building is good, being in the top 20% of the buildings in the BUS database. Had it not been for the problems with lighting and its control, occupant satisfaction would have been excellent.

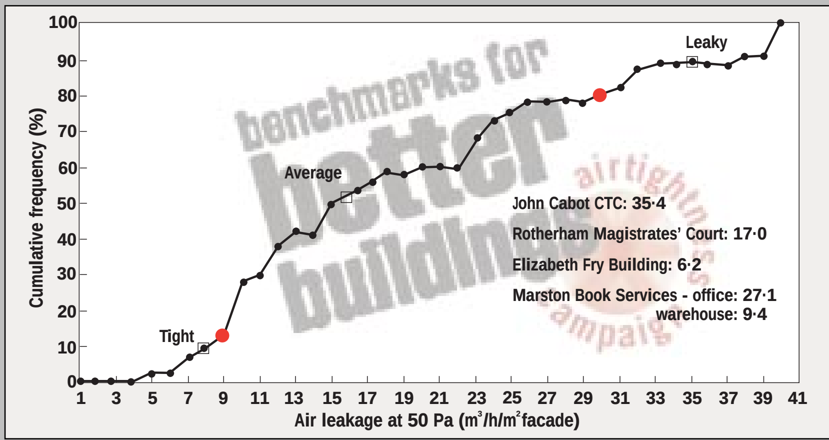

FIGURE 4: The air leakage data for Marston Book Services, plotted on the BRE/BSRIA rolling database.

BRE pressure test

The offices and warehouse at Marston Book Services were subjected to a pressurisation test, carried out by the BRE Building Performance Assessment Centre, on Saturday 4 July, *writes Brian Webb.*

Tests were carried out using the large BREFAN rig, and smoke tubes were used as a tracer to detect any air leakage points in the envelope. The offices were tested alone, and then combined with the warehouse. A deduction was also made for air leakage through the ten flues for the warehouse warm air heaters.

The Q-value (Q_{50}/S) for the offices was calculated to be 27·1 $m^3/h/m^2$ of envelope area (calculated at 1366 m^2). This puts the building near the 'leaky' group on the BRE/BSRIA database (figure 4).

For the warehouse alone, the Q-value was calculated to be 9·4 $m^3/h/m^2$ of envelope area (calculated at 6016 m^2). This value is very good compared to most industrial buildings.

The test on both the office building and the combined test (warehouse and office building) resulted in one ceiling tile being lifted on the first floor of the office building, with one tile being raised in the smoking room in the warehouse.

This indicated significant air leakage through the roof structure of the office building, and at the junction between the office brickwork and the warehouse cladding, which occurs at the smoking room. In depressurisation mode, a ceiling tile was lifted manually, and a severe downdraught of air was detected from the office roof space.

On the ground floor of the office block, the east fire exit door leaked badly along the opening and where the frame met the wall. The south door also leaked badly all around the perimeter.

The upper elements of the Interactive Window Systems were very leaky, with a lot of play in the automatic control mechanism stopping the windows closing tightly against the draughtproofing. All the windows appeared to be the same, with the lower, manually-openable elements better sealed. A few windows leaked at a corner, and there was one faulty window that could not be closed properly. These windows also had leakage points where small lengths of beading or draughtproofing were missing. A few windows leaked through the joints of the frame.

Air leakage was also detected under the window cills, and at the joints between the window and the wall. Air was also found to leak into the office space through the floor service panels.

On the first floor of the office block, air leakage through the eaves of the profiled metal roof was very pronounced. Mineral wool appeared to have been used to seal the junctions. The fire exit door leaked badly. The windows on this floor displayed the same leakage characteristics as those on the ground floor.

In the warehouse, the top of the east fire door leaked. By contrast, the three roller shutter doors were quite good, although there was a little air leakage along the sections. The other external doors had grommets missing in the frames, providing a path for air leakage. There was also significant leakage detected at the cladding/blockwork interface.

The windows were all manually operated. Some had catchplates missing, and could not be tightly closed onto the draughtproofing.

Brian Webb is a senior scientist with the Building Performance Assessment Centre at the BRE. This pressure test was carried out as part of the BRE/BSRIA/*Building Services Journal* collaboration on improving building airtightness.

Conclusions

In some of the earlier PROBE investigations reported in *Building Services Journal* – for example that conducted at the Woodhouse Medical Centre[5] – the PROBE Team found that the simpler buildings sometimes performed better than the more complicated ones in terms of delivering both perceived comfort and energy efficiency.

More complicated buildings could easily prove too demanding for their management teams, at the same time as alienating their occupants. This would lead to disappointment in terms of both comfort and performance.

Being open-plan, the Marston Book Services building is technically more demanding and intrinsically more energy consuming than a cellular building such as the Woodhouse Medical Centre. Nevertheless, the designers have tried to make things simple and, in this aim, have largely succeeded. Where problems have arisen, they have largely been confined to controls and usability.

Manual and automatic controls need more careful integration, and it is also important not to deprive end-users of the means of control, particularly where it can get them out of unwanted or uncomfortable situations.

It follows that equipment suppliers, designers and installers all need to devote more attention to providing the required user-friendly interfaces. At present, the industry seems to regard occupant interaction as "meddling", but in truth appropriately designed interfaces can be an effective way of matching system operation to actual end-user needs.

With buildings like Marston Book Services being so close to all-round excellence, perhaps we should be looking more closely at doing the simple things better and improving the familiarity, confidence, understanding and forgiveness of end-users and management – and spend less time searching for new techniques and technologies which do not meet clearly defined needs, and whose properties we have not yet begun to fully understand.

References and acknowledgements

The PROBE Team for Marston Book Services comprised Bill Bordass, Robert Cohen, Adrian Leaman and Mark Standeven.

The PROBE Team extends its thanks to Wayne Ellis, Tony Whymark, Natalie Rawlins and the staff of Marston Book Services. The Team also thanks Ian Laing and Alan Rowe of Milton Park Ltd.

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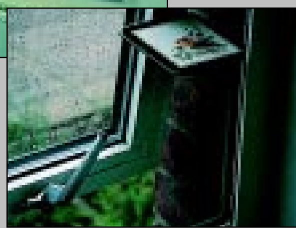
PROBE is a research project conducted by *Building Services Journal* and managed by HGa Consulting Engineers. The PROBE research is co-funded under the Partners in Technology collaborative research programme run by the Department of the Environment, Transport and the Regions (DETR).

Key design lessons

The interactive window system The motorised top window works extremely well, except for some air leakage when closed. Usability problems occurred with the conventional, manually-operated window, whose gear hinge did not provide enough friction. Different manufacturers' offerings of a seemingly generic product are often regarded as interchangeable by designers and window manufacturers, but actually have subtly different design and operational characteristics. The blinds and the light shelves have not been entirely successful.

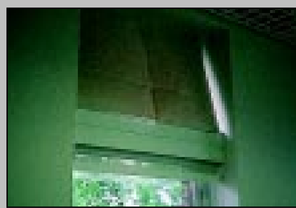
Occupants liked the upper motorised window, but the central window elements close under only a small wind, leading to...



...the use of a coaster as a wedge. Gear hinges need friction to work.

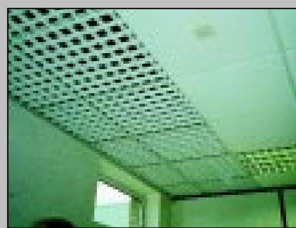
Airtightness was again an issue. The worst leakage detected was at the interface between brickwork and the profiled metal cladding. This occurred particularly at the eaves of the office, but also in the warehouse.

The perforated ceiling on the ground floor – designed to provide access of room air to the thermal capacity of the floor slab – also carries flanking noise between adjacent rooms.



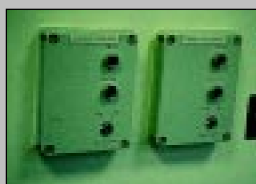
A makeshift anti-glare control for some of the west-facing windows.

Good occupant control in the form of push-buttons for the motorised windows enables occupants who arrive early to 'air' the building before everybody else arrives. This is beneficial, as building security prevents night cooling, except by infiltration. However, peak temperatures are probably higher than the designers anticipated. Occupants at Marston Book Services were less happy with the lighting controls, which had insufficient override facilities.



The perforated ceiling has caused some cross-talk problems.

Office heating energy consumption is relatively high. This is due to the 'tail-wagging-the-dog' operation of the toilet ventilation system, added to the relative difficulty which the system has in trying to determe whether or not space heating is actually needed.



Top marks for the good window controls...

...but thumbs down for placing the summer/winter switch at the end of a plantroom obstacle course.

The summer/winter switch is not located in the reception area, but instead forms part of the compensator units located in the plantroom control panel. While not unfriendly to use, it is nevertheless very inconvenient to reach.